BSR-IICRC S500
Draft Standard for Professional Water Damage Restoration

Fourth Edition
Second Round Public Review Draft Standard

Institute of Inspection, Cleaning and Restoration Certification
2715 East Mill Plain Blvd.
Vancouver, WA 98661 USA
(360) 693-5675 • www.iicrc.org

Disclaimer

This Standard and Reference Guide (S500) is intended to provide information about the restoration of water-damaged structures and contents and to assist individuals and entities working in the water damage restoration industry in establishing and maintaining their professional competence. Users of this document must keep abreast of the rapid developments in the field of water damage restoration, implement changes in technology and procedures as appropriate, and follow applicable federal, state, provincial and local laws and regulations. Restorers should use their professional judgment throughout each and every project. However, the use of professional judgment is not a license to not comply with this Standard. On occasion, a project might have unique circumstances that may infrequently allow for a deviation from the standard. Furthermore, this Standard and Reference Guide is not intended to be either exhaustive or inclusive of all pertinent requirements, methods or procedures that might be appropriate on a particular water damage restoration project. The information upon which this Standard and Reference Guide is based is subject to change, which may invalidate any or all of the information contained herein.

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Acknowledgments

This publication is the result of a collaborative effort involving industry experts and trade associations, educational institutions, training schools and other organizations. The Institute of Inspection, Cleaning and Restoration Certification (IICRC) is the principle designer of the document. Other organizations contributing to the creation of this document include Society of Cleaning and Restoration Technicians (SCRT), Indoor Environmental Institute (IEI) Indoor Air Quality Association (IAQA) and National Air Duct Cleaners Association (NADCA).

The development and publication of this document was made possible through the generous contributions of a dedicated group of volunteers. The IICRC Board of Directors and the Standards Committee genuinely appreciate the time and effort contributed by these individuals. They exhibit the true volunteer spirit that has been the driving force behind the IICRC since its inception. At the time of approval of this third edition of the S500 Standard and Reference Guide for Professional Water Damage Restoration, the IICRC S500 Water Damage Restoration Consensus Body Standard Committee consisted of the members listed below. Other contributors to this document and their respective roles are also listed below.

IICRC Standards Committee:

IICRC Standards Chairman
Howard Wolf
HW3 Consulting, Inc.

IICRC Restoration Division Vice Chair
Chris Taylor
Aspire Training Group

IICRC S500 Committee Chairman
Mickey Lee
Mickey Lee Consulting, LLC

IICRC S500 Committee Vice Chairman
Chris Taylor
Aspire Training Group

IICRC Standards Director
Mili Washington
IICRC

IICRC Legal Counsel
Charles A. Isley
Christel & Isely, LLP

IICRC S500 CONSENSUS BODY

IICRC S500 Consensus Body Chairman

Mickey Lee
Mickey Lee Consulting, LLC, Cumming, GA

IICRC S500 Consensus Body Vice Chairman

Chris Taylor
Aspire Training Group, Kingman, AZ

Consensus Body Members

Howard Wolf
HW3 Consulting, Richfield, WI

Brandon Burton
Dri-Eaz Products, Inc., Burlington, WA

Larry Carlson
Phoenix Restoration Equipment, Anacortes, WA

James Holland
Restoration Consultants, Sacramento, CA

Ron Reese
REE Construction, Bellevue, ID

Important Definitions

Throughout this document the terms “shall,” should,” and “recommend” are used to compare and contrast the different levels of importance attached to certain practices and procedures.

shall: when the term *shall* is used in this document, it means that the practice or procedure is mandatory due to natural law or regulatory requirement, including occupational, public health and other relevant laws, rules or regulations, and is therefore a component of the accepted “standard of care” to be followed.

should: when the term *should* is used in this document, it means that the practice or procedure is a component of the accepted “standard of care” to be followed, while not mandatory by regulatory requirements.

recommend(ed): when the term *recommend(ed)* is used in this document, it means that the practice or procedure is advised or suggested, but is not a component of the accepted “standard of care” to be followed.

In addition, the terms “may” and “can” are also available to describe referenced practices or procedures, and are defined as follows:

may: when the term *may* is used in this document, it signifies permission expressed by the document, and means that a referenced practice or procedure is permissible within the limits of this document, but is not a component of the accepted “standard of care” to be followed.

can: when the term *can* is used in this document, it signifies an ability or possibility open to a user of the document, and it means that a referenced practice or procedure is possible or capable of application, but is not a component of the accepted “standard of care” to be followed

For the practical purposes of this document, it was deemed appropriate to highlight and distinguish the critical restoration methods and procedures from the less critical, by characterizing the former as the perceived and recommended “standard of care”. The IICRC S500 consensus body standard committee interprets the “standard of care” to be: practices that are common to reasonably prudent members of the trade who are recognized in the industry as qualified and competent. Notwithstanding the foregoing, this Standard and Reference Guide is not intended to be either exhaustive or inclusive of all pertinent requirements, methods or procedures that might be appropriate on a particular water damage restoration project. Ultimately, it is the responsibility of the restorer to verify on a case-by-case basis that application of this Standard and Reference Guide is appropriate.

A Scope, Purpose and Application

A.1 Scope

This Standard describes the procedures to be followed and the precautions to be taken when performing water damage restoration in residential, commercial and institutional buildings, and the systems and personal property contents of those structures.

This Standard assumes that the determination and correction of the underlying source or cause of the water intrusion leading to the water damage is the responsibility of the property owner and not the restorer, although the property owner may contract with the restorer or other specialized experts to perform these services.

Water damage restoration consists of the following components for which procedures are described in this Standard:

- Principles of Water Damage Restoration
- Microbiology of Water Damage
- Health Effects from Exposure to Microbial Contamination in Water Damaged Buildings
- Building and Material Science
- Psychrometry and Drying Technology
- Equipment, Instruments, and Tools
- Antimicrobial Biocide Technology
- Safety and Health
- Administrative Procedures, Project Documentation and Risk Management
- Inspections, Preliminary Determinations and Pre-Restoration Evaluations
- Limitations, Complications, Complexities and Conflicts
- Specialized Experts
- Structural Restoration
- Heating, Ventilating and Air Conditioning (HVAC) Restoration
- Contents Evaluation, Restoration and Remediation
- Large or Catastrophic Restoration Projects
- Materials and Assemblies

A.2 Purpose

It is the purpose of this Standard to define criteria and methodology to be used by the restorer for inspecting and investigating water damage and associated contamination, and for establishing water damage restoration work plans and procedures.

Restorers should use their professional judgment throughout each and every project. However, the use of professional judgment is not a license to not comply with this standard. On occasion a project might have unique circumstances that may infrequently allow for a deviation from the standard. When a restorer decides to deviate from the standard of care (i.e., “shall” or “should”) they should document the circumstances that led to such a decision and have the materially interested parties agree in writing to the deviation.

Among other things, this Standard does not specifically address the protocols and procedures for restoration when potentially hazardous, regulated materials are present or likely to be present in water damaged structures, systems and contents. Such potentially hazardous, regulated materials include, but are not limited to: asbestos, lead, arsenic, mercury, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, radiological residues, and other chemical and biological contaminants.

A.3 Application

This Standard was written for use by those involved in the water damage restoration industry, primarily for restoration companies and workers, and secondarily, for others who investigate or assess abnormal water intrusion, prepare restoration specifications and procedures and protocols, and manage restoration projects, (e.g., indoor environmental professionals (IEPs), and other specialized experts) and finally, for other potential materially interested parties (e.g., consumers and occupants, property owners and managers, insurance company representatives, government and regulatory bodies).

B. Definitions

Certain terms and definitions associated with water damage restoration exist. The following are definitions of terms used in this standard:

affected area - An area of a structure that has been impacted by primary or secondary damage.

airflow – The controlled or managed movement of air. Two commonly used airflow measurements are volumetric flow (e.g., cubic feet per minute) and velocity (e.g., feet per minute).

Category of Water - The categories of water, as defined by this document, refer to the range of potential contamination in water, considering both its originating source and quality after it contacts materials present on the job site. Time and temperature can accelerate or retard the amplification of contaminants, thereby affecting its category. Restorers should consider potential contamination, defined as the presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment; and can produce adverse health effects, cause damage to structure and contents and/or adversely affect the operation or function of building systems.

Category 1 - Category 1 water originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. Examples of Category 1 water sources can include, but are not limited to: broken water supply lines; tub or sink overflows with no contaminants; appliance malfunctions involving water-supply lines; melting ice or snow; falling rainwater; broken toilet tanks, and toilet bowls that do not contain contaminants or additives.

Category 1 water can deteriorate to Category 2 or 3. Category 1 water that flows into an uncontaminated building does not constitute an immediate change in the category. However, Category 1 water that flows into a contaminated building can constitute an immediate change in the category. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water. Odors can indicate that Category 1 water has deteriorated.

Category 2 - Category 2 water contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Category 2 water can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). Examples of category 2 water can include, but are not limited to: discharge from dishwashers or washing machines; overflows from washing machines; overflows from toilet bowls on the room side of the trap with some urine but no feces; seepage due to hydrostatic pressure; broken aquariums and punctured water beds.

Category 2 water can deteriorate to Category 3. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water.

Category 3 - Category 3 water is grossly contaminated and can contain pathogenic, toxigenic or other harmful agents. Examples of Category 3 water can include, but are not limited to: sewage; toilet backflows that originate from beyond the toilet trap regardless of visible content or color; all forms of flooding from seawater; rising water from rivers or streams; and other contaminated water entering or affecting the indoor environment, such as wind-driven rain from hurricanes, tropical storms, or other weather-related events if they carry contaminants (e.g., silt, organic matter, pesticides, or toxic organic substances)

Regulated, Hazardous Materials, and Mold - If a regulated or hazardous material is part of a water damage restoration project, then a specialized expert may be necessary to assist in damage assessment. Restorers shall comply with applicable federal, state, provincial and local laws and regulations. Regulated materials posing potential or recognized health risks can include, but are not limited to: arsenic, mercury, lead, asbestos, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, caustic chemicals and radiological residues. For situations involving visible or suspected mold, refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. The presence of any of these substances does not constitute a change in category; but regulated materials shall be properly abated by qualified abatement contractors and mold should be remediated by qualified mold remediators.

Class of water intrusion - a classification of the estimated evaporation load and is used when calculating the initial humidity control (e.g., dehumidification, ventilation). It is based on the approximate amount of wet surface area and the permeance and porosity of the affected materials. Initial information to determine Class should be gathered during the inspection process. The Classes are divided into four separate descriptions, Class 1, 2, 3, and 4.

Class 1 - (least amount of water absorption and evaporation load): Water intrusion where semi-porous materials (e.g., unfinished wood, concrete, brick, OSB) have absorbed minimal moisture; ~5% or less of the combined floor, wall and ceiling surface area in the space is wet, porous material (e.g., carpet, gypsum board, fiber-fill insulation, CMU, textiles)

Class 2 - (significant amount of water absorption and evaporation load): Water intrusion where wet, porous materials involving more than ~5% to ~40% of the combined floor, wall and ceiling surface area in the space.

Class 3 - (greatest amount of water absorption and evaporation load): Water intrusion where wet, ~~highly~~ porous materials involving ~40% or more of the combined floor, wall and ceiling surface area in the space.

Class 4 - (deeply held or bound water): a water intrusion that involves a significant amount of water and absorption into porous and semi-porous materials ~~(e.g., plaster, hardwood, concrete, masonry)~~ or assemblies (e.g., gym floors, structural cavities) that have a low rate of evaporation due to deeply held or bound water. Drying may require special methods, longer drying times, or substantial water vapor pressure differentials.

cleaning - The process of locating, identifying, containing, removing and properly disposing of unwanted substances from an environment or material consistent with this Standard.

contamination - The presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment, and can produce adverse health effects, cause damage to structure and contents and/or adversely affect the operation or function of building systems.

cross-contamination - The spread of contaminants from an affected area to an unaffected area.

damage, primary - The wetting or impairment of the appearance or function of a material from direct exposure to water or contamination carried by the water which is reversible or permanent.

damage, secondary - The wetting or impairment of the appearance or function of a material from indirect or prolonged exposure to water or contamination carried by the water which is reversible or permanent. Examples of secondary damage can include: migrating or absorbed moisture or humidity, microbial growth, acid residue discoloration. See "primary damage"

damage, pre-existing – The wetting or impairment of the appearance or function of a material from direct or indirect exposure to water or other conditions not related to the current water intrusion. Examples of pre-existing damage can include: dry rot, chronic water leaks, urine contamination, visible mold growth.

dehumidification - The process of removing moisture from air.

dew point temperature - The temperature at which humidity in a parcel of air reaches the saturation point (100% RH), below which water vapor can condense from that air to form condensation on surfaces or particles.

drying – The process of removing moisture from materials.

dry standard - A reasonable approximation of the moisture level of a material prior to a water intrusion. An acceptable method is to determine the moisture levels of similar materials in unaffected areas.

drying environment - a controlled environment in which evaporation from damp or wet materials is encouraged, leading to an accelerated reduction in their moisture content.

drying goal - The target moisture content or moisture level in a material to be achieved at the end of the drying process that is based on the dry standard and is established by the restorer.

engineering controls - Utilization of equipment or physical barriers to prevent or significantly minimize exposure of workers, occupants, and unaffected areas and contents to recognized hazards (e.g., contaminants, electrical circuits, falling debris).

equilibrium moisture content (EMC) - The moisture content at which a material neither gains nor loses moisture when surrounded by air at a given relative humidity and temperature.

evaporation - the process of changing a liquid to a vapor.

flood (flooded, flooding) - an overflowing of a large amount of water beyond its normal confines impacting an area that would normally be dry.

humidity - An expression of water vapor in air. Two common measurements used in this document are humidity ratio and relative humidity. Note: In this document, when the term humidity is used without qualification, it will refer to the humidity ratio of the air, one of the absolute measures of the amount of moisture present.

Humidity ratio (HR) (alternatively, vapor content or mixing ratio) - the humidity ratio of a given moist air sample is defined as the ratio of the mass of water vapor to the mass of dry air in the sample. It is expressed in grains per pound (grams per kilogram) of dry air, sometimes shortened to gr/lb or gpp (g/kg).

$$HR = Weight_{water\ vapor} / (Weight_{moist\ air} – Weight_{water\ vapor}) \text{ or } Weight_{water\ vapor} / Weight_{dry\ air}$$

Note: In this document, when the term humidity is used without qualification, it will refer to the humidity ratio of the air, one of the absolute measures of the amount of moisture present.

indoor environmental professional (IEP) - an individual with the education, training and experience to perform an assessment of the microbial ecology of structure, systems and contents at a job site, create a sampling strategy, sample the indoor environment and submit to an appropriate laboratory, interpret laboratory data and determine Category of water or Condition 1, 2, and 3 for the purpose of establishing a scope of work and verifying the return to a normal microbial ecology (e.g., Condition 1).

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materially interested parties - An individual or entity substantially and directly affected by the water damage restoration project.

microorganism (microbe) - An extremely small organism that usually is visible only with the aid of a microscope (e.g., protozoa, algae, bacteria, fungi, virus).

moisture content – The amount of water contained in a material, expressed as a percentage of the weight of the ovendry material. If a restorer is measuring materials with an instrument that is calibrated for that material, then it is recommended that the term moisture content be used.

moisture level – The measurement of the amount of moisture contained in a material on a relative scale. If a restorer is measuring materials with an instrument that is not calibrated for that material, then it is recommended that the term moisture level be used.

moisture meter - A device used to measure the moisture content or level present in a building material.

project – An organized undertaking designed to return structure, systems and/or contents to an acceptable state or condition that is comparable to that which existed prior to a water intrusion event.

psychrometry - A sub-science of physics relating to the measurement or determination of the thermodynamic properties of air/water mixtures (e.g., humidity and temperature).

relative humidity (RH) - The amount of moisture contained in a sample of air as compared to the maximum amount the sample could contain at that temperature. This definition is accurate in concept; but strictly speaking, relative humidity is the ratio of the partial pressure of water vapor in a sample of air to the water vapor pressure at saturation of that air, at a given temperature and barometric pressure.

remediate/remediation – To remove microbial contamination consistent with IICRC standards.

remediator – The remediation firm or contractor, or authorized representative, who is responsible for the remediation of damaged structures, systems and/or contents.

restorative drying - The controlled removal of excess moisture from an indoor environment and affected materials; thereby, bringing a structure and its components, systems and contents to a pre-determined drying goal. See “drying”

restore/restoration - To return to a normal, former or pre-damage state consistent with this standard.

restorer – The restoration firm or contractor, or authorized representative, who is responsible for the restoration of damaged structures, systems and/or contents.

scope of work – The itemization of services to be performed on a restoration project.

standard of care - practices that are common to reasonably prudent members of the trade who are recognized in the industry as qualified and competent.

thermo-hygrometer – A device that measures, at a minimum, temperature and relative humidity of the air. Some models also calculate other psychrometric properties such as humidity ratio, water vapor pressure, and dew point.

Water Vapor pressure (WVP) – water vapor pressure is the pressure exerted by the molecules of a vapor on surrounding surfaces, usually expressed in inches of mercury (”Hg) or millimeters of mercury. Atmospheric pressure is the total pressure exerted by all gas components in the air (e.g., nitrogen, oxygen, argon, carbon dioxide, water vapor). Water vapor pressure (WVP) is only one component of the total atmospheric pressure. Since water vapor is the primary vapor of interest in the restoration industry, the term water vapor pressure (WVP) is often shortened to vapor pressure (VP). Unless noted when "vapor pressure (VP)" is used without qualification, it refers to water vapor pressure.

Vapor diffusion - Vapor diffusion is the movement of moisture in the vapor state through a material. Vapor diffusion is a function of the vapor permeability of a material and the driving force or water vapor pressure differential acting across the material.

Work Plan – The planning and management documentation that describes the implementation of a scope of work.

BSR-IICRC S500 Standard Section

1 Principles of Water Damage Restoration

1.1 Introduction

A "principle" is defined as: "A basic comprehension, or fundamental doctrine or assumption that is accepted as true and that can be used as a basis for reasoning, process, or conduct." There are five general principles used in the restoration of water damaged structures and materials. Applying these principles may require a multi-disciplinary approach involving professionals from several fields of expertise. For any of these principles to be applied effectively, timely response to the water intrusion is a necessity.

1.2 Principles of Water Damage Restoration

1.2.1 Provide for the Safety and Health of Workers and Occupants

Appropriate safety procedures and personal protective equipment (PPE) shall be used to protect restorers. Reasonable effort should be made to inform building occupants of, and protect them from the identified health and safety issues.

1.2.2 Document and Inspect the Project

Throughout the project, the restorer should establish, implement, and consistently follow methods and procedures for documenting all relevant information.

Detailed inspections should be conducted to identify the Category of water, the Class of water or extent of wetting, the types and quantities of affected materials, and apparent and potential damage. The information obtained should then be used to develop a preliminary determination, pre-restoration evaluation, scope of work and procedures. Methods used in the inspection, the data acquired, and decisions reached as a result should be documented.

1.2.2.1 Initial Inspection

Upon entering a building, professional moisture detection equipment should be used to evaluate and document the psychrometric conditions inside and outside the building and the moisture content or levels of materials in affected and unaffected areas.

Restorers should inspect and document the source and time of the water intrusion, visible material deterioration, pre-existing damage and visible microbial growth. Professional moisture detection equipment should be used to inspect and document the extent of water migration and moisture intrusion into building materials and contents.

Restorers should establish drying goals for affected building materials and contents near the beginning of the restoration process, and it is recommended, if possible, that agreement with materially interested parties to the appropriateness of these goals be reached and documented.

1.2.2.2 Ongoing Inspection(s)

Restorers should record, calculate and document moisture measurements required to adequately monitor the drying process. Restorers should record and monitor relevant moisture measurements daily, preferably at the same time of day, until drying goals are achieved. When benchmarks are not being met towards an acceptable drying goal, the restorer should further investigate to identify the cause and take corrective action.

1.2.2.3 Final Inspection (Completion)

Drying equipment should remain in operation until drying goals have been met. It is recommended that materially interested parties be provided access to documentation on the restoration process.

1.2.3 Mitigate Further Damage

Restorers should attempt to control the spread of contaminants and moisture to minimize further damage from occurring to the structure, systems, and contents. When contaminants are present restorers should remediate first, and then dry the structure, systems, and contents.

1.2.3.1 Control Moisture Intrusion

Moisture problems should be identified, located, and corrected or controlled as soon as possible. Unless otherwise agreed by responsible parties, it is the responsibility of the property owner, not the restorer, to correct the source of the water intrusion, or to engage appropriate specialized experts to do so.

1.2.3.2 Control the Spread of Contaminants

Contamination should be contained as close to its source as possible.

1.2.4 Clean and Dry Affected Areas

Restorers should clean and dry water damaged buildings, systems and contents.

1.2.4.1 Cleaning

Cleaning is the process of locating, identifying, containing, removing and properly disposing of unwanted substances from an environment or material consistent with this Standard. Restorers should evaluate and clean materials within the work area as needed.

1.2.4.2 Drying

Drying is the process of removing excess moisture from materials and involves the application of psychrometry and drying principles. Restorers should understand the science of drying and implement the principles of drying during a restoration project.

1.2.4.2.1 Enhancing Evaporation

Evaporation is the process of changing a liquid to a vapor. Once bulk water has been removed, evaporating the remaining water in materials should be promoted.

1.2.4.2.2 Dehumidifying and Ventilating

In order to avoid secondary damage and not retard the drying process, excess moisture evaporating into the air should be exchanged with less humid air or it should be removed from the air through dehumidification.

1.2.4.2.3 Controlling Temperature

Restorers should manage ambient and surface temperatures in the drying environment dependent upon the drying system employed.

1.2.5 Complete the Restoration and Repairs

After cleaning and drying has been accomplished, restorers should re-evaluate the scope of work to complete the restoration project. Qualified and properly licensed persons should perform authorized and necessary repairs.

2 Microbiology of Water Damage

Indoor and outdoor environments naturally harbor a great variety of microscopic life forms termed microorganisms or microbes. After a water intrusion event, the normal indoor ecology begins to rapidly shift as microorganisms and microbes grow quickly. Restorers should have a basic understanding of the normal and shifting ecologies of water damage events.

3 Health Effects from Exposure to Microbial Contamination in Water Damaged Buildings

Microbial contamination associated with water damage in indoor environments is a public health problem. It presents a health risk to both occupants and restoration workers, potentially resulting in a variety of illnesses of an inflammatory, allergic, infectious, and toxic nature. In light of both the recognized and potential health effects associated with microbial contamination in water-damaged indoor environments, restoration professionals should take appropriate measures to protect building occupants, and maximally reduce exposure risks to their workers through training, immunization, and the use of personal protective equipment (PPE).

4 Building and Material Science

The success of a restorer's efforts is impacted by the principles of building science. The impact of a water intrusion can affect the health and safety of occupants, and the functionality of a building. Restorers should understand building systems, assemblies and related physical laws in order to restore a damaged building to its intended function and useful life.

5 Psychrometry and Drying Technology

In returning a building to an acceptable condition after a water intrusion, restorers should manage the environment within the building and the moisture in the structural materials and contents. To accomplish this, restorers should understand how to (1) manage the psychrometric properties of the environment, (2) effect moisture movement through different materials and (3) promote surface evaporation from the materials.

6 Equipment, Instruments and Tools

Equipment, instruments, tools and their use shall conform to safety and inspection requirements of local, state, provincial or federal laws and regulations. Restorers should follow the safety guidelines and operation and maintenance instructions provided by the manufacturer where applicable.

7 Antimicrobial Biocide Technology

7.1 Antimicrobial Biocide Use in Water Damage Projects

In addition to having general knowledge of potential microorganisms present in a water damage restoration project, restorers should have an understanding of the proper use of agents that can help control the growth of these microorganisms and reduce potential risks associated with some of their metabolic by-products (e.g., endotoxins, mycotoxins). It is important to recognize that not all water intrusions warrant the use of antimicrobial biocides. Thus, it is important for restorers to evaluate whether antimicrobial biocide application is appropriate. When there is a Category 1 water intrusion that has not changed in Category (e.g., delayed response, pre-existing condition), the use of antimicrobial biocides is generally not warranted.

There are several steps in the restoration process that restorers should perform or facilitate, which can return the structure to a sanitary condition without using antimicrobial biocides. These steps should include: stopping the source of moisture intrusion, removing un-restorable contaminated materials, followed by remediation, drying, and final cleaning of affected materials, systems, and contents.

Many antimicrobial biocides are deactivated by organic matter in water or on surfaces; therefore, pre-cleaning is an essential first step. In all cases, antimicrobial biocides shall be applied following directions. In determining antimicrobial biocide use, restorers should weigh the benefits of using biocides against the risks associated with their use, and any client concerns or preferences.

7.2 Risk Management

In the United States, as part of a restoration company's risk management program, restorers who use antimicrobial biocides shall receive training in the safe and effective use. This may be the law in other countries. Restorers should determine the legal requirements for commercial use of such products in their respective jurisdictions, and shall comply with applicable laws and regulations governing such products and their use.

7.3 Application Methods

Restorers shall apply only federal/state government-registered or authorized antimicrobial biocides, and shall use them according to label directions. Do not mix or combine these products with other chemicals unless label directions explicitly allow it. Dedicated application equipment should be used. Any specified personal protective equipment shall be used.

Remediation procedures rely on thorough cleaning and source removal first, and then, if appropriate, the application of antimicrobial biocides. With Category 2 water on carpet, thorough cleaning should be completed before applying antimicrobial biocides. Antimicrobial biocides should not be poured into standing water. In order to be effective, they shall be used in sufficient quantity, contact time, and applied according to label directions. The effectiveness can vary depending on porosity of materials, the evaporation rate, and bioburden.

8 Safety and Health

8.1 Worker Safety and Health

The regulations referred to in this Standard and Reference Guide are based on US laws and regulations, but it is understood that other countries generally have comparable health and safety requirements. Restorers shall fully understand the laws and regulations related to health and safety for the particular country or locale in which they work. Although there are few specific federal, state, provincial and local laws and regulations directly related to water damage restoration and microbial remediation, there are safety and health regulations applicable to businesses that perform such work. Federal safety and health regulations in the United States that can impact the employees of a restoration business include, but are not limited to, the following Occupational Safety and Health Act (OSHA) Standards found in Title 29 of the Code of Federal Regulations (CFR) parts 1910 and 1926:

- 29 CFR 1910 – General Industry Standards
- 29 CFR 1926 – Construction Industry Standards

Restoration firms shall comply with applicable sections of both the OSHA General Industry Standards and the Construction Industry Standards. Individual state and local governments may have additional safety and health requirements that are more restrictive than the Federal Occupational Safety and Health Act.

Each state in the United States is required to use Federal OSHA as a minimum statutory requirement. Employers shall comply with these safety and health regulatory requirements. Specific items addressed by these regulations include, but are not limited to, the following:

- Site Safety Survey;
- Emergency Action and Fire Prevention Plans;
- Personal Protective Equipment;
- Respiratory Protection;
- Asbestos;
- Lead-based paint;
- Heat Disorders and Health Effects;
- Bloodborne Pathogens;
- Confined Work Spaces;
- Hazard Communication;
- Lockout/Tagout Procedures and Electrical Safety Orders;
- Fall Protection;
- Noise Exposure; and
- Scaffolds.

Issues directly pertinent to the hazards of occupational exposure in buildings damaged by water are addressed more specifically in Chapter 3, *Health Effects from Exposure to Microbial Contamination in Water Damaged Buildings.*

8.2 OSHA General Duty Clause

The OSHA "General Duty Clause" 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.
- shall comply with occupational safety and health standards promulgated under this Act." See 29 USC 654, §5.

Protection of the safety and health of restorers and building occupants is important on restoration and remediation projects. It is the responsibility of employers to ensure that employees entering and working in water damaged or contaminated work areas, or in designated areas where contaminated contents are cleaned or handled, have received the appropriate training, instruction and personal protective equipment. In the absence of a specific OSHA standard for water damage restoration, it is important to recognize the general principles of exposure prevention as they are conveyed through the "General Duty Clause," as well as to understand the current information available about potential hazards from occupational exposure in water damaged structures, systems and contents. Restoration workers can also encounter lead, asbestos or other hazards as is discussed below. Industry standards have been adopted for recognized hazards by government agencies, such as OSHA and the EPA, as well as ACGIH and industry trade associations.

OSHA regulations are divided into sections that apply to various industries. When performing water damage restoration or remediation services, employees fall under the construction and general industry standards. These regulations address hazards such as scaffolding, electrical safety, confined spaces, falls, and chemical safety including asbestos, lead and chemical exposures, as well as training and education for employees about these hazards. A complete list of federal OSHA regulations can be obtained from http://www.osha.gov/law-regs.html. The OSHA regulations for the General Industry (29 CFR 1910) and Construction Industry (29 CFR 1926) requires that no employee shall work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his or her safety or health. In other words, the employer shall provide a safe workplace, regardless of whether OSHA has considered a particular hazard.

8.3 Emergency Action and Fire Prevention Plans

Emergency action and fire prevention plans (OSHA 29 CFR 1926.35 and 1910.38) are required for all work places, including water damage restoration job sites. Requirements include, but are not limited to:

- communication and alarm systems;
- the location of the nearest hospital and fire station;
- emergency phone numbers (posted);
- shut down, evacuation and rescue procedures (posted);
- escape routes and signage (posted);
- use of less-flammable materials; and
- written program, if the employer has 10 or more employees.

8.4 Personal Protective Equipment (PPE)

29 CFR 1910.132 requires that employers provide their employees with the necessary PPE to reduce the risk of exposure to chemical, physical or biological hazards. Biological hazards that can be encountered when performing water damage restoration work include, but are not limited to, allergenic, toxigenic and/or pathogenic microorganisms. Various types of PPE are available to help prevent exposure.

The following are potential routes of exposure:

- inhalation (respiratory);
- contact with mucous membranes (eyes, nose, mouth);
- ingestion; and
- dermal (contact with skin).

Employers shall provide dermal and respiratory protection for employees entering a containment area where microbial contamination is present and remediation is being performed. Appropriate PPE is used to protect workers from possible inhalation or skin contact with microorganisms and their by-products, as well as chemicals or other substances that may be applied or handled in the course of restoration or remediation work. The selection of PPE depends on the anticipated exposure, types of microbial contamination, activities to be completed and potential hazards of chemicals that may be used in the restoration process. Restorers should consult an IEP or other specialized expert if there is a question regarding PPE selection. PPE can consist of the following:

- respirator;
- eye protection;
- disposable coveralls including hood and booties;
- foot protection;
- hand protection;
- head protection; and
- hearing protection.

8.4.1 Respirator Use and Written Respiratory Protection Plan

Employees shall wear respirators whenever engineering and work practice controls are not adequate to prevent atmospheric contamination at the job site. If microbial remediation work is being performed, and if the restorer determines after the application of the "General Duty Clause" that a hazard exists, then a respirator is required for employees in the contaminated area. OSHA requires that a respiratory protection program be implemented for employees who wear a respirator. Visitors to the work site should be encouraged to wear respiratory protection and other appropriate PPE while in the contaminated work area.

The respiratory protection regulations are found at 29 CFR 1910.134. The respiratory protection program outlines the written program requirements, and shall include but not be limited to:

- selection and use of NIOSH approved respirators;
- medical evaluation;
- respirator fit testing;

- user instruction and training in the use and limitations of the respirator, prior to wearing it;
- designated program administrator; and
- cleaning and maintenance program.

8.4.2 Respirator Types

The types of recommended respiratory protection range from NIOSH-approved N-95 filtering face pieces, to full-face air-purifying respirators (APR) or powered air-purifying respirators (PAPR) equipped with P-100 (HEPA) filters and self-contained breathing apparatus (SCBA). P-100 filters should be used to protect against fungal spores and fragments, bacterial spores, dust and other particles. Organic vapor cartridges protect against Microbial Volatile Organic Compounds (MVOCs), some chemicals used when remediating sewage contamination, and other chemical compounds used in microbiological remediation projects.

When using APRs, air is drawn into the respirator face piece by inhaling through filters or cartridges. When using PAPRs, air is mechanically delivered through the filters or cartridges into the face piece. Different types of cartridges are available to remove chemical contaminants by a process of absorption or adsorption. Filters (e.g., P-100, R-100, N-100, N-95) are for removing particulates. APRs or PAPRs shall not be used in oxygen-deficient atmospheres or in other atmospheres that are immediately dangerous to life or health (IDLH).

8.5 Warning Signs

The need for warning signs should be evaluated during the initial site safety survey as well as throughout the drying project, and as activities and conditions change. Signs shall be posted to identify egress means and exits (29 CFR 1910.37); biological hazards (29 CFR 1910.145(e)(4), (f)(8)); caution (29 CFR 1910.145(c)(2), (d)(4)); and dangers (29 CFR 1910.145(c)(1), (d)(2), (f)(5)) that may exist on the job site. Warning signs that are posted to identify hazards that may exist on the job site should list the following emergency contact information; the company name, company address, 24-hour emergency contact number and name of project supervisor. When warning signs are posted on confined-space projects, they shall be printed with the date they were posted and the approximate date they are expected to be taken down or reassigned. Typical warning signs related to restoration work can include, but are not limited to:

- Do Not Enter – Sewage Damage Remediation in Progress;
- Caution: Slip, Trip and Fall Hazards;
- Caution: Hard Hat Area;
- Work Area Under Negative Air-Pressure; and
- No Unauthorized Entry.

8.6 Mold

Buildings that have been wet for an extended period, or have been chronically wet, can develop mold contamination. If restorers encounter mold growth during the course of the restoration project, water damage restoration activities that may disturb the mold should stop until such time that the area of existing or suspected mold contamination is contained. Further drying and mold remediation in the potentially contaminated area should be performed by trained remediators, following the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. Restorers shall follow applicable federal, state, provincial and local laws and regulations.

8.7 Asbestos

The asbestos safety regulations are found in OSHA Construction Standard 29 CFR 1926.1101 and General Industry Standard 1910.1001. These regulations shall be followed whenever a detectable amount of asbestos is encountered or is presumed to be present and might be disturbed. The restorer shall receive awareness training to ensure potential hazards are known and properly identified. Since its use has never been banned in the United States, asbestos containing materials (ACM) might be found in buildings of any age including newly constructed buildings.

Even if the building owner has a survey for asbestos, the restoration/remediation contractor is still responsible for identifying and controlling asbestos exposure during demolition and removal of materials. If restorers encounter materials containing asbestos or that are presumed to contain asbestos that has been or potentially will be disturbed during the course of work activities, they shall stop activities that can cause the friable material to become aerosolized. A licensed asbestos abatement contractor shall be engaged to perform the asbestos abatement. Many states and local governments require that asbestos inspections be performed by licensed asbestos building inspectors.

8.8 Lead

The lead regulations are found at OSHA Standards 29 CFR 1926.62 and 1910.1025. Lead construction work includes work that involves lead-based paint or other structural materials containing lead (e.g., emergency cleanup, demolition, repair or other work which could disturb lead).

Even if the building owner has a survey for lead, the restorer is still responsible for identifying and controlling lead exposure during demolition and removal of materials in all pre-1978 buildings and some post-1978 industrial applications. Restorers shall be in compliance with USEPA's Renovation, Repair and Painting (RRP) program for lead-based paint and surface coatings as well as any other applicable federal, state, provincial and local laws and regulations.

8.9 Heat Disorders

Work activities involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress. Employees are at risk for heat induced stress particularly when engaged in activities in areas such as attics and crawlspaces, or when wearing PPE.

Outdoor operations conducted in hot weather, such as construction, asbestos removal, and remediation site activities, especially those that require workers to wear semi-permeable or impermeable protective clothing, also present the possibility of heat-related disorders to workers. Heat disorders range from heat rash and dehydration to heat exhaustion and heat stroke. Heat stroke, often characterized by hot, dry skin and sudden loss of consciousness, is a true medical emergency. Seek medical attention immediately. The respiratory protection and other PPE plans of the restoration or remediation contractor shall address prevention, and on-site response to heat disorders. PAPRs can provide additional cooling for restorers in hot environments. For more information on heat-related disorders, see OSHA Technical Manual TED 1-0.15A, Section III, Chapter 4.

8.10 Confined Space Entry

OSHA regulations addressing confined spaces are found in 29 CFR 1910.146 and 29 CFR 1926.21. Further guidance may be obtained from American National Standard ANSI Z117.1-1989, *Safety Requirements for Confined Spaces.* The OSHA and ANSI standards provide minimum safety requirements to be followed while entering, exiting and working in confined spaces at normal atmospheric pressure. A "confined or enclosed space" means any space that:

- is configured so that an employee can enter it;
- has limited means of ingress or egress; and
- is not designed for continuous occupancy.

If it is determined that the workplace is a confined space then the confined space entry program shall include:

- determining if the space meets the definition of a Permit Required Space;
- identifying the confined spaces and hazards in the workplace;
- monitoring of atmospheric conditions in the space;
- instructing workers on the proper use of the safety equipment;

- defining the duties of the confined space entry team; and
- developing training requirements for employees who enter the confined space.

Permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

- contains or has a potential to contain a hazardous atmosphere;
- contains a material that has the potential for engulfing an entrant;
- has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- contains any other recognized serious safety or health hazard.

If it is determined that the confined space is a Permit Required Confined Space, then the confined space shall have a posted permit.

8.11 Hazard Communication

The OSHA Hazard Communication Standard (29 CFR 1910.1200) requires that information concerning chemical hazards (physical or health hazards) be provided to employers by chemical manufacturers and communicated to employees by employers. This is accomplished by means of hazard communication programs, which include a written program, container labeling and other forms of warning, safety data sheets (SDS), and employee training prior to working with hazardous chemicals. Examples of chemicals used during water damage restoration and remediation are the adhesive spray used to make enclosures, detergents and disinfectants (biocides) for cleaning, sealers, and encapsulants.

Restorers working on multi-employer work sites shall:

- inform other employers of hazardous substances;
- inform other employers of means to protect their employees;
- provide access to SDS; and
- inform other employers of the labeling system used.

8.12 Lockout/Tagout (Control of Hazardous Energy)

Employees can be seriously or fatally injured if machinery, utilities or appliances they service or maintain unexpectedly energizes, starts up, or releases stored energy. The OSHA Standard on the Control of Hazardous Energy (Lockout/Tagout), found in 29 CFR 1910.147, delineates steps restorers shall take to prevent accidents associated with hazardous energy. This standard addresses practices and procedures necessary to disable machinery or electrical services, and prevent the release of potentially hazardous energy while maintenance or servicing activities are performed. There are other OSHA standards that apply to energy control and energy release requirements of various types of machinery. Lockout/Tagout shall be performed by a trained and authorized person.

8.13 Safe Work Practices in Contaminated Environments

In addition to the specific safety/health concerns detailed in this Section, a number of basic work practices have been adopted for remediation projects by safety professionals. Restorers should incorporate the following items into restoration and remediation work procedures:

- no eating, drinking, or smoking in any potentially contaminated or designated work area;
- remove protective gear and wash hands before eating, drinking, smoking, or using the bathroom, rest periods and at the end of the work day;
- shower at the end of the work day;
- dispose of contaminated protective clothing with other refuse before exiting the containment;
- do not move used protective clothing from one area to another unless properly contained;
- wear latex, chemical-resistant or vinyl surgical gloves while inside containment areas, designated work areas, or while handling bagged contaminated materials;

- wear a second pair of gloves (rubber, textile or leather work gloves) over surgical gloves to protect against personal injury;
- use the buddy system when working in high heat, remote or isolated work spaces;
- address all cuts, abrasions and first-aid issues promptly, especially when sewage-damaged materials are present;
- discard gloves that are damaged, wash hands with soap and water, and inspect hands for injury; and
- dispose of all used disposable gloves as contaminated material along with contaminated debris.

Restorers shall incorporate the following items into restoration and remediation work procedures:

- tail-gate meetings to discuss the daily work activities, including a review of safety issues;
- wear PPE appropriate to the hazards identified in the work area;
- use protective disposable coveralls with attached or separate shoe covers;
- don protective clothing prior to entering the containment or other designated work areas;
- inspect PPE prior to use;
- repair or replace damaged protective clothing;
- when an injury occurs, the injured worker and co-workers are to take the steps delineated in the company safety program;
- workers are to be instructed as to job specific emergency plans including emergency exits;
- workers are to be informed about the location of the emergency shower and eye wash stations; and
- report injuries to the supervisor as soon as possible.

8.14 Immunizations and Health Affects Awareness

Restorers and remediators should consider reducing the risk of infectious disease to workers by referring them to their primary health care physician (PHCP) for information on available immunizations (e.g., tetanus/diphtheria boosters, Hepatitis A & B). Workers, who are at an increased risk for opportunistic infections, including but not limited to those who are immunocompromised due to HIV infection, neoplasms, chemotherapy, transplantation, steroid therapy, or underlying lung disease, should be advised of the increased risk of disease due to their condition. Such workers are usually precluded from participating in restoration or remediation activities in water-damaged buildings. Employees who have medical conditions that are of concern (e.g., AIDS, HIV seropositivity, pregnancy) should be evaluated by a qualified physician for a recommendation regarding whether performing assigned restoration or remediation activities presents an unacceptable health risk.

8.15 Vehicle Safety

Employers shall comply with applicable federal, state, provincial, and local laws and regulations regarding vehicle safety. Employers should provide instruction to their employees on driver safety. Employees shall comply with applicable federal, state, provincial, and local laws and regulations regarding vehicle operation.

8.16 Ergonomics

Employers shall provide their employees with ergonomically safe tools that will help minimize strain and repetitive motion injuries. Due to the nature of the restorer’s work, they are susceptible to repetitive motion injuries affecting the shoulder, elbow, knees, and back. Employers should take into consideration the set up of the equipment on their trucks and make sure that the tools are placed in easily accessible places that prevent the employee from stretching or straining. In addition, providing ergonomically safe injury prevention tools, such as furniture sliders, reduce the strain on the back and help prevent injury.

8.17 Lifting

Lifting is an action that occurs on every project and one that restorers may take for granted. The movement of items can place a great deal of strain on the back and, when done improperly, can lead to serious injury and lost work time. Employers should train newly hired employees on the proper lifting techniques that will help prevent injury. As part of a back injury prevention program, employers should encourage employees to stretch before, during and after their work shift. Stretching strengthens and warms the muscles used in the lifting process reducing the chances of injury. Limiting the injury risk will keep employees on the job and productive.

8.18 Heat Producing Equipment Cautions

There are potential hazards associated with the use of heat producing equipment (e.g., heaters, dehumidifiers). Restorers should consider the impact of high temperatures on building components and contents. Manufacturer's instructions and safety precautions shall be followed to reduce the potential for fire hazards and occupant safety issues.

Direct-fired heaters shall not be used unless adequate ventilation is available due to by-products of combustion (i.e., carbon monoxide). If indirect-fired heaters are placed within an occupied area, the combustion stream shall be ducted to the outside. When using equipment producing combustion by-products, restorers should monitor the air space for carbon monoxide.

9 Administrative Procedures, Project Documentation and Risk Management

9.1 Administrative Procedures

It is recommended that restorers establish, implement and consistently follow methods and procedures for project administration, including but not limited to, business systems and operational plans and protocols. Competent project administration promotes the delivery of high-quality water damage restoration services and increases the likelihood of having satisfied clients. Water damage restoration project administration typically includes, but is not necessarily limited to:

- use of written contracts;
- good communication with all involved parties;
- thorough project documentation, monitoring and recordkeeping;
- appropriate methods to manage risk;
- ability to understand and coordinate multiple tasks, disciplines and materially interested parties; and
- professional and ethical attitude and business orientation.

9.1.1 Work Authorizations

Restorers should receive proper written work authorization before performing any services on a water damage project. A work authorization is a form that when properly executed, allows an individual or company to work on the premises or property of another, under the terms of the contract or owners insurance policy. The work authorization may be included as a part of the contract and should be signed by the property owner or their authorized agent.

9.1.2 Contracts

Restorers should enter into a written contract before starting a water damage restoration project. What constitutes an adequate written contract in any given situation or jurisdiction is beyond the scope of this Section. However, the restorer should verify that the contract contains all elements necessary to form an enforceable contract under the laws of the applicable jurisdiction. Although projects vary in size and scope and can have unique issues and complications, it is recommended that contracts include, but are not limited to the following:

- the identity and contact information of the client and all materially interested parties;
- a description of the work to be performed, which can include reference to attached project specifications or other documents that specify the details of the work:

- description of and responsibility for repair of collateral and/or consequential damage;
- any known limitations, complexities or potential complications of the project;
- any permits and licensing required for the project;
- the respective duties and responsibilities of the parties;
- the project start date and the time frame for completion of the work;
- the price or method for calculating the price or fees for the work;
- the price or fees for any changes or additions to the work;
- the party responsible for payment and the terms of payment;
- provisions dealing with contract default and termination;
- whether or not an insurance company is involved, and how the project will be handled;
- warranty and disclaimer provisions, if any;
- the completion criteria for the project; and
- provisions relating to changes or additions to the work, including change orders.

When a written contract is executed, it is recommended that each page of the contract be initialed by all parties to the contract. The contract should be dated and signed by the property owner or their authorized agent, and each party should be given a copy of the contract as soon as reasonably practical. Restorers should seek legal counsel for the development of a contract, including appropriate terms and conditions, or when circumstances or situations dictate the need for contract modifications, addendums or project-specific legal advice.

By documenting the understanding of the parties at the beginning of a project, written contracts reduce the possibility of dispute, disagreement or conflict during performance of the scope of work. It is recommended that contract documents be accurate and complete, free of ambiguity, and contain adequate disclaimers, reservations or recommendations when project uncertainties, limitations, complexities or complications exist, or are indicated.

Many contractual disputes develop when contract additions or modifications are made during performance of the work, but are not adequately documented. Verbal change orders may create future misunderstanding or disagreement resulting in legal disputes and litigation. Substantive or material deviations from the original, agreed-upon contract or scope of work should be documented in a written and detailed change order, which includes a description of the changes to the work, time for performance, price/fees, and method of payment. Further, it is recommended that the client or the client's designated agent, and the restorer's representative accept the change order in writing.

Specific information, including the source, cause and extent of the damage, is necessary to adequately define the scope of work and develop a work plan for a water damage restoration project; refer to Chapter 10, *Inspections, Preliminary Determination and Pre-Restoration Evaluations.* Restorers should ascertain whether or not the moisture problem at issue has been identified, controlled or repaired, and if not, to identify the process and party responsible for doing so. The resolution may be delegated to a specialized expert as dictated by the situation. Unless otherwise agreed by responsible parties, it is the responsibility of the property owner, not the restorer, to correct the source of the water intrusion. Restorer should attempt to obtain information for the development of a comprehensive scope and other pertinent project documentation before the water damage restoration project begins.

9.1.3 Communication

Communication between materially interested parties is important on any water damage restoration project. It is recommended that materially interested parties agree on the purpose and subjects of project communication, the frequency and mode of communication, and the contacts with whom communications will be distributed. It is recommended that significant items that could potentially affect the job be discussed verbally and then reduced to writing and distributed to appropriate materially interested parties.

Communication often includes education, recommendations and advisories. Clients and occupants with health concerns or medical questions should be instructed to seek advice from qualified medical professionals or public health authorities. Clients or occupants might ask the restorer whether the building can be occupied during restoration. Since the safety and health of occupants is a priority in a water damage restoration project, potential hazards may necessitate occupant evacuation. There are also times when project operations or containment make continued occupation of the structure problematic or impossible. In some instances, it may be appropriate for the restorer to provide clients or occupants with information used in making a decision to evacuate. When providing such information, restorers should inform clients and occupants that any such information provided is not to be construed as medical or health diagnosis, directive or advice. It is recommended that restorers not give advice, education, recommendations or advisories on subjects outside their area of expertise.

9.2 Project Documentation And Recordkeeping

Thorough project documentation and recordkeeping are important while developing the scope of work and the execution and completion of the restoration work plan, especially if there is a need to review or reconstruct the restoration process or project at some time after completion. To properly develop and document the water damage restoration project, it is recommended that restorers attempt to obtain pertinent project information developed before, during and after the involvement of the restorer in the project. It is also recommended that the restorer document important communications to reduce the possibility of miscommunication. The extent of project documentation and recordkeeping varies with each restoration project.

9.2.1 Time Keeping Documentation

Restorers should record the time of employees involved in the project. Projects can be invoiced on a measured-estimate or bid basis, a time-and-material basis, or a cost-plus-overhead and profit basis. Individual timesheets, either written or electronic, might be required for billing purposes. Individual time records can include, but are not be limited to:

- worker name;
- date of service;
- job title or duties;
- time in for a specific task;
- time out for a specific task;
- brief task description and or a correlating accounting code for the task being performed;
- total time worked;
- validation of time by a supervisor, clerk or record keeper; and
- the signature of the worker.

The specific method of tracking, recording and reporting time records is beyond the scope of this document. It is recommended that water damage restoration contractors consult with qualified legal or accounting professionals on this issue.

9.2.2 Equipment, Material and Supply Usage Documentation

A list of equipment, materials and supplies used on a specific job should be created and maintained. Projects invoiced on a time and material plus overhead and profit basis, or a cost-plus-overhead and profit basis, will require such information.

9.2.3 Project Monitoring Logs

Restorers should maintain organized, written logs for monitoring the progress and effectiveness of the drying process. The specific method for creating and maintaining monitoring logs on a project is beyond the scope of this document. Specific items recorded on a project log can include, but are not limited to:

- the name of the project;
- the dates and times of service;
- the person performing the service;
- the instrumentation used;

- the appropriate psychrometric readings (e.g., temperature, RH) in affected areas; unaffected areas and inlets/outlets of dehumidifiers or HVAC systems, if present;
- moisture level or content measurements of representative materials in the affected and unaffected areas;
- drying goals and standards for the affected materials; and
- location of the moisture level or content readings.

9.2.4 Required Documentation

The documents and records obtained and maintained by the restorer shall include documents required by applicable laws, rules and regulations promulgated by federal, state, provincial and local governmental authorities. This includes appropriate safety and health documentation.

While this is not an exhaustive list, to the extent these documents exist, documents and records should be obtained and maintained by the restorer to include the following:

- the water damage restoration contract and/or the emergency mitigation authorization;
- relevant details of the water intrusion (e.g., source, date of intrusion, date of discovery);
- moisture map;
- psychrometric records;
- moisture level or content records;
- the scope of work and work plan;
- documentation related to project limitations or deviations from compliance with this Standard (e.g., notices, agreements, disclosures, releases, waivers);
- environmental reports made available to the restorer;
- written recommendations or technical specifications from specialized experts, if such documents are made available to the restorer;
- an inventory of contents/personal property that are being removed from the job site, or are in need of restoration or remediation. If contents are removed, the restorer and client should sign and date the inventory, with both parties receiving a copy as soon as practical;
- an inventory of unsalvageable or unsuccessfully restored contents/personal property that will be disposed. Prior to disposal, the restorer and client should sign and date the inventory, with both parties receiving a copy as soon as practical;
- permits and permit applications;
- lien notices and releases;
- change orders;
- estimates, invoices, and bills;
- detailed work or activity logs, including a description of who did what, when, where, how and for what duration, including entry and exit logs, where applicable;
- equipment logs or similar documents that include a description of all equipment, materials, supplies and products used on the project, the quantity and length of time used (where applicable) and other relevant information;
- documentation reflecting client approval for the use of antimicrobial biocides including consumer "Right to Know" information; and
- records of pressure readings in and out of containment erected for the purpose of remediation.

9.2.5 Recommended Documentation

While not an exhaustive list, it is recommended that documents and records obtained and maintained by the restorer include the following:

- administrative information (e.g., clients and materially interested parties contact information and call report records; copies of notices, disclosures, documents and information provided; notes or synopsis of meetings with clients and materially interested parties, which summarize the substance of the meetings and the decisions made and generally document the progression of the project; communication logs; important written communications between and among materially interested parties; decisions to transfer project investigation to a specialized expert or to involve a specialized expert; background and qualification information for subcontractors or trades engaged by the restorer on the project, if any);

- subcontractor contracts, work specifications and change orders for any subcontractors engaged by the restorer on the project;
- insurance and financial information (e.g., identification of the party responsible for payment, payment schedules, and determination of and responsibility for collateral or consequential damage resulting from the restoration project);
- relevant building information (refer to Chapter 10, *Inspection, Preliminary Determination, and Pre-Restoration Evaluations*);
- inspection observations (e.g., diagrams, moisture maps, thermography reports, photography and/or videography of pre-existing conditions, water stains or damage; and areas of visible mold, suspected mold, or efflorescence);
- other relevant project or client observations or perceptions (e.g., odors, condensation, and health complaints);
- an inventory and photographs of contents/personal property either removed from or remaining on the job site; and
- certificate(s) of completion

9.2.6 Documentation of Limitations and Deviations

The client may request or decline water damage restoration services that prevent the restorer from complying with this Standard. When proceeding in such circumstances, there is a heightened risk of future conflict with the client and potential liability to the restorer. If the restorer decides to proceed with the project despite limitations on compliance with industry standards, restorer should adequately document the situation and circumstances, which can include advising the client in writing of the potential consequences of such noncompliance and attempting to obtain a written waiver and release of liability from the client for those potential consequences. However, this might not prevent restorer liability, because of the fact that the job was accepted with knowledge that it could not be completed successfully, or that the results might be questionable.

On occasion a project might have unique circumstances that might infrequently allow for a deviation from the standard. When a restorer decides to deviate from the standard, they should document the circumstances that led to such a decision and have all the materially interested parties agree in writing to the deviation. Restorers should use their professional judgment throughout each and every project. However, the use of professional judgment is not a license to not comply with this standard and its recommendations.

9.2.7 Recordkeeping and Record Retention

The restorer shall maintain restoration project documentation for the time period required by the record retention laws and regulations of applicable jurisdictions, if any. It is also recommended that restoration project documentation be maintained for the longest applicable statute of limitations in the relevant jurisdiction, at a minimum. Many jurisdictions follow the discovery rule, whereby the statute of limitations applicable to a restoration project only begins to run from the date of discovery of the problem, not the date the service was performed. Thus, in some circumstances, it may be appropriate to maintain restoration project documentation indefinitely. It is recommended that the restorer obtain advice from qualified counsel regarding timeframes for documentation retention. The method of recordkeeping and record retention is beyond the scope of this document.

9.2.8 Emergencies

In many circumstances, water damage restoration projects begin on an emergency basis. Emergency situations may impede communications about the project or limit the opportunity to document the project as described in this Section. However, once an emergency situation is resolved, to the extent possible, restorers should complete the appropriate documentation and correct communication deficiencies caused by the emergency.

9.3 Risk Management

"It may be appropriate for restoration businesses to consider development of a formal Risk Management Program, *including a review of insurance coverage both required by law and appropriate to the risk (e.g., General Liability, Contractor's Pollution Liability).* Restorers shall determine and comply with any governmental insurance requirements related to their business operations. The conduct of business as a restoration firm requires consideration of several *[other]* types of insurance coverage, *including*:

- Worker Compensation/Industrial/Employee insurance requirements: restoration firms shall meet legal requirements to provide worker compensation coverage for businesses having employees.
- Automobile insurance requirements: it is recommended, and in many jurisdictions required by law, that restoration firms using vehicles in business obtain commercial automobile liability insurance.

Restorers shall determine and comply with any governmental insurance requirements related to their business operations. It is recommended the restorer to stay abreast of insurance industry developments impacting their business. It is recommended that restorers develop and maintain a relationship with a qualified insurance professional to assist in this regard."

10 Inspections, Preliminary Determination and Pre-Restoration Evaluations

10.1 Introduction

At the start of a restoration project, restorers are often compelled to make initial judgments between taking immediate action to begin quickly removing water and start the drying process, versus the need to accurately identify and control hazards and contaminants. Restorers should conduct the following activities at the beginning of the project:

- information gathering;
- initial response;
- safety and health issue resolution;
- pre-restoration inspection;
- arriving at the preliminary determination;
- pre-restoration evaluations; and
- work planning

The ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration* has been written to provide methods and procedures for restorers to safely restore property damaged from water intrusion. The processes in a project do not always follow a linear progression and may occur in varying orders; even simultaneously. The order of the processes presented in this Section is by no means a mandatory order, although there are steps that should occur early in the initial response. Each project can present a unique set of circumstances that should be considered when establishing the order of the procedures discussed in this Section.

10.2 Qualifications

Restorers are expected to be qualified by education, training, and experience to appropriately execute the skills and expertise required to safely perform restoration of structure and contents. Restorers shall only perform services they are licensed, certified or registered to provide when required by local, state, provincial or federal laws and regulations. If situations arise where there is a need to perform services beyond their expertise, restorers should hire specialized experts or other support services, or recommend to their customer that the appropriate specialized expert be retained, in a timely manner. Restorers should also address occupant questions when the subject is within the scope of their authority and ability.

10.3 Documentation

Throughout the project, the restorer should establish, implement, and consistently follow methods and procedures for documenting all relevant information. This information can affect and provide support for project administration, planning, execution, and cost. In addition, pre-existing conditions (e.g., evidence of wear, use, physical damage, previous water intrusions, staining, odors) should be documented and communicated to materially interested parties. Refer to Chapter 9, *Administrative Procedures, Project Documentation and Risk Management*.

10.4 Definitions

Before beginning the inspection, restorers should have an understanding of the category of water, classes of water, and other factors that influence the appropriate response.

10.4.1 Category of Water

The categories of water, as defined by this document, refer to the range of potential contamination in water, considering both its originating source and its quality after it contacts materials present on the job site. Time and temperature can accelerate or retard the amplification of contaminants, thereby affecting its category. Restorers should consider potential contamination, defined as the presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment; and can produce adverse health effects, cause damage to structure and contents or adversely affect the operation or function of building systems.

Category 1: Category 1 water originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. Examples of Category 1 water sources can include, but are not limited to: broken water supply lines; tub or sink overflows with no contaminants; appliance malfunctions involving water-supply lines; melting ice or snow; falling rainwater; broken toilet tanks, or toilet bowls that do not contain contaminants or additives.

Category 1 water can deteriorate to Category 2 or 3. Category 1 water that flows into an uncontaminated building does not constitute an immediate change in the category. However, Category 1 water that flows into a contaminated building can constitute an immediate change in the category. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water. Odors can indicate that Category 1 water has deteriorated.

Category 2: Category 2 water contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Category 2 water can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). Examples of category 2 water can include, but are not limited to: discharge from dishwashers or washing machines; overflows from washing machines; overflows from toilet bowls on the room side of the trap with urine but no feces; seepage due to hydrostatic pressure; broken aquariums; and punctured water beds.

Category 2 water can deteriorate to Category 3. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water.

Category 3: Category 3 water is grossly contaminated and can contain pathogenic, toxigenic, or other harmful agents. Examples of Category 3 water can include, but are not limited to: sewage; toilet backflows that originate from beyond the toilet trap regardless of visible content or color; all other forms of contaminated water resulting from flooding from seawater; rising water from rivers or streams; and other contaminated water entering or affecting the indoor environment, such as wind-driven rain from hurricanes, tropical storms, or other weather-related events if they carry contaminants (e.g., silt, organic matter, pesticides, or toxic organic substances).

10.4.2 Regulated, Hazardous Materials and Mold

If a regulated or hazardous material is part of a water damage restoration project, then a specialized expert may be necessary to assist in damage assessment. Restorers shall comply with applicable federal, state, provincial and local laws and regulations. Regulated materials posing potential or recognized health risks can include, but are not limited to: arsenic, mercury, lead, asbestos, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, caustic chemicals and radiological residues. For situations involving visible or suspected mold, refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. The presence of any of these substances does not constitute a change in category; but restorers shall abate regulated materials, or should remediate mold prior to drying.

10.4.3 Class of Water Intrusion

Restorers should estimate the amount of humidity control needed to begin the drying process. A component of the humidity control requirement is the Class of water.

The term “Class of water intrusion” is a classification of the estimated evaporation load and is used when calculating the initial humidity control (e.g., dehumidification, ventilation). It is based on the approximate amount of wet surface area the permeance and porosity of the affected materials. Initial information to determine Class should be gathered during the inspection process. The Classes are divided into four separate descriptions, Class 1, 2, 3, and 4.

Class 1 - (least amount of water absorption and evaporation load): Water intrusion where low porosity materials (e.g., hard surface flooring) or medium porosity materials (e.g., structural framing, wood substrates) have absorbed minimal moisture; ~5% or less of the combined floor, wall and ceiling surface area in the space is wet, highly porous material (e.g., carpet, gypsum wall board).

Class 2 - (significant amount of water absorption and evaporation load): Water intrusion where wet, highly porous materials (e.g., carpet, gypsum wall board) involving more than ~5% to ~40% of the combined floor, wall and ceiling surface area in the space.

Class 3 - (greatest amount of water absorption and evaporation load): Water intrusion where wet, highly porous materials (e.g., carpet, gypsum wall board) involving ~40% or more of the combined floor, wall and ceiling surface area in the space.

Class 4 - (deeply held or bound water): a water intrusion that involves a significant amount of water and absorption into porous materials (e.g., plaster, hardwood, concrete, masonry) or assemblies (e.g., gym floors, structural cavities) that have a low rate of evaporation due to deeply held or bound water. Drying may require special methods, longer drying times, or substantial water vapor pressure differentials.

10.4.4 Other Factors Necessary to Estimate Drying Capacity

Other factors can impact the drying environment. Restorers should understand and consider these factors when estimating the drying capacity needed to prevent additional damages and begin the drying process. These factors include:

- influence of heating, ventilating, and air conditioning (HVAC) systems;
- build-out density of the affected area;
- building construction complexity; and

- influence of outdoor weather.

10.5 Initial Contact and Information Gathering

The information gathering process begins with the initial contact between the restorer and the property owner or authorized agent. In addition to administrative information found in Chapter 9 *Administrative Procedures, Project Documentation, and Risk Management*, the restorer should gather information to allow for an effective mobilization and response. Inaccurate or incomplete information can impact the ability for the restorer to take appropriate measures during the initial response. This information can include, but is not limited to:

- structure type and use;
- source, date and time of water intrusion;
- status of water source control;
- general size of affected areas (e.g., number of rooms, floors);
- suspect or known contaminants;
- history of building usage;
- history of previous water damage;
- types of materials affected (e.g., flooring, walls, framing);
- age of structure;
- changes in structure design; and
- number of occupants.

The restorer can make assumptions using the information above to mobilize a proper response. Once the restorer arrives at the worksite and performs an initial inspection these assumptions can change. The information gathered helps to establish a moisture inspection strategy and evaluate the existence of moisture problems that have caused or can lead to structural, system or content damage or contamination. Contaminants (e.g., fungal or bacterial) can be visible or hidden. Where mold growth is discovered or is suspected refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation.*

10.6 Initial Response, Inspection and Preliminary Determination

During the initial response, the information gathering process should continue with a site walkthrough and customer and occupant interviews. At a minimum, the restorer should conduct the following activities during the initial response:

- conduct a site specific safety survey;
- identify customer priorities and concerns;
- verify the source of water intrusion;
- identify the extent of the water migration;
- arrive at a preliminary determination;
- identify pre-existing damage;
- identify immediate secondary damage concerns; and
- establish drying standards and drying goals.

10.6.1 Safety and Health Hazards

Safety and health hazards shall be documented. As hazards are identified, appropriate actions shall be implemented to resolve the hazard, or minimize the potential for injury or other safety risks. Actions may include the involvement of a specialized expert. Refer to Chapter 8, *Safety and Health.*

10.6.2 Identify Priorities and Concerns

During the initial inspection, restorers should consider the priorities and concerns of the materially interested parties. The type of structure, contents affected, building use, occupancy, and the impact associated with the loss-of-use can significantly influence priorities and concerns. Refer to Chapter 11, *Limitations, Complexities, Complications and Conflicts*.

10.6.3 Extent of Water Migration

Restorers should evaluate and document the extent of water migration in structure, systems and contents, using the appropriate moisture detection equipment which can include, but is not limited to:

- moisture sensors;
- thermo-hygrometers;
- invasive and non-invasive moisture meters;
- infrared thermometer; and
- thermal imaging devices.

Since water can flow under walls, and come from above, restorers should inspect adjoining rooms even when no water is visible on the surface of floor coverings. The amount of surface area to inspect within a building can make it inefficient to detect moisture using moisture meters alone. Thermal imaging devices can be used to show possible water flow patterns in a building in hard to reach places, increasing the efficiency of documenting affected areas and water migration. Thermal imaging cameras can be useful as they show surface temperature variations commonly associated with moisture, but should always be verified by a moisture meter.

10.6.4 Pre-existing Damage

Throughout the inspection process, restorers should inspect for pre-existing damage issues. Pre-existing damage is the wetting or impairment of the appearance or function of the material from direct or indirect exposure to water or other conditions not related to the current water intrusion. Examples of pre-existing damage can include, but are not limited to: dry rot, chronic water leaks, urine contamination, and visible mold growth. Indications of pre-existing conditions can include, but are not limited to:

- malodors;
- visible evidence of staining and deterioration; and
- evidence of damage unrelated to water (e.g., wear, use, lack of maintenance).

10.6.5 Secondary Damage

Throughout the drying process, restorers should inspect for water related secondary damage issues. Secondary damage is defined as the wetting or impairment of the appearance or function of a material from prolonged indirect exposure to water or indirect exposure to contamination carried by or resulting from the water, which is reversible or permanent. Restorers should inspect for excessive humidity and elevated moisture content in areas adjacent to the affected area.

10.6.6. Dry Standards and Drying Goals

Dry standards are a reasonable approximation of the moisture content or level of materials prior to a water intrusion. An acceptable method to establish a dry standard is to evaluate the moisture content or level of similar materials in unaffected areas. When unaffected materials are not present, the restorer may use a reference from similar structures, experience from similar drying projects, and knowledge of the geographical area. The dry standards are then used by the restorer to establish acceptable drying goals.

Drying goals are a target moisture content or level of materials established by the restorer that are based on the dry standards. Individuals establishing drying goals should have a working knowledge of the instrumentation used and local influences on normal moisture content or level in building materials.

Drying goals may be at, or above the dry standard and should be documented as they relate to specific materials. The restorer should establish drying goals that would be expected to:

- inhibit microbial growth; and
- return materials to an acceptable moisture content or level.

Returning materials to an acceptable moisture content or level can be accomplished by setting a drying goal that returns materials to a close approximation of their dry standard. In the case of solid wood products, the drying goal should be within 4 percentage points of its normal moisture content or dry standard, but in all cases, below the point that would support microbial growth (i.e., less than 16% MC). For other materials, it is recommended the drying goal be within 10% of the dry standard. To illustrate this, if the measured dry standard is 20 points, then the drying goal would be determined as 22 points.

10.6.7 Preliminary Determination

The "preliminary determination" is the determination of the Category of water. If the preliminary determination is that the water is Category 1, then the restorer can proceed without contamination controls (e.g., erecting containment barriers, initial cleaning, establishing pressure differentials) and worker protection. With regard to Category 2 or 3 water intrusions, remediation should occur prior to drying. Restorers should use contamination controls and appropriate worker protection. Where necessary, an indoor environmental professional (IEP) should be used to assess the levels of contamination.

In many cases an assessment by an IEP on a water damage restoration project is not necessary. However, if the inspection shows that one or more of the following elevated risk situations are present, then an IEP should be retained by one of the materially interested parties (refer to Chapter 12, *Specialized Experts*). Considerations can include, but are not limited to:

- occupants are high risk individuals; (refer to Chapter 3, *Health Effects from Indoor Exposure to Microbial Contamination in Water Damaged Buildings*);
- a public health issue exists (e.g., elderly care or child care facility, public buildings, hospitals);
- a likelihood of adverse health effects on workers or occupants;
- occupants express a need to identify a suspected contaminant;
- contaminants are believed to have been aerosolized; or
- there is a need to determine that the water actually contains contamination.

The preliminary determination prepares the restorer to perform a pre-restoration evaluation.

10.6.8 Performing the Initial Moisture Inspection

An initial moisture inspection should be conducted to identify the full extent of water intrusion, including the identification of affected assemblies, building materials, and the edge of water migration. Normally, this process begins at the source of water intrusion. Water migration can then be traced across and beneath carpeted surfaces with a moisture sensor. Hard surfaces such as wood flooring, gypsum wallboard, resilient flooring and plaster should be inspected. This can initially be accomplished using a non-invasive (non-penetrating) moisture meter. Thermal imaging cameras can be used to help identify areas of potential migration followed by appropriate moisture detection instruments, especially on projects with complex or multiple areas of water intrusion.

The initial inspection should continue in all directions from the source of water intrusion until the restorer identifies and documents the extent of migration. As affected assemblies are discovered, the restorer should identify and document the building materials that comprise the assembly and the impact of the water on each material. In some cases limitations and complexities (refer to Chapter 11 *Limitations, Complications, Complexities and Conflicts*) can hinder the identification of materials and assemblies. Identification of building materials within an assembly can be accomplished through several methods (e.g., building drawings, existing access openings, inspection holes, partial disassembly, invasive moisture meters). The extent of moisture migration should be documented using one or more appropriate methods including at a minimum a moisture map (i.e., a diagram of the structure indicating the areas affected by migrating water).

The initial inspection process should include establishing a dry standard for affected materials. An acceptable method to establish a dry standard is to evaluate the moisture content or level of similar materials in unaffected areas. The dry standard should be documented, and used to establish a drying goal for salvable affected materials. Results of the initial moisture inspection should be used to establish a monitoring method (i.e., the same meter and setting) to be followed for subsequent follow up visits to the project (i.e., daily). The results of the inspection should be documented (e.g., meter, setting, types of material).

Infrared thermometers measure the average temperature on a spot at the surface of the material. The size of the sample area is determined by the distance-to-spot ratio. An infrared thermometer can be used to determine temperature differentials. The surface temperature difference can indicate evaporative cooling of wet materials. Cooler surfaces do not always indicate evaporative cooling. For this reason, all suspect areas should be verified with a moisture meter.

Restorers should use the appropriate meter or instrument during inspections and follow the manufacturer instructions. An understanding of meter operation and limitations is critical to accurate measurements. Restorers using infrared thermography equipment in surveying buildings for moisture damage should receive proper training on its use. Areas identified with the infrared camera as suspect for being wet should be verified by further testing with a moisture meter.

10.7 Pre-Restoration Evaluation

Following the preliminary determination, the restorer should conduct a pre-restoration evaluation. Pre-restoration evaluations establish recommended corrective actions based on information and evidence collected during the inspection process and conclusions derived from the preliminary determination. The information gathered from the pre-restoration evaluation is then used to develop the work plan, drying plan, safety and health plan, and to identify the need for specialized experts that may be required to clean and dry the structure, building systems and contents to an acceptable drying goal. Information gathered shall include safety and health hazards and the approximate age of the building. Factors considered in the pre-restoration evaluation process can include but are not limited to:

- emergency response actions;
- building materials and assemblies;
- contents and fixtures;
- HVAC, plumbing and electrical systems; and
- below-grade, substructure and unfinished spaces.

10.7.1 Evaluating Emergency Response Actions

Restorers shall identify and manage potential safety and health hazards. During the inspection process, restorers shall make a reasonable effort to identify potentially hazardous materials that could impact building occupants or might be disturbed. Whenever occupants or other workers are present during the initial inspection, restorers should communicate known potential hazards (refer to Chapter 8, *Safety and Health*). Restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection or handling of hazardous or regulated materials, such as asbestos or lead-based paints.

10.7.2 Evaluating Building Materials and Assemblies

Determining the composition of affected materials and assemblies helps establish and implement an appropriate restoration strategy. The construction, permeability, placement of vapor retarders, number of layers, degree of saturation, presence of contamination, degree of physical damage, and the presence of interstitial spaces should be considered when evaluating materials and assemblies.

If materials are restorable, the restorer should use appropriate measuring devices to obtain and document moisture readings, and compare them to the drying goals. All building materials that are likely to be affected, including multiple layers in a single assembly, should be considered.

10.7.3 Evaluating Contents

Determining the material composition of affected contents helps establish a moisture inspection strategy and implement an appropriate restoration strategy. The construction, permeability, degree of saturation and the presence of contamination should be considered when evaluating contents. Affected contents should be evaluated. Refer to Chapter 15, *Contents Evaluation and Restoration*.

10.7.4 Evaluating HVAC Systems

Determining the material composition of affected HVAC systems helps establish a moisture inspection strategy and implement an appropriate restoration strategy. The construction, presence of moisture and contamination should be considered when evaluating HVAC systems. Affected HVAC systems should be evaluated by a qualified individual. Refer to Chapter 14, *Heating, Ventilating and Air Conditioning (HVAC) Restoration*.

10.7.5 Evaluating Below-Grade, Substructure And Unfinished Spaces

Depending on the type of construction, water can collect in below-grade, substructure or unfinished spaces (e.g., basements, crawlspaces, mechanical chase, and attics). These areas should be evaluated. Below-grade, substructure and unfinished spaces can present unique challenges and may involve special evaluation procedures. The inspection and evaluation process shall be conducted according to federal, state, local or provincial laws and regulations. Restorers should consult with a specialized expert when appropriate.

Below-grade, substructure and unfinished spaces can contain safety and health hazards. Safety issues for entrants to consider include, but are not limited to: electrical shock hazards, puncture wounds and bites from rodents, insects or small animals, oxygen deprived atmospheres and airborne contaminants. If a hazardous condition is known or suspected, it should be contained or removed by a qualified individual as necessary. Entrants should wear appropriate personal protective equipment. Refer to Chapter 8, *Safety and Health.*

A water intrusion can be a single, short duration event; however, the amount of flow into the space can be significant. The restorer should evaluate the Category of Water, Class of Water Intrusion specific to the space, size of the affected area, and the composition and moisture content of structural materials (e.g., joists, subflooring).

Many Below-grade, substructure and unfinished spaces are considered a confined space. Before entering, accessibility issues for a confined space shall be addressed. Some confined spaces are classified as "permit-required" spaces. Refer to Chapter 8, *Safety and Health.*

Once safety and health issues have been addressed, the below-grade, substructure and unfinished space inspection can begin and evaluations can be made. Items that can be useful when inspecting these areas include a flashlight, safety harness and rope, drop lights with GFCI cords, GFCI extension cords, a mechanics creeper, thermo-hygrometers, moisture meters, plastic sheeting and drop cloths.

10.8 Project Work Plans

The information gathered from the pre-restoration evaluation is used to develop work plans. Refer to Chapter 9, *Administrative Procedures, Project Documentation and Risk Management.* The structural restoration procedures that follow the development of work plans are discussed in Chapter 13, *Structural Restoration*, and in Chapter 15, *Contents Evaluation, Restoration and Remediation.*

10.9 Ongoing Inspections and Monitoring

Once the project has been controlled and the correction of the damage has begun, the restorer should continue gathering information through ongoing inspections and monitoring. The monitoring process can include, but is not limited to: recording temperature and relative humidity readings and other calculated psychrometric values, checking the moisture levels of materials and updating progress reports.

Because differences in calibration occur from one instrument to another, restorers should use the same meter throughout a project or establish an in-house method to verify that the meters used are within a reasonable tolerance of each other. Refer to Chapter 6, *Equipment, Instruments, and Tools*.

Restorers should record and monitor relevant moisture measurements daily, preferably at the same time of day, until drying goals have been achieved and documented. The frequency of monitoring may be adjusted by the agreed scope of work, potential for secondary damage, job site accessibility, or by agreement between the materially interested parties. Such adjustments should be documented.

The information gathered during ongoing inspections and monitoring can lead the restorer to adjust the placement of drying equipment and modify drying capacity. Where progress is not acceptable, the restorers should take corrective action. The ongoing inspection process can lead to the discovery of a complication. As complications arise, restorers should document the nature of the complication, the impact on the restoration process and scope, and communicate with materially interested parties. Refer to Chapter 11, *Limitations, Complications, Complexities and Conflicts.* Restorers should continue the drying process until drying goals have been achieved and documented. Refer to Chapter 13, *Structural Restoration*.

11 Limitations, Complexities, Complications and Conflicts

11.1 Introduction

Restorers can be faced with project conditions that present challenges. These challenges can produce limitations, complexities, complications or conflicts. Restorers should have an understanding of these issues and communicate them to appropriate parties. The following is a definition of each of these challenges.

Before beginning non-emergency work, known or anticipated limitations and complexities, and their consequences, should be understood, discussed and approved in writing by the restorer and the owner or owner's agent. The following is a discussion of each of these challenges.

11.2 Limitations

Limitations are restrictions placed upon the restorer by another party that results in a limit on the scope of work, the work plan or the outcomes that are expected, and can include but are not limited to one or more of the following:

1) the source of the water intrusion has not been corrected;
2) funds are limited;
3) the appropriate use of containment is not allowed on contaminated water losses;
4) the restorer is told to extract Category 3 water but not remove and discard contaminated porous material (e.g., carpet, gypsum board, fiber-fill insulation, CMU, textiles); and
5) the restorer is told to return contaminated contents without returning them to a sanitary condition.

Only the owner or owner's agent, not the restorer or others, can impose limitations on the performance of a project. If an attempt to impose a limitation is initiated by any other materially interested party, the owner or owner's agent should be advised and provide approval before the limitation takes effect. Limitations that allow for services to be rendered in compliance with this standard should be clearly defined in writing. Limitations placed on any project that are inconsistent with this standard can result in a conflict.

11.3 Complexities

Complexities are conditions causing a project to become more difficult or detailed, but do not prevent work from being performed adequately, and can include but are not limited to one or more of the following:

- inconvenient or limited space or path for entry and exit serving the work area or building;
- the restoration occurs after business hours or within a specified time period;
- work needs to proceed during adverse weather;

- the restoration includes a permit required confined space;
- the business will be in operation or the space requiring work will be occupied during restoration;
- access to the restoration area is desired by occupants;
- a lack of available storage space for equipment, supplies, and debris; and
- a project site location is complicated due to building-specific uses (e.g., a clean room, intensive care unit or immunocompromised patient ward in a hospital).

11.4 Complications

Complications are conditions that arise after the start of work causing or necessitating a change in the scope of work or work plan, and can include but are not limited to one or more of the following:

- mold is found requiring an expanded scope of work (see current edition of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*);
- unexpected changes occur in weather conditions;
- there are unanticipated delays;
- the client needs the restoration work completed sooner than originally planned;
- additional water loss, burglary, fire or other disaster occurs while the restorer has possession of the building or area to be restored; and
- hazardous or regulated materials are discovered after work has begun.

The owner or owner's agent should be notified in writing as soon as practical regarding any complications that develop. The presence of project complications can necessitate a written change order.

11.5 Conflicts

Limitations, complexities or complications that result in a disagreement between the parties involved about how the restoration project is to be performed are called conflicts. When limitations, complexities or complications develop or are placed on the project by the owner or owner's agent, which prevent compliance with this standard, restorers can choose to negotiate an acceptable agreement, decline the project, stop work, or accept the project with appropriate releases and disclaimers. Conflict resolution should be documented. For further information see *Chapter 9: Administrative Procedures, Project Documentation and Risk Management.*

11.6 Related Issues

The presence of limitations, complexities, complications and conflicts on a water damage restoration project can create additional consequences and ramifications. These related issues include the potential for work stoppages, insurance coverage questions, and the need for change orders.

11.6.1 Hazardous or Regulated Materials

The presence of a hazardous or regulated material on a project site can present a limitation, complexity or complication. The presence or potential presence of a hazardous or regulated material on a project site shall be carefully evaluated to determine if the restorer and its employees are qualified to work in that environment. Some hazardous or regulated materials require hazmat training; others require more specific training and licensing or may necessitate engaging a qualified specialized expert.

11.6.2 Insurance

Restorers should be aware that the terms and conditions of their insurance coverage can create project limitations and complications. The extent of applicable insurance coverage, as further prescribed by the insurance exclusions in the policy, can exclude certain work activities from the insurance coverage (e.g., regulated, hazardous materials, mold). If the applicable insurance does not cover the work anticipated at commencement of the project, a limitation can result. If a complication develops or is discovered after commencement of the work plan, it is possible that resultant changes in the scope of work might not be covered by the insurance policy of the restorer. Providing restoration services without insurance, or providing such services that exceed the scope of existing insurance coverage, can potentially expose the restorer or other materially interested parties to risk. In some jurisdictions, restorers are required to maintain insurance coverage as a condition to performing restoration services. Restorers shall determine whether or not insurance coverage is required for their operations.

11.6.3 Change Orders

Contractual disputes can develop if contract additions or modifications are made during performance of the work, and not adequately documented. In order to protect all parties to a restoration contract, substantive changes in the scope of work, time frame, price or method of payment or other material provision of a contract should be documented in a written change order that details the changes. The change order should be dated and signed by all parties to the contract, and each party should be given a copy of the change order as soon as reasonably practical.

11.6.4 Work Stoppage

In some situations, limitations, complexities, complications or conflicts can necessitate work stoppage. In the event an illegal or unreasonably dangerous limitation, complexity or complication exists, occurs or is discovered on a restoration project, the condition shall be resolved or the project shall be refused or the work shall be stopped.

Restorers shall avoid any situation that results in an activity that is illegal or is likely to result in injury or adverse safety or health consequences for workers. Restorers should avoid any situation that results in an activity that is likely to result in injury or adverse safety or health consequences for occupants.

The reason for a work stoppage and the significant events leading to such a decision should be documented. It is recommended that a qualified attorney review a work stoppage decision.

12 Specialized Experts

12.1 Introduction

Restorers, as a company, should be collectively qualified by education, training and experience to appropriately execute the skills and expertise required to safely perform restoration of structure and contents. Restorers should perform only those services they are qualified to perform. If there are situations that arise where there is a need to perform services beyond the expertise of the restorer, specialized experts, whether from within or outside the company, should be used. When the service of a specialized expert is needed, restorers should hire, or recommend in a timely manner that the client hire, the appropriate specialized expert.

A list of specialized experts that may be considered by a restorer performing water damage restoration, and the issues that can lead to considering their involvement, are noted below. Although this list is provided to assist restorers, it is not intended to suggest or require that a specialized expert is necessary in every situation.

While specialized experts are occasionally used on routine residential or commercial water restoration projects, they are more likely to be used in complex moisture intrusions involving sewage, catastrophic flooding, mud accumulation, asbestos, lead-based paint, visible mold growth, building safety, or the need for specialty trades. Specialized experts include, but are not limited to:

- engineering (e.g., building science, electrical, HVAC mechanical systems, soils or landscape, construction, materials, structural);
- specialty trades (e.g., plumbing, electrical, roofing, masonry, carpentry, waterproofing, landscape grading, glazing, floor installation);
- hazardous materials abatement or remediation (e.g., asbestos, lead, fuel oil);

- safety and health (e.g., Certified Safety Professional (CSP), Certified Industrial Hygienist (CIH, CAIH), indoor environmental professional (IEP), safety engineer);
- contents (e.g., antiquities, art conservation, electronics, documents, moving and storage); or
- other experts (e.g., drying consultants, mold remediators, leak detection services, infrared thermographers).

Projects which can require additional information beyond the restorer's ability can include, but are not limited to:

- extensive or complex structural damage;
- long term moisture problems resulting in a musty, moldy or other abnormal odor in the absence of visible microbial growth;
- the need to document the presence of visible microbial growth;
- the need to document the presence of pre-existing conditions;
- the need for thermal imaging and photo documentation;
- plumbing, electrical and roofing problems;
- complex sewage backflows;
- the presence of regulated or hazardous materials (e.g., asbestos, lead, fuel oil);
- complex drying situations;
- issues involving worker and occupant safety and health;, or
- the need for project oversight (e.g., administration, supervision, management and auditing of project closure).

If a pre-restoration or pre-remediation assessment are needed, then an independent specialized expert that meets the description of indoor environmental professional (IEP) should be used. If microbial post-restoration or post-remediation verifications are needed, they should be conducted by an indoor environmental professional. Where elevated risk factors are present (see section 10.6.7), then an IEP should be retained by one of the materially interested parties.

12.2 Indoor Environmental Professional (IEP)

The term indoor environmental professional (IEP), was originally introduced in the IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*, for the purpose of identifying an individual with the education, training and experience to determine mold Conditions 1, 2 and 3, assess shifts in the fungal ecology of buildings, systems and contents, and to verify their return to a Condition 1 status. As used in this document, the same general descriptions and qualifications have been expanded to include the skills needed to assess other microorganisms, specifically those organisms associated with sewage backflow, mud slides and flooding. Refer to the S500 Reference Guide Chapter 12 *Specialized Experts.*

Indoor environmental professional skills include performing an assessment of contaminated property, systems and contents, creating a sampling strategy, sampling the indoor environment, interpreting laboratory data, and, if necessary confirming Category 1, 2 or 3 water for the purpose of establishing a scope of work and verifying the return of the environment to an acceptable or otherwise non-contaminated status. If mold is present or suspected, then refer to the current edition of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*.

12.3 Working with a Specialized Expert

From the perspective of the restorer, the primary functions of the specialized expert are to determine issues and make assessments beyond the knowledge base and core skill set of the restoration company, to provide an independent second opinion about the restorer's plan of action, or for verification. Regardless, restorers shall follow applicable federal, state, provincial and local law and regulations.

The relationship of a specialized expert to the various parties can become quite complex depending on the reason they were hired and why the specialized expert accepted the assignment. While it is preferred that specialized experts be independent and unbiased resources, there can be contractual, adversarial and unforeseen conflicts of interest that can limit or even prevent that from happening. However, an independent, unbiased opinion is essential when a specialized expert is hired to provide a second opinion. Other relationship issues can include:

- Confidentiality: A company owes a duty to its client, which can include confidentiality. When someone other than the restorer retains a specialized expert, there might be a limit to the information that the specialized expert can provide to the restorer. Ideally, a specialized expert will be authorized by the client to share information with materially interested parties. The EPA's *Mold Remediation in Schools and Commercial Buildings*, for example, encourages communication with occupants to help alleviate concerns and suspicions. However, in cases involving litigation, it can be difficult to share or obtain information.
- Reliance: In some cases restorers rely on a specialized expert to determine the scope of work and other essential tasks. However, relying on the training, experience, reputation or credentials of a specialized expert might not absolve the restorer of legal risk or other responsibilities.
- Overlap: There can be circumstances when the normal activities of a restorer overlap or conflict with those of a specialized expert. In those circumstances, the restorer can reach the point where a decision should be made about whether to continue the inspection and not perform the restoration, or to transfer responsibility for further inspection and assessment to a specialized expert.

Using the services of a specialized expert increases the cost of a restoration project. However, since the safety and health of occupants and workers is a paramount principle of restoration, and since contaminated water and associated health impacts remain uncertain, restorers should engage the services of a specialized expert when necessary, including an IEP when appropriate, to protect the safety and health of occupants and workers, or when necessary to effectively complete a restoration project. Federal, provincial, state, and local laws requiring the use of a specialized expert shall be followed.

Additional factors that influence the decision of whether and when to involve specialized experts are addressed in Chapter 10, *Inspections, Preliminary Determination and Pre-Restoration Evaluations*.

13 Structural Restoration

13.1 Introduction

The purpose of this Section is to provide procedural guidance and assist restorers in applying principles of water damage restoration. The five principles are: provide for the safety and health of workers and occupants, document and inspect the project, mitigate further damage, clean and dry affected areas, complete the restoration and repairs. This Section is divided into three sections:

- Initial Restoration Procedures;
- Remediation Procedures for Category 2 or 3; and
- Drying and Completion Procedures for Category 1

If the preliminary determination is that the water is Category 1, then the restorer can proceed without contamination controls (e.g., erecting containment barriers, initial cleaning, establishing pressure differentials) and worker protection. With regard to Category 2 or 3 water intrusions, remediation should occur prior to drying.

13.2 Initial Restoration Procedures

13.2.1 Rapid Response

Mitigation procedures should begin as soon as safely possible following the initial moisture intrusion. If building materials and structural assemblies are exposed to water and water vapor for extended periods, moisture penetrates into them more deeply. The more water they absorb, the more time, effort and expense is required to dry them.

13.2.2 Administration and Job Coordination

It is recommended that job coordination takes place at or near the start of the water restoration project, though due to the time-critical nature of many emergency services, some aspects are often delayed until mitigation services are performed and the drying system is operational. Coordination steps may include but are not limited to reaching agreement on:

- procedures to be performed;
- drying goals; and
- completion requirements.

Restorers should execute a valid contract before beginning mitigation procedures and obtain informed consent for antimicrobial biocide application, if used.

13.2.3 Inspection

Restorers, as a company, should be collectively qualified by education, training and experience to appropriately execute the skills and expertise required to safely perform restoration of structure and contents. The restorer or another qualified individual should gather information, conduct an inspection, make a preliminary determination, communicate to materially interested parties, provide initial restoration procedures, and know when to involve others who can assist in decision making and the performance of tasks. When appropriate, the response can include implementing emergency response actions.

13.2.4 Health and Safety Considerations

Potential safety and health hazards shall be identified and, to the extent possible, eliminated or managed before implementing restoration procedures. Before entering a structure, the building's structural integrity, and the potential for electrical shock hazards and gas leaks, shall be evaluated. Such evaluation or assessment may require a specialized expert, such as a structural engineer. Customers should be warned of imminent hazards that are discovered. When hazards or potential hazards are discovered, appropriate steps, such as posting warning signs, shall be taken to inform workers and occupants.

13.2.5 Examining Water Source

Before restoration begins, the source or sources of moisture intrusion should be located and eliminated, repaired or contained to the extent practical. In some cases it may be appropriate to mitigate the spread of damage by starting procedures, such as extraction, to prevent further water migration, even before the source is found and contained or repaired.

13.2.6 Determining the Category of water

The categories of water, as defined in Section 10.4.1, refer to the range of potential contamination in water, considering both its originating source and its quality after it contacts materials present on the job site. Restorers should consider potential contamination, defined as the presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment; and may produce adverse health effects, cause damage to structure and contents and/or adversely affect the operation or function of building systems.

13.2.7 Determining the Class of Water Intrusion

Restorers should estimate the amount of humidity control needed to begin the drying process. The term “Class of water” as defined in Section 10.4.3 is a classification of the estimated evaporation load and is used when calculating the initial humidity control (e.g., dehumidification, ventilation). It is based on the approximate amount of wet surface area and the permeance and porosity of the affected materials. Initial information, to determine Class, should be gathered during the inspection process. The Classes are divided into four separate descriptions, Class 1, 2, 3, and 4. The determination of class may be dependent upon the restorability of wet materials and access to wet substrates. Depending upon the project, this determination may occur at a different point of the initial restoration procedures.

13.2.8 Evaluating for Restorability

Information obtained from the preliminary determination and during the inspection should be used to evaluate the restorability of materials on the project. Based on this evaluation, a work plan can be developed to address the affected materials and protect the unaffected materials. For more information on the evaluation of specific materials and assemblies, refer to Chapter 17, *Materials and Assemblies*.

13.2.9 Contents

Steps should be taken as quickly as practical to minimize damage to contents. This includes, but is not limited to protecting contents from moisture absorption, which can result in stain release, discoloration of finish, splitting of wood components in direct contact with wet surfaces (legs, bases), staining, rusting, ringing or other forms of moisture damage. If contents restrict access to walls, ceiling or other areas, the restorer should manipulate them (e.g., move, relocate, discard).

Note: For Category 1 drying procedures, proceed to Section 13.5 *Drying and Completion of the Restoration Process (Category 1 and Post Remediation Category 2 and 3).*

13.3 Remediation Procedures for Category 2 or 3

This Section covers procedures for remediation of areas that contain or are believed to contain one or more types of contaminants. Remediation should occur prior to drying. Contaminants are defined as the presence of undesired substances the identity, location and quantity of which are not reflective of a normal indoor environment and can produce adverse health effects; and can cause damage to structure or contents; and can adversely affect the operation or function of building systems. Contaminated environments can result from:

- Category 2 or 3 water;
- Condition 2 or 3 mold contamination;
- Trauma or crime scene; or
- Hazardous or Regulated Materials.

An environment can be contaminated as a result of pre-existing conditions. The remediation procedures should not vary regardless of whether contaminants are the result of water intrusion or pre-existing conditions. Restorers shall inspect the structure for the presence and location of contaminants, as part of their site safety survey. Restorers shall develop a safety plan outlining how workers will be protected against hazards. Restorers should take appropriate steps to disclose known or suspected contaminants to other materially interested parties, and recommend appropriate precautions.

13.3.1 Restorer, Occupant Protection

Before entering structures that are known or suspected to be contaminated, either for inspections or restoration activities, restorers shall be equipped with appropriate personal protective equipment (PPE) for the situation encountered. Restorers can make recommendations regarding personal protection to persons entering structures, as appropriate. Restorers should refer occupants with questions regarding health issues to qualified medical professionals for advice.

13.3.2 Engineering Controls: Containment and Managed Airflow

Contaminants should not be allowed to spread into areas known or believed to be uncontaminated. Information provided in this section generally assumes the contamination level is severe (i.e., Category 3 water). The procedures in this section may be scaled back, as appropriate, for less severely contaminated environments. Contaminants can be spread in many ways:

- Solid and liquid contaminants can be: tracked on feet, spread on wheels or bases of equipment, carried on contents, bulk materials, or debris during manipulation or removal; and
- Airborne contaminants can be spread by natural circulation, an installed mechanical system, or by using air moving equipment. When drawing moist air out of potentially contaminated cavities using negative pressure, an in-line HEPA filter should be used to remove contamination before exhausting the air into the room.

In grossly contaminated environments, restorers shall implement procedures to minimize the spread of contaminants. This can be accomplished by isolating contaminated areas, erecting containment, and employing appropriate work practices.

For details on the setup and maintenance of containment and airflow management, restorers should consult the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. The principles of containment found therein, although specifically addressing mold contamination, are generally applicable to environments in which aerosolizing of other types of contaminants is likely.

AFDs used in contaminated areas should be sealed at the air intake side upon turning off to avoid releasing contaminants. Filters should be replaced as necessary following manufacturer's guidelines to maintain performance efficiency. Restorers should ensure that contaminated equipment is cleaned and decontaminated, or contained prior to moving through unaffected areas, transported, or used on subsequent jobs.

13.3.3 Bulk Material Removal and Water Extraction

Bulk contamination (e.g., solid waste, silt, debris) should be removed to expose structural surfaces or assemblies for further inspection and evaluation, prior to demolition or detailed cleaning. When extracting contaminated water or vacuuming contaminated dry material, restorers should take appropriate steps to prevent contaminants from becoming aerosolized in work areas or other parts of a building by using HEPA vacuum systems or directing a vacuum's exhaust to unoccupied areas of the building's exterior.

Tools and equipment should be cleaned and decontaminated on the job site before being loaded for transport away from the site. Wastewater shall be handled, transported and disposed of in accordance with all local, state, provincial or federal laws and regulations.

13.3.4 Pre-remediation Evaluation and Assessment

Following the bulk removal of contaminants and water extraction, restorers should evaluate remaining materials and assemblies as specified in Chapter 10*, Inspections, Preliminary Determinations, and Pre-restoration Evaluations*. Further assessment may be necessary and should be performed by an indoor environmental professional (IEP) or other specialized expert as dictated by the situation.

13.3.5 Humidity Control in Contaminated Structures

The priority for restorers is to complete remediation activities before restorative drying. However, the restorer should control the humidity in contaminated buildings to minimize moisture migration, potential secondary damage, and microbial amplification. Restorers should maintain negative pressure in relation to uncontaminated areas. Maintaining negative pressure in an affected area can increase the dehumidification capacity needed to maintain desired psychrometric conditions. This may be implemented before, during, or after decontamination. Restorers should limit the velocity of airflow across surfaces to limit aerosolization of contaminants. Restorers should complete the drying process after the remediation has been completed.

13.3.6 Demolition and Controlled Removal of Unsalvable Components or Assemblies

During demolition, contaminants can be easily dislodged or aerosolized. Restorers should minimize dust generation and aerosolization by using appropriate engineering controls.

The cutting depth of saw blades should be set so that they do not penetrate past wallboard materials. This can avoid possible damage of plumbing, electrical or other components within the cavity. Wet or contaminated insulation should be removed carefully and bagged immediately, preferably in 6-mil disposable polyethylene bags. A razor knife or utility knife is recommended for cutting rather than tearing or breaking it into pieces.

Contaminated materials should be double bagged if they are going to pass through uncontaminated areas of the building. Sharp items capable of puncturing polyethylene material should be packaged before being bagged or wrapped in manner that prevents them from penetrating packaging material.

13.3.7 Pockets of Saturation

Restorers should open assemblies (e.g., walls, stairs, flooring, wall base areas, voids, built-ins) to access pockets of saturation and remove unsalvable, contaminated materials and components. Exposed materials that remain in place should be cleaned and decontaminated, as appropriate.

13.3.8 HVAC System Components

In projects where Category 2 or 3 water has directly entered HVAC systems, they should be contained and disassembled, and affected HVAC system components should be removed. Restorers should plan for component cleaning, using a specialized HVAC contractor as appropriate, followed by system replacement, after structural restoration and remediation has been completed. Restorers should consult specialized experts when HVAC system removal, restoration or replacement is complex or outside their area of expertise.

13.3.9 Cleaning and Decontaminating Salvable Components

Decontamination should be accomplished to the extent possible by cleaning. Restorers should employ cleaning methods that minimize aerosolizing contaminants while maximizing complete removal. However, pressure washing to flush contaminants from salvable components may be appropriate. Wastewater from cleaning processes should be collected and properly disposed. It is recommended that when decontamination cannot be practically completed by cleaning alone, that appropriate antimicrobial biocide or mechanical means be employed.

13.4 Antimicrobial Biocide Application

13.4.1 Antimicrobial Biocide Risk Management

Restorers who use antimicrobial biocides shall be trained in the safe and effective use of them. Safety data sheets (SDS) for chemicals used during a water restoration project shall be maintained on the job site and made available to materially interested parties upon request. Restorers should obtain a written informed consent from the customer before they are applied, and occupants should be evacuated prior to application. Restorers shall follow label directions and comply with federal, state, provincial and local regulations.

13.4.2 Customer "Right to Know" when using Antimicrobial Biocide

Restorers should brief customers before antimicrobial biocides are applied. This can include providing customers with the product information label and obtaining informed consent of product use in writing. If a customer requests the product label or safety data the restorers shall provide it. Written documentation of the antimicrobial biocide type, application method, time and quantity, location, and other antimicrobial biocide application details should be recorded and maintained for each antimicrobial biocide application.

13.4.3 Biocide Use, Safety and Liability Considerations

Antimicrobial biocides can harm humans, pets and wildlife if used improperly. When using antimicrobial biocides in water damage restoration activities, for efficacy, safety and legal liability reasons, follow label directions carefully and explicitly. In some countries, such as the United States, it is a violation of law to use these products in a manner inconsistent with the label. In order to minimize potential liability, restorers shall:

- Comply with applicable training, safety, use and licensing requirements in their respective jurisdictions;
- Train and supervise employees and agents handling biocides;
- Ensure that proper PPE is available to restorers who are engaged in antimicrobial biocide use and application;
- Not use such products in any heating, ventilation, air-conditioning, or refrigeration systems unless:
  - A. the product is specifically approved by the appropriate federal/state regulatory authority;
  - B. trained heating, ventilation, air-conditioning, or refrigeration systems technicians apply it and remove its residual;
  - C. the heating, ventilation, air-conditioning, or refrigeration systems system is not operating; and
  - D. occupants and animals have been evacuated;
  - E. Apply products strictly in accordance with label directions;
  - F. Dispose of remaining antimicrobial biocides according to label directions; and
  - G. Determine whether or not the local government agencies where the antimicrobial biocide is to be applied has adopted laws or regulations further restricting or regulating the use of the specific antimicrobial biocide in question, and if so, follow those specific use restrictions and regulations;

In addition, restorers should:

A. Discuss potential risks and benefits with the customer, make available product information including the label and the SDS, and obtain a written informed consent with the customer's signature before applying any antimicrobial biocide. Inquire about any pre-existing health conditions that might require special precautions. Advise customers to remove occupants and animals from the product application site, particularly children and those with compromised health;

B. When antimicrobial biocides are used, document all relevant biocide application details;

C. Refrain from making statements or representations to the customer beyond those stated on the product label or in the efficacy claims made by the product and approved by the applicable government agency;

D. Ask questions when in doubt. Consult the appropriate federal, state, provincial, or local governmental agency. In the United States, the Antimicrobial Division within the Office of Pesticide Programs of the USEPA, the respective state agricultural department, or other state agency with pesticide jurisdiction, should be consulted when there is a question about a specific antimicrobial biocide product, or its use and regulation;

E. Clean treated surfaces of antimicrobial biocide residues as part of the remediation process; and

F. Apply products that have been tested and registered by appropriate governmental agencies;

13.4.4 Post Restoration/Remediation Verification

Where the following elevated risk factors are present, an IEP should be retained by one of the materially interested parties. An independent IEP should conduct required post-restoration or post-remediation verifications. Considerations can include, but are not limited to:

- occupants are high risk individuals; (refer to Chapter 3, *Health Effects from Indoor Exposure to Microbial Contamination in Water Damaged Buildings*);
- a public health issue exists (e.g., elderly care or child care facility, public buildings, hospitals);
- a likelihood of adverse health effects on workers or occupants;
- occupants express a need to identify a suspected contaminant;
- contaminants are believed to have been aerosolized; or
- there is a need to determine that the water actually contains contamination.

13.5 Drying and Completion of the Restoration Process (Category 1 and Post Remediation Category 2 and 3)

13.5.1 Controlling Spread of Water

Excess water should be absorbed, drained, pumped or vacuum-extracted. Excess water removal may be required on multiple levels, in basements, crawlspaces, stairwells, interstitial spaces, HVAC systems, utility chases, or elevator shafts. Repeatedly extracting materials and components may be required as water seeps out of inaccessible areas, especially in multi-story water restoration projects.

13.5.2 Controlling Initial Humidity

Humidity within the structure should be controlled as soon as practical, just as steps are taken to control the spread of water. While a spike in the humidity is not uncommon at the outset of a drying project, if it persists beyond the first day, this can indicate an adjustment is necessary (e.g., additional ventilation, dehumidification equipment). Ventilating the structure during the initial stages of processing may be an effective way to reduce the build up of excess humidity.

13.5.3 Controlled Demolition, as Necessary, to Accelerate Drying

It is recommended that consideration be given to whether demolishing and removing structural materials is appropriate in setting up the initial drying system. Materials that are unrestorable or that pose a safety hazard should be removed as soon as practical.

Controlled demolition should be done safely and removed materials should be disposed of properly. In some jurisdictions, firms performing demolition or other work practices may require licensing. Also, it is important to note presumed asbestos containing materials (PACM), or materials containing lead; see Chapter 8, *Safety and Health*.

13.5.4 Final Extraction Process

Multiple final extractions of salvable materials often are required to decrease drying time, especially for ~~highly~~ porous materials, such as carpet and cushion. Excess water that may have been inaccessible during the initial extraction process often seeps out of systems or assemblies into locations or materials where it can be extracted later.

Extracted waste water shall be disposed of in accordance with applicable laws and regulations. Normally this means disposal into a sanitary sewer system or, especially where HAZMAT may be involved, at a licensed disposal facility.

13.5.6 Determining and Implementing the Appropriate Drying System

13.5.6.1 Using Outside Air in the Drying Process

When considering the use of outside air in the drying process, restorers should determine if the outside environment is favorable to their drying effort or can be used as a means of quickly reducing the humidity levels in the space temporarily. The decision on the approach to use is generally based on:

- Prevailing weather conditions anticipated over the course of the project;
- Humidity levels inside the affected area that are present or can be maintained; and
- Job logistics or other concerns (e.g., ability to maintain security, expected energy loss, owner preferences, potential outdoor pollutants).

The three system approaches are:

13.5.6.1.1 Open Drying System

An open system to drying introduces outdoor air without mechanical dehumidification to reduce indoor humidity or remove evaporated water vapor. This ventilation can be beneficial when outdoor humidity is significantly lower than indoor humidity, especially at the very beginning of the job. If indoor humidity level increases, (1) a greater rate of exchange may help, (2) supplemental dehumidification can be installed, converting to a combination drying system or (3) the outdoor air exchange can be stopped, converting to a closed drying system.

13.5.6.1.2 Closed Drying System

Closed drying systems are commonly used as it provides the greatest amount of control over the drying environment and the best protection from varying outdoor conditions while preserving building security. Restorers should isolate the building or affected area from the outside, and install dehumidification equipment. When appropriate, the existing building's HVAC system may provide some dehumidification. Though in many cases, it is not sufficient to achieve optimum conditions for restorative drying. A closed approach is recommended when outdoor humidity levels (i.e., humidity ratio) are not significantly lower than indoor. A closed approach is also employed when building security, changing weather patterns, energy loss, outdoor pollutants, available ventilation or other issues cannot be overcome.

13.5.6.1.3 Combination Drying System

A third approach is to use a combination of the above, especially at the beginning of a project when indoor humidity levels are at their highest. Restorers may consider ventilating the moist air to the outside while bringing in the drier air. This is often done at the time debris removal, extraction and initial cleaning is performed, as security is not typically an issue during the early stage of a project while restorer is actively working onsite. Once closed up, drying equipment can then be used to create the conditions needed.

Restorers may also consider a continuous use of outdoor air while dehumidification systems are deployed, when conditions are appropriate. This can be necessary when access to outdoor air is limited or at risk of interruption.

Air exchange and heat drying equipment may be used in conjunction with dehumidification to provide dry, warm air to a space while maintaining security and filtering the incoming air. This combination should be considered when the use of an air exchange and heat system alone is insufficient to maintain proper drying conditions.

Depressurizing the workspace can lower humidity ratio by drawing in drier, outdoor air. Excessive depressurization or the improper placement of air moving equipment (e.g., air movers, AFDs) within a structure can create safety hazards by potentially causing backdrafting of combustion appliances, such as water heaters or furnaces, and thereby create possible carbon monoxide hazards, or contamination problems by pulling contaminants into the structure from crawlspaces or other areas.

13.5.6.2 Using the Installed HVAC System as a Drying Resource

Restorers can use the installed HVAC system as a resource; provided contaminants will not be spread or the drying effort will not be negatively impacted. The HVAC system can add to or remove energy from the environment being dried. Although HVAC systems can help restorers gain control of ambient humidity, they generally do not create the conditions necessary for drying of the building and contents. In addition, they may not be able to control ambient humidity quickly enough to prevent secondary damage.

13.5.7 Controlling Airflow, Humidity, and Temperature to Promote Drying

Restorers should control airflow (i.e., volume, velocity), humidity (i.e., dehumidification, ventilation) and temperature (i.e., vapor pressure differential) to work towards the drying goals. These conditions should be managed through the various stages of drying as follows:

- 1st Stage - Constant Rate (Surface Evaporation) - liquid water is present at the surface and evaporates into the air over the material at a constant, unhindered rate;
- 2nd Stage - Falling Rate (Capillary Action) – liquid water moves between pores to the surface and is also evaporated from the meniscus of each pore; and
- 3rd Stage - Falling Rate (Vapor Diffusion) – water vapor moves by differences in moisture gradients within the material and between the material and surrounding air.

13.5.7.1 Controlling Airflow

During the initial constant rate stage (refer to Chapter 5, *Psychrometry and Drying Technology*) of drying, the increased rate of evaporation caused by airmovers is directly related to the airspeed across the wet surface. Airmovers used during this stage should be set up so that continuous rapid airflow is provided across wet surfaces. The restorer should install airmovers to deliver air along the lower portion of the wall and the edge of the floor, in a circular fashion. Airmovers should be installed at an angle (e.g., 5-45^{o}) that provides constant airflow along the entire length of all affected walls. In addition, airmovers should be added to direct flow across the open areas of the room or space if the size of the room or the presence of contents prevents sensible airflow across the entire floor surface.

Airmovers should also be used to ensure circulation of air throughout the workspace as needed. To accomplish this, the restorer should install at least one airmover in each affected room or space, to include bay windows, hallways, rooms, insets and offsets. The restorer should also consider the addition of airmovers to ensure airflow in and out of structural cavities and voids whenever water has affected the materials in these spaces.

In Class 1 and 2 water intrusions, restorers should install one airmover for every 50 to 70 SF of affected floor space, ensuring at least one airmover in each affected room or space at a minimum. The calculated number of airmovers should be installed to address both affected wall surfaces (e.g., an airmover every 10-16 lineal feet) and the affected field of the floor. When a calculated number produces a fraction, it should be rounded up. Restorers should place an additional airmover for each offset or inset that impedes airflow across wet surfaces (e.g., wall sections that are greater than 18-24 inches). Narrow or odd shaped rooms or spaces may require an additional airmover to adequately address affected wall surfaces, especially during the constant rate drying stage.

In Class 3 water intrusion, restorers should place additional airmovers to ensure sufficient airflow across wet ceiling or upper wall surfaces (e.g., recommend one airmover for every 150 square feet of these surfaces).

The quantity of airmovers needed to accomplish these goals will vary between projects, depending upon the build out density, amount and type of contents and the location of wet or damp surfaces.

When Class 4 materials enter the falling rate drying stage, airflow should be reduced (e.g., one airmover that will deliver between 150 to 500 fpm for every 100 to 150 square feet of wet surface), provided remaining wet or damp surfaces continue to receive sensible air flow and circulation is maintained throughout the workspace. In addition, the vapor pressure differential should be increased (e.g., increase temperature of wet materials; reduce humidity of the surrounding air; or a combination of both). Refer to Chapter 5 *Psychrometry and Drying Technology* for more information on falling rate drying adjustments.

Directed airflow is used in the restorative drying process to accomplish two objectives:

1. To circulate air throughout the workspace to ensure drier air continually displaces more humid air. Air should be circulated to all effected interstitial cavities, such as wall and ceiling voids, beneath cabinetry and underneath and within wood flooring systems.
2. To direct air at material surfaces in order to displace the evaporating surface moisture within the boundary layer of air and transfer energy to the surface moisture and materials. The boundary layer is a thin layer of air at the surface of materials that due to surface friction does not move at

the full speed of the surrounding airflow. This layer needs to be continuously displaced to enhance evaporation.

Airmoving devices inherently tend to aerosolize soils and particulates present in the environment. As water evaporates from surfaces and materials, such as carpet, more particles often become aerosolized, creating possible health, safety, comfort and cleanliness issues. To minimize or control aerosolization of particles, restorers should consider implementing the following:

1. To reduce the amount of soil or particulates that can become aerosolized before activating airmoving devices, materials and surfaces (e.g., carpet, hard surface floors, exposed subfloors) restorers should perform a preliminary cleaning.
2. Where preliminary cleaning is not sufficient or there are high-risk occupants, restorers can install one or more air filtration devices or AFDs, as a negative air machine.

13.5.7.2 Controlling Humidity and Determining Initial Dehumidification Capacity

When a closed drying system using mechanical dehumidification equipment is planned, restorers should establish an initial dehumidification capacity. The restorer should document factors considered to determine the initial dehumidification capacity. Considerations may include but are not limited to:

A. Types of building materials, assembly and build-out characteristics
B. Class and size of the affected area
C. Prevailing weather conditions over the course of the drying effort
D. Power available on the project
E. Type and size of drying equipment available

Two examples of calculation methods to determine initial dehumidification capacity can be found in the Reference Guide (see Chapter 13 *Structural Restoration).* Following the implementation of an initial calculation, the restorer should consider other factors that may require adjustments. This information may include but is not limited to:

- An imposed deadline to complete the drying process
- Power is known to be less than adequate to serve the indicated inventory of equipment
- The building will be occupied during the drying process; potentially causing equipment cut-off, frequent opening of doors, higher moisture load
- An unusual schedule within which the restorer must work (e.g., retail store that wants to remain open each day)
- Required pressure differential to achieve contaminant control

After the initial installation, appropriate adjustments in dehumidification equipment capacity should be made based on subsequent monitoring readings. When Class 4 materials enter the falling rate drying stage, airflow should be reduced, and the vapor pressure differential should be increased (e.g., increase temperature of wet materials; reduce humidity of the surrounding air; or a combination of both). Refer to Chapter 5 *Psychrometry and Drying Technology* for more information on falling rate drying adjustments.

13.5.7.3 Controlling Temperature to Accelerate Evaporation

The temperature within a work area, and the temperature of wet materials themselves, also impacts the rate of evaporation significantly. Increasing the temperature of wet materials can be accomplished by using the sensible energy gained by airmovers, dehumidification or heating equipment. The greater the temperature of wet materials, the more energy is available for evaporation to occur.

Restorers should consider the impact of high temperatures on building components and contents. Manufacturer's instructions and safety precautions shall be followed to reduce the potential for fire hazards and occupant safety issues. Restorers should be familiar with drying equipment and how ambient temperatures affect their performance.

After the initial installation, appropriate adjustments in heat producing equipment should be made based on subsequent monitoring readings. When Class 4 materials enter the falling rate drying stage, airflow should be reduced, and the vapor pressure differential should be increased (e.g., increase temperature of wet materials; reduce humidity of the surrounding air; or a combination of both). Refer to Chapter 5 *Psychrometry and Drying Technology* for more information on falling rate drying adjustments.

13.5.8 On-going Inspections and Monitoring

Normally, psychrometric conditions and MC measurements should be recorded at least daily. Relevant moisture measurements normally include: temperature and relative humidity outside and in affected and unaffected areas, and at dehumidifier outlets. Also, the moisture content of materials should be taken and recorded. Because differences in calibration occur from one instrument to another, restorers should use the same meter throughout a project or establish an in-house method to verify that the meters used are within a reasonable tolerance of each other. It is recommended the restorer record readings at the same locations, until drying goals have been met and documented. On each visit, if monitoring does not confirm satisfactory drying, restorers should adjust drying procedures and equipment placement, or possibly to add or change equipment to increase drying capability.

13.5.9 Verifying Drying Goals

Restorers should use appropriate moisture meters to measure and record the moisture content of specific structural materials and contents. Drying equipment should remain in operation on site until drying goals have been verified and documented.

13.5.10 Post Restorative Drying Evaluation

Restorers should evaluate structural materials, assemblies, and contents that have been cleaned and dried to ensure pre-determined goals have met. In some cases, items that have been dried may need additional services including cleaning, repair or additional appearance enhancement. In some circumstances, structural materials, assemblies, and contents cannot be successfully restored and replacement or reconstruction is necessary, despite a restorer's effort to salvage the items.

13.5.11 Reconstruction/Repair

After completing thorough drying and other procedures discussed above, qualified and properly licensed persons should perform authorized and necessary structural repairs, reconstruction or cleaning.

13.5.12 Final Cleaning

Throughout the restoration and reconstruction process, foot traffic and settling of aerosolized particles results in the accumulation of soils on surfaces. Restorers should clean structural surfaces before re-occupancy or after reconstruction, using methods appropriate for particular materials and types of soil.

13.5.13 Contents Move-back

The final step in the restoration process is usually returning contents to their proper location in the structure; see Chapter 15*, Contents Evaluation and Restoration*.

14 Heating, Ventilating and Air Conditioning (HVAC) Restoration

14.1 The Relationship between A Building and Its HVAC System

Heating, Ventilating and Air-Conditioning (HVAC) systems, when directly contacted by water, can cease to operate, or they can function inefficiently or spread excess humidity throughout both affected and unaffected areas of a structure. If contacted directly by Category 2 or 3 water, they can spread contamination to unaffected areas. Even if an HVAC system is not directly contacted by water, when operating, it can spread humidity or contamination from affected to unaffected areas. Further, microbial growth from other causes can be carried to the interior of HVAC system components where it can accumulate and degrade HVAC component operation.

In addition, HVAC systems can have a major impact on controlling the conditions that lead to secondary damage. The design, installation, operation and maintenance of HVAC systems can be important factors in controlling microbial growth and dissemination. This can lead to the spread of contamination by the system and increase the scope of the microbial problem by dispersing contaminants throughout a building.

Types of HVAC systems include residential, commercial and industrial. In a typical system, the fan or blower circulates air from occupied space through the air filter, return grills, return ducting, heating or cooling coils, and through the supply ducting into occupied space. The system's mechanical components can be located in various areas of the occupied space, outdoors, or in other locations. Residential systems vary in configuration and type from one part of North America to another; however, within each region HVAC systems are generally similar in design.

Contaminated HVAC systems should not be used for dehumidification purposes during water damage restoration. The restorer shall comply with any applicable laws or regulations prior to servicing an HVAC system.

In addition to the HVAC system, it is useful to understand other mechanical systems in a building, including: plumbing; heating, ventilating, and air conditioning (HVAC) systems; gas appliances; chimneys; fireplaces; air-exchange systems; vents in kitchens and baths; clothes dryer vents; recessed light fixtures and central vacuums. These systems can create varying pressure differentials (i.e., positive, negative, neutral); which should be considered during restoration projects. For more information on the environment's impact on the HVAC system, see Section 13.5.6.1.3.

14.2 Overview of HVAC Operations and Particulate Implications

14.2.1 Up-flow Systems

In a vertically-mounted, up-flow system, air is drawn through the bottom of the system and discharged out the top. Typically, these systems are located within the conditioned portion of the residence, in a basement or within a closet constructed of wood and drywall materials. In addition, the return-air plenum often is a part of this enclosure, with openings covered by a metal grill. Organic construction materials can provide an excellent food source for microbial contamination if moisture from the HVAC is allowed to accumulate on or penetrate into them.

14.2.2 Down-flow Systems

In a down-flow system, the air being conditioned enters the unit from the top and is discharged out the bottom of the air handler. Often, vertical down-flow systems are installed in a closet or garage, with the ductwork installed in a crawlspace under the occupied space. Because of the location of these components, conditions can be favorable for moisture to infiltrate or accumulate within mechanical system components, thereby leading to microbial growth. Generally, these types of systems are difficult to service, because working conditions are confined and access is often limited. In order to access the air ducts it may be necessary to have a licensed HVAC contractor remove the air handler or the air conditioning coil.

14.2.3 Horizontal Systems

Horizontal systems are designed to allow air to flow from left to right or right to left. These systems often are found in attics or underneath houses. They are designed to be used in-line with corresponding return and supply main trunk lines. Major considerations when working on these types of units include: the ambient temperature surrounding the unit, general service access to the unit and associated ductwork, safety difficulties while working in confined attic spaces (such as drywall breakthrough and ceiling cracking), and the possibility of moisture collection progressing to an advanced stage before being detected.

14.2.4 Ductwork

HVAC ductwork systems can consist of several types of materials including: fiberglass duct board, galvanized metal duct with interior fiberglass linings, galvanized metal duct with fiberglass exterior wrap, fabric duct, and insulated flexible duct. Ductwork consisting of a non-porous internal surface (usually galvanized sheet metal) generally responds well to cleaning when visible microbial growth is present. Galvanized sheet metal can withstand the aggressive cleaning techniques necessary for removing Condition 3 contamination (actual mold growth and associated spores: refer to the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*) or other types of microbial contamination. However sections of internally lined ductwork, duct board or flexible ductwork with microbial contamination cannot be successfully cleaned; therefore, sections of such ducting with Condition 3 contamination or Category 3 water (e.g., sewage) should be removed and replaced with new materials.

14.2.5 Commercial HVAC Systems and Components

Commercial mechanical systems incorporate more variations and combinations of HVAC system design and components, compared to residential systems. Typical commercial systems may include, but are not limited to, single-zone, multi-zone, single-duct variable-volume, double-duct or dual-duct, and induction systems. Commercial systems are larger and more complex to inspect and service than residential systems. Commercial systems have additional components, including mixing boxes, chillers, and variable air volume (VAV) boxes.

When a building containing widespread Condition 3 contamination or Category 3 water is remediated, special attention should be given to restoring HVAC system that supports the building's indoor environment. Also, HVAC systems should be inspected as described in this section and returned to acceptable status (normal ecology) as part of the overall restoration project. It is recommended that HVAC deficiencies be identified for immediate correction by the client's HVAC service contractor. Otherwise, microorganisms can grow again, and adversely affect environmental conditions within the building.

Causes of visible or suspected microbial growth should be identified and moisture sources controlled, before restoring or remediating either building components or the HVAC system. An indoor environmental professional (IEP) should perform this assessment. Building design or construction-related moisture accumulation can often be beyond the capacity of properly designed, maintained and operated HVAC system. These issues raise serious questions about the project scope and overall loss responsibility. Water damage restoration or microbial remediation does not include activities that would modify either a building or its mechanical systems from their original design. Property owners should be advised of known conditions that place the future integrity of the building at risk.

14.3 Evaluating HVAC Systems

Affected HVAC systems should be inspected for cleanliness and returned to acceptable status as part of structural restoration. The National Air Duct Cleaners Association (NADCA) standard, *Assessment, Cleaning and Restoration of HVAC Systems* (ACR current version), includes specifications for acceptable levels of cleanliness for HVAC systems, and appropriate inspection techniques. Often, it is recommended that HVAC system drying and cleaning be performed after other building restoration procedures are complete, to avoid cross-migration of soils or particulate contaminants into mechanical systems. When this is not possible and the environment is contaminated (e.g., settled spores, bacteria, or visible microbial growth), HVAC system components should be isolated from the environment as part of the overall building restoration strategy.

Restored HVAC system components that are potentially exposed to recontamination during on-going building drying and restoration activities should be re-inspected after building demolition procedures and reconstruction activities are complete. This re-inspection should be conducted before removing pressure differential containments or isolation engineering controls, if erected. It may be necessary to provide temporary heating, cooling and other environmental controls within areas undergoing restoration, when they are not being served by their normal mechanical systems. Often, the condition of makeup air drawn through the containment provides satisfactory working conditions. In other cases it is recommended that supplemental heating, cooling or dehumidification systems be arranged to provide adequate environmental control in affected areas. When supplemental systems are utilized inside critical containments, decontamination procedures should be implemented, such as bagging or wrapping equipment used, before removing it from the workspace.

In addition to a cleanliness inspection, a complete engineering assessment of the design and condition of the entire HVAC system may be performed, depending on the conditions that exist in the restoration project. This is especially important if: temperature and/or relative humidity conditions cannot be maintained within affected areas in compliance with the requirements of American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standards 62.1 *Ventilation for Acceptable Air Quality* and 62.2 *Ventilation and Acceptable Indoor Air Quality in Low-rise Residential Buildings*; temperatures, RH or airflow varies between different areas of the building, or mechanical components are not in good condition or repair. There are four reasons this is important to the success of a restoration project:

1. the original system design may not have been adequate to maintain optimum indoor environmental (or psychrometric) conditions in the building;
2. expansions, renovations or changes in the use of the original space may have rendered the HVAC system design inadequate for the current needs of the building and its occupants;
3. the system may not have been installed as designed or commissioned, so as to assure that its operation met the design objectives; and
4. mechanical deterioration and/or physical damage to system components may have degraded their performance to the point at which they cannot provide the needed level of air flow or capacity.

The description of what constitutes an adequate engineering evaluation of HVAC system, condition and capacity is beyond the scope of this standard. It is recommended that qualified engineering professionals or licensed HVAC contractors be consulted for such an evaluation. The Air Conditioning Contractors of America (ACCA), National Air Filtration Association (NAFA), American Society of Heating and Air-Conditioning Engineers (ASHRAE), North American Insulation Manufacturers Association (NAIMA), and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), and their published guidance documents, provide construction standards and design guidance for proper sizing, design and layout of HVAC systems. Regardless of compliance with the latest HVAC system guidance, at a minimum an HVAC system shall conform to applicable building codes.

Many airborne spores are typically in the range of one to five micrometers in diameter, but they may appear in clumps or in growth structures two to ten times that size. Airborne microbial fragments, such as hyphae, may be much smaller, measured in sub-micron sizes, and they also may agglomerate forming larger clumps. Conventional HVAC system filters of MERV 6 rating or less are not effective at stopping the distribution of particles in this size range throughout an HVAC system. In systems with filters of MERV ratings of 11 or higher, a substantial amount of bioaerosol is captured. Completely containing or eliminating contamination in HVAC systems requires HEPA filtration, which is 99.97% efficient in removal of particles at 0.3 micron aerodynamic diameter, and more efficient in particles both larger and smaller.

Filtration is important in decreasing the spread of microbial spores from one part of a building to another. Filtration upgrades should be considered in buildings that have experienced Condition 3 contamination (actual mold growth and associated spores) or Category 3 water as part of a strategy to prevent future problems. In many cases, existing filter housings or tracks will accommodate upgraded filtration. In others, modifications should be made to the HVAC system layout to accommodate upgraded filtration. Whenever modifications are made to an HVAC system to accommodate upgraded filtration, airflow restrictions below design levels should not occur.

14.4 HVAC System Cleaning and NADCA *Assessment, Cleaning and Restoration of HVAC Systems* (ACR)

Once the HVAC system's condition has been assessed for cleanliness, and mechanical corrections and/or enhancements have been completed, cleaning should be carried out in accordance with procedures described in NADCA ACR current version, which is incorporated herein by reference, or in similar industry standards

14.4.1 Contamination Considerations

Determining the extent of contamination present in an HVAC system can be challenging. Cleanliness verification methods are described in the NADCA ACR current version. These methods include visual inspections, surface comparison tests and the NADCA vacuum test. The minimum requirement is that the systems must be visibly clean as described in the NADCA ACR current version. Multiple cleanings may be required to achieve satisfactory results.

The complex nature of HVAC system construction provides interior reservoirs for spores, viable organism collection and other contamination. There can be numerous amplification sites in HVAC system interior components that may or may not be of concern. Specialized experts procuring and interpreting samples should be IEPs with specific training in identifying contamination issues within HVAC systems.

All portions of each heating and cooling coil assembly should be cleaned in accordance with NADCA ACR current version section 7. Both upstream and downstream sides of each coil section should be accessed for cleaning. Where limited access is provided between close proximity or zero-tolerance heating coils in an air-handling unit, cleaning may require removal and/or replacement. Coils that are not completely cleaned of soil, accumulated microbial growth or other contamination can restrict airflow and have reduced latent capacity (i.e., ability to remove moisture). Such coils are at risk for contributing to future microbial growth.

After the coils have been cleaned, an inspection should be performed. However, visual inspections of coil surfaces can be misleading; therefore, it is recommended a static pressure drop test be performed before and after the cleaning process to demonstrate the effectiveness of such efforts. This type of measurement, which can be performed using a magnehelic gauge, or manometer, is a more accurate indicator for the presence of debris that has either been removed or remains within the coil.

The reconditioning efforts typically result in a static pressure drop sufficient to allow the HVAC system to operate within 10% of its nominal, or design (if known) volumetric flow and can be verified by an appropriate air test and balance procedure. However, other factors such as air leakage, fan blade condition, compromised duct, and permanently impacted coils (which are not capable of being fully cleaned), can have an effect on the overall static capability and subsequent performance of the HVAC system.

Special attention should be given to inspecting fan blades and blower wheels. Bacterial and fungal growth on these components can lead to rusting or pitting, and premature metallurgic decay. A heavily fouled blower wheel is only capable of a fraction of the air movement of a wheel with smooth, clean surfaces. Where components are badly pitted, a decision will have to be made between the probable loss in efficiency and the required capital expenditure of replacement.

Accumulated contamination or microbial growth is difficult to clean from coil fin surfaces. Restorers often are tempted to use aggressive cleaning agents (high and low-pH), because of difficulty in removing soil. Overly aggressive cleaners, such as those containing acids or caustics, can damage heat-transfer surfaces. Damage can range from surface pitting, which interferes with flow of condensate from fin surfaces, to accelerated structural deterioration of HVAC system components. Residues from cleaners also can add contamination to air flowing over coil surfaces, if not completely rinsed. Excess water pressure used during cleaning can also damage fin structures. Pressure as low as 100 psi can deform coil fins if solution flow rate and volume is high enough. Refer to NADCA ACR current version for more information.

14.5 Conclusion

Since HVAC systems circulate the air that workers and occupants breathe when the system is operating both during and after restoration, it is a critical component in the overall water damage restoration work plan. Category 1 water should be drained or vacuumed thoroughly from HVAC ductwork, systems and mechanical components as soon as practical. Once excess water has been removed, the system should be thoroughly dried. In situations where Category 2 or 3 water has directly entered HVAC systems, especially where internal insulation or fiberglass duct board is present, it might not be possible or practical to decontaminate HVAC ductwork, systems, and possibly even mechanical components. Mechanical and other system components should be evaluated, and cleaned, as necessary, following NADCA ACR current version.

15 Contents Evaluation and Restoration

15.1 Introduction

For purposes of this document the term “contents” generally is defined as personal property and fixtures that are not included in the building plans of a structure. These could include appliances, clothing, electronics, furniture, food, and many other items.

When a water intrusion occurs, often it is not just the structure that is impacted but the contents as well. An appropriate response is often the difference between successful restoration or repair, or costly replacement. When water intrusion occurs, many items that have become affected by moisture are not damaged initially. Affected contents should be evaluated and, if restorable, appropriate mitigation procedures be taken to preserve them from further damage, including secondary damage.

This process begins with a visual inspection, including documentation, to determine the extent of the damage. Contents should be inventoried and documented before being removed from the building. The restorable water damaged contents are cleaned by various methods and dried to appropriate moisture content. In many cases damaged items require storage until a professional evaluation is made and confirmation of the need for repair or replacement is determined. Disposal of non-restorable contents should be handled by the protocols described below. Finally, certain types of contents require special handling and procedures.

15.2 Overview of the Contents Restoration Process

Effective restoration of contents from a water intrusion generally includes, but is not limited to, the following tasks:

1. determine the Category (1, 2 or 3) of water and separate contents by their likely restorability;
2. determine the composition of affected materials. Porosity also can help determine restorability. General categories of contents are defined as follows:
    - Porous: Materials that absorb or adsorb water quickly, (e.g., clothing and other textiles, padded or upholstered items, leather, taxidermy, paper goods and many types of fine art);
    - Semi-porous: Materials that absorb or adsorb water slowly, can support microbial growth, (e.g., unfinished wood, concrete, brick, OSB) and
    - Non-porous: Materials that do not absorb or adsorb moisture easily, (e.g., finished wood, glass, plastic, metal).
        1. provide options related to the relative cost of cleaning versus the cost of replacement;
        2. determine whether to clean and store contents on-site or in-plant;
        3. determine the method of cleaning;
        4. dry to acceptable moisture content levels;
        5. determine those contents requiring restoration by specialty restoration professionals, (e.g., fine art, electronics, rare books, priceless keepsakes);
        6. communicate with materially interested parties to make final determinations on restorability;
        7. inform all materially parties and obtain written authorization before disposal; and
        8. properly dispose of non-restorable contents.

15.3 Inspection and Evaluation for Restorability

The restorability of contents is dependent upon several factors, including but not limited to:

1. category of water;
2. time of exposure;
3. basic material composition;
4. cost of restoration;
5. value or cost of replacement; and
6. types of value (e.g., sentimental, legal, artistic, cultural, historical).

The type of service required for each content item may be categorized in one of three ways:

- restore: Items that will be dried, and if required, cleaned or resurfaced, and returned to the client in an acceptable condition, if possible.
- dispose: Items that will not be cleaned because the owner has no interest in salvaging and/or the value does not justify the cost of restoration (see Disposal section).
- preserve: Items that are irreplaceable but cannot be properly restored to an acceptable condition.

Materially interested parties should participate in decisions about whether to restore or dispose of contents. Recommendations supplied by a specialized expert can be beneficial in making these decisions, especially when high-value items are involved.

15.3.1 Time of Exposure

The longer the time from the initial moisture exposure to completion of the restoration process, the less likely the contents can be restored. Prolonged exposure to moisture can result in swelling, cracking, color migration, material degradation or microbial amplification. Restorers should separate, contain, and document items that have been affected by mold according to standards set forth in the current edition of the IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*.

15.3.2 Removing Contents from Affected Areas

Before moving affected contents to another location, the restorer or a specialized expert should:

- inspect all contents prior to inventory, if practical;
- determine and document the condition of contents, which can include actual or perceived value;
- photo-document high-value or damaged items; and
- consider the possibility of drying contents in the affected area.

15.3.3 Inventory, Packing, Transport and Storage

Restorers should, prior to the pack out of contents, prepare a detailed inventory containing the following information, at a minimum:

- description;
- quantity;
- condition;
- location within the structure; and
- an inventory number for each item, box, or group of items.

Clients should sign a form accepting the inventory as representative of the existence and actual damage or condition of the contents before restorers assume responsibility for contents transport and processing. A photo inventory is recommended by first taking a picture of the initial documentation to capture the name and address of the client. Next take a picture of the front of the building as a visual reference to make it easier for the site manager to recall the jobsite for any future inquiries. Further, a list of photos can include, but is not limited to, occupants, exterior and interior, contents, demolition materials (if any), equipment placement, meter readings, and any other photos that would clearly depict the conditions and outcome of the water intrusion. Some restorers may use video recorders instead of photos to more accurately capture the visual documentation. Regardless of which media is chosen; a copy should stay with the job records and be kept in a secure place in the event future review is necessary.

Contents should be packed, transported and stored using appropriate measures to minimize breakage, damage, loss, or contamination of affected contents. It is recommended that vehicles, equipment, storage vaults or facilities be clean and orderly so that there is less potential for additional problems arising while contents are offsite.

Temporary storage conditions should be environmentally controlled while contents are in the restorer's custody to minimize conditions favorable to any type of contamination. Affected contents should be cleaned and dried, and cleaned contents should be stored in a clean area that is separate from the area where any uncleaned contents are stored. In some cases it may be necessary to add desiccant material to packaged contents to adsorb moisture and prevent moisture-related damage. Cleaned and dried contents should not be returned to the structure until complete restoration of the affected area has been achieved.

15.3.4 Drying or Cleaning First

In each loss, once a determination is made to restore an item, decisions should be made about whether to dry or clean the item first. Generally, if the item has been affected by Category 1 water, it is dried first, re-evaluated, and cleaned. If the water is Category 2 or 3, the item should be cleaned first and then dried. This helps remove as much contamination as possible and controls the spread of contaminants during the drying process.

15.3.5 Drying of Contents

To stop potential damage and return contents to an acceptable condition, steps should be taken to return items to a normal level of moisture content. Usually, this is accomplished by physically removing excess water from the surface. Additional moisture can be removed by using dehumidification, controlling temperature control, and by directing airflow across the affected items.

Consider drying affected contents in the area of the moisture intrusion in conjunction with drying the affected structure. This helps minimize cost and inconvenience for occupants. However, if the amount and type of damage to the structure prevents drying contents in the area of the moisture intrusion, or if contents require special handling, specialized drying chambers can be created to process the contents outside the affected area.

Specialized drying chambers can be as simple as another room separated by containment where the humidity, airflow and temperature can be used in a controlled manner to dry contents, and as complex as mobile freeze drying trailers used for books, documents, and electronic media.

15.3.6 Cleaning Contents

Cleaning is the traditional activity of removing contaminants and other undesired substances from an affected environment or surface to reduce damage or potential harm to human health or valuable materials. The goal of contents restoration is to clean items by maximizing the physical removal of soil, contaminates and odors.

Contents restoration implies returning items to as close to an acceptable condition as possible. It does not necessarily mean that an item has been improved in appearance. There are factors involving client expectations that could be addressed. It is recommended that appropriate appearance enhancement processes, as discussed below, be applied to items after their return to an acceptable condition.

As with structural restoration, additional damage can be discovered or created during the contents restoration process. When additional damage to contents is discovered, restorers should notify supervisors, so that it can be documented, and that materially interested parties can be informed within a reasonable period of time.

Contents can be cleaned either on-site or in-plant. There are advantages and disadvantages to each alternative listed depending on the specifics involved in a project. Some or all of the following can apply.

15.3.7 On-site versus In-plant

15.3.7.1 Advantages of on-site cleaning include:

- items remain in the client's control;
- expenses of packing, transport and storage are eliminated;
- normally, there is less chance of breakage or "mysterious disappearance;" and
- an on-site cleaning system, as discussed below, can be set up to process items before being moved to an unaffected area.

15.3.7.2 Disadvantages of on-site cleaning include:

- it may extend the wait time before start of the structural restoration;
- cleaning systems set up on-site can be significantly less efficient than well-designed plant facilities; and
- contents not removed from affected areas can require several "rounds" of cleaning, similar to structural materials.

15.3.7.3 Advantages of in-plant cleaning include:

- minimizing the time before structural restoration begins;
- allowing the use of specialty cleaning systems that cannot be set up onsite, and
- allowing structure and contents restoration to proceed simultaneously, potentially reducing total job time.

15.3.7.4 Disadvantages of in-plant cleaning include:

- significant costs are associated with inventory, packing, transport and storage;
- it increases the possibility of breakage, "mysterious disappearance" or accusations of theft; and

- the restorer assumes responsibility for the contents.

Regardless of whether contents are cleaned on-site or in-plant, appropriate precautions should be taken to prevent the spread of contaminants, such as dust and dirt from affected areas into unaffected or uncontaminated areas.

15.3.8 Outdoors

It is recommended that restorers take relevant factors into consideration before deciding to perform contents cleaning outdoors (e.g., weather, safety to workers and contents, possible public alarm at the sight of people attired in PPE).

When cleaning affected contents outdoors, cleaning should be performed at a distance from a structure to create a safe working environment. When cleaning out doors, restorers should use appropriate measures to protect the contents from any further damage. If restorers determine, after application of the General Duty Clause, that there is a risk to employees, then restoration workers handling or working near contaminated contents shall wear appropriate PPE; refer to Chapter 8, *Safety and Health.*

15.4 Cleaning Methods

When selecting a cleaning method, it is important to choose the best method for the situation. Knowing the material composition, the Category of water, and the location where contents are to be cleaned, is instrumental in selecting the proper method. A combination of methods can be necessary to facilitate contents restoration. These methods may be used before or after drying, as required.

15.4.1 Air-based Methods

- HEPA-vacuuming, or vacuuming with other units that exhaust a safe distance outside the structure;
- air washing is a method that uses an air stream to blow contaminants or moisture off surfaces, which can result in aerosolization, creating potential exposure for workers and occupants. This method shall not be used except outdoors, or in laminar-airflow, high-volume cleaning chambers, or in other situations where engineering controls are adequate to prevent excessive concentration of contaminants and minimize spreading of contamination in a Category 2 or 3 water. Air washing has the potential to drive contaminants and fragments deeper into porous materials (e.g., padded or upholstered items).

15.4.2 Liquid-based Methods

The Liquid-based cleaning methods rely on water combined with physical or mechanical cleaning processes to dislodge contamination. The following are examples of liquid-based cleaning methods:

- immersion cleaning with an appropriate cleaning agent;
- ultrasonic cleaning;
- washing with an appropriate cleaning agent;
- steam cleaning with live steam systems;
- cleaning with non-water-based liquid solutions;
- low-pressure flushing;
- high-pressure washing is a method that causes "splattering," resulting in aerosolization and an increase in RH. High-pressure washing techniques should be limited to situations in which aerosolization is not a critical factor (e.g., outdoors); and
- hot water extraction with truck-mounted or portable units.

15.4.4 Appearance Enhancement

There are many methods that are effective in improving the appearance of contents. Although removing contaminants and drying to an acceptable drying goal are the primary focus of contents restoration, there are client expectations that also should be addressed. It is recommended that contents be "appearance enhanced" to the extent practical before being returned to the client. This can include, but is not limited to, refinishing, polishing, waxing, and buffing using such products as:

- chemical strippers;
- rubout products for finishes;
- toners and bleaches;
- stains, glazes, and grain fillers;
- solvent-based finishes;
- gold leafing kits;
- touch-up products; and
- finishing and waxing products.

15.5 Cleaning Porous, Semi-Porous and Non-Porous Contents

Because of the nature of porous contents, particularly textiles, it is important to note the Category of water and the presence of contamination. Special care should be taken when unaffected contents are stored with affected contents to control potential cross contamination. Dry soil removal by thorough vacuuming and/or brushing with a soft bristle brush are the most commonly used methods for cleaning porous contents after being dried to an acceptable drying goal. A liquid-based or abrasive method may be necessary after the dry soil extraction has been performed. Rapid drying and any practical appearance enhancement follow cleaning methods. Also, distinguishing between Category 2 and Category 3 water may require visual inspection by a qualified restorer.

15.5.1 Porous and Semi-Porous Contents

Discussed below are general guidelines, by Category of water, for restoring porous and semi-porous items that are affected during a water intrusion. These contents can include, but are not limited to:

- books, documents and manuscripts;
- family records, scrapbooks and photographs;
- clothing, fabrics and other textile items;
- area rugs, tapestries and loose carpet;
- upholstery and mattresses;
- wicker furniture and similar items;
- paintings, sculptures and other art; and
- unfinished or unsealed wood.

15.5.1.1 Porous and Semi-Porous Contents – Category 1 and 2 Water

After carefully examining items for restorability, the proper cleaning method selected should be based on material composition and manufacturer instructions. Knowing the type of affected material is important in determining the type of restoration needed, such as multiple launderings.

For fabrics with heavy odor, a deodorization process, such as confined use of ozone or application of deodorizers, can be desirable prior to or following laundering or dry cleaning and drying to an acceptable goal.

15.5.1.2 Porous and Semi-Porous Contents – Category 3 Water

Restorers should dispose of most porous and semi-porous contents affected by Category 3 water, (e.g., padded or upholstered items) due to the inability to clean all areas of saturation, along with staining, discoloration or fiber damage. However, clothing and other household fabrics may be restorable with submersion washing in appropriate detergents. High-value or irreplaceable items of sentimental value, may justify cleaning and restoration using specialized techniques discussed later in this Section. The restorer should recommend to the client that post remediation verification by an indoor environmental professional (IEP) be performed.

15.5.2 Non-Porous Contents

All items should be examined first for restorability. Some glass and plastic items can be etched or stained by long-term exposure to water and associated microbial growth. Metal items can be unrestorable due to corrosion, which can be accelerated by acids produced by fungal growth; see *IICRC S520 Standard and Reference Guide for Professional Mold Remediation*. Discussed below are general guidelines by Category of water for restoring non-porous items affected during a water intrusion.

15.5.2.1 Non-Porous Contents – Category 1 and 2 Water

Usually, cleaning can be accomplished by using one or more of the following cleaning methods:

- detergent washing and rinsing;
- ultrasonic cleaning;
- damp wiping with a cleaning agent; or
- other suitable processes for the particular item.

15.5.2.2 Non-Porous Contents – Category 3 Water

If an item is non-porous and there are no indications that bonded materials have absorbed water, cleaning procedures are the same as those for Category 1 and 2. After thorough cleaning, restorers should remove cleaning residue, followed by the application of appropriate antimicrobial biocides, rapid drying and appearance enhancement, if necessary. If bonded materials have been affected, by water intrusion and are deemed non-restorable, the item should be discarded following guidelines for non-restorable contents discussed later in this Section. It may be advisable to review the owner's manual for water damaged contents, if applicable and available, for special or recommended cleaning methods or considerations that could affect warranty or restorability.

15.6 High-value and Irreplaceable Contents

High-value contents are those with high monetary value or replacement cost. Irreplaceable contents are those with unusual historical, sentimental, cultural, artistic, legal or other value. Specialized cleaning and restoration techniques may be appropriate for these contents. Such procedures can be as simple as repeated cleanings, using standard practice as described above, or can require the use of specialized experts.

For many categories of high-value and irreplaceable contents, specialty restoration services are available. Some restorers may provide these services in-house, while others may out-source the work. Specialty restoration services include, but are not limited to:

- art restoration or conservation for paintings, valuable books, works of art on paper, documents, objects, frames, tapestries and other textiles;
- collectable doll restoration;
- freeze drying for valuable books and documents;
- area rug cleaning and repair;
- electronics and machinery restoration;
- data recovery; and
- musical instrument restoration.

Cleaning processes should start with soil and contaminant removal. If heavy odors exist, multiple cleanings and deodorizing attempts may be needed. Post remediation verification by an indoor environmental professional (IEP) should be performed and documented to ensure decontamination before the item is returned to the client. Organic materials, such as leather objects, animal trophy heads, and similar items, are highly susceptible to mold growth after water damage, and might not be restorable; refer to current version of the *IICRC S520 Standard and Reference Guide for Professional Mold Remediation.* Such additional or specialty restoration procedures might not return these items to an acceptable condition. Depending on the item restored and the level of contamination, a specialized expert may be necessary to determine whether or not an item has been restored. If items are not restorable, materially interested parties should be consulted to determine an acceptable course of action with respect to the disposition of the items.

15.7 Unrestorable Contents

Unrestorable contents should be inventoried, photo-documented, and removed or disposed in compliance with the removal and disposal recommendations later in this Section. Unrestorable contents should not be disposed without the permission of the client or other materially interested parties, as applicable. These parties authorize disposal by signing an appropriate form listing the items. It is recommended that unrestorable contents be removed from the work area before restoration services begin. When returning contents that have not been restored to an acceptable condition, restorers should inform the client of the circumstances involved, advise them in writing of the potential consequences of accepting contaminated contents and attempt to obtain a written waiver and release of liability for those potential consequences.

15.8 Disposal

It is recommended that waste materials be moved from the work area to a waste container in a manner that minimizes the possibility of cross-contamination of unaffected areas. It is recommended that sharp items capable of puncturing poly material be packaged in such a way as to prevent penetrating the material before being bagged or wrapped to prevent leakage. It is recommended that bags not be dropped, thrown or handled roughly.

If timely disposal of affected contents is not possible, it is recommended that staged debris be stored in a reasonably secure location. Generally, no special disposal provisions are recommended for water-damaged materials; however, federal, state, provincial and local disposal laws and regulations apply. If waste-materials are contaminated, then procedures listed above should be followed.

15.9 Specific Handling Recommendations

15.9.1 Sculptures, Artwork and Other High-Value Collectables

Consider establishing an on-going business relationship with a nearby art storage facility to pick up and care for high-value sculptures, paintings, photographs and other high-value collectables. Restorers should take a complete inventory of the affected items to be removed and have the property owners sign the inventory.

Inventories should include the artist, title, subject, date, size, medium, inscriptions or markings, distinguishing features, condition history, the value if known and a photographic image. A copy of this inventory should be kept in a secure location at a site separate from the collection in the event of any potential harm that may occur to the collection itself. A professional conservator will also keep a copy of the records.

15.9.2 Books and Documents

Water-damaged paper goods can include books, manuscripts, family records, scrapbooks, keepsakes and collectibles. On average, such paper goods can absorb up to 60% of their weight in additional water. Major damage to these items usually takes place within the first 8 hours. These items should be removed if exposed to high humidity or if contaminated during drying. Recovery efforts using sublimation (vacuum freeze-drying) can be up to 99% effective.

When sending affected paper goods to a specialist use cardboard banker's boxes for packing the books and documents. Label boxes with your company name and contact information. Handle the wet materials carefully to avoid additional damage while rinsing off mud and dirt using clean water. Pack books with the spine down and documents upright in the boxes. Books should be packed in one layer with no other contents items packed on top. When palletizing boxes, stack them no more than three high to prevent crushing the bottom box during shipping to the sublimation specialist.

Restorers should freeze uncoated paper within 24 hours, or as soon as reasonably possible, to minimize the potential for damage and/or mold growth. Coated-paper should be interleaved with an appropriate sheet product and frozen within 8 to 12 hours to reduce the potential for blocking of pages. Low temperature blast freezers produce smaller ice crystals during the freezing process and can produce better results.

15.9.3 Electronic Media

It is recommended that media recovery specialists, whose primary business is software-related media or video, handle the restoration of affected media as quickly as possible. These experts use the proper chemicals and techniques to examine, retrieve and preserve information stored on such media. If the affected media's value or importance outweighs the cost of specialized restoration, then the procedures listed for books and documents should be followed.

It is recommended that the restorer contact and partner with these specialists ahead of time to obtain the procedures that need to be followed in order to properly prepare the media for transporting. Typically initial steps taken by the restorer would include:

- packaging the media in tightly sealed plastic bags;
- labeling and inventorying the bags;
- freezing the inventory as soon as possible;
- placing the bags with the frozen media in a sturdy container labeled with your company's mailing address and contact information; and
- shipping it to the specialist with the media in a frozen state.

15.9.4 Draperies

Draperies that have not been directly affected should be placed on hangers or removed from the immediate area of the moisture intrusion. If any of the synthetic material items have become wet, it is usually best to wet out the entire panel and then place in a dryer for uniform drying.

Draperies made with natural fibers can shrink and/or develop water stains or sizing rings that might not be correctable. Commercial laundries that specialize in drapery cleaning might be able to steam and re-stretch the fabric. Note that many draperies have become weakened from use and exposure to sunlight and might not withstand restoration procedures.

15.9.5 Mattress, Box Springs and Pillows

If deemed salvageable by the restorer, mattresses, box springs and pillows that have been affected by Category 1 water can be extracted, cleaned and dried. Mattresses, box springs, pillows and fabrics containing stuffer materials that have become contaminated with Category 2 water may not be restorable, while the same contents contaminated with Category 3 water should not be restored regardless of value. Proper disposal of these materials can include bagging in plastic and removal to an appropriate disposal site.

15.9.6 Upholstered Furniture

Upholstered furniture, throw pillows and stuffed fabrics that have become wet with Category 1 water usually can be cleaned and dried, if response is timely. Stuffed fabric furnishings that are wet with Category 2 water may not be restorable, while items contaminated with Category 3 water should be removed and properly disposed. In the case of irreplaceable or high-value furnishings, it is recommended that materially interested parties be involved in making this decision.

Upholstery and fabric cleaning procedures are found in IICRC S300, *Standard and Reference Guide for Professional Upholstery Cleaning.* Thorough moisture extraction and rapid drying are critical if restoration procedures are to be successful. As with clothing and soft goods, deodorization of severely affected contents may be conducted with appropriate techniques. One or more repeat cleanings may be needed to remove odors and further reduce contaminant levels. Rapid drying and appearance enhancement, as practical, can follow cleaning.

15.9.7 Case Goods

Affected case goods (e.g., bookcases, chests of drawers, dining or bedroom furniture) should be blocked up and wiped dry with an absorbent towel to limit potential damage. Case goods made of soft or hard wood can typically be restored by cleaning, drying to normal moisture content and using cream refinishers to remove white discolorations from excessive moisture. If necessary, it is recommended that furniture requiring light or full refinishing be referred to a specialized expert.

If the case goods are made of compressed wood and have already swelled, it is recommended that the restorer consult with the client and other materially interested parties to determine the course of action. Normally, these case goods are non-restorable and should be discarded. In the case of Category 3 water, case goods made of compressed wood should be discarded at an appropriate disposal site.

15.9.8 Pianos and Musical Instruments

The construction components of a piano and its internal mechanisms are subject to instability and variation because of its surroundings. Typical piano construction includes a cast iron plate, reinforced beams, hardwood multi-ply bridges and pin-blocks, and steel strings. The recommended ambient relative humidity range for pianos is 35% to 55%.

The objective in restoring a piano affected by a water intrusion is to return the instrument to its quality of sound, the precision and sensitivity of its action, and its appearance and value.

Restorers should retain a specialized expert to transport or restore a water-damaged piano. If it becomes necessary for the restorer to transport the piano off-site, it should be carefully padded and placed sideways on a professional skid-board for moving. The legs and pedal assembly (lyre) should be removed and carefully padded, additional blankets should be added for extra protection, and the piano should be secured in an appropriately equipped vehicle for transportation. It is recommended that the owner of the piano visit the piano restoration company upon completion of the restoration to inspect the piano before having it returned to the client's premises.

Other portable instruments that have been directly or indirectly affected by a water intrusion should be documented and inventoried by the restorer and either dried in the affected area or referred to a specialized expert for restoration. If an instrument has high value, restorers should ensure that it is delivered into the care of a specialized expert who is acceptable to the client, as soon as possible.

15.9.9 Pool and Snooker Tables

When pool or snooker tables are affected by a water intrusion the restorer needs to be aware that there are degrees of restoration that could affect the value of the table. The more restoration, the less pristine of an original and the less it will hold and increase its value. An antique pool table could be entirely rebuilt with all new marquetry and veneers, in which case its authenticity and collectible value could be decreased.

Restoration could be as simple as drying the table in the affected area to normal moisture content. More elaborate steps could include a new billiard cloth, re-leveling, re-rubbering the rails, applying hot oil and wax finish, honing the slate, and replacing damaged sections or pockets by a table restoration expert that is acceptable to the client.

15.9.10 Area Rugs, Loose Carpeting and Tapestries

Cleaning procedures for area rugs and carpet are found in the latest edition of IICRC S100, *Standard and Reference Guide for Professional Cleaning of Textile Floorcovering.* Thorough moisture extraction and rapid drying are critical if restoration is to be successful. As with clothing and soft goods, deodorization can be conducted with appropriate techniques. One or more repeat cleanings might be needed to remove odors and further reduce contaminant levels. Appearance enhancement, as practical, follows cleaning.

It is recommended that area rugs and tapestries be cleaned at an in-plant facility by a specialized expert. Spreading contaminants during cleaning can be a potential problem. Submersion cleaning of area rugs under water is less likely to aerosolize contaminants. If a high-value area rug or tapestry is saturated with Category 3 water and there is a decision to attempt salvage, it should be cleaned with submersion pre-cleaning, followed by saturation with appropriate antimicrobial biocides and a secondary submersion cleaning. The severity of contamination in the case of Category 3 water may necessitate involving an IEP for post-restoration testing to ensure complete decontamination. Documentation of complete decontamination should be obtained from the IEP and included in job records. Furthermore, loose carpeting affected with Category 3 water should be discarded and replaced, as with installed carpet, due to the cost and unfeasibility of restoration.

15.9.11 Clothing, Bedspreads and Other Porous Articles

Wet clothing should be separated into darks, colors and whites, and laundered according to the recommended care labels. Using a detergent in the laundering process facilitates removing contaminants. Laundry sanitizers may be added, if textile manufacturer directions permit. They help reduce microorganisms, and may significantly reduce odors. For fabrics that are not chlorine bleach safe, adding oxygen bleaches, such as sodium perborate or sodium percarbonate can provide similar benefits, if permitted by manufacturer directions. Increasing the water temperature also can enhance the laundering process. Care should be taken not to exceed the manufacturer's water temperature recommendations.

When dry cleaning, restorers should follow manufacturer label directions, and standards of care for the dry cleaning industry, based on fabric or material type. In addition to traditional solvent-based processes, new liquid carbon dioxide dry cleaning and other alternatives are available, and can be better suited for some items. As with laundering, the primary goal of dry cleaning is the physical removal of contaminants and associated odors, rather than microbial kill. Repeat laundering or dry cleaning may be needed to satisfactorily eliminate microbial odors, as well as to provide an additional measure of assurance of maximum contaminant removal. The decision to perform multiple launderings or dry cleanings involves professional judgment in consultation with the property owner or other materially interested parties.

15.9.12 Furs and Animal Trophies

If fur clothing or items are affected by Category 1 water, it is recommended that restorers shake off excess moisture and let the fur dry naturally by hanging it in the affected area. The heat and low humidity generated in the course of normal structural drying will dry out the fur to its original texture. If the fur is drenched, blotting from the inside (not the fur side) with clean white towels is recommended. Do not to rub or squeeze the lining in the process. Using moth or cedar balls for deodorizing near a fur coat during drying is not recommended, as the smell often adheres to fur and creates unpleasant odors that can be difficult to remove.

After drying a fur, it may need further care by a professional to condition and re-glaze the animal skin. Glazing is a process that replenishes essential oils necessary to maintain the fur's longevity.

When animal skins and hunting or fishing trophies are affected by a water intrusion, these items should be documented and inventoried, then sent to a taxidermist for restoration. Usually, these items are specially treated and can have stuffing material that needs to be replaced to prevent on-going damage. Restoration could include re-casing, creating new scenery or ground work, and appearance repairs including, but not limited to, new eyes, new fins, recapping, and recoloring.

15.9.13 Appliances and Electronics

If direct wetting of appliances and electronics takes place, evaluation and restoration by a qualified electrical or electronics specialist should be accomplished. Restorers should remove electronic components from high-humidity environments as soon as practical. Only a short period of time exists between initial wetting or exposure to high humidity and the onset of damage that could necessitate replacement of costly equipment. It is recommended to test, evaluate and clean appliances, electronic and other electrical equipment before major damage occurs. These items can include, but are not limited to:

- televisions;
- stereo equipment and speakers;
- computer-related equipment (e.g., servers, personal computers, monitors, printers, scanners, speakers, miscellaneous hardware);
- appliances (e.g., refrigerators, freezers, ranges, washing machines, dryers, water coolers);
- small appliances (e.g., toasters, coffee makers, convection ovens, microwaves, air filters, fans, clocks, telephones); and
- power equipment and tools.

15.9.14 Aquariums

If aquariums need to be moved or removed from an area that has been affected by a water intrusion, fish or other inhabitants should be removed by the client and the tank should be emptied to avoid unnecessary stress and possible failure of tank seals. If the client is untrained in the proper removal or is uncomfortable about it, then a specialized expert should be retained to care for the inhabitants until restoration is complete. When structural restoration is complete, aquariums can be re-set and prepared, and the inhabitants can be returned.

If aquariums do not need to be removed, then restorers should work with clients to plan a schedule of maintenance for inhabitants during restoration. Also, aquariums should be fitted with a protective covering to eliminate the possibility of contaminants entering or water evaporating out of the aquarium.

15.9.15 Firearms and Ammunition

If firearms and ammunition are discovered at the worksite, restorers should immediately inform clients. When safe to do so, clients should collect firearms and ammunition in work area and move them out for closer evaluation. If there is no one available to collect firearms or ammunition, restorers should communicate with company management for instructions. Firearms should not be handled by someone who is unfamiliar with safety protocols, to eliminate the possibility of an unintentional discharge of a weapon.

If firearm restoration is necessary, it is recommended it be performed by a reputable and qualified firearms restoration firm. Restorers shall comply with applicable laws and ordinances for handling and transporting firearms. Sources for finding firearms restoration professionals may be obtained through recommendations from local law enforcement agencies or gun clubs.

Safety precautions shall be taken if ammunition has visibly deteriorated, so as not to create the potential for physical harm to individuals on site. When appropriate, officials (e.g., police or bomb squad) should be contacted to determine whether or not ammunition may become unstable during movement. A specialized firearms expert for deterioration and safety can check ammunition before returning it to clients for use.

ISO 3175 - Textiles -- Professional care, drycleaning and wetcleaning of fabrics and garments, International Organization for Standardization (ISO), Geneva 20, Switzerland, website: www.iso.ch

16: Large or Catastrophic Restoration Projects

16.1 Introduction

Large projects generally involve four basic types of structures: commercial, industrial, institutional, and complex residential. Large projects involve many building materials, components, systems and methods of construction different from those found in typical residential structures. Differences in large projects are especially apparent in the size and intricacy of mechanical and HVAC systems and electrical systems, the presence of low voltage and special wiring systems (e.g., fire suppression, security systems) and in more complex building materials and construction methods. Large projects also involve challenges related to public access, security, authority, or organizational hierarchy.

- Large projects are handled differently from other water damage restoration projects and usually require a higher level of project management or administration. The management and administration might be accomplished in-house or outsourced to a specialized expert. Questions that should be asked at the beginning of a large project include, but are not limited to: Is the use of the structure or facility commercial, industrial, institutional, or complex residential?
- Who are the materially interested parties that are involved?
- Is the project complex enough to necessitate the use of one or more specialized experts?
- Is public safety and health a concern?
- Are property owners self insured or do they have a substantial deductible?
- Are the impacted areas extensive, involve multiple buildings or are special security areas involved?
- Was the project a sudden, accidental, natural or weather related occurrence?
- Is there a third party agency involved (e.g., government, a multinational or corporate office in another location)?
- Does the structure contain high-value, sensitive or historical materials or contents that require special insurance coverage, additional security, procedures or personnel to perform specific restoration services?

16.2 Types of Structures

Large projects generally involve four basic types of structures: commercial, industrial, institutional, and complex residential. Large projects can result from improper maintenance, casualty (e.g., accidents, failure of building components), intentional acts (e.g., vandalism) and weather-related events.

16.2.1 Commercial

Commercial structures are buildings or facilities where the use is primarily for retail, office, mixed-use and warehousing. These structures usually have limited power availability, partitions or demising walls, and have multiple finished surfaces and fixtures.

16.2.2 Industrial

Industrial structures are buildings or facilities where the use is primarily for manufacturing, foundry, and distribution. These structures usually have heavy power availability, few partitions or finished surfaces.

16.2.3 Institutional

Institutional structures are buildings or facilities where the use is primarily for public facilities such as schools, hospitals, municipal buildings, sports complexes, airports, libraries or other governmental facilities. These structures can have power availability, public access and security challenges, or various layers of authority and organizational hierarchy.

16.2.4 Complex Residential

Complex residential structures are residential facilities include: townhouses, condominiums, apartment complexes, hotels, multi-family dwellings, or large single-family mansions or estates. These structures may have multiple owners and insurance policies, and common construction components and accessibility challenges.

16.3 Building Systems

Because of the wide variety of uses of large structures, there are a wide variety of building components and systems which are not found in typical residential construction. Many building materials and methods of construction in large structures are different from those used in residential structures.

16.3.1 Mechanical and HVAC Systems

Mechanical and HVAC systems in large projects are generally larger in size and more intricate in design than residential systems. A specialized expert may be necessary when dealing with a commercial mechanical or HVAC system; see Chapter 12, *Specialized Experts*. Large project HVAC systems can be roof-mounted, ceiling-mounted; or they may be located in an area completely separate from the area of water intrusion. These systems can have several intermediate heating and cooling elements and several air distribution systems. They can also have electronically controlled climate sensors, dampers, fire dampers, barometric pressure relief systems, fire suppression, exhaust and fresh air systems, as well as other systems of which the restorer should be aware when working with or around such systems. Insulation can be on the interior or the exterior. The ductwork can be fixed or flexible and can be constructed from a variety material. Commercial mechanical and HVAC systems are to be carefully evaluated and handled by restorers or specialized experts; see Chapter 14, *Heating, Ventilation and Air Conditioning Restoration*.

Other commercial mechanical systems (e.g., plumbing, fire suppression, electrical, gas) can be dramatically different from residential systems, and may vary depending upon building use. These systems can have fault sensors, pressure switches and electronic distribution systems. Many systems are monitored by in-house or third party monitoring services, which detect faults, system failures and manual tampering. Monitoring systems should be controlled or shut down before working around or servicing them. Failure to do so can result in costly repairs and unnecessary procedures to reset or recharge the system.

16.3.2 Electrical, Low Voltage and Special Wiring Systems

Similar to mechanical and HVAC systems, commercial electrical systems are larger and more intricate than residential systems, and include low voltage and special wiring. A specialized expert might be necessary when dealing with commercial electrical, low-voltage or special wiring systems; see Chapter 12, *Specialized Experts*. Special wiring systems can include: CAT 5 or other computer wiring, fiber-optic wiring, alarm and security systems, coax cabling and other wiring or cable systems. Low-voltage wiring can sometimes be particularly difficult to work with since many systems are wired to special transformers and relays.

The greatest variability in a commercial environment is the electrical system. Depending upon the requirements, a system can have single phase and three phase power, voltages can vary from 110 to 480 and breakers can be 15 to 300 amps, or more. Portable generators may be advisable when the available power is known or suspected to be insufficient for the project. Also, portable generators can be necessary when access to the in-house power supply is restricted or prohibited.

16.3.3 Building Materials and Systems

Commercial, industrial, institutional, and complex residential structures vary greatly in composition, construction and materials. Ceilings can have open steel or wood framing, drywall or plaster, acoustic ceiling tiles, among others. Walls can consist of different structural compositions such as drywall, plaster or brick over steel, wood or masonry, and be insulated or non-insulated. While the most common flooring materials are carpet, vinyl composition tile (VCT), or concrete, there are many new specialty materials being introduced to the market that can necessitate special treatment during the restoration process. It is recommended that restorers stay informed about the latest construction methods and materials.

16.4 Administration

16.4.1 Cost and Pricing Methods

The cost and pricing methods below are commonly used in the administration of large projects. The increased need for equipment, products, materials and labor in large projects can create extraordinary demands on restorers and their vendors. These methods include:

16.4.1.1 Cost-plus-overhead-and-profit

This method involves tracking the actual cost of labor, materials or products, equipment cost or rental, and subcontracted invoices. The sum of these costs plus a predetermined margin of overhead and profit, constitute the total cost of performing services. The advantages of this method include: eliminating the need for a predetermined or published price guideline, and eliminating the need to spend time on measuring and making decisions on a scope that can change many times throughout the project. The disadvantages include: lower margin of profit, and the uncertainty that might result without an advance agreed-upon scope of work, and the necessity to renegotiate overages that might exceed the previously-set budget for time, materials, equipment and subcontract costs.

16.4.1.2 Time-and-materials

This method involves tracking the actual cost of labor, materials or products, equipment cost or rental, and subcontracted invoices. The data are then compiled and assigned an amount based on a predetermined or published pricelist. Data collected early in a project can be broken down into units that can be used to estimate the total potential cost of a project. This allows restorers to concurrently establish a budget to follow. The advantages of this method include: streamlined data compilation for auditing and estimating; a balanced margin of profit; creation of a budget to aid in the processing of payments on the project, and avoiding the need to spend time on measuring and making decisions on a scope that can change many times throughout the project. The disadvantages of this method include: the uncertainty that might result without an advance agreed-upon scope of work, and the need for a predetermined or published price guideline.

16.4.1.3 Measured Estimate or Bid

This method involves measuring and inventorying the project, and calculating the exact scope and price for performing the services. Changes involving scope or price during the course of the project should be documented by a written change order, signed by an authorized party and the restorer.

Advantages of this estimating method include: more precision in estimating and implementing a project; lower administration cost during the project; a fixed budget and margin of profit, and the development of a scope agreed-upon in advance. Disadvantages of this method include: a greater expenditure of time on project estimating prior to the services being performed; higher likelihood of work stoppage for processing potential change orders; an incentive to increase the rate of production, which might compromise service quality, and reduced opportunity for restorers to apply professional judgment when implementing and completing a project.

For projects performed on a cost-plus-overhead-and-profit basis, or time-and-materials basis, administration may be completed by in-house daily reports of time, material and products usage, and equipment rental and subcontract expenses. An on-sight project manager or administrator collects these reports; than compiles them for auditing and billing.

The administration required to mobilize, implement and complete a large project can be extensive, especially if the project is performed on a cost-plus-overhead-and-profit basis, or a time-and-materials basis. Regularly scheduled monitoring, inspection and evaluations are more crucial when processing a large project because of size, complexity and potential variables. Many times a large project is administered or audited by a third party, ensuring accuracy and transparency in billing. Even when projects are based on a measured estimate or bid, proper coordination of administrative practices during a large project is essential.

16.4.2 Payment Schedules

To expedite large project administration, payment (draw) schedules are required to finance the project through completion. A payment schedule is a means of payment for portions of the project at regular intervals. These schedules should be predetermined, agreed upon and incorporated within the project contract. The type of payment schedule is usually dependent on the size, complexity and method of handling the project.

In the case of a measured estimate or bid, the schedule may be based on weighted percentages of the estimate during the course of the project, such as an initial payment, a number of equal interval payments and a final payment contingent upon successful completion. In the case of a cost-plus-overhead-and-profit project or time-and-materials basis, the schedule may consist of a down payment, interval payments based on invoices for work completed and a final payment based on substantial completion.

The funding for a large project can be escrowed by a third party, the customer or an insurance company. In these situations, draw schedules are often negotiated so as not to affect on-going cash-flow needs of the restorer.

16.4.3 Communication

As with any other project, communication is one of the most important factors in successfully completing a large project. The difference is in the extent and frequency of communication necessary to complete it. In a typical residential water damage restoration project, the restorer should communicate with the owner or owner's representative, restorer's crews, subcontractors and specialized experts, and possibly an insurance company representative. On large projects, however, there often is an on-site manager for the restorer, a facilities manager, a board of directors, an insurance auditor, legal counsel, and other materially interested parties. A communication structure or "tree" should be established and strictly adhered to before, during and after completing a large project.

In the case of catastrophic large projects, (e.g., widespread flooding, hurricanes and tornadoes) federal, state and local government agencies can be involved. Examples in the United States include: Federal Emergency Management Agency (FEMA), state or local boards of health, building inspectors, and Housing and Urban Development (HUD). Many of these agencies offer loans, grants and other aid to victims of disasters. In many cases, when dealing with these agencies, legal counsel or certified public accountants may be necessary to file the correct documents allowing for prompt service and payment.

16.4.4 Project Documentation

Consistent documentation at regular intervals during a large project is essential. Many of the daily logs, notes and reports are similar to those outlined in Chapter 9, *Administrative Procedures, Project Documentation and Risk Management*. In addition to limiting liability for restorers, documentation is necessary for communicating, billing and reporting to the customer. The amount of documentation necessary to administrate a large project is often the primary justification for an on-site, full-time or third-party administrator. The expense associated with documentation should be considered in estimating the cost or billing for a large project.

16.5 Security

Large restoration projects require special security considerations, including, but not limited to: working in commercial buildings that already have a full-time security staff; projects where restorers out-source security; projects where the restorer's staff provides a safety watch without activity documentation; and government or high-security projects where personnel must pass security clearance to work in restricted project areas.

16.5.1 Full-Time Staff Security

Generally, commercial buildings and large corporations have a full-time security system in place, which includes security personnel on-location around the clock. Restorers can be required to work with building security in large projects. Security companies usually issue security badges and obtain general information about the restoration company, and make sure that appropriate insurance certificates are filed with the building manager. The restorer should comply with the rules and policies of building security or third-party security provider.

16.5.2 Security contracted by Restorer

There are also many large project job sites where the building does not have security in place. On these projects, restorers may want to consider hiring an outside company to assist in securing the project site. When considering security outsourcing, restorers should evaluate whether or not it is prudent for security to be outsourced, the experience and qualifications of the security company (e.g., indoor or outdoor security or other special needs), and the necessity for the security company to be licensed and bonded. Restorers should work with the building owner or manager, the insurance company and other materially interested parties regarding the financial aspects of hiring and securing a large project site.

16.5.3 Monitoring provided by Restorer

In many large projects, restorers may want to use a safety-watch option. This is an option in which restorers actually provide around-the-clock monitoring without record keeping. The purpose of this lower level of security is to monitor for potential operational problems and unauthorized attempts to enter the premises or remove equipment.

16.5.4 Regulated Security Areas

If the large project is a regulated security site, information on all employees may be requested for background investigation of project employees. When providing such information, restorers shall comply with applicable data-protection or privacy laws and regulations. Investigations can include: criminal background, homeland security, and credit checks of restoration company owners, as well as those entering the site on the company's behalf. Restorers may be required to provide training about working in high-level security areas, on how to observe specialized security policies, and on complying with applicable regulations.

16.6 Labor

16.6.1 In-House and Contract Employees

While it is preferable to use trained, in-house employees, sometimes on large projects it is necessary to employ temporary labor, trained restorers from other restoration firms or on-call contract help. Frequently, it is not financially feasible to maintain a permanent staff large enough to handle large projects.

The ability of restorers to manage people, such as employees, contract help and subcontractors, is important to the successful completion of a large project. Therefore, it is recommended that restorers performing large projects maintain a well-trained, full-time staff with the skills required to manage a quantity of contract employees, as well as the technical competence to handle their assigned portion of a large project.

16.6.2 Subcontractors

Many times subcontractors are needed to staff a large project. A large project restorer should consult a legal professional to draft a formal subcontract agreement for use when engaging subcontractors. There are many differences between subcontractors and contract employees, including the degree of control asserted over them. Subcontractors are independent contractors having greater discretion and control over the conduct of their activities than employees. Subcontractors can indemnify a restorer for acts and omissions, including those caused by negligence, and they usually carry insurance covering their operations.

16.7 Equipment

It is usually preferable to use equipment owned by the restorer. However, it is unlikely that any large project restorer will have enough equipment to handle multiple large projects simultaneously. Therefore, using equipment from various sources, such as equipment sharing plans with other restorers, short term leases, job-specific rentals, or obtaining equipment from other sources might be necessary. Often on large projects the required size and number of pieces of equipment is much greater than that required on residential projects. Tracking equipment can be a challenge. Equipment inventory, tracking and movement systems should be used to maintain efficiency and effectiveness on large projects.

16.8 Working out of State, Province or Country

When working on large projects outside the restorer's home state, province or country, restorers shall comply with pertinent federal, state, provincial, and local laws and regulations applicable to their activities in those areas. Restorer insurance requirements, including those for general liability, worker compensation, and pollution liability, can vary by jurisdiction. Licensing and permits, as well as laws regulating the conduct of a restoration business, also can be different between jurisdictions.

Generally, laws and regulations applicable in the jurisdiction where a large project is located apply to restorers performing services there even when they are based in a different jurisdiction. Restorers shall comply with business regulations, licensing and insurance requirements applicable in jurisdictions in which they conduct business.

17 Materials & Assemblies

Buildings are constructed in such a way that the restorer cannot consider specific materials without regard to others as they are designed to work together in various structural, flooring, roofing and mechanical assemblies. Restorability and cleaning should be determined by the assembly, and not the specific material. For a more detailed discussion on various materials and assemblies, refer to Chapter 17, *Materials & Assemblies*.

17.1 Evaluating the Restorability of Building Materials and Assemblies

Restorers should consider several criteria when determining that materials or parts of an assembly are restorable. The restorer should understand the affected materials and construction. This can include but is not limited to the presence of interstitial spaces, vapor barriers, integrity of the top finish-coat or other finish material. While some affected materials can be readily restored, they may require removal in order to access other components. Understanding the affected materials and assemblies will help the restorer determine a successful approach to drying (refer to Chapter 10, *Inspections, Preliminary Determination and Pre-Restoration Evaluations).*

Much of the information is obtained during the initial inspection. When materials are determined restorable but contamination issues exist restorers should employ the appropriate remediation procedures prior to drying efforts defined in this Section (refer to Chapter, 13 *Structural Restoration*)

○ Descriptions of Restoration Procedures

The following section contains definitions and descriptions of common restoration processes and procedures. For a complete description of the procedures and their application to a particular material or assembly, restorers can refer to Chapters 4, *Building and Material Science*; Chapter 11, *Limitations, Complexities, Complications and Conflicts,* Chapter 13, *Structural Restoration* and particularly Chapter 17, *Materials and Assemblies*.

17.2.1 Restorability:

- Restorable – This material or assembly is restorable if flaws or cosmetic effects are insignificant and acceptable.
- Generally restorable – This material or assembly can be restored if it is structurally sound, cleanable and can be returned to acceptable condition. In some cases, the materials may not be damaged, but their presence can slow drying of more critical materials or assemblies behind or below them (e.g., vinyl wallpaper over wet drywall, sheet vinyl flooring over wet subflooring).
- Generally unrestorable – This material or assembly may be unrestorable due to (1) quick developing impacts of moisture sorption, (2) inability to adequately clean or sanitize or (3) inability to ensure achievement of drying goals throughout the assembly.
- Unrestorable - This material or assembly should not be restored due to (1) quick developing impacts of moisture sorption, (2) inability to adequately clean or sanitize or (3) inability to ensure achievement of drying goals throughout the assembly.

17.2.2 Bulk water removal (Extraction):

- Pump bulk water – Pumps (i.e., submersible or surface) with sufficient lift and volume capacity can be used to remove standing water from floors and structural components. Wastewater shall be handled, transported and disposed of in accordance with all local, state, provincial or federal laws and regulations.
- Extract/Remove water – Water can be efficiently removed from the structure, systems, and contents using surface extraction (e.g., truckmount, portable, squeegee, mop). When using truckmount or portable extraction equipment for removing water from soft goods, equipment with sufficient vacuum capability (lift and airflow) is necessary. These units can also be used for removing deep standing water when pumps are not available. Wastewater shall be handled, transported and disposed of in accordance with all local, state, provincial or federal laws and regulations.
- Follow-up extraction can be needed due to seepage – Repeatedly extracting water from materials and components can be required as water seeps out of inaccessible areas, especially in multi-story water restoration projects.

17.2.3 Cleaning

Cleaning is the process of locating, identifying, containing, removing and properly disposing of unwanted substances from an environment or material consistent with this Standard. Restorers should evaluate and clean materials within the work area as needed. The three basic levels of cleaning are (a) initial/bulk cleaning, (b) detailed cleaning and (c) final cleaning.

- Initial/bulk removal of debris, unsalvageable or contaminated materials – the process of removing bulk debris, soil or materials from the work area. This process can include but is not limited to: the demolition of unsalvageable materials, removal of materials to gain access to expedite drying, or to remove bulk contamination (e.g., sewage).
- Perform controlled demolition, as needed – During demolition, contaminants can be easily dislodged or aerosolized. Restorers should minimize dust generation and aerosolization by using appropriate engineering controls (e.g., source-controls, vacuum attachment on saws, bagging wet materials immediately)
- Control potential spread of contaminants - Contaminants should not be allowed to spread into areas known or believed to be uncontaminated. Contaminants can be spread in many ways (e.g., tracked on feet, natural circulation, HVAC, air movers)
- Biocide can be applied, as appropriate - Initial decontamination should be accomplished to the extent possible by cleaning. Restorers should employ cleaning methods that minimize aerosolizing contaminants while maximizing complete removal. It is recommended that when

decontamination cannot be practically completed by cleaning alone, that appropriate antimicrobial or mechanical means be employed.

- Detailed cleaning by damp wiping – The process of thoroughly removing soils and contaminants from the work area. Wiping or mopping with a towel, sponge or mop that has been wrung out tightly after being immersed in a clean solution containing mild detergent, disinfectant or sanitizing agent. Depending on label directions, rinsing with clear water may be required.
- Detailed cleaning by hot water extraction – hot water extraction is a method of removing soils and contaminants using pressurized hot water. Almost immediately thereafter, injected water is extracted to physically remove soils and excess moisture.
- Detailed cleaning by vacuuming – This is the process of removing dry soils and contaminants by using an upright or canister equipment operating through suction, often incorporating mechanical agitation (e.g., brush, beater bar).
- Detailed cleaning by HEPA vacuuming - The process of removing dry soils and contaminants from the work area, by using HEPA-rated vacuum equipment that prevents contaminants from becoming aerosolized in work areas or other parts of a building.
- Detailed cleaning by low-pressure techniques - The process of removing soils and contaminants by using low-pressure (20-60 psi) flushing, usually followed by extraction. Low-pressure flushing typically produces larger droplets, which reduces air suspension time (drift) and the potential for inhalation.
- Detailed cleaning by high-pressure techniques - The process of removing soils and contaminants by using high-pressure (>60 psi) flushing, usually followed by water removal. Restorers are cautioned that it can cause “splattering” resulting in aerosolization of contaminants and an increase in humidity. High-pressure washing techniques should be limited to situations in which aerosolization is not a critical factor (e.g., outdoors) and damage to structural components is unlikely.
- Final appearance cleaning using appropriate method(s) - The process of removing residual soils or materials from the work area to improve appearance and prepare for re-occupancy.

17.2.4 Drying

Drying is the process of removing moisture from materials and involves the sciences of psychrometry and moisture mechanics in materials. Restorers should understand the science of drying and implement the principles of drying during a restoration project.

- Open assemblies to access pockets of saturation - Restorers should open assemblies (e.g., walls, stairs, flooring, wall base areas, voids, built-ins) to access pockets of saturation. Methods of opening assemblies can include but are not limited to drilling hole(s) or removing other components of the construction.
- Maintain water vapor pressure differential in all phases of the process – Restorers should maintain water vapor pressure differential in the affected area during all phases of the drying process by controlling the humidity in the surrounding air through dehumidification or ventilation. Restorers can add energy to wet materials, increasing internal water vapor pressure and providing energy for the phase change of water.
- Increase the internal water vapor pressure of materials during falling rate drying period - For Class 4 materials (e.g., concrete, stone, timbers) restorers should increase the internal water vapor pressure by adding more energy into wet materials.

17.2.5 Airflow

- Implement cross-contamination controls – Restorers should take precautions to prevent the spread of contaminants from an affected area to an unaffected area by use of one or more controls (e.g., containment, pressure differential, AFDs). This should be done for air exiting interstitial spaces when structural cavity drying systems are in use.

- Achieve aggressive airflow during early stage – Higher airflow during the constant rate stage of drying, the period of highest moisture availability and evaporation, is especially beneficial for porous and permeable materials (e.g., gypsum board, fiber-fill insulation,). For Category 2 or 3, aggressive airflow should only be used after remediation.
- Maintain sensible airflow during all stages of drying – Airflow at the surface of wet materials is needed during the entire drying process to displace the evaporating surface moisture and to transfer energy (i.e., heat) into the materials.
- Reduce airflow during later phase – Reduced airflow during the falling rate of drying, the period of lowest moisture availability and evaporation, is beneficial. This is especially true for Class 4 materials (e.g., concrete, stone, timbers) as a high rate of airflow can retard the drying process by decreasing the wetted pore surfaces or shrinking the pore in the overly dry surface layer thus reducing moisture movement within the material.
- Introduce airflow within the structural cavity (i.e., interstitial space) – Airflow should be delivered to wet surfaces inside interstitial spaces (e.g., wall cavities, internal chases, under cabinets). This can often be achieved more effectively through the use of structural cavity drying systems that create a positive or negative pressure causing filtration (i.e., infiltration, exfiltration) through the structural assembly.

17.2.6 Comments/Cautions:

- Minimize aerosolization of contaminants - Restorers should limit the velocity of airflow across surfaces to limit aerosolization of contaminants. When extracting contaminated water or vacuuming contaminated dry material, restorers should take appropriate steps to prevent contaminants from becoming aerosolized in work areas or other parts of a building by using HEPA vacuum systems or directing a vacuum's exhaust to unoccupied areas of the building's exterior.
- Use specialized expert, as appropriate - Restorers should perform only those services they are qualified to perform. If there are situations that arise where there is a need to perform services beyond the expertise of the restorer, specialized experts, whether from within or outside the company, should be used. When the service of a specialized expert is needed, restorers should hire, or recommend in a timely manner that the client hire, the appropriate specialized expert.
- Should receive clearance by specialized expert - Upon completion of the work, consider using third party verification or clearance testing, particularly in problematic situations.

17.3 Materials, Assemblies and Restoration Procedures

17.3.1 Pre-restoration Evaluation of assemblies

Evaluating layers or assemblies of materials should be done when it is suspected that water has migrated under or into it. Restorers should understand the particular construction in order to determine the best restoration approach. Properly inspecting, cleaning, drying and restoring these assemblies can require removal of surface or multiple layers of them. If finished wall material (e.g., gypsum board, plaster) requires replacement, restorers should commence removal first; then properly dry exposed sub-surfaces and framing to the predetermined drying goal prior to reinstallation of finish materials.

For more information on the following assemblies that are prone to water migration go to the table in the Reference Guide, Chapter 17 *Materials and Assemblies.*

- Flooring assemblies comprised of finish flooring (e.g., hardwood, engineered hardwood, laminate), vapor barriers (e.g., polyethylene sheeting, rosin paper) and subfloor materials (e.g., plywood, OSB);
- Multiple layers of gypsum board walls;
- Gypsum walls potentially having sound attenuation or insulation in the assembly;
- Suspended ceilings with insulation;
- Gypsum board ceilings that are wet or sagging;

- Fire-rated wall;
- Plaster walls;
- Wood paneled walls;
- Wallpaper (e.g., vinyl, textile);
- Carpet and carpet pad/underlayment;
- Vinyl sheet and vinyl composition tile;
- Residential hardwood floors or hardwood sports floors having interstitial spaces within the construction;
- Surrounding walls of elevator shafts, mechanical rooms and chases (e.g., trash chutes, plumbing, electrical, HVAC); and
- Concrete masonry unit walls.

17.3.2 Remove and replace unrestorable materials

Some affected materials or assemblies should not be restored due to (1) quick developing impacts of moisture sorption, (2) inability to adequately clean or sanitize or (3) inability to ensure achievement of drying goals throughout the assembly. Materials and assemblies that should be removed and replaced include but are not limited to:

- Gypsum board ceilings that are sagging due to saturation;
- Gypsum board that has obvious physical damage;
- Laminate flooring; and
- Many multi-layer flooring systems (e.g., laminate, vinyl sheet, parquet, engineered wood) under which water has migrated cannot generally be sufficiently dried, cleaned or sanitized.

17.3.2.1 Remove and replace in Category 2 or 3 intrusion

Following a Category 2 or 3 water intrusion the following affected materials or assemblies should be removed and replaced:

- Carpet cushion (pad, underlay);
- HVAC internally lined duct board;
- HVAC external insulation on metal duct;
- Wall insulation (e.g., loose-fill, cellulose, mineral wool, fiberglass, open-cell foam);
- Particleboard or MDF; and
- Many multi-layer flooring systems (e.g., laminate, vinyl sheet, parquet, engineered wood) under which Category 2 & 3 water has migrated cannot generally be sufficiently dried, cleaned or sanitized.

17.3.2.2 Remove and replace in Category 3 intrusions

Following a Category 3 water intrusion the following affected materials or assemblies should be removed and replaced:

- Gypsum wallboard (single-layer, multiple-layers, both standard and fire-rated);
- Mineral fiber lay-in ceiling tiles;
- Wall insulation;
- Sound attenuation board;
- Wallpaper (e.g., vinyl, textile);
- Wood paneling; and
- Carpet and carpet cushion (pad, underlay).

17.3.2.3 Asbestos containing materials or Presumed Asbestos containing materials

If restorers encounter ACM or PACM they shall stop activities that can cause the materials to become friable or aerosolized (e.g., dry sweeping, scraping, breaking). A qualified asbestos abatement contractor or Class III-Trained Employee shall be used to perform the abatement. Many states require that licensed inspectors perform asbestos inspections.

For more background information, refer to section below on Asbestos Containing Material.

If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials. *(note: the above 3 BPs are from "Tile; asbestos" row).*

Assemblies that are more likely to have ACM or PACM include but are not limited to:

- Mineral fiber ceiling panels;
- Gypsum drywall joint compounds;
- Resilient flooring (e.g., vinyl composition tile, vinyl sheet, linoleum);
- Flooring adhesives;
- Pipe insulation; and
- Concrete masonry unit (CMU) block loose-filled with vermiculite, perlite, etc.

If the ACM or PACM shows signs of compromise, a specialized expert should be used for further evaluation.

17.3.3 Controlled demolition of assemblies

If it is determined that a layer or layers of material require removal in order to facilitate inspection, drying, cleaning or restoring an assembly, it should be done as soon as practical after the decision is made. Removing exposed layer(s) of the assembly can facilitate cleaning and drying of the framing or other substructure materials.

17.3.4 Post-drying evaluation of assemblies

Once drying goals have been achieved in some assemblies, further inspection should be done to ensure prolonged exposure has not created unacceptable damage. Assemblies that are particularly prone to damage of this nature include but are not limited to:

Multiple layers of subfloor materials (e.g., OSB, plywood)

17.4 Specific Procedures for Miscellaneous Assemblies

17.4.1 Timber framing

Restorers drying saturated timber-framed buildings might encounter issues related to drying stresses created as a result of differences in radial, tangential, and longitudinal shrinkage. Timbers that are saturated should be dried slowly and monitored regularly to reduce the potential for stress cracks and damage

17.4.2 Engineered Wood (e.g., plywood, OSB)

If material is a substrate to other finish materials, check for moisture damage. If significantly damaged and unable to dry and decontaminate, remove and replace.

17.4.3 Walls, Insulated

Restorers should inspect walls for the presence of insulation and evaluate if drying is preferable to removal of finished wall material (e.g., gypsum board, plaster) and removal/replacement of the insulation would be quicker and more desirable.

Insulation will typically be found in all exterior walls, ceilings and sometimes under floors in crawlspaces and basements. If wet, it should be dried or replaced to return its insulating value to pre-intrusion condition.

17.4.4 Walls, fire-rated

Any opening of fire-rated walls shall be properly repaired to restore the fire rating.

17.4.5 Carpet and Carpet Cushion (pad, underlay)

Following a Category 2 water intrusion carpet pad should be removed and restorers can consider on location drying of carpet.

Following a Category 3 water intrusion the carpet and cushion should be removed, and its substrate evaluated for drying and cleaning.

17.4.6 Concrete

Water can migrate under floor coverings, around the perimeter of installations or between concrete and framing. The hidden issues with wet concrete can become evident well after the project is completed and new finish materials have been reinstalled. Flooring and the sub-structural assemblies should be inspected to determine the extent of moisture migration and/or damage

In situations where water has migrated deeply into the concrete and restorative drying must be done to facilitate the reinstallation of moisture sensitive floor coverings, it should be expected that drying times could be significantly longer.

Restorers are cautioned that measuring and validating that a concrete floor is sufficiently dry to ensure suitability for the installation of moisture sensitive or impervious floors (e.g., hardwood, bamboo, roll vinyl, VCT) should be done by a competent and qualified expert in accordance with applicable standards (e.g., ASTM F1869, F2170) in order for the customer’s floor to be warranted.

17.4.7 Vinyl sheet & VCT

Restorers should inspect to determine if water has migrated under finish floor materials. If it has, the flooring should be removed and the substrate evaluated for drying, cleaning and in the case of contaminated water, sanitizing.

17.4.8 Hardwood floors (i.e., residential, commercial and sports floors)

If Category 2 or 3, water has collected in interstitial spaces under the floor, finish flooring should be removed and subfloor evaluated for damage. If the substrate can be cleaned and sanitized, it should be dried to acceptable moisture content prior to replacement of finish flooring.

17.4.9 Engineered and laminate floors

Regardless of Category of water, If flooring swells, it is unrestorable. Restorers should check for subsurface moisture using an appropriate meter. If there is trapped moisture present in cushioning material or the subfloor, the flooring material should be replaced.

17.4.10 Stone, granite, slate floors

When substrate is wood, it should be checked for moisture migration and if damaged, it is recommended that a specialized expert be consulted.

17.4.11 HVAC, components

Refer to Chapter 14, *Heating, Ventilating and Air Conditioning (HVAC) Restoration.*

Mechanical and other system components should be evaluated, cleaned, repaired or replaced by qualified experts, as necessary, following NADCA ACR current version.

Restorers should plan for component cleaning; using a specialized HVAC contractor as appropriate, followed by system replacement, after structural restoration and remediation has been completed

Contaminated systems should not be used as a drying resource and should have supply & returns isolated.

17.4.12 HVAC Duct; internally & externally insulated

When insulated ductwork has Condition 3 contamination or affected by Category 2 or 3 water it should be removed and replaced with new materials, according to NADCA ACR 2006 standards.

17.4.13 Elevators

- Any services provided (e.g., pump out, cleaning, debris removal) to the equipment, shaft, or pit should be performed under the guidance of the building engineer or contracted service considered a “permit required confined space” (PRCS) requiring additional procedures.
- Prior to performing any work in an elevator pit, restorers shall ensure the safety of workers and the general public. The elevator shall be shutdown and locked out securely. Signs shall be posted notifying the public of maintenance work and an adequate supply of filtered and unfiltered air should be arranged through ventilation in the pit.
- Qualified personnel shall perform elevator cleanup and maintenance in accordance with local regulations. These procedures are beyond the scope of this document.
- An elevator pit is considered a confined space. Restorers shall have documented safety training and signage prior to work. Depending on the work being performed, it can be 17.4.14**.**

17.4.14 Electrical Systems

Caution shall be used when entering a flooded or flood-damaged building. Restorers shall employ safe work practices. If necessary, a specialized expert should be employed.

Electrical systems and equipment exposed to water can be quickly compromised, especially if it is contaminated (e.g., sea-water, chemicals). Compromised systems should not be reenergized until evaluated by a specialized expert.

17.4.15 Electrical Systems (e.g., low voltage, special wiring systems)

Deposited residue should be cleaned from metallic surfaces after a water intrusion, to reduce the potential long-term corrosion concern.

Equipment should be evaluated and reconditioned by qualified persons.

17.4.16 Fire-suppression systems

Any work performed on sprinkler systems should be done by qualified specialized experts.

17.4.17 Insulation; cellulose or other loose-fill organic material

Wet cellulose insulation should be removed, regardless of the Category of water, and, after structural drying, replaced with new material.

17.4.18 Insulation; mineral wool, fiberglass, rock wool
Compacted or contaminated materials should be removed and replaced.

17.4.19 Cabinets, attached and built-in

Restorers should identify and eliminate moisture migration below or behind built-in cabinets or fixtures. A complete inspection can require drilling holes in inconspicuous areas and evaluating levels of moisture and drying options. If removal is necessary, it should be completed near the beginning of the project

17.4.20 Stairs & mechanical rooms

Restorers should open assemblies (e.g., walls, stairs, flooring, wall base areas, voids, built-ins) to access pockets of saturation and remove unsalvable, contaminated materials and components. Exposed materials that remain in place should be cleaned and decontaminated, as appropriate.

Stairwells that are fire exits shall not be blocked during open hours, unless cleared by local officials.

17.4.21 Sub-grade walls (e.g., basements)

Restorers should check for trapped moisture between decking and sub-floor materials, or on the vapor retarder over bat insulation in basements or crawlspaces installed between joists, and directly under subfloors.

Restorers shall consider the possibility of electrical shock and other hazards when entering a flooded basement. When appropriate, electrical power should be turned off at the meter.

17.4.22 Crawlspaces

Restorers should be knowledgeable about the operation of an active ventilation system prior to making any modifications to a system.

Restorers should check for moisture trapped by vapor retardant materials.

Crawlspaces generally meet the definition of a confined space. Additionally, if it meets certain criteria, it shall be considered a permit required confined space. Refer to *Chapter 8: Safety and Health.*

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Institute of Inspection, Cleaning and Restoration Certification
2715 East Mill Plain Blvd.
Vancouver, WA 98661 USA
(360) 693-5675 • www.iicrc.org

Chapter 1

Principles of Water Damage Restoration

INTRODUCTION

A "principle" is defined as: "A basic comprehension, or fundamental doctrine or assumption that is accepted as true and that can be used as a basis for reasoning, process, or conduct." There are five general principles used in the restoration of water damaged structures and materials. Applying these principles may require a multi-disciplinary approach involving professionals from several fields of expertise. For any of these principles to be applied effectively, timely response to the water intrusion is a necessity.

PRINCIPLES OF WATER DAMAGE RESTORATION

o **Provide for the Safety and Health of Workers and Occupants**

Water damaged buildings and materials and the investigation and performance of water damage restoration work can create and expose workers to a wide range of health and safety concerns. Potential hazards include, but are not limited to: exposure to microbial contaminants, chemicals, lead and asbestos; electrical shock and slip-and-fall hazards. Appropriate safety procedures and personal protective equipment (PPE) shall be used to protect restorers. Reasonable effort should be made to inform building occupants of, and protect them from the identified health and safety issues. Refer to Chapter 8, *Safety and Health*.

2. Document and Inspect the Project

Throughout the project, the restorer should establish, implement, and consistently follow methods and procedures for documenting all relevant information. This information can affect and provide support for project administration, planning, execution and cost. Refer to Chapter 9, *Administrative Procedures, Project Documentation and Risk Management*.

Detailed inspections should be conducted to identify the Category of water, the Class of water or extent of wetting, the types and quantities of affected materials, and apparent and potential damage. The information obtained should then be used to develop a preliminary determination, pre-restoration evaluation, scope of work and procedures. Methods used in the inspection, the data acquired, and decisions reached as a result should be documented. Refer to Chapter 10*, Inspections, Preliminary Determination and Pre-Restoration Evaluations.*

Initial Inspection

Upon entering a building, professional moisture detection equipment should be used to evaluate and document the psychrometric conditions inside and outside the building and the moisture content or levels of materials in affected and unaffected areas.

Restorers should inspect and document the source and time of the water intrusion, visible material deterioration, pre-existing damage and visible microbial growth. Professional moisture detection equipment should be used to inspect and document the extent of water migration and moisture intrusion into building materials and contents.

Restorers should establish drying goals for affected building materials and contents near the beginning of the restoration process, and it is recommended, if possible, that agreement with materially interested parties to the appropriateness of these goals be reached and documented. This can be achieved by determining a dry standard, which is a reasonable approximation of conditions prior to the moisture intrusion, or by comparing moisture content conditions in unaffected areas of the building.

Ongoing Inspection(s)

Restorers should record, calculate and document moisture measurements required to adequately monitor the drying process. Restorers should record and monitor relevant moisture measurements daily, preferably at the same time of day, until drying goals are achieved. The frequency of monitoring may be increased or decreased based on a documented agreement by the materially interested parties. The information gathered during ongoing inspections and monitoring can lead the restorer to adjust the placement of drying equipment and modify drying capacity. When benchmarks are not being met towards an acceptable drying goal, the restorer should further investigate to identify the cause and take corrective action.

Final Inspection (Completion)

Materials are considered dry when they meet pre-determined drying goals. Drying equipment should remain in operation until drying goals have been met. It is recommended that materially interested parties be provided access to documentation on the restoration process.

3. Mitigate Further Damage

Restorers should attempt to control the spread of contaminants and moisture to minimize further damage from occurring to the structure, systems, and contents. When contaminants are present restorers should remediate first, and then dry the structure, systems, and contents.

Control the Spread of Contaminants

In some water damage situations, such as those involving sewage, microbes present can include a variety of disease-causing human viruses and parasites, in addition to bacteria and fungi. When waterborne contaminants (e.g., fungal, bacterial, viral, algae) are present in the building environment, they can become airborne during the drying process and spread to previously unaffected areas within the structure. Contamination should be contained as close to its source as possible.

Control Moisture Intrusion

Moisture problems should be identified, located, and corrected or controlled as soon as possible. Failure to correct or control moisture intrusion significantly degrades the ability of restorative drying techniques to return the structural materials and contents to an acceptable drying goal. Unless otherwise agreed by responsible parties, it is the responsibility of the property owner, not the restorer, to correct the source of the water intrusion, or to engage appropriate specialized experts to do so.

4. Clean and Dry Affected Areas

Restorers should clean and dry water damaged buildings, systems and contents. The cleaning process can help prevent the spread of soils and contaminants to unaffected areas and return the building and contents to an acceptable appearance. Cleaning can include bulk removal of unsalvageable materials, remediation of contamination and detailed cleaning. The objective of drying is to minimize the amount of time that materials spend in an abnormally wet state, and to return affected materials to an acceptable drying goal as quickly and safely as practical.

Cleaning

Cleaning is the process of locating, identifying, containing, removing and properly disposing of unwanted substances from an environment or material consistent with this Standard. Restorers should evaluate and clean materials within the work area as needed. There are three basic levels of cleaning. They are as follows:

- Initial/Bulk Cleaning - The process of removing bulk debris, soil or materials from the work area. This process can include but is not limited to: the removal of unsalvageable materials, removal of materials to gain access to expedite drying, or bulk contamination (e.g., sewage).

- Detailed Cleaning - The process of thoroughly removing soils and contaminants from the work area. This process can include but is not limited to: dry soil removal, abrasive cleaning, damp wiping, high-pressure washing, low-pressure flushing, or the application of appropriate cleaning agents or antimicrobial biocides.

- Final Cleaning - The process of removing residual soils or materials from the work area to improve appearance and prepare for re-occupancy. Final cleaning can include but is not limited to: dry soil removal, damp wiping, or other appropriate activities.

Drying

Drying is the process of removing excess moisture from materials and involves the sciences of psychrometry and drying principles. Restorers should understand the science of drying and implement the principles of drying during a restoration project. Refer to Chapter 5, *Psychrometry and Drying Technology.*

- Enhancing Evaporation - Once bulk water has been removed, evaporating the remaining water in materials should be promoted. Evaporation is the process of changing a liquid to a vapor. It is enhanced by adding energy and air movement to the surface of wet materials.

- Enhancing Moisture Diffusion - Excess moisture in affected materials moves as a liquid and as a vapor toward the surface, where it can evaporate. The rate of this movement is a function of water vapor pressure, moisture content and physical properties (i.e., porosity, permeability) of the material. It is enhanced by managing the surrounding humidity, air movement and by introducing energy (i.e., heat) into the material.

- Dehumidifying and Ventilating - As moisture evaporates from structural materials and contents, the indoor relative humidity, humidity ratio and water vapor pressure will increase if not controlled. Abnormally high water vapor pressure can drive elevated moisture into materials increasing the potential for secondary damage (e.g., microbial growth, discoloration, adhesive release, delamination, swelling, buckling, and warping). Therefore, in order to avoid secondary damage, excess moisture evaporating into the air should be exchanged with less humid air or it should be removed from the air through dehumidification. Failure to remove evaporating moisture can retard the drying process.

- Controlling Temperature - Restorers should control temperature in the drying environment. Reasons include but are not limited to affect evaporation load, moisture movement in materials; avoid secondary damage, limit microbial amplification and maximize equipment performance

5. Complete the Restoration and Repairs

After cleaning and drying has been accomplished, restorers should re-evaluate the scope of work to complete the restoration project. Completing the restoration can incorporate repairs, refinishing, and reconstruction. Project scope and procedures vary depending on the Category of water and other factors (e.g., code requirements, client priorities and concerns, occupancy). Qualified and properly licensed persons should perform authorized and necessary repairs. In some cases, a separate remodeler or general contractor may handle the remaining reconstruction.

Chapter 2

Microbiology of Water Damage

INTRODUCTION

Indoor and outdoor environments naturally harbor a great variety of microscopic life forms termed microorganisms or microbes. Found everywhere in nature, their largest components are classified as bacteria and fungi (i.e., molds and yeasts). Bacteria are an extremely large and diverse group of single-celled organisms found in all earthly habitats to include the most extreme and harsh physical environments. Fungi constitute a higher and more complex category of microscopic life forms. Detailed information on indoor environmental fungi can be found in the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. Bacteria and fungi of concern in indoor environments are those that utilize a variety of organic materials as nutrient substrates, to include a spectrum of building, finishing, and furnishing materials.

MICROBIAL ECOLOGY

Normal Ecology

Clean/Dry Environment: Environmental bacteria and fungi are ubiquitous in the indoor environment. They are typically introduced as cells and spores from outdoors through openings between interior and exterior spaces, from carriage on clothing and from tracked-in soil. Spores are the reproductive and resting stage for many molds and some bacteria. They enable the organisms to resist unfavorable environmental conditions for varying lengths of time (i.e., weeks, months or years). Once indoors, these biological agents interact with the inanimate environment by collecting or settling in or on a variety of surfaces or materials. Such collecting places, or "micro-environments" or "reservoirs," include carpet, upholstered furniture, wood and various painted surfaces such as walls and ceilings, a variety of contents materials, and heating, ventilating, and air-conditioning (HVAC) systems.

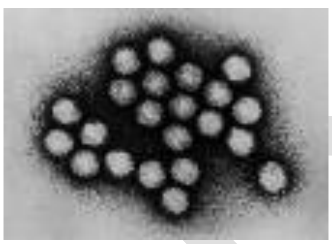
Both bacteria and fungi, along with their various components and by-products, constitute a major portion of indoor dusts. In a dry environment subject to routine cleaning (e.g., dust removal), such reservoirs are normally non-problematic. However, as water intrudes, or moisture condenses onto surfaces and materials, the microbial ecology begins to change with potentially detrimental effects.

Shifting Ecology

Damp/Wet Environment: Bacteria and fungi grow in areas where moisture is available, and thus are commonly found in damp areas such as unvented bathrooms, basements, under-sink cabinets where leaks and/or condensate is common, and in air conditioning system components. Continued chronic moisture conditions allow bacteria and fungi with higher moisture requirements to flourish. If conditions are such that moisture is limited, then these microorganisms can have a stable and non-problematic relationship with the inanimate components of the built environment.

However, when moisture intrudes or accumulates more rapidly than the natural drying process, such as with chronic plumbing leaks or sudden flooding from rainwater or sewage backflow, the microbial ecology changes and favors rapid growth (amplification) of bacteria and fungi with high moisture requirements, to include a variety of gram-negative bacteria, such as *Pseudomonas* and *Enterobacter;* odor-causing, gram-positive, spore-forming bacterial "actinomycetes," such as *Streptomyces, Microbispora*, and *Saccharopolyspora*, and species of *Aspergillus*, *Penicillium*, *Ulocladium*, and *Stachybotrys* molds, among others. This amplification can damage valuable materials, and affect the quality of the indoor air, creating health risks for those who live or work there (Andersson et al, 1997).

In some water damage situations, such as with sewage contamination, the organisms present can include a variety of disease-causing human viruses and parasites in addition to the bacteria and fungi (Berry et al, 1994). For a comprehensive discussion of indoor fungal biology, consult the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*.


viruses (CDC)


gram-negative bacteria


mold

(© J. L. Carson, University of North Carolina)

Sewage

Bacterial pathogens in sewage can include virulent strains of gram-negative organisms such as *Salmonella, Shigella,* and *Escherichia coli* (Berry et al, 1994). Over 120 different viruses can be excreted in human feces and urine and can be found in municipal sewage (Straub et al, 1993), in addition to a wide variety of fungi and animal and human parasites. Sewage also constitutes a tremendous source of bacterial endotoxins (cell wall components) that can induce a variety of adverse health effects. The potential adverse health consequences to occupants and restorers from sewage contamination and clean-up activities are discussed in Chapter 3, *Health Effects from Exposure to Microbial Contamination in Water Damaged Buildings*.

WATER ACTIVITY

Microorganisms can grow in moisture films on a variety of surfaces and within porous materials. The amount of free water available to them for growth on a substrate, such as wallboard, carpet or ceiling tile, is described as water activity (a_w). It can be compared to the equilibrium relative humidity (ERH) of a material. ERH refers to the relative humidity (RH) of the atmosphere in equilibrium with a material with a particular moisture content (ISIAQ, 1996). A measurement of 80% RH at the surface of a material would equate to a water activity (a_w) of 0.8.

Growth Requirements

Most bacteria have a minimum requirement of $a_w$for growth that is >0.95 (95% ERH) while many molds have a lower minimum requirement of a_w >0.88 (88% ERH). However, most molds that appear in the environment during the early stages of water damage require less moisture to grow. For these dry-tolerant (or xerophilic) molds, a_w of 0.66-0.70 (66%-70% ERH) is sufficient to promote growth. Xerophilic molds include species of *Penicillium* and *Aspergillus* that may produce potent allergens and toxic substances. A high percentage of *Penicillium* or *Aspergillus* species in an indoor dust or air sample is normally an indicator of a previously or currently damp condition due to water intrusion (such as floods and leaks) or an accumulation of condensation. Very wet or damp environments, particularly those with cellulose-based materials (such as wallpaper, drywall, books, cardboard), favor the growth of molds such as *Stachybotrys, Ulocladium* and *Chaetomium*.

Also, a variety of soil bacteria as well as some yeasts and molds, can grow in stagnant flood waters, as well as water reservoirs of heating, ventilating and air conditioning (HVAC) systems. Additionally, a variety of microorganisms can grow under low-to-moderately moist conditions, utilizing a variety of nutrient substrates that have collected in, on, or as a part of the composition of a variety of building, finishing, and furnishing materials such as wood, drywall, wallpaper, ceiling tile, insulation, carpet and upholstery, and wicker furniture. Porous contents materials such as books and papers are especially susceptible.

Microbial Odors

In addition to visible bacterial or fungal growth and detection of moisture in porous materials, an obvious indicator of microbial growth and contamination is a “musty,” “moldy,” or “mildewy” odor. Bacteria and fungi produce a variety of volatile organic compounds (VOCs) during active growth on damp or wet building, finishing, and furnishing materials (Korpi et al, 1998). These microbial volatile organic compounds (MVOCs), which are detected through the olfactory senses (smell), are generated by many molds, and also gram-negative and actinomycete bacteria as they rapidly metabolize and amplify.

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Chapter 3

Health Effects from Exposure to Microbial Contamination in Water Damaged Buildings

INTRODUCTION

Microbial contamination associated with water damage in indoor environments is a public health problem. It presents a health risk to both occupants and restoration workers, potentially resulting in a variety of illnesses of an inflammatory, allergic, infectious, and toxic nature. Floodwaters carry soil bacteria and fungi whose types, components, and by-products can induce respiratory inflammation and sensitivity, while sewage backflows additionally introduce a variety of infectious disease agents. Moisture accumulation (chronic leaks, condensation), leading to a state of unabated dampness, results in the growth and amplification of molds that can damage valuable materials and adversely affect human health.

DAMPNESS AND HEALTH

Epidemiologic Studies

A recent review of 61 peer-reviewed articles demonstrates that dampness in buildings is consistently associated with an increased risk for symptoms in respiratory airways, as well as self-reported tiredness, headache and airways infections (Bornehag et al, 2001). Another review of case reports, case-control studies and cross-sectional studies from a 15 year period has concluded that ". . . evidence of an association between respiratory problems and the presence of fungi and dampness is strong." (King and Auger, 2002). One recent study of 19 office buildings has measured a dose-response effect for dampness and symptoms of eye irritation, cough and lethargy/fatigue (Wan and Li, 1999), while another study of 231 buildings has determined that dampness and odorous compounds are associated with an increase in symptoms consistent with sick building syndrome (SBS) (Engvall et al, 2002). In these and many other studies involving exposure to damp indoor environments and resultant health effects, the overwhelming evidence points to microbial contamination as the major pollutant.

Critical Assessment

The Institute of Medicine (IOM) of the National Academies of Science conducted its own exhaustive assessment of the scientific literature regarding the relationship between damp or moldy indoor environments and the manifestation of adverse health effects, particularly respiratory and allergic symptoms. The results were published in *Damp Indoor Spaces and Health* (IOM, 2004). The IOM stated that "Excessive indoor dampness is not by itself a cause of ill health, but it is a determinant of the presence or source strength of several potentially problematic exposures." It noted that damp environments favor bacterial and fungal growth and house dust mites; standing water supports cockroach and rodent infestations, and moisture may initiate chemical emissions from building materials and furnishings. In summary, on the basis of its review, the committee concluded that "... excessive indoor dampness is a public health problem."

In its summary findings, the IOM found sufficient evidence of an association between exposure to damp indoor environments and cough, wheeze, upper respiratory tract symptoms (nasal and throat), and asthma symptoms in sensitized persons. It also detailed limited yet suggestive evidence of an association between exposure to damp indoor environments and shortness of breath, the development of asthma, and lower respiratory illness in otherwise healthy children, all of which require additional research.[1]

SEWAGE AND HEALTH

Risk to the public's health from sewage exposure is demonstrated in a 1988-89 epidemic of hepatitis A in Ocoee, Florida, that resulted in 39 cases and one fetal death (Vonstille et al, 1993). Unprotected workers who remediate sewage damage losses, as well as sewage treatment workers, and sewage sludge processors, are at risk for chronic respiratory disease, other systemic health effects, and a host of acute and chronic bacterial, fungal, viral, and parasitic diseases. Over 120 different viruses can be excreted in human feces and urine and find their way into sewage (Straub et al, 1993). These can include rotavirus, causing severe and sometimes life-threatening diarrhea in children, adenoviruses, causing respiratory and eye infections, and Norovirus, a significant cause of gastroenteritis. Parasitic agents include the highly infectious *Giardia* and *Cryptosporidium* that can result in chronic and severe intestinal diseases in both adults and children.

Bacterial pathogens in sewage can include virulent strains of gram-negative organisms such as *Salmonella, Shigella,* and *Escherichia coli* (Berry et al, 1994). In addition to the infectious disease risk, gram-negative bacteria contain endotoxins that are released at the time of cell death and destruction. These cell fragments with endotoxins can be aerosolized during improper remediation activities, such as attempts to clean and dry sewage-saturated carpet in-place, as opposed to careful removal and disposal. Endotoxins can induce respiratory inflammation and airway restriction (chest tightness), and create the potential for allergic and infectious disease responses. There is also evidence that inhaled endotoxins may adversely influence the central nervous system (Rylander, 1994).

Attempts at salvaging sewage-contaminated carpet and other porous materials can also liberate extensive amounts of allergens, as well as potentially infectious agents. This poses a risk for susceptible populations such as the elderly, infants, convalescents, and those that are immunocompromised through disease or therapy**.**

SECONDARY FUNGAL CONTAMINATION

As discussed in Chapter 1, *Principles of Water Damage Restoration*, if water damage events are not mitigated timely, fungal contaminants will grow and amplify, quickly posing an allergic, toxic, and infectious disease health risk to both occupants and restoration personnel. An

[1] ASHRAE Position Document on Limiting Indoor Mold and Dampness in Buildings Approved by ASHRAE Board of Directors 6/27/2012, Reaffirmed by ASHRAE Technology Council 1/29/2013

in-depth presentation of the health effects from indoor mold contamination is found in the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*.

Allergic/Inflammatory Effects

The relationship between various building-related symptoms of an allergic or inflammatory nature and exposure to indoor mold contamination in the form of spores, hyphal fragments, and glucans, has been recognized by several investigators as a distinct symptom complex of mucous membrane, upper, and possibly lower respiratory tract inflammation, fatigue and neurocognitive symptoms among occupants of mold-contaminated buildings. Such symptoms typically exhibit the important features of temporality (discrete onset after occupying a particular building or after a particular event, such as a flood or leak), consistency (among multiple occupants), and reversibility (symptoms abate when away from the indoor environment) (Craner, 1999; Johanning et al, 1999). Additionally, it is recognized that fungal contamination can trigger asthma, a chronic inflammatory disease of the respiratory system.

Toxic Effects

A variety of molds associated with water-damaged indoor environments, such as *Stachybotrys charatarum*, and species of *Aspergillus*, *Penicillium*, *Fusarium*, and others, can produce a variety of toxic metabolic by-products known as mycotoxins, under optimum environmental conditions (Burge and Ammann, 1999). From animal, field, and laboratory toxicology studies, a variety of responses, primarily from ingestion or inoculation, have been observed, to include immunosuppressive, neurologic, and carcinogenic effects, among others. While such symptoms, along with others, have been associated with the inhalation of mycotoxin-containing fungal spores, a definitive causal association has not been demonstrated and requires appropriate research.

Infectious Disease

Fungal pathogens are emerging as significant causes of morbidity and mortality in immunocompromised adults and children. Uncommon diseases and atypical cases due to fungal infections are increasingly being reported, and their incidence over the last decade has increased dramatically (Walsh, 1998; Ampel, 1996). Individuals at an increased risk for opportunistic fungal infections include those immunocompromised due to HIV infection, neoplasms, chemotherapy, transplantation, steroid therapy, and underlying lung disease (Nash et al, 1997; Teh et al, 1995). Children with neutropenia or prolonged corticosteroid or antibiotic therapy are especially susceptible to infection (Shenep and Flynn, 1997). Species of *Aspergillus* in particular are recognized as significant emerging pathogens in persons with HIV/AIDS, causing invasive sinusitis and invasive pulmonary disease (Nash et al, 1997; Mylonakis et al, 1997).

CONCLUSION

In light of both the recognized and potential health effects associated with microbial contamination in water-damaged indoor environments, restoration professionals should take appropriate measures to protect building occupants, and maximally reduce exposure risks to their workers through training, immunization, and the use of personal protective equipment (PPE).

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Chapter 4

Building and Material Science

INTRODUCTION

This Chapter is intended to provide an introduction to some of the principles of how buildings function based on natural physical laws. The success of a restorer's efforts is impacted by the principles of building science. Building envelopes are subject to the laws of thermodynamics, which imply that hot moves toward cold; wet moves toward dry; high pressure moves toward low pressure; and everything seeks equilibrium. These principles prevail and cause natural change in temperature, pressure and moisture content, unless variables are present that enhance or hinder natural movement.

Restorers are regularly called upon to provide service when buildings are affected by sudden and unexpected water intrusion. At other times, they may be called upon to identify and address the causes and damages resulting from chronic moisture problems in buildings. Often, a restorer finds that the effectiveness of measures taken to mitigate what is represented as a sudden and unexpected water intrusion are complicated or fail because of unrelated chronic conditions caused by patent or latent construction failure. An understanding of how moisture moves into, through, out of or accumulates in buildings is critical to successful water damage restoration.

Building systems and assemblies are interrelated so that even a small change in one component can have a dramatic and potentially unexpected effect on the structure, systems and contents. The impact of a water intrusion can affect the health and safety of occupants, and the functionality of a building. Restorers should understand building systems, assemblies and related physical laws in order to restore a damaged building to its intended function and useful life. Lack of such understanding can result in inappropriate action that can lead to a failure.

THE BUILDING ENVELOPE

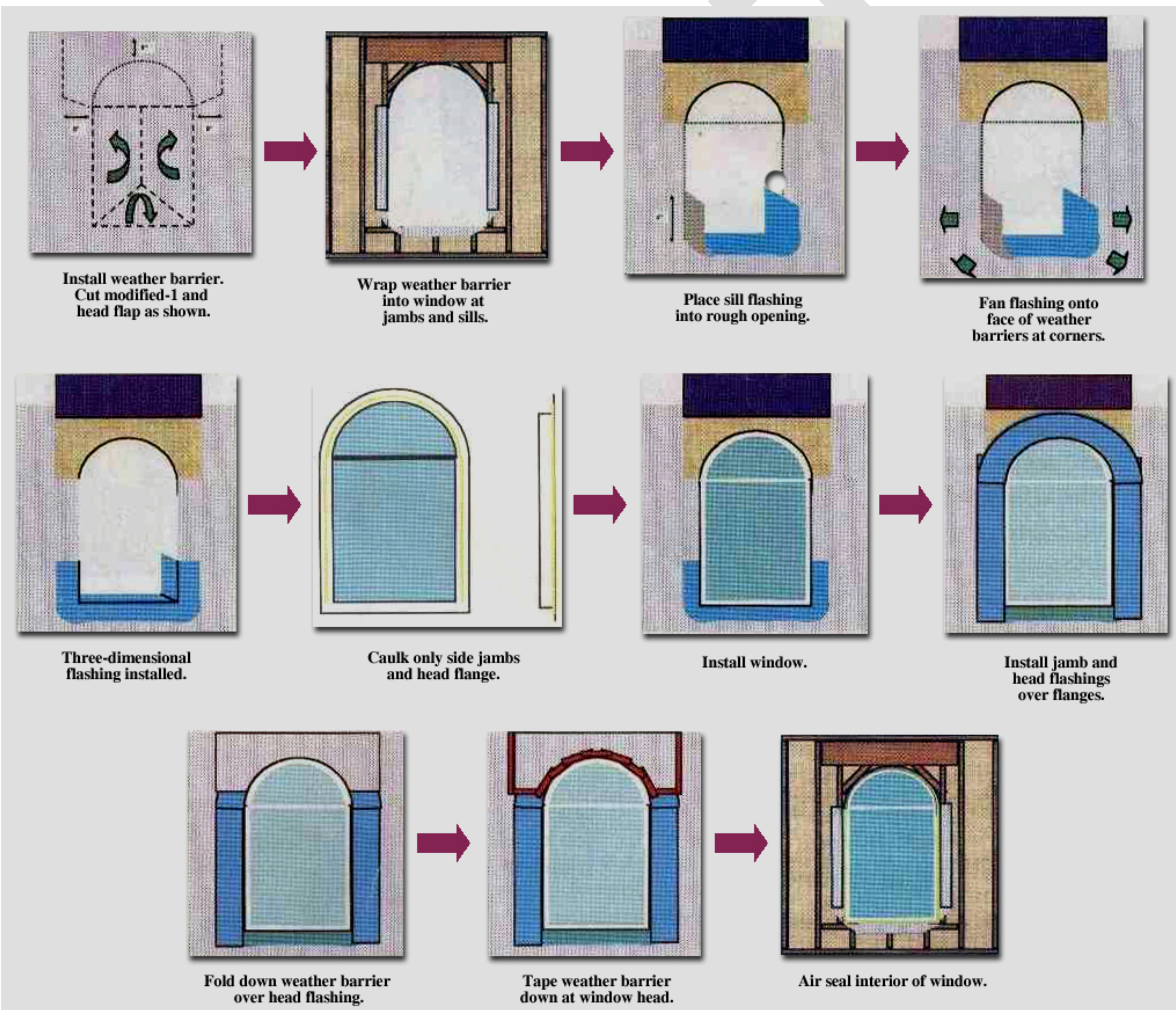
To properly construct building envelopes, it is necessary to apply the principles of building science. The building envelope separates the interior of a built environment from the outside environment. The building envelope includes exterior walls, foundation, floors, windows, doors, roofs and ceilings. The building envelope has several purposes including keeping out wind, rain and ground water, and controlling the transfer of energy between the inside and the outside.

A major purpose of building envelope design is to provide a structure that maintains comfortable temperature and relative humidity, while allowing adequate ventilation inside, regardless of outside conditions. The study of heat, air, and moisture flow is crucial to understanding building dynamics. Proper construction helps avoid problems, such as mold, poor indoor air quality, unwanted water intrusion, and other issues. Small changes in one component can have a dramatic effect on the entire structure.

Building Penetrations and Flashing

A common error in building envelope design or construction occurs when materials at doors and windows are incorrectly installed or applied. If installed or applied correctly, the possibility of unwanted moisture entering the building envelope is reduced. Understanding such details help restorers understand where to investigate potential moisture intrusion and migration. Any opening or penetration in the building envelope that is not properly flashed can result in moisture intrusion. Below are examples of a proper flashing sequence for a flanged window installation.

Examples of Building Penetration Flashing Details

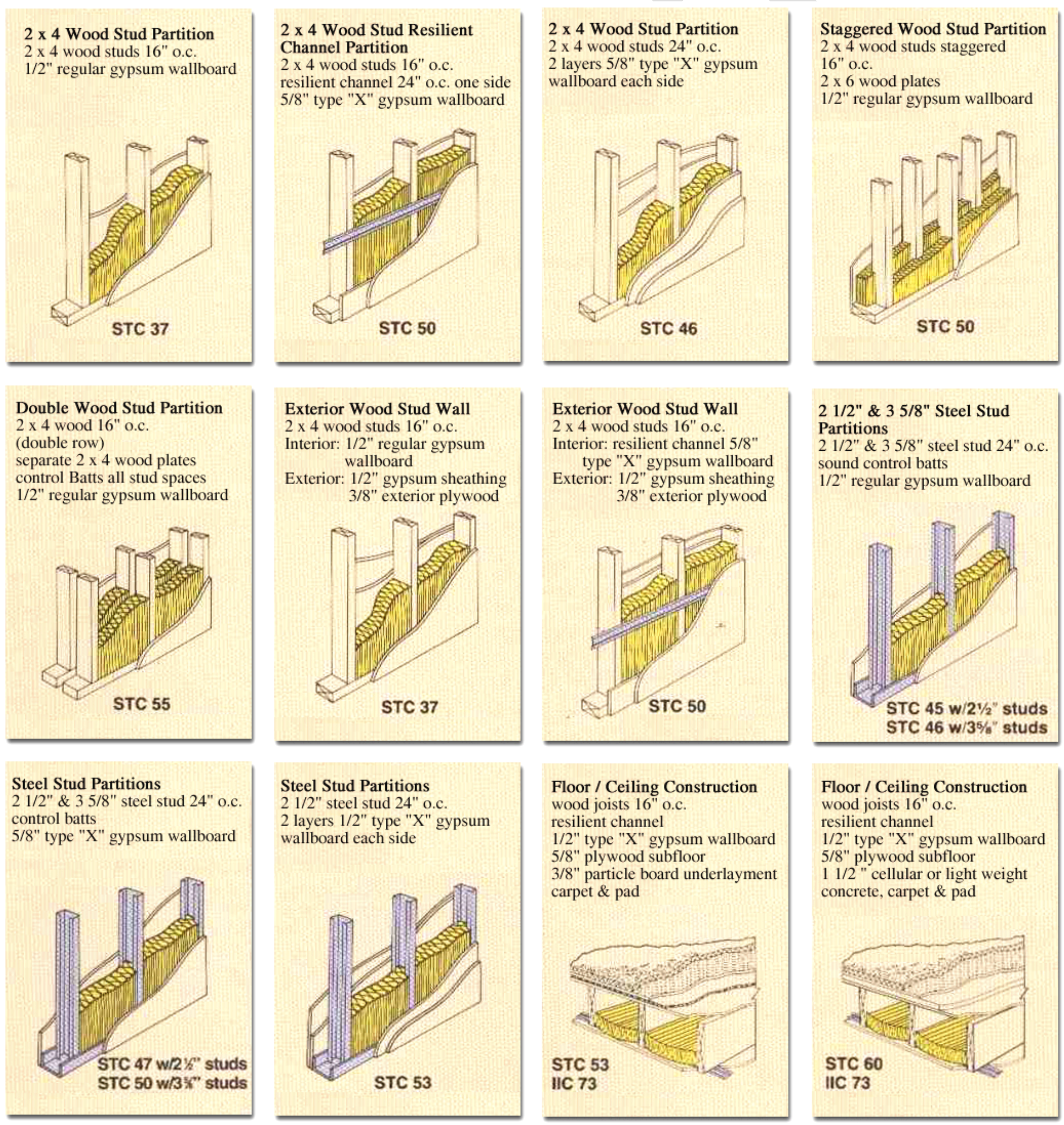


The pictures above were adapted from: Weston, Ph.D., T. A., & Katsaros, Ph. D., J. D. (2003). Innovations in window installations: keep the water out; *Walls & Ceilings*, *66*(9), 34-44.

Wall, Floor and Ceiling Assemblies

It is important for restorers to understand the construction of wall and floor assemblies to facilitate educated decision making about drying and restoration. Knowledge of construction materials and their applications for strength, sound transmission and fire ratings, all affect decisions as to how a building or structure can be properly dried and restored. Since all components of a building are interrelated, it is recommended that restorers attempt to discern the intent of the building's design or construction during a restoration project, and address those aspects individually and collectively.

Examples of Exterior and Interior Wall, Floor and Ceiling Assemblies



For more information on sound transmission coefficient (STC) ratings, impact class ratings (IIC) and hourly fire resistance ratings, refer to the Gypsum Association (www.gypsum.org) GA 600 fire-resistance design manual and Underwriters Laboratories (www.ul.com) fire resistance directory.

Mechanical Systems

It is useful to understand mechanical systems and their function within a building. These mechanical systems include: plumbing; heating, ventilating, and air conditioning (HVAC) systems; gas appliances; chimneys; fireplaces; air-exchange systems; vents in kitchens and baths; clothes dryer vents; recessed light fixtures and central vacuums. Some of these systems create positive pressure, while some create negative pressure, and some are neutral. Pressure differentials should be considered when investigating problematic systems.

21st Century Building Envelope Techniques

Existing building design and construction practices present challenges to drying after water intrusion. For example, commonly used moisture retarders can prevent expeditious drying of building components. In a warm humid climate, moisture tends to move from outside to inside and can become trapped inside walls. In a cold climate, moisture tends to move from inside to outside and can also get trapped within walls. In a mixed climate, moisture enters interstitial spaces from either side, depending on the season. An increase in insulation decreases the drying potential of buildings. Installing semi permeable or non-permeable materials and assemblies on the interior, such as polyethylene vapor retarders under the gypsum wallboard, vinyl and other wall coverings, prevents drying to the interior. Using materials that are moisture sensitive, such as particleboard, paper-faced gypsum wallboard, and some laminate flooring, presents a challenge to drying. Some materials, such as oriented strand board (OSB) and concrete with chemical plasticizers do not absorb water easily; if they become wet they can be very difficult to dry.

Air, Moisture and Heat Flows in Buildings-

Mechanisms of Airflow

To evaluate how systems within a building interrelate, it is important to understand the elements of airflow. For a given volume of air entering a building, an equal volume of air must leave. Conversely, if air is being removed from a building, an equal volume must enter. This can be stated as: cubic feet per minute (CFM) in, equals CFM out. The better the restorer's understanding of the mechanisms of air ingress, egress and passage through a structure, the more efficiently and effectively the drying process can be planned and executed. Proper execution of the drying process results in an enhanced opportunity to properly maintain the integrity of a building system, and the indoor air quality. The type of building design and construction influences where air enters or exits, and how indoor air quality is affected (e.g., air coming down a chimney or up through a crawlspace, may not be good quality air for breathing, due to potential airborne contaminants).

As with fluids, moving air seeks the path of least resistance. In most cases air rises when heated and falls when cooled. Air flows from high pressure to low pressure (e.g., an inflated balloon has higher pressure on the inside relative to the outside. The obstruction of the balloon casing prevents the high pressure from moving toward the lower outside pressure).

All structures have planned openings (e.g., doors, windows, vents) and unplanned openings (cracks, crevices, gaps, material shrinkage, utility penetrations). Planned openings may be designed to either add or remove air from a building. If designed properly these openings do not compete for air. In order for air to move into or out of an enclosed space, such as a building or portion of a building, there must be an opening and a driving or pulling force. At times, these forces may be unexpected and potentially dangerous (e.g., a dryer vent may pull air so strongly on the built environment that it causes the airflow from a water heater gas vent to reverse).

Caution should be used when blocking, sealing, or restricting airflow, or reversing the direction of airflow through a planned opening. Serious health and safety problems may result. If large amounts of air are drawn out of a building, the probability of combustion appliances back drafting or experiencing flame rollout is increased.

There are always unplanned openings in a building. If accompanied by a driving force, an unplanned opening can allow airflow into a building from garages, crawlspaces, attics or other air spaces. Driving forces, such as wind, heat/stack pressure, fans and duct systems, can affect the indoor environment and a building system.

- **Wind**: The impact of driving wind on a building envelope creates pressure differentials. Wind can drive air and moisture into or out of a building.
- **Heat**: As air is heated, it rises and pulls cool air from lower areas of a structure. This is known as the "*stack effect.*" The taller the building the stronger the force.
- **Fans**: Some fans are designed for moving air within a building and other fans are used to move air out of a building, e.g., fans in attics, kitchens, bathrooms, clothes dryers, air exchange and central vacuum systems. These devices often create unplanned pressure imbalance because they intentionally force air out of a building while causing a pressure differential that results in infiltration of makeup air from unplanned openings.
- **Duct systems**: Duct systems usually are connected to fans that distribute air through heating and cooling systems. These ducts often leak and sometimes run through unconditioned spaces. They may draw air from many unknown and uncontrolled areas.

Mechanisms of Moisture Flow

Moisture moves into and through buildings in four ways. Understanding these four mechanisms is helpful in determining where and how moisture gets into a building, and it is necessary when devising an effective drying plan. The following are the four mechanisms of moisture movement:

- **Liquid flow (bulk water):** Liquid flow causes the greatest amount of moisture to enter a building in the least amount of time. Rain, melting snow, ground water, overflowing appliances, or water intrusion from a broken water supply or drain line are some causes or sources of liquid flow.
- **Air transport:** Moving air carries moisture through either planned or unplanned openings in a structure.
- **Vapor Diffusion:** Water vapor pressure causes moisture to move through airspaces, whether in a room, a smaller interstitial space, or through voids within materials. In areas where water vapor pressure is different from one side of a structural component (e.g., a wall) to another, moisture diffuses through the component (e.g., a wall) to equalize the pressure.
- **Capillary Suction:** Porous materials are capable of absorbing water through capillarity. Concrete, wood, and gypsum are examples of materials that absorb water through capillarity.

Porosity and Permeability

Permeability and porosity are two of the primary components related to the movement and storage of fluids in materials.

Permeability describes the potential ease with which fluids move though a material. Porosity describes the structure of a material and its void spaces. While there is a relationship between the degrees of permeability and porosity, there is not always a direct correlation. Typically, non-porous material will be non-permeable. However, the permeability of otherwise porous materials will vary depending on construction of void spaces.

The porosity of a material is determined by measuring the amount of void space (i.e., pores) inside a material and determining what percentage of the total volume of that material is made up of void space. The moisture conducting properties of porosity are more complex than the simple ratios of pores to solids inside a material. Other important considerations are; the size and shape of the pores and whether they are open or closed.

Open pores are connected to the outer surface of the material. This allows water to enter and move within the material. Open pores can be interconnected or have a dead-end. Open and interconnected pores increase permeability.

Closed pores are completely isolated from the surface and do not allow water to enter either in a liquid or vapor phase. They do not increase permeability.

The characteristics of the internal pores of certain materials may cause the permeability to be significantly greater in one direction (i.e., hysteresis).

Porosity is important in terms of the volume of moisture that a material may sorb and hold, while permeance is more relevant to the ability to move moisture through or out of a material. Porosity is also important when contamination is present as the construction of the void space will impact restorability and influence decisions to restore or discard materials. Porosity of organic materials can also influence conditions supporting microbial growth.

We generally define materials as:

Porous: Materials that sorb moisture quickly and if organic, can support microbial growth (e.g., carpet, gypsum board, fiber-fill insulation, CMU, textiles);
Semi-Porous: Materials that sorb water slowly and if organic, can support microbial growth (e.g., unfinished wood, concrete, brick, OSB); and
Non-Porous – Materials that do not sorb moisture (e.g., glass, plastic, sheet metal).

Materials are also generally described as being:
Permeable: (i.e, perm rating greater than 10) (e.g., latex paint, gypsum board, clay tile, fiber-fill insulation);
Semi-Permeable: (i.e, perm rating greater than 1, and less than or equal to 10) (e.g., plywood, OSB, brick, stucco, plaster); and
Non- permeable: (i.e, perm rating equal to or less than 1) (e.g., vinyl floorcovering, foil-face insulation, polyethylene sheeting).

Mechanisms of Heat Flow

Heat flowing into and out of buildings is a major factor in determining comfort levels and operating costs. Heat flows from areas of warm temperature to areas of cool temperature in the absence of other factors. The greater the temperature difference between warmer and cooler areas (temperature gradient), the faster the heat flows. In winter, a heated building loses heat to colder outside air. Conversely, in summer an air-conditioned building gains heat from outdoor air. Buildings lose or gain heat in three ways: conduction, convection, and radiation heat transfer. These changes may be occurring at the same time to a greater or lesser degree.

- **Conduction:** Conduction is transmission of heat through a material; example: a metal cooking pan conducts heat from the stove's burner through the pan to the handle making it hot to the touch. During the winter, warm air inside a building is separated from the cold air outside by the building envelope. Because heat moves from areas of high temperature to areas of low temperature, the inside surface of a wall warms as heat moves toward the colder air outside a building*; example, as an inside wall surface heats up, adjacent material also begins to warm.* Over time, heat from inside a building will transfer through the wall to the outside. Because exterior building materials and outside air are cold, the heat that travels through wall materials is lost to the outside.

  The rate of heat loss is directly affected by the temperature gradient between inside and outside air, and the conductivity of a material. Some materials transfer heat well. The more readily materials transmit heat, the more conductive they are. Glass, concrete and metals are examples of good conductors. Other materials—called insulators—are very poor at transferring heat. They include wood, fiberglass and foam sheathing.

- **Convection:** Convection is the movement of heated gases or liquids. This movement can be either natural or forced. Natural convection occurs when the movement of gas or liquid is caused by differences in density. Warm air rises because it has a lower density than the surrounding cool air. Since cool air has a higher density than warm air, the cool air drops as the warm air rises. The movement of air along the surface of a wall increases heat transfer and causes convection loops adjacent to both interior and exterior surfaces. Convection may also take place inside interior wall cavities, especially uninsulated empty cavities.

Another example of convection is the movement of air in a double-pane window. In winter, air is heated on the inside surface of the window cavity, causing the air to rise. The air adjacent to the outside surface cools and drops. This creates a convection loop between the panes of glass that transfers heat from the inside to the outside.

In forced convection, the movement of a gas or liquid is caused by outside forces. If the wind is blowing, the air movement across an outside wall is higher, increasing the rate of heat transfer. This rate of heat transfer depends on the temperature difference, the velocity of the gas or liquid, and what kind of gas or liquid is involved. For example, heat transfers more quickly through water than through air.

- **Radiation Heat Transfer:** Radiation heat transfer is the invisible electromagnetic waves that pass from one object to another (from areas of higher temperature to areas of lower temperature). For example, if someone stands by a window on a cold day, their body radiates heat to the cold surface of the window, making them feel cold. In the summer radiant energy from the sun enters a building through windows. The walls and contents of a room absorb energy, while at the same time, various objects in the room release radiant energy, causing the room to heat up.

The Effects of Moisture on Materials and Assemblies

Understanding how materials react to moisture, allows restorers to more adequately devise a drying system. How materials react to moisture includes many factors, such as: their susceptibility to damage, permeability, absorption, and evaporation rates, and susceptibility to microbiological growth. For information on the affect of water intrusion on materials and assemblies, refer to Chapter 17 *Materials and Assemblies.*

Impacts on the Building Envelope

Occupancy

The habits and lifestyles of people occupying a building directly influence the flow of air, moisture and heat in a building. Occupants can change the efficiency of the building envelope by opening and closing windows and doors, and operating venting devices, such as fans. Since people and plants release heat and moisture into buildings, they also affect and change the flow of heat, air and moisture. These conditions may also create the need for additional dehumidification or ventilation.

Climate

Climatic and regional variables include rainfall, temperature and humidity. Such variations may require that restorers use different equipment and techniques when drying similar wet structures during different times of the year, or in different regions of the world. A building envelope acts as a physical separator between the interior of a building and the effects of outside climatic conditions. However, a restorer's actions can introduce outside conditions into the built environment. The result can be either positive or negative with respect to drying goals.

It is complex and expensive for buildings to be constructed to function optimally in a single climatic zone during all climatic conditions throughout the year. Because of variations within a single year or season, a building's construction may be more or less appropriate with respect to prevailing ambient conditions. It follows that drying techniques will not be the same at all times of the year in all regions.

The unwanted intrusion and movement of water, in any of its phases, can be caused by or result in construction and component failures. Groups, such as the Energy Efficient Building Association (EEBA), have had a positive influence on how buildings are designed and constructed. When selecting building components and specialized construction techniques, these groups are addressing the comfort and health of building occupants, the durability, longevity and energy efficiency of structural components, and environmental responsibility.

Building scientists designate climates according to general differences in temperature, humidity and rainfall. Microclimates exist within these general climates. General climatic differences can be seen in the following illustrations:

Temperature Variations Map

Source: *U.S. Department of Energy, NREL, National Renewable Energy Laboratory, SR55034585*

Heating Degree Day, a basis on which the use of fuel for home heating is measured; one Heating Degree Day is given for each degree below 65° Fahrenheit of the daily average temperature. *If the average temperature is above 65degrees, there are no heating degree days that day. If the average is less than 65 degrees subtract it from 65 to find the number of heating degree days. Example: If the day's high temperature is 60 and the day's low temperature is 40, then the average temperature is 50 degrees. Using 65 degrees as the base minus 50 degrees for the average, equals 15 heating degree days.*

Subarctic/Arctic – A region with approximately 12,600 heating degree days or more.

Very Cold – A region with approximately 9,000 heating degree days or more and fewer than 12,600 heating degree days.

Cold – A region with approximately 5,400 heating degree days or more and fewer than 9,000 heating degree days.

Mixed-Humid – A region that receives more than 20 inches of annual precipitation and has approximately 5,400 heating degree days or fewer and where the average monthly outdoor temperature drops below 45 degrees Fahrenheit during the winter months.

Hot-Humid – A region that receives more than 20 inches of annual precipitation and where one or both of the following occur:

- A 67 degree Fahrenheit or higher wet bulb temperature for 3,000 or more hours during the warmest consecutive 6 months of the year; or
- A 73 degree Fahrenheit or higher wet bulb temperature for 1,500 or more hours during the warmest 6 consecutive months of the year.

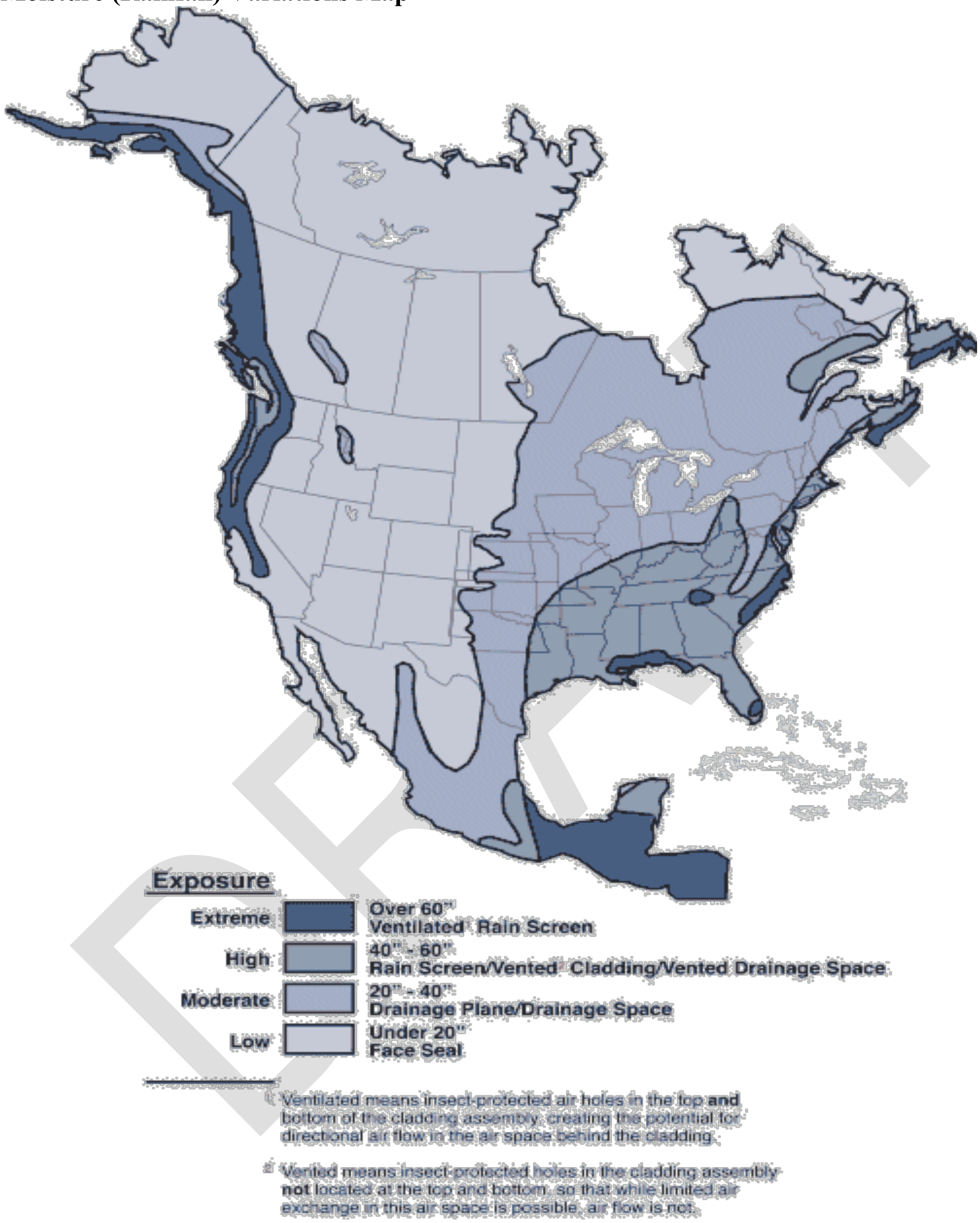
Hot-Dry – A region that receives less than 20 inches of annual precipitation and where the monthly average outdoor temperature remains above 45 degrees Fahrenheit throughout the year.

Mixed-Dry – A region that receives less than 20 inches of annual precipitation.

Marine – A region that meets all of the following criteria:

- A mean temperature of coldest month between 27 and 65 degrees Fahrenheit;
- A warmest month mean of less than 72 degrees Fahrenheit;
- At least 4 months with mean temperatures more than 50 degrees Fahrenheit; and
- A dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.

Moisture (Rainfall) Variations Map



Source: National Renewable Energy Laboratory (NREL), U.S. Department of Energy, Introduction to Building Systems Performance: Houses That Work, II, April 2004

Chapters 5

Psychrometry and Drying Technology

INTRODUCTION

This chapter deals with the science, which supports the restorative drying process. In returning a building to an acceptable condition after a water intrusion, restorers should manage the environment within the building keeping in mind what is happening with the moisture in the structural materials and contents. To accomplish this, restorers should understand how:

- to manage the psychrometric properties of the environment during the different stages of drying;
- moisture impacts and moves through different materials;
- to promote surface evaporation from the materials; and
- the materials are assembled in the construction of the building.

PSYCHROMETRY

Psychrometry is a sub-science of physics relating to the measurement or determination of the thermodynamic properties of air/water mixtures (e.g., humidity and temperature). Measuring and evaluating these properties enables restorers to better analyze and manage conditions during drying. [2]

When discussing psychrometrics, this mixture is termed either moist air or air. It is important to understand that air is a mixture of many gases; some in steady proportions and some that vary. The gases in steady concentrations are nitrogen (77.5%), oxygen (20.5%), argon, neon, helium and others. This accounts for approximately 99% of the mixture. The rest of the makeup of air is in variable concentrations. These gases are water vapor (0.05% to 0.09%), radon, carbon dioxide, and many others. Water vapor behaves as any other gas in air dispersing equally throughout a sample or volume of air. All gases follow the second law of thermodynamics. That is, areas of higher energy or concentration always disperse and move toward areas of lower energy or concentration.

Critical Laws in Psychrometry

Three important laws that relate to air and water vapor mixtures that can help restorers understand the restorative drying process are:

1. **Second law of thermodynamics** states that in an isolated system, concentrated energy disperses over time to lower energy areas. Energy dispersal also means that differences in temperature, gas pressure, and water vapor pressure attempt to even out until equilibrium

[2] Gatley, Donald P. Understanding Psychrometrics – 2nd Edition, (Atlanta, ASHRAE, 2005) p xi

is achieved. The second law implies that heat does not flow from a cold material to a hot material; it only flows from hot to cold.

a. This law helps the restorer understand why (1) moisture in an enclosed environment disperses to other areas of the environment, (2) moisture moves through materials from areas of high to low water vapor pressure and (3) heating a space causes heat energy to be introduced into building materials.

2. **Dalton's Law of Gases** states that (1) within a mixture of gases each gas occupies the same overall volume and (2) atmospheric pressure is the sum total of the partial pressures of the various gas components (e.g., nitrogen, oxygen, argon, moisture vapor, radon).

   a. Dalton's Law helps to explain the concept of relative humidity - the ratio of the partial pressure of the water in the air to its saturation vapor pressure at a given temperature and barometric pressure.

3. **The Ideal Gas Laws** are a combination of several laws of which Robert Boyle's and Jacques Charles' laws are more relevant.

   a) Boyle's Law basically states that for a fixed mass of an ideal gas (water vapor being one) at a given temperature, pressure and volume are inversely proportional.

   b) Charles' Law deals with the behavior of ideal gases at relatively low pressures and relatively high temperatures.

   The Ideal Gas Laws explains why (1) equipment being used at 5280' elevation (e.g., mile-high Denver, CO) will not deliver the same volume of air as it would at 0' elevation (i.e., sea level) and (2) how a vacuum freeze dry chamber causes solid ice to sublime, becoming gas without going through the liquid state.

These laws account for many things we see in everyday life, including weather patterns, vapor movement in the air and moisture movement in materials. Psychrometric conditions influence the rate at which moisture moves within materials as well as from wet materials to the air. Therefore, managing humidity, airflow and temperature will influence the length of time necessary to return abnormally wet materials to an acceptable drying goal.

A frequent application of the Ideal Gas Law can be observed in the operation of a vacuum freeze-dry (VFD) chamber, used for restorative drying of documents and books. A VFD follows the principles of the Ideal Gas Laws that there is an inverse relationship between pressure, volume and temperature. If the pressure is lowered, the volume

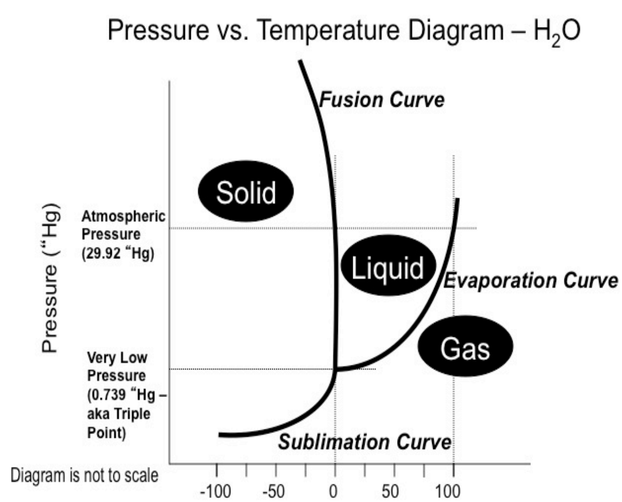


Figure 1

of the air increases proportionately, lowering the boiling point. (See Figure 1)

This is easily observed in areas of higher elevations (e.g., Denver, CO) where water will boil around 202^{o}F. In fact, for each thousand feet above sea level, the boiling point of water drops about 2^{o}F. It is also the principle by which a vacuum freeze dry chamber operates – reducing the pressure to such an ultra low level the boiling point converges to the fusion (i.e., freezing) point. Below this triple point, water will change phases from solid (i.e., ice) to gas (i.e., vapor) without going through the liquid state.

HUMIDITY

Humidity is water vapor present in an air mass. There are four generally accepted expressions of humidity used in the water damage restoration industry:

1. **Humidity ratio (HR)** (alternatively, vapor content or mixing ratio) of a given moist air sample is defined as the ratio of the mass of water vapor to the mass of dry air in the sample. It is expressed in grains per pound (grams per kilogram) of dry air, sometimes shortened to gr/lb or gpp (g/kg).

   $HR = Weight_{water\ vapor} / (Weight_{moist\ air} - Weight_{water\ vapor})$ or $Weight_{water\ vapor} / Weight_{dry\ air}$

   NOTE: This is the term used on most psychrometric charts on the vertical axis just to the right of the chart. It is the most appropriate way to compare two air masses using a common denominator (i.e., dry air). In this document, when the term humidity is used without qualification, it will refer to the humidity ratio of the air, one of the absolute measures of the amount of moisture present.

2. **Relative humidity (RH)** is the amount of moisture contained in a sample of air as compared to the maximum amount the sample could contain at that temperature. This definition is accurate in concept; but strictly speaking, relative humidity is the ratio of the partial pressure of water vapor in a sample of air to the water vapor pressure at saturation of that air, at a given temperature and atmospheric pressure.

3. **Water Vapor Pressure (WVP)** is the pressure exerted by the molecules of a vapor on surrounding surfaces, usually expressed in inches of mercury ("Hg) or millimeters of mercury (MM Hg). Atmospheric pressure is the total pressure exerted by all gas components in the air (e.g., nitrogen, oxygen, argon, carbon dioxide, water vapor). VP is only one component of the total atmospheric pressure. Since water vapor is the primary vapor of interest in the restoration industry, the term water vapor pressure (WVP) is often shortened to vapor pressure (VP). Unless noted when "vapor pressure (VP)" is used without qualification, it refers to water vapor pressure.

4. **Specific humidity (SH)** is the ratio of the mass of water vapor to the total mass of a moist air sample. Often incorrectly used as a synonym for humidity ratio. Specific humidity is expressed as grains per pound of moist air.

   $SH = Weight_{water\ vapor} / (Weight_{dryair} + Weight_{water\ vapor})$ or $Weight_{water\ vapor} / Weight_{moist\ air}$

Note: It is difficult to use specific humidity to compare two air masses since the amount of moisture in each sample of moist air can vary (i.e., no common denominator).

AIRFLOW

Directed airflow is used in the restorative drying process to accomplish two objectives:

1. To circulate air throughout the workspace to ensure drier air continually displaces more humid air. Air needs to be circulated to all effected interstitial cavities, such as wall and ceiling voids, beneath cabinetry and underneath and within wood flooring systems. Airflow can be directed using various equipment or techniques (e.g., temporary ducting, stairwells, air movers, structural cavity drying systems).
2. To direct air at material surfaces in order to displace the evaporating surface moisture within the boundary layer of air and transfer energy to the surface moisture and materials. The boundary layer is a thin layer of air at the surface of materials that due to surface friction does not move at the full speed of the surrounding airflow. This layer needs to be continuously displaced to enhance evaporation. .[3] [4]

Airflow needs to be properly managed. This means that "more is not always better". On some materials like concrete, plaster or wood, excessive airflow (i.e., velocity) can hinder the drying process. On some denser materials like concrete, plaster or wood, excessive airflow during the falling rate drying stage can overdry the wetted pores at the surface of the materials and potentially hinder the drying process.

Properties of Airflow

Airflow is usually described in terms of velocity and volume.

The Velocity of Airflow describes the speed of airflow moving through equipment or across a surface. The velocity of air moving across a wet surface plays an important role in the drying process. It is typically measured in feet per minute (FPM), feet per second (FPS) or meters per second (MPS). The effect of velocity on drying is discussed later in this chapter.

The Volume of Airflow describes the amount of air delivered by an air mover, dehumidification system, air conditioner or similar piece of equipment. The volume of airflow is typically measured in cubic feet per minute (CFM) or cubic meters per hour (CMH) and is useful in calculating circulation or exchange rates within an environment.

Manufacturers of drying equipment usually provide the rated volume of air the unit delivers at its outlet in standard cubic feet per minute (SCFM). This is defined as the airflow through a device at a standard 70°F/21°C, 50% RH at sea level. The density of the air will be

[3] Bloomfield, Louis A. How Everything Works (Hoboken, NJ, John Wiley & Sons Inc., 2008) p 656
[4] http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/5940/Effects_Boundary_ocr.pdf?sequence=1

reduced as the altitude or temperature increases. In both cases the volume of airflow through the device will be reduced. Boyle's Law helps us to understand why this occurs.

Static pressure describes the potential pressure exerted by a flow of gas (i.e., air) as measured in the normal direction of its flow. In the Inch-Pound System (IP), it is usually expressed in inches of water gauge ("WG) or simply inches of water ("$H_2$0) when dealing with air. In the International System of Units (SI), it is expressed in Pascals (Pa). Equipment manufacturers will usually provide pressure ratings for their fans, which are useful when a long run of flexible ducting is required to distribute air throughout a space. The fan must deliver air at a static pressure great enough to overcome the resistance of a duct system, interstitial constraints, or floating carpet.[5]

TEMPERATURE

Temperature indicates the intensity of sensible heat of the air and within materials. Heat energy influences the ability for water vapor to be suspended in a sample of air and is critical in the physical phase changes between solid, liquid, and vapor. The process of evaporation is a product of adding energy. The more energy added to a liquid, the more rapidly evaporation occurs.

Various expressions of temperature are:

- **Dry Bulb Temperature:** temperature as measured by a standard thermometer with a dry-sensing bulb; commonly expressed in degrees Fahrenheit or Celsius. Throughout this document, when temperature is mentioned with no reference to "dry" or "wet" bulb temperature, it is referring to "dry" bulb temperature.
- **Wet Bulb Temperature:** temperature obtained using a standard thermometer where the sensing bulb has been covered by a sock wetted with distilled water. Airflow across the sock creates evaporation, thereby cooling the sensing bulb. The amount of cooling at the bulb's surface is dependent upon the amount of moisture in the air and the speed of the air flowing across the wet sock. Greater cooling occurs when humidity is low, while less cooling occurs when humidity is high.
- **Dew Point Temperature:** temperature at which humidity in air reaches saturation; below which water vapor will condense from that air to form condensation on surfaces. Dew point temperature, like humidity ratio and water vapor pressure, is another term to describe the non-relative amount of moisture that is contained within a sample of air. It is useful to the restorer when evaluating high water activity or the likelihood of condensation forming on surfaces and interstitial spaces (e.g., wall cavities).

Other Related Terms

Two other psychrometric properties that are beneficial for the restorer to understand are:

[5] Schuman, M.M. Chairman – Committee on Industrial Ventilation. Industrial Ventilation 14th Edition. (Lansing, MI, American Conference of Governmental Industrial Hygienists, 1976)

1. **Specific volume:** the specific volume of air as indicated on a psychrometric chart refers to the volume (e.g., cubic feet) of air per mass (e.g., pound) of dry air. At normal atmospheric pressure (i.e., sea level) a pound of air at normal room conditions (i.e., 70°F and 50%RH) will occupy approximately 13.5 cubic feet of volume. Whereas a pound of air at normal atmospheric pressure and 90°F and 50%RH will occupy approximately 14.2 cubic feet of volume. Warmer air will be less dense, thus a pound of air is larger in volume.

   This concept is only important to the restorer when trying to understand why warmer air has the capacity to contain more humidity. It is mistakenly believed by some that warmer air can contain more humidity due to its larger volume. But a calculation of the volume and humidity capacity of air demonstrates otherwise. The difference in volume between 70°F air and 90°F air at 50% RH is approximately 5%. But the difference in the amount of moisture that 90°F air could contain (i.e., suspend as a gas) over 70°F air is approximately 94%. The amount of moisture that can be suspended as a gas in a sample of air is not a function of its volume, but a function of the total energy content of the air.

2. **Enthalpy:** the enthalpy of the air is a measure of the total energy in the air. It is expressed in British Thermal Units per pound of dry air (kilojoules per kilogram of dry air). A British Thermal Unit (BTU) is the amount of heat needed to raise a pound of water by one (1) degree. There are two components of energy in the air:

   a. **Sensible energy** is the energy in the air that can be sensed or measured with a dry-bulb thermometer. A change in sensible energy changes the temperature we feel.

   b. **Latent energy** (sometimes referred to as hidden energy) is the energy that is required to bring about a phase change in water. It is the energy associated with evaporating and suspending water vapor in air.

   The greater the energy in a sample of air, the more moisture can be evaporated and suspended as a gas in the sample of air. In short, the reason warmer air can suspend or contain more moisture is not due to the enlarged volume of the air, but because the amount of energy in the air is greater. Therefore if moisture is available for evaporation, more will be evaporated and suspended as a gas.

Managing Psychrometric Properties for Restorative Drying

Humidity, airflow and temperature influence the movement of moisture within a material as well as the evaporation rate from the surface of material. These properties greatly impact the overall drying time for a project. The restorer's task is to manage the environment to return the affected materials and structure to the moisture levels and environmental conditions prior to the water intrusion.

Equilibrium as it relates to the restorative drying industry assumes that prior to the water intrusion, a structure and its materials were in equilibrium relative to its surrounding environment. Throughout the year and from day to day the moisture content of materials changes in response to the fluctuations of humidity and temperature of the built environment. As long as these materials' moisture content remains below thresholds needed for microbial growth, the changing moisture content is of little concern as all building materials have some tolerance for fluctuating moisture content.

When a water intrusion occurs, the materials respond to the surroundings by taking on moisture either through direct contact with water or indirectly through the high humidity environment. The moisture content of materials that are in direct contact with water can quickly exceed the threshold that promotes microbial growth or deterioration of the material. Executing a proper drying plan will reduce the amount of time necessary to return materials to a moisture level below the threshold for microbial growth and acceptable moisture content (i.e., drying goal).

It is important to quickly control the moisture in the air (e.g., dehumidification, ventilation) and use sufficient airflow to dry the surfaces of materials to reduce water activity thus lowering the potential for microbial growth. This also stabilizes the environment; rapidly reducing the potential for secondary humidity damage to materials. At this point, the focus is on eliminating the surface moisture.

As the job progresses and the environment is stabilized, materials can appear dry on the surface but can still be wet internally. The moisture in the materials is moving toward the surface. It is important to control humidity, provide constant airflow, and manage energy (heat) applied to the materials to promote drying. At this point, the focus is on moving the moisture within the materials.

As the job progresses, there can still be some affected areas of the materials that meet the drying goals and other areas that do not. It is important during this stage to re-direct air movement and ensure good transfer of energy (heat) to the remaining wet areas. The overall need for humidity control and airflow is lower than at the beginning, since there is a reduced amount of moisture being evaporated. It is important for the restorer to monitor the moisture in materials carefully and manage the equipment to achieve the drying goals throughout the affected area.

DRYING TECHNOLOGY

Drying technology is an established body of knowledge and practice that deals with the effects of moisture in materials, its movement within, and evaporation from their surfaces. Drying principles are applied in the manufacture of many products, including food (e.g., meat, cereal, and pasta), paper, building materials (e.g., gypsum board, kiln-dried wood, bricks), pharmaceuticals and cosmetics. Many of the drying technologies used in manufacturing (i.e., industrial drying) are also used in restorative drying (e.g., forced-air drying, dehumidification, vacuum freeze drying and heat drying).

However, differences do exist between industrial drying and restorative drying. Drying building materials that have been re-wetted due to a moisture intrusion is very different than the initial industrial drying of those materials during production (e.g., green wood to dimensional kiln-dried lumber, new concrete to in-service concrete). Products in the process of manufacturing are homogenous, similar in size and characteristics with known properties and drying times. Everything is controlled, akin to a "laboratory" with set inputs and predictable, repeatable results. Conversely, in the restoration industry, a variety of materials are in a complex, built up system, with each component of that system having varying properties, and drying characteristics. In industrial drying the product is placed into the drying apparatus, but in restorative drying, the drying apparatus is placed inside the "product" – the affected area.

How Moisture is Held in Materials

Many of the materials that are used in building construction are hygroscopic, meaning they draw moisture into them from the surrounding environment. All hygroscopic materials in the built environment will contain moisture and will generally be at equilibrium relative to its surrounding environment in the absence of a vapor barrier or retarder. The water is held in the material either through adsorption (water or vapor adhering to the exterior surface and interior surfaces of cell walls) or absorption (vapor penetrating into the cells or crystalline structure). With some materials (e.g., salts), absorption actually dissolves the compound, thus changing its chemical makeup. The term sorption can be used to indicate the process of taking up moisture without specifying either adsorption or absorption while desorption describes a material giving up its moisture.[6]

In a controlled laboratory environment, porous and semi-porous building materials will reach a state of equilibrium according to the surrounding relative humidity (RH) and temperature. At equilibrium the net effect is that the material is neither gaining nor losing moisture – usually referred to as equilibrium moisture content (EMC). Additionally, the water vapor pressure of the moisture held in the pores of the material will be equal to the surrounding environment. In a normal building environment a steady state of EMC is not possible since the relative humidity and temperature is always fluctuating.

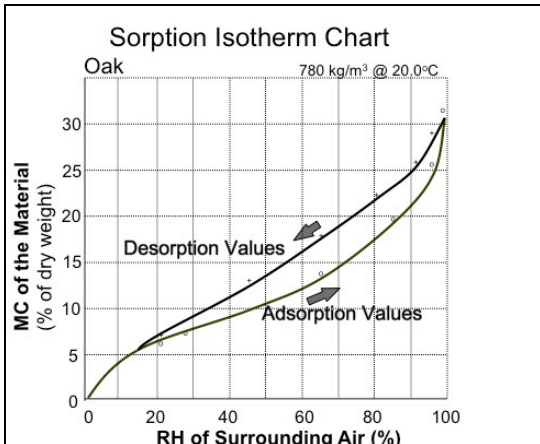


Figure 2

Moisture content (MC) is defined as the amount of water contained in a material, expressed as a percentage of the weight of the oven-dry (or bone-dry) material. [7] [8]

$$MC\% = ((W_{material} - W_{oven\ dry\ weight\ of\ the\ material}) / W_{oven\ dry\ weight\ of\ the\ material}) \times 100$$

Where W = weight

If a restorer is measuring materials with an instrument that is calibrated for that material, then the

[6] "Adsorption." Encyclopedia Britannica. 2010. Encyclopedia Britannica Online. 2 Nov. 2010 <http://www.britannica.com/EBchecked/topic/6565/adsorption>.

[7] Source for the definition of moisture content Wood Handbook - Wood as an Engineering Material - General Technical Report FPL-GTR 190. Department of Agriculture, Forest Products Laboratory, Madison, WI, 2010) p G-10 Glossary

[8] Boone, S and Wengert, E. (Forestry Facts #89 "Guide For Using the Oven-Dry Method for Determining the Moisture Content of Wood" (Madison, WI, University of Wisconsin-Madison, 1998)

term moisture content is the proper term. However, if the restorer is measuring the moisture using an instrument not calibrated specifically for that material or is being read on the relative scale; it is recommended the term moisture level be used.

A sorption isotherm (Figure 2) graphically depicts the relationship between the moisture content of the material with the surrounding relative humidity at a constant temperature. Sorption isotherms for various materials are developed in controlled environments, and almost always demonstrate a characteristic S-shape.[9]

The desorption values characterize the drying process, and the adsorption values characterize the wetting process. The observable difference between the two curves indicates that drying takes place slower than wetting (lagging). This observed lagging effect, termed hysteresis, is observed in all materials. Desorption curves will always lie above the adsorption curve.

A restorer could practically use a sorption isotherm to make a general estimation of the moisture content of a material at normal building conditions – usually estimated to be 50-55% RH at 70^{o}F. This can be useful when benchmark readings are not available. Using the isotherm above a restorer could estimate that under normal building conditions the MC of oak during the drying stage would be approximately 12%.[10]

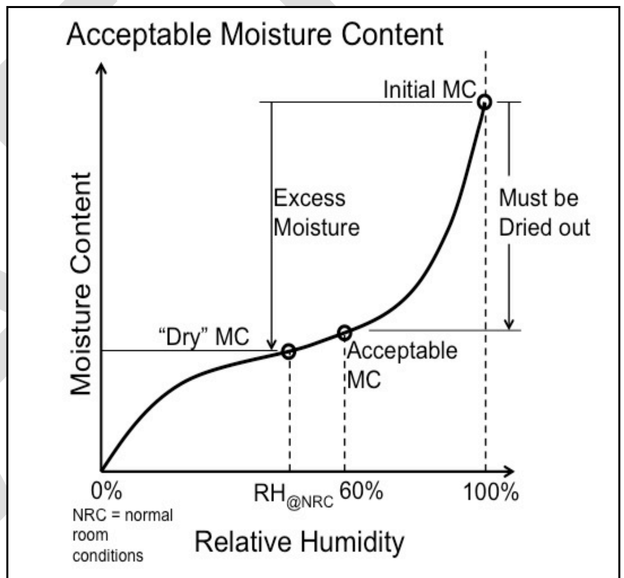


Figure 3

Water can be held in hygroscopic materials as bound or free water:

1. **Bound water:** this is moisture held within the cellular or crystalline structure of the material. This moisture may be sorbed into the cells or can become physically or chemically bound to the surfaces of cells. Some of this moisture is always present in the material and does not need to be removed. In fact, much of the bound water in concrete is a critical part of the hydration process and actually strengthens it. A certain amount of bound water in wood is also desirable, contributing to its dimensional stability and strength.

2. **Free water:** this is liquid moisture on the surface and held in the pores of the material. All of this is excess moisture that has been drawn into the materials through capillary action. As free water remains, the cell material will absorb the moisture, thus becoming bound water, until the point of saturation. In most cellulose-based products (e.g., wood,

[9] Trechsel, Heinz R and M. Bomberg, Editors, "Sorption Isotherms: A Catalog and a Data Base", Water Vapor Transmission Through Building Materials and Systems: Mechanisms and Measurement. ASTM STP 1039, (West Conshohocken, PA, American Society for Testing Materials, 1989).
[10] Trechsel, Heinz R. Moisture Analysis and Condensation Control in Building Envelopes, (West Conshohocken, PA American Society for Testing Materials, 2001).

paper) this fiber saturation point is between 25-30% MC. All free water needs to be removed during the restorative drying process. (Figure 3)[11]

As it relates to specific materials they need to dried to the point they will:

1. Not support microbial growth (e.g., mold, bacteria);
2. Regain their structural integrity; and
3. Restore them to their intended purpose.

Water activity (a_w) is the best indicator of the likelihood of a material to support microbial growth. It describes the amount of free water available for microbial growth on a substrate and is comparable to the ERH of a material, which is the relative humidity taken at the surface of a material. A a_w of 0.80 is equivalent to an ERH of 80%. According to ACGIH's *Bioaerosols: Assessment and Control* book in section 10.3.3, "Practically speaking, if a_w can be kept below ~0.75, microbial growth will be limited; below an a_w of 0.65, virtually no microbial growth will occur on even the most susceptible materials."[12] In other words, the restorer's task is to dry all materials to be at equilibrium with an environment below this threshold (i.e., 0.65 a_w) although, a threshold of 0.60 a_w would provide a greater level of assurance. If the surfaces of hygroscopic materials (e.g., gypsum board) can be dried and maintained below the above threshold, microbial growth can be quickly halted; even though the core of the material may still have elevated moisture content. Figure 2 is a qualitative depiction of the excess moisture that needs to be removed. The pre-event MC is shown as "Dry Equilibrium". Moisture in excess of the "Acceptable" line of relative humidity must be removed.[13]

How Moisture Moves through Materials

When building materials become wet following a water intrusion, the drying effort needs to reverse the mechanisms by which the moisture entered. The free water is drawn out through capillary action, followed by the excess bound water via diffusion – both mechanisms can be driven by water vapor pressure differentials.

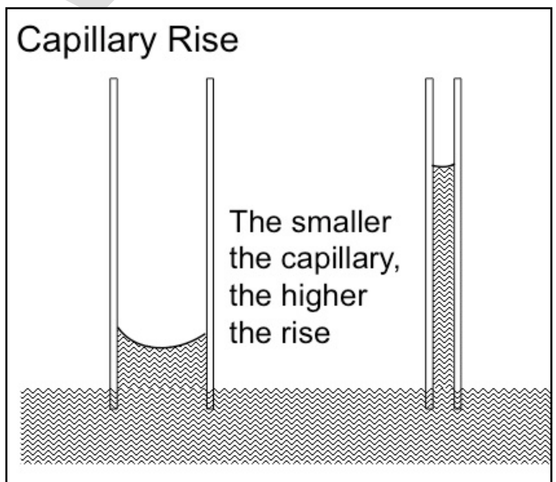


Figure 4

1. **Capillary action** is the movement of a liquid through the slender tubes or pores of a material. It is a result of, (a) surface tension of the water and (b) the adhesion of the water with the pore walls. These attractive forces cause the water to rise to the point that it balances the force of gravity of the column of water. The narrower the pore, the higher the water rises (See Figure 4). Since capillary action is a movement of liquid,

[11] Mujumdar, Arun S. Handbook of Industrial Drying, 2nd Edition, (Marcel Dekker, Inc. NY, NY 1995).
[12] Shaugnessy, Richard, Philip Morey and Eugene Cole, editors. Bioaerosols: Assessment and Control, (Cincinnati, American Conference of Governmental Industrial Hygienists, 1999)
[13] Nillson, Lars-Olaf. Advanced Course in Moisture Mechanics (course manual), Lund University, Lund Sweden, 1995

it is a quicker means of moisture movement than diffusion.[14] Water moves through a material easier when it does not have to overcome surface tension within the capillaries of the materials.

2. **Moisture diffusion** is the movement of water vapor molecules through the mass of the material. It is driven by moisture gradients within the material as well as vapor pressure differential from inside the material to one or both outer surfaces of the material. Diffusion occurs much slower than capillary action but is a necessary part of the process by which excess bound water is removed.[15][16]

Drying is the combination of water and vapor movement through material to the surface where it can evaporate. While free water is moving to the outer surface and evaporating, the external conditions of temperature, humidity removal, airflow, and material exposure drive the drying process.

How Materials are Dried

During the drying of any material, two processes can occur simultaneously (See Figure 5):

Process 1: Surface evaporation: This occurs as energy (i.e., heat) transfers from the surrounding environment to the material. The rate of evaporation depends on the temperature of the moisture in the materials, the humidity of the air, the airflow at the surface and exposure of the wet surfaces to the environment. Surface evaporation is controlled by the diffusion of vapor from the surface of the material to the surrounding atmosphere through a thin film of air in contact with the surface.

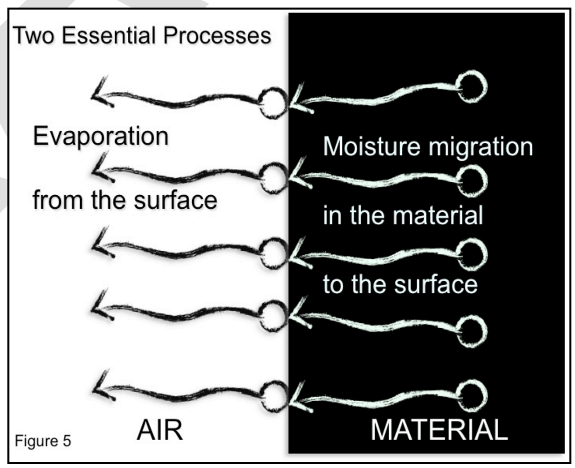


Figure 5

Process 2: Internal moisture movement: This involves internal moisture moving (as liquid, vapor or both) within the material toward the surface, in order to be removed at the surface. The movement of moisture internally within the material is a function of the physical properties (i.e., porosity, permeability, composition) of the material, the vapor pressure differential across the material and its internal moisture gradient.

Both of these processes continue throughout the drying period, and either can be a limiting factor to the rate of drying. [17], [18], [19], [20]

[14] Capillarity. (2010). In *Encyclopedia Britannica*. Retrieved October 15, 2010, from Encyclopedia Britannica Online: http://www.britannica.com/EBchecked/topic/93801/**capillarity**
[15] 2013 ASHRAE Handbook – Fundamentals (Atlanta, ASHRAE, 2013) p 25.12
[16] Forest Products Laboratory, Wood Handbook – Wood as an Engineering Material – Centennial Edition (USDA-FPL, 2010) p 13-6
[17] Majumdar, Arun S, editor, Handbook of Industrial Drying (New York, NY, Marcel Dekker, Inc., 1987), p 3-4, 18-19

CONSTANT & FALLING DRYING RATE STAGES

During drying, most materials go through three distinct stages of drying: a constant drying rate stage followed by two falling drying rate stages. Figure 6 depicts qualitatively a typical drying rate curve of a hygroscopic material.

During the constant drying rate stage, liquid water is present at the surface and evaporates into the air over the material at a constant, unhindered rate. Warm, dry, rapidly moving air will cause faster evaporation than cool, stagnant air. As the liquid evaporates, it is replenished with water from within the body of the material via capillary action. The constant drying rate can be quite short (e.g., minutes) or much longer (e.g., hours) depending on the degree of saturation, physical properties of the material (e.g., porosity, permeability, composition) and the factors influencing surface evaporation (see later section on Evaporation from Material Surfaces). As long as liquid water is continually available at the surface the rate of drying remains constant.

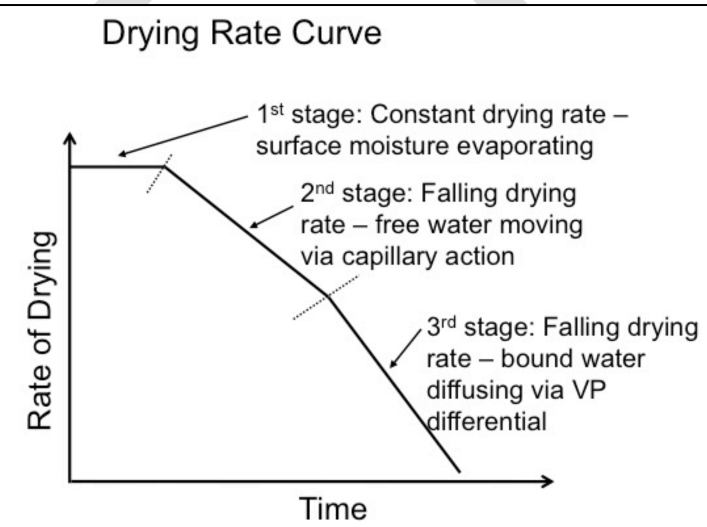


Figure 6

When liquid water is no longer available at the surface, the second stage of drying begins (i.e., falling drying rate). Howard Kanare in his book Concrete Floors and Moisture explains the falling rate stage in this manner. "Liquid water recedes from the exposed surface of the material into the pores. Within each pore, water clings to the sidewalls and forms a curved surface called the meniscus. At the surface, water evaporates from the meniscus in each pore of the material. At this point, water still fills the pore structure of the material; there are continuous paths for liquid water to flow from within to the partially filled pores at the surface where the water can evaporate. The surface may appear to be "dry," but the material is just beginning to dry in a very thin layer. The rate of drying during this stage steadily decreases."[21]

The third stage of drying (i.e., falling drying rate) results when there is no longer sufficient liquid-filled pores to support capillarity and moisture must now move through the material toward the surface as a vapor. This vapor diffusion is driven by differences in moisture

[18] Stacey, A. E. Jr. Evaporation Rates of Moisture from a Wet Material and from a Free Water Surface. Proceedings of the Symposium on Drying and Air Conditioning of the American Chemical Society, 1937, University of Pennsylvania, Philadelphia, p 1385-1389.

[19] Green, Don W. and Robert H. Perry. eds. Perry's Chemical Engineers Handbook – 8th Edition. McGraw-Hill Companies: New York, NY. 1934-2008. p 12-30

[20] 2011 ASHRAE Handbook – HVAC Applications (Atlanta, ASHRAE, 2011) p 30.1

[21] Kanare, Howard. Concrete Floors and Moisture, (Portland Cement Association, Skokie, IL 2005), p 36-37

content gradient within the material (following the second law of thermodynamics) and by a differential in vapor pressure in the material and the surrounding air.[22], [23]

Figure 7 illustrates how this moisture gradient between the core of the material and the surface is the key to drying the core. Moisture in the core equalizes at a rate determined by the moisture content in the next layer of material and so on. The evaporation at the surface can be retarded by the material's permeability (i.e., the path water takes through the material) and its' internal moisture gradient (i.e., difference in water vapor pressure through the material).[24]

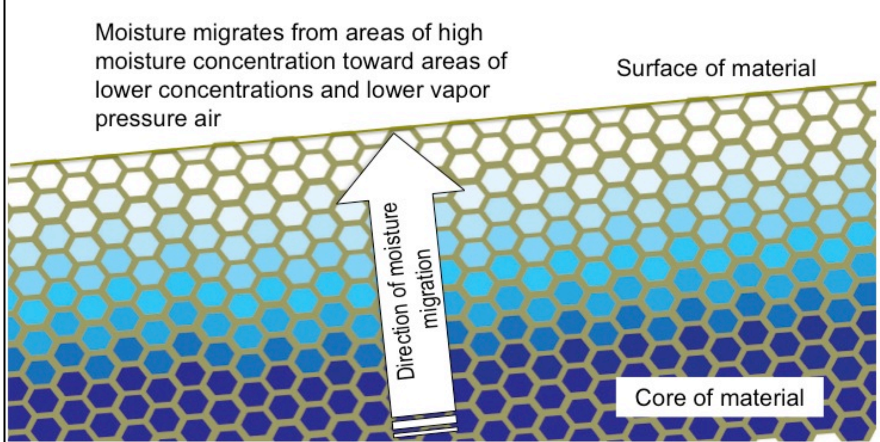


Figure 7

HOW ENERGY IMPACTS THE MOVEMENT OF MOISTURE IN MATERIALS

For water to change phase from liquid to gas, energy (i.e., heat) is required – called the heat of vaporization. When energy is applied to material with bound moisture, the bond between moisture molecules and the material is broken, thereby increasing vaporization. The greater the water vapor pressure differential and the more energy that is transferred into the core of the material, the faster the moisture will move through and evaporate from the material.

Heat energy transfer occurs in three ways:

1. Conduction – transfer of energy between adjacent molecules.
2. Convection – transfer of energy through movement of a heated fluid, such as air.
3. Radiation - transfer of energy emitted from a heated surface to another surface; requiring no medium (e.g., air) to convey the energy.

EVAPORATION FROM MATERIAL SURFACES

[22] Majumdar, Arun S, editor, Handbook of Industrial Drying (New York, NY, Marcel Dekker, Inc., 1987), p 524-527

[23] Earle, R.L. "Drying", (New Zealand Institute of Food Science & Technology, Inc., 1983) retrieved 31-Jan-2013, http://www.nzifst.org.nz/unitoperations/drying5.htm

[24] Walker, J.C.F., Butterfield, B.G., Langrish, T.A.G., Harris, J.M. and Uprichard, J.M. (1993). Primary Wood Processing. Chapman and Hall, London.

Evaporation is the process by which water changes from its liquid phase to its gaseous phase while staying below the boiling point. The evaporation load is influenced by several factors:[25][26]

- Concentration of the moisture in the air – impacts the capacity of the air to contain more moisture;
- Water vapor pressure differential between the surface of the wet material and the surrounding environment – impacts the direction and speed of moisture movement;
- Temperature of the wet material – impacts the available energy required for the phase change (i.e., vaporization) of the water;
- Air movement across the surface of the wet material – impacts the removal of the evaporating surface moisture within the boundary layer; and
- Access to wet materials – impacts the surface area available to the dry air (e.g., open walls, move furniture, remove vapor retarding materials).

Materials & Moisture Movement

	In the Materials	From the Surface
Moisture Transfer Mechanism	Capillary action & diffusion	Evaporation
Moisture Phase	Liquid & Vapor	Vapor
Driving Mechanism	Vapor pressure differential within the material	Vapor pressure differential, airflow & temperature
Restorer's Actions	• Lower humidity ratio of the air • Add energy into materials	• Lower humidity ratio of the air • Maintain constant airflow • Add energy into materials

Figure 8

SUMMARY

A working knowledge of psychrometry, drying technology and how moisture moves through materials will help the restorer develop an effective drying plan. Proper management of these concepts will help restorers to dry the affected structure, systems, and content effectively and efficiently. (See Figure 8)

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[25] Dalton, J. (1802), "Experimental essays on the constitution of mixed gases; on the force of steam or vapor from water and other liquids in different temperatures, both in a Torricellian vacuum and in air; on evaporation and on the expansion of gases by heat", Manchester Literature and Philosophical Society 5 – 535-602.

[26] Brutsaert, Wilfried. Evaporation into the Atmosphere, 1991 (Kluwer Academic Publishers, Norwell, MA)

Chapter 6

Equipment, Instruments and Tools

INTRODUCTION

Equipment, instruments, tools and their use shall conform to safety and inspection requirements of local, state, provincial or federal laws and regulations. Restorers should follow the safety guidelines and operation and maintenance instructions provided by the manufacturer where applicable.

WATER REMOVAL EQUIPMENT AND TOOLS

Restorers should initially remove as much liquid water as is reasonably possible before any evaporative drying procedures are initiated. There is an extensive array of equipment and tools available for removing water from affected areas. Water can be mechanically removed with pumps and vacuum extraction units, or manually removed with mops and towels. These direct methods of water removal can greatly reduce the amount of water needing removed through the much slower evaporative drying methods.

Pumps

Pumping equipment with sufficient lift and volume capacity can be used to remove standing water from floors and structural components. Restorers use two types of pumps: submersible pumps and surface pumps. The electrically operated submersible pump sits or is submerged in the water being pumped out, utilizes a discharge hose and has an integrated intake. The surface pump is powered by an electric motor or internal combustion engine located outside the flooded area, and has an intake and a discharge hose.

Extraction Units

Water can be efficiently removed from the structure, systems, and contents using extraction units with sufficient vacuum capability (lift and airflow). These units can also be used for removing deep standing water when pumps are not available. Extraction can be performed with units designed specifically for this purpose or with units designed for carpet cleaning with water extraction capability. The extracted water is either captured in a holding tank or pumped into a sanitary sewer system. Local, state, provincial and federal regulations determine the proper disposal of extracted water. There are two basic types of extraction units: truckmount and portable.

Extraction Tools

Extraction tools are normally attached to extraction units by a vacuum hose and are used to remove water. A variety of extraction tools are available that are appropriate for specific surfaces and areas. They include, but are not limited to: light wands, weighted drag tools, stationary tools, hand-held tools (e.g., stair and upholstery tools) and self-propelled units. The effectiveness of the tools for the extraction of water from carpet and cushion varies with the type and weight of carpet, type and weight of cushion, and amount of water present.

Light Wand: A light wand is a non-weighted tool used for water extraction and carpet cleaning. The light wand is an appropriate tool for initial water removal, extracting water from glue-down carpet and is also effective to remove residual water on the surface of carpets after stationary tools have extracted water from the cushion.

A hard surface wand is a tool specifically designed to extract standing water from hard surfaces (e.g., concrete, tile, vinyl, hardwood). A hard surface wand incorporates a non-abrasive head that minimizes the risk of causing damage to the flooring surface (e.g., rubber, plastic, synthetic blade or brush).

Weighted Drag Tool: A weighted drag tool is generally used for extraction on carpeted surfaces. It uses weight and a roller to compress a vacuum head into the carpet and cushion and extract water as the tool is dragged across it.

Stationary Tool: Stationary tools are rectangular panels with multiple holes or slots in the base of the unit. The restorer typically stands on the stationary unit compressing the carpet and cushion creating a vacuum seal beneath the unit. As extraction is completed in each position, the unit is moved systematically across the floor. Effectiveness can be increased by pre and post-extracting with a light wand.

Self-Propelled Unit: Self-propelled units are powered by a motor that moves the unit across the carpet. Weight for compression of the carpet and cushion is provided by the weight of the machine or the operator. Self-propelled extraction tools provide a speed control mechanism allowing a consistent rate of extraction over large areas.

AIR MOVING EQUIPMENT

Air moving equipment or fans can be used to direct airflow at or across wet materials, to accelerate evaporation, to provide ventilation, or create an air pressure differential between two areas. Many air movers can also be fitted with ducting to direct airflow to other areas or out of the structure. Air moving equipment has various airflow and static pressure capabilities. Generally, there are two types of air movers: centrifugal and axial.

Centrifugal Air Movers

The centrifugal air mover (e.g., squirrel cage blower, carpet dryer) has a moving component called an impeller that consists of a central shaft around which a set of blades is positioned. The impeller rotates, causing air to enter the impeller near the shaft and move perpendicularly from the shaft to the outlet due to centrifugal force. A centrifugal air mover produces a higher static pressure for a given air volume than a typical axial design. Several components of the design influence the performance of a centrifugal air mover (e.g., motor type, impeller design, housing design).

High-pressure centrifugal air movers typically produce static pressure levels above 2.5" water column (WC), and utilize motors of at least ¾ HP. They are primarily used to direct airflow into restricted areas that are resistant to ambient air movement and exchange (e.g., under carpet, under kitchen cabinets, into building cavities, or under flooring systems). Many accessory attachments exist to assist in directing airflow into these areas.

Low-pressure centrifugal air movers typically produce static pressure levels below 2.5" WC and have motors rated from ¼ to ½ HP. They are primarily used to promote evaporation by creating airflow across the surface of materials. Examples can include carpet and hard surface floor coverings, walls and ceilings.

Axial Air Movers

Axial-flow air movers have blades that force air to move inline, parallel to the shaft around which the blades rotate. They move air parallel to the axis of the fan. Generally, axial air movers produce higher volume airflow and a lower static pressure than centrifugal air movers.

High-pressure axial air movers typically have 1.0 or greater HP motors and blade configurations with the ability to move large quantities of air at static pressure levels above 3.0" WC. Most models have inlet and outlet duct collars to attach ducting or various accessories that can divide the airflow into several streams, and direct airflow into or out of interstitial spaces or areas with restricted airflow.

Low-pressure axial air movers typically have lower HP motors and blade configurations with the ability to maximize airflow at a much lower static pressure. They generally draw a fraction of the amperage of high-pressure axial air movers while producing equal or greater airflow. Generally manufacturers do not recommend using ducting or other attachments due to the air mover's low static pressure. Low-pressure axial air movers are generally used to direct airflow at surfaces to accelerate evaporation. Some models are used with stands to direct airflow to different surfaces (e.g., ceilings, floors, walls).

Structural Cavity Drying Equipment

In addition to the systems designed to operate with high-pressure centrifugal and axial air movers, specially designed units exist that create even higher-pressure airflow. These units are specifically designed to force air into or out of wall cavities or other interstitial spaces, or under flooring materials for efficient drying of otherwise inaccessible areas. This equipment is designed primarily for drying wet wall, ceiling, and other assemblies including complex flooring systems. These systems can be classified according to pressure ranges and by the manner in which they handle airflow through ducting and attachments.

These systems generally produce at least 7" WC, and can be designed and deployed to create positive pressure, negative pressure or both. The higher-pressure capabilities are necessary to overcome the resistance of small diameter air delivery systems, attachments and the restriction of tight airspaces where moisture can be trapped.

Attachments can be affixed to these systems for filtering, directing and manipulating air. Such manipulation could include utilizing ducting and wall vents to direct air beneath floor systems with sleepers or flutes, and into wall or ceiling cavities. Pressurization can be positive, negative or both (i.e., push-pull). Attachments can include a system of panels or mats temporarily adhered to the top of wood flooring to negatively pressurize interstitial spaces beneath floor. The usefulness of these panels can be influenced by the amount of actual pressure exerted on the flooring system. The greater the pressure, the faster the moisture will be removed from beneath the flooring material. Positive-pressure systems carry many of the same risks as other air movers in that they can spread contamination. When drawing moist air out of potentially contaminated cavities using negative pressure, an in-line HEPA filter should be used to remove contamination before exhausting the air into the room.

AIR TREATMENT EQUIPMENT

Air treatment equipment is designed to alter or remove airborne contaminants, classified as particulates or gases. Particulates are solids and can be organic (e.g., mold, pollen, bacteria and viruses), or inorganic (e.g., asbestos, mineral dusts, soot and ash). Some gases can be the byproduct of biological activity, combustion, or material off gassing. Source removal of contaminants or odor-causing substances is always preferred. Where the cause of odors (i.e., contaminants) or the perception of odors cannot be eliminated by physical removal of the source, alternate methods can be considered (e.g., filtration, ozone, pairing agents, dilution).

Air Filtration Devices (AFDs)

AFDs consist of a motorized fan, filter(s), and housing; designed to remove airborne contaminants from the incoming air stream. AFDs typically have a series of filters consisting of a pre-filter, secondary filter, and a primary HEPA filter. The pre-filter and secondary filters prevent premature loading of the HEPA filter by trapping larger particles.

Airborne gases can be removed through the use of sorption filters like activated carbon. The sorption media will be effective on specific gases. Unlike particle filters, sorption filters only remove a portion of the gases in a single pass and can require multiple passes through the filter to be effective. Activated carbon filters will adsorb water vapor along with other gases and when used in high humidity situations, the carbon media can load with water vapor and lose capacity for other airborne gases.

AFDs are sized based on the cubic feet of air per minute (cfm) they process. They can be installed to create negative, neutral, or positive pressure in an area. It is recommended that AFDs be evaluated for use on a job based on filtration efficiency and air volume requirements. Several testing procedures are available to validate the operating integrity of AFDs.

AFDs can be installed to create negative or positive pressure differentials. When used to create negative pressure differentials they are referred to as negative air machines (NAMs). They also may be used as air scrubbers to recirculate and filter air within a space.

AFDs used in contaminated areas should be sealed at the air intake side upon turning off to avoid releasing contaminants. They should be cleaned and decontaminated before being removed from the affected area and used on a subsequent job. Filters should be replaced as necessary following manufacturer's guidelines to maintain performance efficiency. Restorers should ensure that contaminated equipment is cleaned and decontaminated, or contained prior to moving through unaffected areas, transported, or used on subsequent jobs. Refer to the latest edition of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*, for further guidance on using AFDs in mold-contaminated areas.

Additional Air Treatment Devices

Other air treatment devices exist that alter contaminants or make claims to improve air quality and control odors. These devices can include ozone and hydroxyl generators, electrostatic precipitators and ultraviolet lamps. At the time of this document's publication there is insufficient information available to support the use of these air purifiers in water damage restoration projects. This equipment can produce varying amounts of ozone, which can cause health concerns in an occupied environment.

DEHUMIDIFICATION EQUIPMENT

Dehumidification is the process of removing moisture from air. The two primary dehumidification technologies used in the drying industry are refrigerant and desiccant. Refrigerant dehumidification involves cooling the air below its dew point, causing moisture to condense. Desiccant dehumidification places air in contact with a desiccant material that removes moisture by direct sorption. In closed-drying systems, dehumidification is essential for removing evaporated moisture from air to promote drying and minimize or prevent secondary damage. Dehumidifiers of sufficient performance and capacity are necessary to create an effective drying system.

Refrigerant Dehumidifiers

Refrigerant dehumidifiers (i.e., conventional, low grain) remove moisture from air by the process of condensation. They contain a sealed refrigeration system, defrost mechanism, a fan and a water collection system (e.g., drip tray and pump). The dehumidifier removes energy (i.e., sensible and latent, refer to Chapter 5 *Psychrometry and Drying Technology*) from the incoming air, then returns this energy as sensible heat to the exiting air. During the energy removal process, water vapor condenses on the evaporator (cool) coil and is collected. Most refrigerant dehumidifiers are rated for water removal in pints per day at an Association of Home Appliance Manufacturers' rating (AHAM; 80^{o}F & 60% RH over a 24 hour period of operation). Defrost mechanisms manage ice formation on the evaporator coil that forms in low energy environments.

Low-Grain Refrigerant (LGR)

LGRs contain modifications to the conventional refrigeration system that result in cooling the evaporator to significantly lower temperatures using various energy exchange systems. This allows the LGR to remove additional energy resulting in a lower exiting humidity (e.g., dew point, humidity ratio) and greater moisture removal capacity. It is important to note the term LGR has no authoritative or third party regulation.

LGR is a general industry term used to identify the performance characteristics described above for dehumidifier selection and sizing purposes as discussed in Chapter 14 *Materials and Assemblies*. The type of defrost mechanism does not define whether a dehumidifier is considered a Conventional or LGR. These modifications allow an LGR to be used in class 4 applications, whereas conventional refrigerants are not suitable.

Desiccant

Desiccant dehumidifiers work on the principle of sorption with the key component being a slowly turning desiccant impregnated rotor or wheel; typically silica gel. The rotor revolves through two separate air streams; process and reactivation. Process air enters the unit and the desiccant sorbs water vapor. The dehumidified process air then exits the unit and is delivered to the affected area.

The water vapor sorbed by the rotor from the process air stream is then desorbed in the reactivation air stream. The reactivation air stream is heated, causing the desiccant to release its moisture. The moisture laden reactivation air then exits the dehumidifier and is delivered to the outdoor environment. Desiccant dehumidifiers utilize vapor pressure differential to remove water and can be effective across a broad range of atmospheric conditions, To compensate for sensible heat gain in the affected area, pre cooling may be added to the process intake of the Desiccant Dehumidifier. This also generally increases the vapor pressure differential between the process and reactivation airstreams, which will improve the performance.

HEAT DRYING SYSTEMS

Heat drying systems dry wet materials by circulating heated air throughout the affected area or by focusing the heat directly on the wet materials. The resulting moisture laden air is either dried by mechanical dehumidification or exhausted to the outdoor environment. Heat energy accelerates evaporation and desorption of moisture from materials. Heat drying systems in use today have different configurations, however they all have three components in common:

- a heating apparatus that can be electric, diesel or gas-fired;
- a delivery system (e.g., fan, ducting or hoses) to get the heat into the structure; and
- a means of removing the moisture-laden air from inside the building (e.g., exhaust ventilation, dehumidification)

It is important to understand that heat needs to be used properly and with appropriate precautions. Issues can include damage to heat-sensitive materials and condensation within the building envelope. To prevent uncontrolled heat-rise in the air and on materials, it is recommended that restorers use thermostatic control devices or actively manage the temperature in the space.

HEAT DRYING EQUIPMENT

Supplemental heat can be used in the event the installed heating system is not operational or its use is not advisable. Heat may also be used to achieve desirable drying conditions and accelerate evaporation from building materials and contents.

The types of heating equipment which can be used are convective (i.e., forced air), conductive (i.e., hydronic) or radiant (i.e., infrared). Forced air heaters have an electric resistance or fuel combustion heat source, which heats a fan-forced air stream. There are two types of combustion heaters; direct-fired and indirect fired. Hydronic heaters utilize a fluid that is heated and then pumped to an energy exchange unit, which transfers the heat from the fluid to the air.

There are potential hazards associated with the use of heat and heating equipment. Restorers should consider the impact of high temperatures on building components and contents. Manufacturer’s instructions and safety precautions shall be followed to reduce the potential for fire hazards and occupant safety issues.

Direct-Fired Heaters

Direct-fired heaters incorporate a single air stream where both combustion and the process air are combined. They shall not be used unless adequate ventilation is available and monitoring is provided because the combustion by-products (i.e., carbon monoxide) remain in the air stream. Direct-fired heaters are available using gas (i.e., propane, natural gas) or fuel oil (i.e., kerosene, diesel). Typically, direct-fired units are available in the 40,000-1,200,000 Btu/hr. range. It has been estimated that direct-fired heaters will produce eight (8) pints of water per hour for every 150,000 Btu/hr delivered.

Indirect-Fired Heaters

Indirect-fired heaters have a heat exchanger incorporated into their design that separates the combustion chamber from the process air stream. If indirect-fired heaters are placed within an occupied area, the combustion stream shall be ducted to the outside. When units are positioned outside, the processed air stream is ducted into the building. Indirect-fired heaters are available using gas (i.e., propane, natural gas) or fuel oil (i.e., kerosene, diesel). Typically, indirect-fired units are available in the 100,000 to 1,500,000 Btu/hr. range.

Electric Heaters

Electric heaters can be radiant or forced air units with a wide range of power requirements, including but not limited to: 115-volt/single phase, 230-volt/single phase, 230-volt/three phase and 460-volt/three phase. Sizes of units can range from 1 to 150kW. Availability of adequate power can limit practical use.

Hydronic Heaters

Hydronic heaters utilize a heating chamber or boiler to heat a glycol/water solution that is pumped through hoses to and from fan coil units located in the areas to be heated. They are fueled by gas (i.e., propane, natural gas) or fuel oil (i.e., kerosene, diesel) and are located outside of the structure. Hydronic heaters are typically available in the 199,000 to 1,000,000 Btu/hr. range.

Radiant Heat Devices

Radiant and infrared heat devices are used to accelerate evaporation from wet materials. Since they primarily heat objects instead of the air, they can be used to focus heat on specific surfaces. Restorers are cautioned that some radiant heat devices are capable of raising temperatures beyond the flashpoint of some materials. Devices are only considered radiant heaters if at least 50% or more of their heat transfer is by radiant energy. An infrared heater is a type of radiant heater with an element designed to produce heat in the infrared range. Radiant heaters are normally electrically operated devices ranging from 1500 to 3000 watts.

Desiccant Dehumidifier

Desiccant dehumidifiers are not primarily heaters, but a by-product of the moisture removal process is sensible heat, which results in a significant rise in the temperature of the process air stream. This heat rise is a result of the moisture removal process (i.e., release of the latent heat of vaporization) and heat carryover from the reactivation airstream. In many situations this heat can be used for comfort or to accelerate evaporation of moisture from materials.

OTHER EQUIPMENT

Air Exchangers

Air exchangers work by exchanging indoor and outdoor air through a cross-flow heat exchanger, which results in transfer of energy (heat) from one air stream to the other. Air exchange units, also called energy recovery ventilators (ERV), are typically used in colder climates where removal of moist air inside a space is desirable but where the loss of heat from interior air is not. Air exchangers use blowers to move the two opposing airstreams through the heat exchanger and into and out of a space. Their efficiency in recovering the energy typically is in the 60-70% range. Air exchangers can be found as installed components in a HVAC systems or as portable units for temporary use.

Portable Air Conditioners

These units usually are direct expansion (DX) refrigerant systems used for cooling purposes, similar to those found in most houses and many smaller commercial buildings. Portable air conditions can be used when there is no installed cooling system, the installed system is not functional, or is insufficient to overcome the additional heat load generated by drying. Various sizes, from 1-50 tons, are typically available.

A by-product from the use of air conditioning can be the incidental removal of moisture from the air in the affected area. However, installed air conditioners are engineered primarily for the normal thermal load of a building, not for the additional heat and moisture load encountered during water damage restoration. Although air conditioners can help restorers gain control of ambient humidity, they generally do not create the conditions necessary for drying of the building and contents. In addition, they may not be able to control ambient humidity quickly enough to prevent secondary damage.

DETECTION AND MONITORING INSTRUMENTS

A variety of instruments may be used to determine the scope of the water damage restoration project; monitor drying progress and environmental conditions. Instruments can include, but are not limited to:

- thermometers (i.e., air, surface contact, and infrared);
- hygrometers;
- psychrometers;
- manometers;
- gas detectors;
- particle counters;

- moisture meters;
- thermal imaging cameras;
- psychrometric charts and calculators;
- data logging devices; and
- remote monitoring systems

Multi-function meters are available that incorporate a number of the above functions in a single device.

Thermometers

Thermometers measure temperature (e.g., Fahrenheit, Celsius) of either air or materials. Three commonly used thermometers are air, surface contact and infrared.

- Air thermometers measure dry or wet bulb temperature using a glass bulb or electronic sensor. Adequate acclimation time is required for accurate measurement,
- Surface contact thermometers measure temperature of a material using a direct contact sensor. Adequate acclimation time and direct contact is required for accurate measurement.
- Infrared thermometers measure the average temperature on a spot at the surface of the material. The size of the sample area is determined by the distance-to-spot ratio (D:S). An infrared thermometer can be used to determine temperature differentials. The surface temperature difference can indicate evaporative cooling of wet materials. Cooler surfaces do not always indicate evaporative cooling. Suspect areas should be verified with a moisture meter.

Hygrometers

Hygrometers measure the relative humidity of an air sample. These devices are often combined with an electronic thermometer (thermo-hygrometer). Many thermo-hygrometers calculate other psychrometric properties (e.g., wet bulb, humidity ratio, dew point, and water vapor pressure).

Psychrometers

A psychrometer measures the difference in readings between two thermometers, one having a wet bulb and the other having a dry bulb, to determine the moisture content or relative humidity of air. By using a psychrometric chart or calculator these measurements can be used to determine all psychrometric values and check calibration of thermohygrometers in the field.

Manometers

A manometer is an analog or digital instrument that measures the static air pressure differential between two or more adjacent areas. This device can be used to monitor contained, contaminated spaces to reduce the potential risk of cross-contamination.

Gas Detectors

A gas detector is a device that measures the concentration of one or more gases in a space (e.g., carbon monoxide, oxygen). These devices can be equipped with alarms to alert occupants of hazards.

Particle Counters

A particle counter is an instrument that detects and counts particles in the air and can differentiate particles based upon size. Particle counting is based upon either light scattering or light obscuration of a particle as it passes through a detection chamber.

Moisture Sensors

A moisture sensor has penetrating pins used to indicate potential elevated moisture in various materials with an audible, visible signal or both. Sensor pins are inserted into the material to be evaluated and the sensor signal changes in intensity as conductivity between the pins changes. Substances in materials (e.g., salts, animal urine) that are conductive can give false indications of moisture.

Moisture Meters

Moisture meters are devices that display a value of moisture content or level based on electrical variances in materials. They measure moisture either on a relative (qualitative) scale and referred to as moisture level; or in actual percentage of moisture content (quantitative). Two types of moisture meters are:

- **Non-invasive (non-penetrating) Meters:** Non-invasive meters use either electrical conductivity or radio frequency emissions to detect moisture. These meters allow restorers to test or scan areas without damaging the material. They can also be used to quickly identify areas needing further evaluation. The readings obtained are based on the presence of moisture in, on or under materials, with limitations due to false positives (e.g., foil back insulation, metal ductwork, steel studs, lead paint, corner beads) and false negatives (e.g., air gaps, voids, material density, layering). Available meters include those with settings for wood, drywall, and concrete.

- **Invasive (penetrating) Meters:** Invasive meters measure moisture based on the electrical conductivity between two probes in the material being tested and displayed on an analog or digital readout. These instruments can be used to provide quantitative and qualitative measurements. Because the probes penetrate materials, it is recommended that restorers consider potential collateral damage before use. Meter attachments include, but are not limited to:

    - pin probes;
    - insulated deep cavity probes;
    - hammer probes with insulated pins; and
    - paddles.

A wide variety of professional-grade moisture meters are available that are designed and calibrated for a specific material or a combination of different materials. Some models feature different scales for wood, gypsum board, oriented strand board (OSB), plywood or other building materials. Restorers should use the appropriate meter and follow the manufacturer instructions. An understanding of meter operation and limitations is critical to accurate measurements.

Thermal Imaging Cameras

Thermal Imaging Cameras (infrared camera) area used to detect surface temperature differences and do not directly detect moisture or measure through materials. Restorers using infrared thermography equipment in surveying buildings for moisture damage should receive proper training on its use.

An infrared camera produces a thermal image of a material that can provide rapid identification of potentially moist areas by indicating temperature differences at the surface of materials. Non-permeable materials that do not allow moisture to reach the surface do not experience evaporation and thus may not show a temperature differential, even though moisture can be present in the assembly. Areas identified with the camera as suspect for being wet should be verified by further testing with a moisture meter. Temperature differentials on material surfaces can be due to various influences including but not limited to:

- an evaporative cooling effect on the material's surface;
- missing or compacted insulation;
- thermal bridging; and
- air striking the surface of the material from the HVAC system.

Psychrometric Charts and Calculators

A psychrometric chart or calculator is an instrument that allows the restorer to use measured conditions such as temperature and relative humidity to calculate other psychrometric properties, such as dew point, water vapor pressure, humidity ratio, enthalpy, air volume, density and wet bulb temperature. Calculators exist as either digital instruments or slide rules. Charts are graphic instruments.

Data Logging Devices

Data loggers and paper chart recorders are instruments that measure and record various data over time (e.g., atmospheric conditions, moisture levels, equipment operations). These devices can keep a hard copy of electronic record, providing restorers with supporting data and reports that document atmospheric conditions. Typically, a data logger is installed at the beginning of the project, and provides a historical record of conditions throughout a project. Some devices can collect and transfer data through a wired or wireless connection to a central data collection instrument.

Remote Monitoring Systems

Remote monitoring systems combine data logging instruments with the added functionality of offsite access to the data. The information is accessed through the internet, direct modem or satellite.

Chapter 7

Antimicrobial Biocide Technology

INTRODUCTION

In addition to having general knowledge of potential microorganisms present in a water damage restoration project, restorers should have an understanding of the proper use of agents that can help control the growth of these microorganisms and reduce potential risks associated with some of their metabolic by-products (e.g., endotoxins, mycotoxins). The intent of this chapter is to provide a general overview of technology, regulatory considerations, product application, and safety and risk management.

Microbiological growth is inevitable when moisture, nutrients, and moderate-to-warm temperatures are present. It is important to recognize that not all water intrusions warrant the use of antimicrobial biocides. Thus, it is important for restorers to evaluate whether antimicrobial biocide application is appropriate.

There are several steps in the restoration process that restorers should perform or facilitate, which can return the structure to a sanitary condition without using antimicrobial biocides. These steps should include: stopping the source of moisture intrusion, removing un-restorable contaminated materials, followed remediation, drying, and final cleaning of affected materials, systems, and contents. Note, however, that unless otherwise agreed to by materially interested parties, it is the responsibility of the property owner, not the restorer, to correct the source of the water intrusion, or to engage appropriate specialized experts to do so.

When there is a Category 1 water intrusion that has not changed in Category (e.g., a delayed response, or pre-existing condition), the use of antimicrobial biocides is generally not warranted. When a Category 1 water intrusion has changed in Category or when there is a Category 2 or 3 water intrusion then the use of antimicrobial biocides may be warranted. Along with other cleaning products and processes, antimicrobial biocides can play an important role in limiting the spread of bio-contamination and disease.

There are also factors that might preclude the use of a antimicrobial biocide. Many antimicrobial biocides are deactivated by organic matter in water or on surfaces (e.g., chlorine-based formulations, alcohol, peroxide, quaternary ammonium compounds); therefore, pre-cleaning is an essential first step. In addition, many antimicrobial biocides require physical contact with affected surfaces for substantial periods of time (e.g., 10–30 minutes) to be effective. Some antimicrobial biocides, which can be strong irritants or sensitizers, might not be appropriate for application in close proximity to building occupants who could be exposed and adversely affected. Finally, products with strong odors can be undesirable to some clients or occupants. In all cases, antimicrobial biocides shall be applied following label directions. In determining antimicrobial biocide use, restorers should weigh the benefits of using biocides against the risks associated with their use, and any client concerns or preferences.

DEFINITION AND REGULATION

Antimicrobial biocides are substances used to destroy (biocides) or suppress growth (growth inhibitors/static agents) of microorganisms (i.e., bacteria, viruses, or fungi) on inanimate objects, surfaces, and materials. The United States Environmental Protection Agency (USEPA) Antimicrobials Division registers and regulates antimicrobial biocides (which the Agency refers to as a pesticide) under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). Some jurisdictions require commercial applicators of antimicrobial biocides to be licensed, certified, or to be specially trained

Terminology

Classes of antimicrobial products include sanitizers, disinfectants, sterilizers (sporicides), and growth inhibitors:

- **sanitizers:** Products used to reduce, but not necessarily eliminate, microorganisms from the inanimate environment to levels considered safe as determined by public health codes or regulations.
- **disinfectants:** Products that kill or inactivate at least 99.9% of disease-producing (pathogenic) microorganisms on inanimate objects. Used to destroy or irreversibly inactivate infectious fungi and bacteria but not necessarily their spores.
- **sterilizers (sporicides):** Products used to destroy or eliminate all forms of microbial life including fungi, viruses, and all forms of bacteria and their spores.
- **growth inhibitors (bacteriostats, fungistats):** Products used to treat surfaces or be incorporated into materials to suppress or retard future vegetative bacterial and fungal growth under moist conditions.

Other commonly used terms and their definitions include the following:

- **antimicrobial**: Substances that kill or control microorganisms (such as bacteria, fungi, viruses) or inhibit growth of microorganisms.
- **bacteriostat**: A compound that suppresses bacterial growth when used according to label directions. The suffix "-stat" means to inhibit growth without necessarily killing targeted organisms.
- **biocide**: Any substance that kills living organisms. The term is used commonly within the water damage restoration industry to describe an agent that kills microorganisms or controls amplification. Descriptions of products specific to a target group of living things generally include the suffix "-cide," meaning "to kill" (e.g., bactericide, fungicide).
- **FIFRA:** The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) regulates the registration, distribution, use and sale of pesticides within the United States.
- **fungicides**: Substances that kill vegetative fungi and some fungal spores (including blights, mildews, molds, and rusts).

- **pesticide**: The USEPA defines a pesticide as any substance that is intended for "preventing, destroying, repelling or mitigating any pest" or for "use as a plant regulator, defoliant or desiccant." Pests are defined as insects, rodents, worms, fungi, weeds, plants, viruses, bacteria, microorganisms and other animal life.

ANTIMICROBIAL BIOCIDE CHEMISTRY

There are several general chemical classes of compounds commercially available for use as biocides. These products encompass a wide range of physical and performance characteristics. Whether a biocide is appropriate for a specific use depends on the objectives of the application. Therefore, restorers shall adhere to label directions, since effective use of an antimicrobial biocide product depends upon proper handling (e.g., dilution concentration, pH, contact time) and condition of the surface or material to be treated (i.e., most registered products are required to be used on pre-cleaned surfaces).

Types of Biocides (Disinfectants):

Disinfectant/Class	Use Dilution Concentration	Action	Advantages	Disadvantages
Alcohols (ethanol, isopropanol)	60 to 90%	B, V, F	Non-staining, non-irritating	Inactivated by organic matter; highly flammable
Quaternary ammonium compounds	0.4 to 1.6%	B*, V*, F	Inexpensive	Inactivated by organic matter; limited efficacy
Phenolics	0.4 to 5%	B, F, V, (T)	Inexpensive, residual action	Toxic, irritant; corrosive
Iodophors	75 ppm	B, V, F, S**, T**	Stable, residual action	Inactivated by organic matter; expensive
Glutaraldehyde	2.0%	B, V, F, S**, T	Unaffected by organics; noncorrosive	Irritating vapors; expensive
Hypochlorites	≥5,000 ppm free chlorine (mix 1:10)	B, V, F, S**, T	Inexpensive	Bleaching agent; toxic; corrosive; inactivated by organic matter; 1, 2
Hydrogen peroxide	3%	B, V, F, S**, T	Relatively stable	Corrosive; expensive; 3

Abbreviations:
B = Bactericidal
V = Virucidal
F = Fungicidal
S = Sporicidal

* = Limited effectiveness
** = Requires prolonged contact
( ) = Not all formulations
T = Tuberculocidal

1 = Removes color from many interior decor fabrics
2 = Dissolves protein (wool, silk)
3 = Degrades in heat or UV light

Source: *Cole (1987), Rutala (1987), Rutala et al. (1991): Research Triangle Institute.*

Note: A product may not be labeled "disinfectant" unless it has been tested and approved by federal regulatory agencies, such as the U.S. EPA or Health Canada. Product labels shall list actual ingredients.

REMEDIATION OF MICROBIAL GROWTH AND BIOCIDE USE

The IICRC recognizes the practices for management of microbial growth and of antimicrobial biocide use outlined by the American Conference of Governmental Industrial Hygiene (ACGIH), *Bioaerosols: Assessment and Control*, 1999, as a valuable resource for understanding biocide use and its limitations. Some useful quotes from that work follow:

- **Section 15.4 Biocide Use. "**Remediators must carefully consider the necessity and advisability of applying biocides when cleaning microbially contaminated surfaces [see 16.2.3]. The goal of remediation programs should be removal of all microbial growth. This generally can be accomplished by physical removal of materials supporting active growth and thorough cleaning of non-porous materials. Therefore, application of a biocide would serve no purpose that could not be accomplished with a detergent or cleaning agent. Prevention of future microbial contamination should be accomplished by (a) avoiding the conditions that led to past contamination, (b) using materials that are not readily susceptible to biodeterioration, and (c) where necessary, applying compounds designed to suppress vegetative bacterial and fungal growth or using materials treated with such compounds."
- **Section 16.2 Biocide Use and Application. "**Biocide use should not be considered if careful and controlled removal of contaminated material is sufficient to address a problem. [b]biocide use may play an important role in the remediation of certain conditions (e.g., microbial contamination from sewage backflow into buildings)."
- **Section 16.2.3 Biocide Use and Application. "**Effective remediation of water-damaged or microbially contaminated buildings involves (a) the use of appropriate techniques to promote rapid drying, and (b) complete removal of contaminated materials rather than the application of biocides without these steps."
- **Section 16.2.4 Aqueous Biocides.** "Disinfectant-detergents and sanitizer-detergents clean and inactivate microbial contamination in one step. Studies have shown that cleaning with a detergent may be as effective as cleaning and treatment with a biocide."

RISK MANAGEMENT

In the United States, as part of a restoration company's risk management program, restorers who use antimicrobial biocides shall receive training in the safe and effective use. This may be the law in other countries. Restorers should determine the legal requirements for commercial use of such products in their respective jurisdictions, and shall comply with applicable laws and regulations governing such products and their use.

Restorers shall apply only federal/state government-registered or authorized products. In many jurisdictions the product label provides a registration number and instructions on how to get more information if the product is government registered and approved. Test data for these formulations have been reviewed by government safety and health officials, and determined to be effective and safe for their intended use when applied according to label directions. Follow label directions explicitly. In most jurisdictions, the content in biocide and similar product labels is intended to convey all information relevant to its appropriate use and thus is closely regulated. Labels are used to enforce safety and efficacy standards, to convey proper handling information to users (including personal protective equipment), and to communicate risks to those who might come in contact with the product. Labeling encompasses not only what is attached to the product container or packaging, but also all other written, printed or graphic matter accompanying the product.

Application Methods

Antimicrobial biocides shall be used according to label directions. The label provides directions about proper mixing, equipment, application method, application rates, application sites, target organisms, precautionary measures and incompatibilities with materials and surfaces. In addition, the label contains an ingredient statement and provides instructions for product storage and disposal. The best source of information about safety and emergency medical treatment in case of an accident is found on the antimicrobial biocide product label.

Do not mix or combine these products with other chemicals unless label directions explicitly allow it. Use only the application equipment specified in the product label directions. Dedicated application equipment should be used. Avoid buckets, mops and sponges used for general cleaning, which can render antimicrobial biocide solutions ineffective because of the presence of heavy organic loads (soiling). Any specified personal protective equipment shall be used.

Remediation procedures rely on thorough cleaning and source removal first, and then, if appropriate, the application of antimicrobial biocides. Clean contaminated surfaces as thoroughly as practical before applying antimicrobial biocides. With Category 2 water on carpet, thorough cleaning is required before applying antimicrobial biocides. Do not pour antimicrobial biocides into standing water.

In order to be effective, antimicrobial biocides shall be used in sufficient quantity, contact time, and applied according to label directions. The effectiveness can vary depending on porosity of materials, the evaporation rate, and bioburden.

A low-pressure sprayer is usually the recommended equipment for application. This produces large droplets, which reduce air suspension time (drift) and the potential for inhalation. High-pressure air streams can result in undesired dispersal of spores, microorganisms, and other biological debris. Forming aerosols or wet fogging antimicrobial biocides has performance limitations and is not recommended, because of the increased risk of inhalation of antimicrobial biocides.

Chapter 8

Safety and Health

INTRODUCTION TO WORKER SAFETY AND HEALTH

The regulations referred to in this Standard and Reference Guide are based on US laws and regulations, but it is understood that other countries generally have comparable health and safety requirements. Restorers shall fully understand the laws and regulations related to health and safety for the particular country or locale in which they work.

Although there are few specific federal, state, provincial and local laws and regulations directly related to water damage restoration and microbial remediation, there are safety and health regulations applicable to businesses that perform such work. Federal safety and health regulations in the United States that can impact the employees of a restoration business include, but are not limited to, the following Occupational Safety and Health Act (OSHA) Standards found in Title 29 of the Code of Federal Regulations (CFR) parts 1910 and 1926:

- 29 CFR 1910 – General Industry Standards
- 29 CFR 1926 – Construction Industry Standards

Restoration firms shall comply with applicable sections of both the OSHA General Industry Standards and the Construction Industry Standards. Individual state and local governments may have additional safety and health requirements that are more restrictive than the Federal Occupational Safety and Health Act. Each state in the United States is required to use Federal OSHA as a minimum statutory requirement. Employers shall comply with these safety and health regulatory requirements. Specific items addressed by these regulations include, but are not limited to, the following:

- Site Safety Survey
- Emergency Action and Fire Prevention Plans;
- Personal Protective Equipment;
- Respiratory Protection;
- Asbestos;
- Lead-based paint;
- Heat Disorders and Health Effects;
- Bloodborne Pathogens;
- Confined Work Spaces;
- Hazard Communication;
- Lockout/Tagout Procedures and Electrical Safety Orders;

- Fall Protection;
- Noise Exposure; and
- Scaffolds.

Issues directly pertinent to the hazards of occupational exposure in buildings damaged by water are addressed more specifically in Chapter 3, *Health Effects from Exposure to Microbial Contamination in Water Damaged Buildings.*

OSHA General Duty Clause

The OSHA "General Duty Clause" 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.
- shall comply with occupational safety and health standards promulgated under this Act." See 29 USC 654, §5.

Protection of the safety and health of restorers and building occupants is important on restoration and remediation projects. It is the responsibility of employers to ensure that employees entering and working in water damaged or contaminated work areas, or in designated areas where contaminated contents are cleaned or handled, have received the appropriate training, instruction and personal protective equipment. In the absence of a specific OSHA standard for water damage restoration, it is important to recognize the general principles of exposure prevention as they are conveyed through the "General Duty Clause," as well as to understand the current information available about the potential hazards from occupational exposure in water damaged structures, systems and contents. Restoration workers can also encounter lead, asbestos or other hazards as is discussed below. Industry standards have been adopted for recognized hazards by government agencies, such as OSHA and the EPA, as well as ACGIH and industry trade associations.

OSHA Regulations

OSHA regulations are divided into sections that apply to various industries. When performing water damage restoration or remediation services, employees fall under the construction and general industry standards. These regulations address hazards such as scaffolding, electrical safety, confined spaces, falls, and chemical safety including asbestos, lead and chemical exposures, as well as training and education for employees about these hazards. A complete list of federal OSHA regulations can be obtained from http://www.osha.gov/law-regs.html. The OSHA regulations for the General Industry (29 CFR 1910) and Construction Industry (29 CFR 1926) requires that no employee shall work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his or her safety or health. In other words, the employer shall provide a safe workplace, regardless of whether OSHA has considered a particular hazard.

EMERGENCY ACTION AND FIRE PREVENTION PLANS

Emergency action and fire prevention plans (OSHA 29 CFR 1926.35 and 1910.38) are required for all work places, including water damage restoration job sites. Requirements include, but are not limited to:

- communication and alarm systems;
- the location of the nearest hospital and fire station;
- emergency phone numbers (posted);
- shut down, evacuation and rescue procedures (posted);
- escape routes and signage (posted);
- use of less-flammable materials; and
- written program, if the employer has 10 or more employees.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

29 CFR 1910.132 requires that employers provide their employees with the necessary PPE to reduce the risk of exposure to chemical, physical or biological hazards. Biological hazards that can be encountered when performing water damage restoration work include, but are not limited to, allergenic, toxigenic and/or pathogenic microorganisms. Various types of PPE are available to help prevent exposure.

The following are potential routes of exposure:

- inhalation (respiratory);
- contact with mucous membranes (eyes, nose, mouth);
- ingestion; and
- dermal (contact with skin).

Employers shall provide dermal and respiratory protection for employees entering a containment area where microbial contamination is present and remediation is being performed. Appropriate PPE is used to protect workers from possible inhalation or skin contact with microorganisms and their by-products, as well as chemicals or other substances that may be applied or handled in the course of restoration or remediation work. The selection of PPE depends on the anticipated exposure, types of microbial contamination, activities to be completed and potential hazards of chemicals that may be used in the restoration process. Restorers should consult an IEP or other specialized expert if there is a question regarding PPE selection. PPE can consist of the following:

- respirator;
- eye protection;
- disposable coveralls including hood and booties;
- foot protection;

- hand protection;
- head protection, and
- hearing protection.

Respirator Use and Written Respiratory Protection Plan

Employees shall wear respirators whenever engineering and work practice controls are not adequate to prevent atmospheric contamination at the job site. If microbial remediation work is being performed, and if the restorer determines after the application of the "General Duty Clause" that a hazard exists, then a respirator is required for employees in the contaminated area. OSHA requires that a respiratory protection program be implemented for employees who wear a respirator. Visitors to the work site should be encouraged to wear respiratory protection and other appropriate PPE while in the contaminated work area.

The respiratory protection regulations are found at 29 CFR 1910.134. The respiratory protection program outlines the written program requirements, and shall include but not be limited to:

- selection and use of NIOSH approved respirators;
- medical evaluation;
- respirator fit testing;
- user instruction and training in the use and limitations of the respirator, prior to wearing it;
- designated program administrator; and
- cleaning and maintenance program.

Respirators

The types of recommended respiratory protection range from NIOSH-approved N-95 filtering face pieces, to full-face air-purifying respirators (APR) or powered air-purifying respirators (PAPR) equipped with P-100 (HEPA) filters and self-contained breathing apparatus (SCBA). P-100 filters should be used to protect against fungal spores and fragments, bacterial spores, dust and other particles. Organic vapor cartridges protect against Microbial Volatile Organic Compounds (MVOCs), some chemicals used when remediating sewage contamination, and other chemical compounds used in microbiological remediation projects.

When using APRs, air is drawn into the respirator face piece by inhaling through filters or cartridges. When using PAPRs, air is mechanically delivered through the filters or cartridges into the face piece. Different types of cartridges are available to remove chemical contaminants by a process of absorption or adsorption. Filters (e.g., P-100, R-100, N-100, N-95) are for removing particulates. APRs or PAPRs shall not be used in oxygen-deficient atmospheres or in other atmospheres that are immediately dangerous to life or health (IDLH).

Respirators provide varying levels of protection based on how well they seal to the face.

They are divided into classes, with each respirator class assigned a protection factor to help compare its protective capabilities with other respirators for a properly fitted and trained user. An assigned protection factor (APF) is a unitless number generated by dividing the airborne concentration of the contaminant outside the respirator by the airborne concentration of that agent inside the respirator wearer's facepiece, hood or helmet. Thus, if concentrations both outside and inside a respirator were equal, then the APF would be 1. An APF of 5 therefore indicates that the respirator wearer was exposed to 1/5 (20%) of the airborne concentration that he or she would have been exposed to without a respirator, for an 80% reduction.

Respirators available for use on remediation projects related to water damage restoration and their assigned protection factors are:

	Assigned Protection Factor			
Respirator Type	Half face	Full face	Helmet hood	Loose fitting face piece
Air Purifying	10	50	--	--
PAPR	50	1,000	1,000	25
Supplied Air: Demand mode Continuous flow Pressure demand	 10 50 50	 50 1,000 1,000	 -- 1,000 --	 -- 25 --
Self-Contained Breathing Apparatus (SCBA): Demand mode Pressure demand	10 --	50 10,000	50 10,000	-- --

Respirator cartridges and filters are color coded according to the contaminant to be removed. Cartridges most frequently used in the restoration and remediation industry are:

Color Code	**Contaminant Protection**
Magenta	P-100 (HEPA) filter (for particulates)
Black	Organic vapor
Yellow	Organic vapor/acid gases
White	Organic vapor/acid gases/formaldehyde
Green	Ammonia

WARNING SIGNS

The need for warning signs should be evaluated during the initial site safety survey as well as throughout the drying project, and as activities and conditions change. Many hazards can be present on a project. Potential hazards can include, but are not limited to, wet floors, active electrical wiring or devices, overhead debris, unstable structural components and the activities of others.

Signs shall be posted to identify egress means and exits (29 CFR 1910.37); biological hazards (29 CFR 1910.145(e)(4), (f)(8)); caution (29 CFR 1910.145(c)(2), (d)(4)); and dangers (29 CFR 1910.145(c)(1), (d)(2), (f)(5)) that may exist on the job site. Warning signs that are posted to identify hazards that may exist on the job site should list the following emergency contact information; the company name, company address, 24-hour emergency contact number and name of project supervisor. When warning signs are posted on confined-space projects, they shall be printed with the date they were posted, and the approximate date they are expected to be taken down or reassigned. Typical warning signs related to restoration work can include, but are not limited to:

- Do Not Enter – Sewage Damage Remediation in Progress;
- Caution: Slip, Trip and Fall Hazards;
- Caution: Hard Hat Area;
- Work Area Under Negative Air-Pressure; and
- No Unauthorized Entry.
- Personal protective equipment required

MOLD

Buildings that have been wet for an extended period, or have been chronically wet, can develop mold contamination. If restorers encounter mold growth during the course of the restoration project, water damage restoration activities that may disturb the mold should stop until such time that the area of existing or suspected mold contamination is contained. Trained remediators following the current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation* should perform further drying and mold remediation in the potentially contaminated area. Restorers shall follow applicable federal, state, provincial and local laws and regulations.

ASBESTOS

The asbestos safety regulations are found in OSHA Construction Standard 29 CFR 1926.1101 and General Industry Standard 1910.1001. These regulations shall be followed whenever a detectable amount of asbestos is encountered or is presumed to be present and might be disturbed. The restorer should receive awareness training to ensure potential hazards are known and properly identified. Since its use has never been banned in the United States, asbestos containing materials (ACM) might be found in buildings of any age including newly constructed buildings.

Even if the building owner has a survey for asbestos, the restorer is still responsible for identifying and controlling asbestos exposure during demolition and removal of materials. If restorers encounter materials containing asbestos or that are presumed to contain asbestos that has been or potentially will be disturbed during the course of work activities, they shall stop activities that can cause friable material to become aerosolized. A licensed asbestos abatement contractor should be engaged to perform the asbestos abatement. Many states and local governments require that asbestos inspections be performed by licensed asbestos building inspectors.

Both 29 CFR 1926.1101 and 1910.1001 state that asbestos regulations apply any time there is asbestos present. An OSHA interpretation letter clarifies that this means, "any detectable amount of asbestos," whether the amount present is >1% (ACM) or not. Both aforementioned regulations also contain requirements for dealing with asbestos content determined to be less than 1%.

LEAD

The lead regulations are found at OSHA Standards 29 CFR 1926.62 and 1910.1025. Lead construction work includes work that involves lead-based paint or other structural materials containing lead (e.g., emergency cleanup, demolition, repair or other work which could disturb lead).

Even if the building owner has a survey for lead, the restorer is still responsible for identifying and controlling lead exposure during demolition and removal of materials in all pre-1978 buildings and some post-1978 industrial applications. Restorers shall be in compliance with USEPA's Renovation, Repair and Painting (RRP) program for lead-based paint and surface coatings as well as any other applicable federal, state, provincial and local laws and regulations.

HEAT DISORDERS

Work activities involving high air temperatures, radiant heat sources, high humidity, direct physical contact with hot objects, or strenuous physical activities have a high potential for inducing heat stress. Employees are at risk for heat induced stress particularly when engaged in activities in areas such as attics and crawlspaces, or when wearing PPE.

Outdoor operations conducted in hot weather, such as construction, asbestos removal, and remediation site activities, especially those that require workers to wear semi-permeable or impermeable protective clothing, also present the possibility of heat-related disorders to workers. Heat disorders range from heat rash and dehydration to heat exhaustion and heat stroke. Heat stroke, often characterized by hot, dry skin and sudden loss of consciousness, is a true medical emergency. Seek medical attention immediately. The respiratory protection and other PPE plans of the restoration or remediation contractor shall address prevention, and on-site response to heat disorders. PAPRs can provide additional cooling for restorers in hot environments. For more information on heat-related disorders, see OSHA Technical Manual TED 1-0.15A, Section III, Chapter 4.

CONFINED SPACE ENTRY

OSHA regulations addressing confined spaces are found in 29 CFR 1910.146 and 29 CFR 1926.21. Further guidance may be obtained from American National Standard ANSI Z117.1-1989, *Safety Requirements for Confined Spaces.* The OSHA and ANSI standards provide minimum safety requirements to be followed while entering, exiting and working in confined spaces at normal atmospheric pressure. A "confined or enclosed space" means any space that:

- is configured so that an employee can enter it;
- has limited means of ingress or egress; and
- is not designed for continuous occupancy.

If it is determined that the workplace is a confined space then the confined space entry program shall include:

- determining if the space meets the definition of a Permit Required Space;
- identifying the confined spaces and hazards in the workplace;
- monitoring of atmospheric conditions in the space;
- instructing workers on the proper use of the safety equipment;
- defining the duties of the confined space entry team, and
- developing training requirements for employees who enter the confined space.

Permit-required confined space (permit space) means a confined space that has one or more of the following characteristics:

- contains or has a potential to contain a hazardous atmosphere;
- contains a material that has the potential for engulfing an entrant;
- has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
- contains any other recognized serious safety or health hazard.

If it is determined that the confined space is a Permit Required Confined Space, then the confined space shall have a posted permit.

HAZARD COMMUNICATION

The OSHA Hazard Communication Standard (29 CFR 1910.1200) requires that information concerning chemical hazards (physical or health hazards) be provided to employers by chemical manufacturers and communicated to employees by employers. This is accomplished by means of hazard communication programs, which include a written program, container labeling and other forms of warning, safety data sheets (SDS), and employee training prior to working with hazardous chemicals. Examples of chemicals used during water damage restoration and remediation are the adhesive spray used to make enclosures, detergents and disinfectants (biocides) for cleaning, sealers, and encapsulants.

Restorers working on multi-employer work sites shall:

- inform other employers of hazardous substances;
- inform other employers of means to protect their employees;
- provide access to SDS; and
- inform other employers of the labeling system used.

Although sewage-related microorganisms are not specifically regulated hazardous materials, workers engaged in sewage damage remediation activities are at increased risk of exposure to contaminants (e.g., bacteria, molds and their metabolic by-products), which have the potential to cause adverse health effects. Although the use of engineering and administrative controls, PPE, and other methods of exposure prevention or minimization may be in use, employee exposure can nevertheless occur in certain circumstances, including failure of such systems. Employers may consider including additional content in their workers' medical screening and surveillance (e.g., respirator fitness and pre-placement physical examinations) to identify pre-existing conditions or symptoms that may be related to, or aggravated by, past or present occupational exposures.

Over the next few years most developed countries will transition parts of their national health and safety policies to the Globally Harmonized System (GHS), which will standardize the classification, and labeling of chemicals. GHS is a system that defines and classifies the hazards of chemical products, and communicates health and safety information on labels and material safety data sheets (called Safety Data Sheets, or SDSs, in GHS). The goal is that the same set of rules for classifying hazards, and the same format and content for labels and safety data sheets (SDS) will be adopted and used around the world.

The two major elements of GHS are:

1. Classification of the hazards of chemicals according to the GHS rules
2. Communication of the hazards and precautionary information using Safety Data Sheets and product labels

LOCKOUT/TAGOUT (CONTROL OF HAZARDOUS ENERGY)

Employees can be seriously or fatally injured if machinery, utilities or appliances they service or maintain unexpectedly energizes, starts up, or releases stored energy. The OSHA Standard on the Control of Hazardous Energy (Lockout/Tagout), found in 29 CFR 1910.147, delineates steps restorers shall take to prevent accidents associated with hazardous energy. This standard addresses practices and procedures necessary to disable machinery or electrical services, and prevent the release of potentially hazardous energy while maintenance or servicing activities are performed. There are other OSHA standards that apply to energy control and energy release requirements of various types of machinery. A trained and authorized person shall perform Lockout/Tagout.

SAFE WORK PRACTICES IN CONTAMINATED ENVIRONMENTS

In addition to the specific safety/health concerns detailed in this chapter, safety professionals have adopted a number of basic work practices for remediation projects. Restorers should incorporate the following items into restoration and remediation work procedures:

- no eating, drinking, or smoking in any potentially contaminated or designated work area;
- remove protective gear and wash hands before eating, drinking, smoking, or using the bathroom, rest periods and at the end of the work day;
- shower at the end of the work day;
- dispose of contaminated protective clothing with other refuse before exiting the containment;
- do not move used protective clothing from one area to another unless properly contained;
- wear latex, chemical-resistant or vinyl surgical gloves while inside containment areas, designated work areas, or while handling bagged contaminated materials;
- wear a second pair of gloves (rubber, textile or leather work gloves) over surgical gloves to protect against personal injury;
- use the buddy system when working in high heat, remote or isolated work spaces;
- address all cuts, abrasions and first-aid issues promptly, especially when sewage-damaged materials are present;
- discard gloves that are damaged, wash hands with soap and water, and inspect hands for injury, and
- dispose of all used disposable gloves as contaminated material along with contaminated debris.

Restorers shall incorporate the following items into restoration and remediation work procedures:

- tail-gate meetings to discuss the daily work activities, including a review of safety issues;
- wear PPE appropriate to the hazards identified in the work area;
- use protective disposable coveralls with attached or separate shoe covers;
- don protective clothing prior to entering the containment or other designated work areas;
- inspect PPE prior to use;
- repair or replace damaged protective clothing;
- when an injury occurs, the injured worker and co-workers are to take the steps delineated in the company safety program;

- workers are to be instructed as to job specific emergency plans including emergency exits;
- workers are to be informed about the location of the emergency shower and eye wash stations; and
- report injuries to the supervisor as soon as possible.

Immunizations and Health Affects Awareness

Restorers and remediators should consider reducing the risk of infectious disease to workers by referring them to their primary health care physician (PHCP) for information on available immunizations (e.g., tetanus/diphtheria boosters, Hepatitis A & B). Workers, who are at an increased risk for opportunistic infections, including but not limited to those who are immunocompromised due to HIV infection, neoplasms, chemotherapy, transplantation, steroid therapy, or underlying lung disease, should be advised of the increased risk of disease due to their condition. Such workers are usually precluded from participating in restoration or remediation activities in water-damaged buildings. Employees with medical conditions that are of concern (e.g., AIDS, HIV seroposivity, pregnancy) should be evaluated by a qualified physician for a recommendation regarding whether performing assigned restoration or remediation activities presents an unacceptable health risk.

Vehicle Safety

Employers shall comply with applicable federal, state, provincial, and local laws and regulations regarding vehicle safety. Employers should provide instruction to their employees on driver safety. Employees shall comply with applicable federal, state, provincial, and local laws and regulations regarding vehicle operation.

Ergonomics

Employers shall provide their employees with ergonomically safe tools that will help minimize strain and repetitive motion injuries. Due to the nature of the restorer's work, they are susceptible to repetitive motion injuries affecting the shoulder, elbow, knees, and back. Employers should take into consideration the set up of the equipment on their trucks and make sure that the tools are placed in easily accessible places that prevent the employee from stretching or straining. In addition, providing ergonomically safe injury prevention tools, such as furniture sliders, reduce the strain on the back and help prevent injury.

Lifting

Lifting is an action that occurs on every project and one that restorers may take for granted. The movement of items can place a great deal of strain on the back and, when done improperly, can lead to serious injury and lost work time. Employers should train newly hired employees on the proper lifting techniques that will help prevent injury. As part of a back injury prevention program, employers should encourage employees to stretch before, during and after their work shift. Stretching strengthens and warms the muscles used in the lifting process reducing the chances of injury. Limiting the injury risk will keep employees on the job and productive.

HEAT PRODUCING EQUIPMENT CAUTIONS

There are potential hazards associated with the use of heat producing equipment (e.g., heaters, dehumidifiers). Restorers should consider the impact of high temperatures on building components and contents. Manufacturer's instructions and safety precautions shall be followed to reduce the potential for fire hazards and occupant safety issues. Direct-fired heaters shall not be used unless adequate ventilation is available and monitoring is provided because the combustion by-products (i.e., carbon monoxide) remain in the air stream. If indirect-fired heaters are placed within an occupied area, the combustion stream shall be ducted to the outside.

Chapter 9

Administrative Procedures, Project Documentation and Risk Management

ADMINISTRATIVE PROCEDURES

It is recommended that restorers establish, implement and consistently follow methods and procedures for project administration, including but not limited to, business systems and operational plans and protocols. Competent project administration promotes the delivery of high-quality water damage restoration services and increases the likelihood of having satisfied clients. Water damage restoration project administration typically includes, but is not necessarily limited to:

- use of written contracts;
- good communication with all involved parties;
- thorough project documentation, monitoring and recordkeeping;
- appropriate methods to manage risk;
- an ability to understand and coordinate multiple tasks, disciplines and materially interested parties; and
- a professional and ethical attitude and business orientation.

Work Authorizations

Restorers should receive proper written work authorization before performing any services on a water damage project. A work authorization is a form that when properly executed, allows an individual or company to work on the premises or property of another, under the terms of the contract or owners insurance policy. The work authorization may be included as a part of the contract and should be signed by the property owner or their authorized agent.

Contracts

Restorers should enter into a written contract before starting a water damage restoration project. What constitutes an adequate written contract in any given situation or jurisdiction is beyond the scope of this chapter. However, the restorer should verify that the contract contains all elements necessary to form an enforceable contract under the laws of the applicable jurisdiction. Although projects vary in size and scope and can have unique issues and complications, it is recommended that contracts include, but are not limited to the following:

- the identity and contact information of the client and all materially interested parties;
- a description of the work to be performed, which can include reference to attached project specifications or other documents that specify the details of the work;

- description of and responsibility for repair of collateral and/or consequential damage;
- any known limitations, complexities or potential complications of the project;
- any permits and licensing required for the project;
- the respective duties and responsibilities of the parties;
- the project start date and the time frame for completion of the work;
- the price or method for calculating the price or fees for the work;
- the price or fees for any changes or additions to the work;
- the party responsible for payment and the terms of payment;
- provisions dealing with contract default and termination;
- whether or not an insurance company is involved, and how the project will be handled;
- warranty and disclaimer provisions, if any;
- the completion criteria for the project; and
- provisions relating to changes or additions to the work, including change orders.

When a written contract is executed, it is recommended that all parties to the contract initial each page of the contract. The contract should be dated and signed by all parties to the contract, and that each party should be given a copy of the contract as soon as reasonably practical. Restorers should seek legal counsel for the development of a contract, including appropriate terms and conditions, or when circumstances or situations dictate the need for contract modifications, addendums or project-specific legal advice. The property owner or their authorized agent should sign the contract.

By documenting the understanding of the parties at the beginning of a project, written contracts reduce the possibility of dispute, disagreement or conflict during performance of the scope of work. It is recommended that contract documents be accurate and complete, free of ambiguity, and contain adequate disclaimers, reservations or recommendations when project uncertainties, limitations, complexities or complications exist, or are indicated.

Many contractual disputes develop when contract additions or modifications are made during performance of the work, but are not adequately documented. Verbal change orders may create future misunderstanding or disagreement resulting in legal disputes and litigation. Substantive or material deviations from the original, agreed-upon contract or scope of work should be documented in a written and detailed change order, which includes a description of the changes to the work, time for performance, price/fees, and method of payment. Further, it is recommended that the client or the client's designated agent, and the restorer's representative accept the change order in writing.

Specific information, including the source, cause and extent of the damage, is necessary to adequately define the scope of work and develop a work plan for a water damage restoration project; refer to Chapter 10, *Inspections, Preliminary Determination and Pre-Restoration*

Evaluations. Restorers should ascertain whether or not the moisture problem at issue has been identified, controlled or repaired, and if not, to identify the process and party responsible for doing so. The resolution may be delegated to a specialized expert as dictated by the situation. Unless otherwise agreed by responsible parties, it is the responsibility of the property owner, not the restorer, to correct the source of the water intrusion. Restorer should attempt to obtain information for the development of a comprehensive scope and other pertinent project documentation before the water damage restoration project begins.

Communication

Many times the source of a dispute between parties is the failure of the parties to communicate timely, clearly and adequately. The following communication strategies are helpful in preventing or reducing communication problems:

- listen carefully and restate the request or inquiry to the other party;
- be realistic in providing assessments and completion schedules;
- communicate with appropriate parties at the commencement of a project work day to determine and verify priorities and objectives;
- meet with the client at the end of each project work day to communicate project progress;
- maintain a professional demeanor and attitude with all communications;
- be responsive and compassionate, since a water damage event is extremely disruptive to the client;
- develop, implement and consistently follow an organized, systematic method of receiving, evaluating and acting upon information received during the course of a water damage restoration project; and
- document communications when necessary or appropriate to verify the communication and satisfy documentation and recordkeeping recommendations set forth elsewhere in this document.

Communication between materially interested parties is important on any water damage restoration project. It is recommended that materially interested parties agree on the purpose and subjects of project communication, the frequency and mode of communication, and the contacts with whom communications will be distributed. It is recommended that significant items that could potentially affect the job be discussed verbally and then reduced to writing and distributed to appropriate materially interested parties.

Communication often includes education, recommendations and advisories. Clients and occupants with health concerns or medical questions should be instructed to seek advice from qualified medical professionals or public health authorities. Clients or occupants might ask the restorer whether the building can be occupied during restoration. Since the safety and health of occupants is a priority in a water damage restoration project, potential hazards may necessitate occupant evacuation. There are also times when project operations or containment make continued occupation of the structure problematic or impossible. In some instances, it may be appropriate for the restorer to provide clients or occupants with information used in making a decision to evacuate. When providing such information, restorers should inform clients and occupants that any such information provided is not to be construed as medical or health diagnosis, directive or advice. It is recommended that restorers not give advice, education, recommendations or advisories on subjects outside their area of expertise.

PROJECT DOCUMENTATION AND RECORDKEEPING

Thorough project documentation and recordkeeping are important while developing the scope of work and the execution and completion of the restoration work plan, especially if there is a need to review or reconstruct the restoration process or project at some time after completion. To properly develop and document the water damage restoration project, it is recommended that restorers attempt to obtain pertinent project information developed before, during and after the involvement of the restorer in the project. It is also recommended that the restorer document important communications to reduce the possibility of miscommunication. The extent of project documentation and recordkeeping varies with each restoration project.

Time Keeping Documentation

Restorers should record the time of employees involved in the project. Projects can be invoiced on a measured-estimate or bid basis, a time-and-material basis, or a cost-plus-overhead-and-profit basis. Individual timesheets, either written or electronic, might be required for billing purposes. Individual time records can include, but are not be limited to:

- worker name;
- date of service;
- job title or duties;
- time in for a specific task;
- time out for a specific task;
- brief task description and or a correlating accounting code for the task being performed;
- total time worked;
- validation of time by a supervisor, clerk or record keeper; and
- the signature of the worker.

The specific method of tracking, recording and reporting time records is beyond the scope of this document. It is recommended that water damage restoration contractors consult with qualified legal or accounting professionals on this issue.

Equipment, Material and Supply Usage Documentation

A list of equipment, materials and supplies used on a specific job should be created and maintained. Projects invoiced on a time and material plus overhead and profit basis, or a cost-plus-overhead and profit basis, will require such information.

Equipment usage logs are used to record, track and report on the individual pieces of equipment used on a project. An equipment log can include, but is not limited to:

- the name or code for the equipment;
- the date placed and removed;
- the duty or type of equipment;
- the location on the project; and
- the hour meter readings in and out, if possible.

Material and supply usage records are used to record and track a list of items used on a project. A material and supply record can include, but is not limited to:

- the name or code for the product used;
- the date of usage;
- the quantity used;
- the location of usage on the project;
- attached regulatory documents, such as OSHA, SDS and Right-to-Know consent forms; and
- the initials of person responsible for usage.

Project Monitoring Logs

Restorers should maintain organized, written logs for monitoring the progress and effectiveness of the drying process. The specific method for creating and maintaining monitoring logs on a project is beyond the scope of this document. Specific items recorded on a project log can include, but are not limited to:

- the name of the project;
- the dates and times of service;
- the person performing the service;
- the instrumentation used;
- the appropriate psychrometric readings (e.g., temperature, RH) in the:
    - affected area;
    - unaffected area;
    - outdoors;
    - inlet to and outlet from dehumidifiers or HVAC systems, if present
- moisture level or content measurements of representative materials in the affected and unaffected areas;
- drying goals and standards for the affected materials; and

- location of the moisture level or content readings.

Written monitoring logs generally provide the restorer with a clear picture of the progress of the drying process, allowing them to make adjustments to the process as needed. Monitoring logs also provide the necessary documentation for invoicing.

Required Documentation

The documents and records obtained and maintained by the restorer shall include documents required by applicable laws, rules and regulations promulgated by federal, state, provincial and local governmental authorities. This includes appropriate safety and health documentation.

While this is not an exhaustive list, to the extent these documents exist, documents and records should be obtained and maintained by the restorer to include the following:

- the water damage restoration contract and/or the emergency mitigation authorization;
- relevant details of the water intrusion (e.g., source, date of intrusion, date of discovery);
- moisture map;
- psychrometric records;
- moisture level or content records;
- the scope of work and work plan;
- documentation related to project limitations or deviations from compliance with this Standard (e.g., notices, agreements, disclosures, releases, waivers);
- environmental reports made available to the restorer;
- written recommendations or technical specifications from specialized experts, if such documents are made available to the restorer;
- an inventory of contents/personal property that are being removed from the job site, or are in need of restoration or remediation. If contents are removed, the restorer and client should sign and date the inventory, with both parties receiving a copy as soon as practical;
- an inventory of unsalvageable or unsuccessfully restored contents/personal property that will be disposed. Prior to disposal, the restorer and client should sign and date the inventory, with both parties receiving a copy as soon as practical;
- permits and permit applications;
- lien notices and releases;
- change orders;
- estimates, invoices, and bills;

- detailed work or activity logs, including a description of who did what, when, where, how and for what duration, including entry and exit logs, where applicable;
- equipment logs or similar documents that include a description of all equipment, materials, supplies and products used on the project, the quantity and length of time used (where applicable) and other relevant information;
- documentation reflecting client approval for the use of antimicrobial biocides including consumer "Right to Know" information; and
- records of pressure readings in and out of containment erected for the purpose of remediation.

Recommended Documentation

While not an exhaustive list, it is recommended that documents and records obtained and maintained by the restorer include the following:

- administrative information (e.g., clients and materially interested parties contact information and call report records; copies of notices, disclosures, documents and information provided; notes or synopsis of meetings with clients and materially interested parties, which summarize the substance of the meetings and the decisions made and generally document the progression of the project; communication logs; important written communications between and among materially interested parties; decisions to transfer project investigation to a specialized expert or to involve a specialized expert; background and qualification information for subcontractors or trades engaged by the restorer on the project, if any);
- subcontractor contracts, work specifications and change orders for any subcontractors engaged by the restorer on the project;
- insurance and financial information (e.g., identification of the party responsible for payment, payment schedules, and determination of and responsibility for collateral or consequential damage resulting from the restoration project);
- relevant building information (refer to Chapter 10, *Inspection, Preliminary Determination, and Pre-Restoration Evaluations*);
- inspection observations (e.g., diagrams, moisture maps, thermography reports, photography and/or videography of pre-existing conditions, water stains or damage; and areas of visible mold, suspected mold, or efflorescence);
- other relevant project or client observations or perceptions (e.g., odors, condensation, and health complaints); and
- certificate(s) of completion.

Documentation of Limitations and Deviations

The client may request or decline water damage restoration services that prevent the restorer from complying with this Standard. When proceeding in such circumstances, there is a heightened risk of future conflict with the client and potential liability to the restorer. If the restorer decides to proceed with the project despite limitations on compliance with industry standards, restorer should adequately document the situation and circumstances, which can include advising the client in writing of the potential consequences of such noncompliance and attempting to obtain a written waiver and release of liability from the client for those potential consequences. However, this might not prevent restorer liability, because of the fact that the job was accepted with knowledge that it could not be completed successfully, or that the results might be questionable.

On occasion a project might have unique circumstances that might infrequently allow for a deviation from the standard. When a restorer decides to deviate from the standard, they should document the circumstances that led to such a decision and have all the materially interested parties agree in writing to the deviation. Restorers should use their professional judgment throughout each and every project. However, the use of professional judgment is not a license to not comply with this standard and its recommendations.

Recordkeeping and Record Retention

The restorer shall maintain restoration project documentation for the time period required by the record retention laws and regulations of applicable jurisdictions, if any. It is also recommended that restoration project documentation be maintained for the longest applicable statute of limitations in the relevant jurisdiction, at a minimum. Many jurisdictions follow the discovery rule, whereby the statute of limitations applicable to a restoration project only begins to run from the date of discovery of the problem, not the date the service was performed. Thus, in some circumstances, it may be appropriate to maintain restoration project documentation indefinitely. It is recommended that the restorer obtain advice from qualified counsel regarding timeframes for documentation retention. The method of recordkeeping and record retention is beyond the scope of this document.

Emergencies

In many circumstances, water damage restoration projects begin on an emergency basis. Emergency situations may impede communications about the project or limit the opportunity to document the project as described in this chapter. However, once an emergency situation is resolved, to the extent possible, restorers should complete the appropriate documentation and correct communication deficiencies caused by the emergency.

RISK MANAGEMENT

Risk Management Tools

Prudent business management in the water damage restoration field includes an awareness of risk and potential exposure to liability, and the application of various risk management tools. Indeed, much of the material contained within this document addresses directly and indirectly matters relevant to risk management. It may be appropriate for restoration businesses to consider development of a formal Risk Management Program. Although not necessarily an exclusive list, at a minimum it is recommended that the restorer consider application of the risk management tools summarized below:

- conduct the restoration business within an entity having limited liability;
- be reasonably well capitalized;
- consider including risk allocation provisions in project contracts, if and when appropriate;
- perform thorough, quality work with the assistance of a quality assurance program;
- make sure to do what you say you will do when you said you would to it;
- hire qualified and competent employees and invest in and regularly update industry education, training and certification;
- engage qualified and competent subcontractors and specialized experts when necessary. (It is recommended that such subcontractors and specialized experts carry appropriate business liability insurance that includes coverage for environmental liability, if engaged in water damage restoration or microbial remediation work);
- avoid working outside the scope of your expertise;
- stay current with industry developments;
- be aware of industry standards and follow them;
- during completion of the work, make sure required drying objectives are achieved, and the source of water intrusion is identified and responsibility for correction determined;
- use standardized management and operational systems, procedures and forms if possible and appropriate;
- create and maintain adequate project documentation and records;
- upon completion of the work, consider using third party verification or clearance testing, particularly in problematic situations;
- assure compliance with applicable laws and regulations;
- deal with problem situations immediately and do not ignore them;
- resist compromising applicable standards and protocols to satisfy the requests of the owner and insurance adjuster or other materially interested parties, but if required to do so, consider taking precautions such as documenting the deviation request, notifying appropriate materially interested parties, disclaim, and obtain releases;
- conduct the business with integrity and treat others with respect and professionalism;
- obtain the counsel of a qualified lawyer if regulatory compliance or legal issues arise;
- investigate and obtain appropriate insurance coverage(s) if possible; and
- understand the lien rights and procedures of the restorer and assert such rights lawfully.

Client Insurance

In response to the explosion of mold insurance claims between 2001 and 2002, insurance companies in North America added new exclusions and low coverage limits for mold-related losses to virtually all personal lines of insurance (e.g., homeowners and auto liability), commercial lines (e.g., general liability and property), and professional liability policies (e.g., consultants, insurance agents and architects). These exclusions and coverage limits left property owners and contractors with a significant gap in their insurance coverage.

Recent mold claims research reveals that insurance companies are paying fewer mold claims now than they were in 2002. Since the numbers of water damage events are more or less constant if the impact of major water events like hurricanes and floods are taken into account, the loss data implies that the mold losses have been shifted away from insurance policies and on to insurance consumers. This means that less mold remediation work is currently being paid for under homeowner's insurance policies and commercial property insurance policies. In this environment, it is more likely a vendor will face liability claims if something goes wrong at the job site.

These developments in the insurance industry have created ramifications for the restorer and mold remediator. Accordingly, it is recommended that restorers and remediators be mindful of the following:

- owner insurance policies covering structures subject to water damage or mold remediation are complex. Their interpretation is not the responsibility of the remediator and beyond the scope of the restorer's expertise. In some circumstances, even if a policy contains a mold exclusion or coverage limitation that may appear on its face to preclude recovery, the facts surrounding the loss and legal precedent applicable in the jurisdiction may actually allow a recovery. Therefore, it is recommended that restorers refrain from analyzing and interpreting insurance policies related to their water damage or mold remediation projects, and that such matters be referred to an appropriate insurance professional or attorney;
- the existence and evaluation of insurance coverage for a water damage or mold remediation project has become much more uncertain and problematic;
- payment for mold remediation services is increasingly coming directly from the owner rather than through an insurance company; and
- since the owner can be more inclined to engage in damage recovery efforts when insurance is not involved, the restorer or remediator is more likely to be involved in supporting or assisting the owner in those efforts, including litigation.

Restorer/Remediator Insurance

The water damage restoration and mold remediation insurance markets have undergone extensive change over the past several years, particularly in North America. General liability policies now written for restorers and remediators, and most other types of commercial liability policies, exclude some or all claims for injury or damage resulting from mold and pollutants, including the cost of clean up. This exclusion creates a gap in coverage. Without environmental insurance specifically adapted to cover mold as a pollutant, restorers and remediators might not be insured for mold related liability losses. Due to the nature and extent of the potential liability, which may be experienced by restorers and remediators, the only business insurance available in North America to cover losses from mold is through specialized environmental insurance packages. This specialized environmental insurance coupled with proper planning can maximize the value of the insurance purchased while minimizing premiums paid and the potential professional liability exposure for all materially interested parties.

Because of the introduction of universal mold exclusions in insurance policies, it is recommended that restorers and remediators obtain appropriate Contractors Pollution Liability insurance to cover their operations. These are available from various providers within the highly-specialized environmental insurance market. The purchase of Contractors Pollution Liability insurance brings the insurance coverage on the remediator back to where it was before the mold exclusions on Commercial General Liability insurance policies took mold coverage away.

Environmental insurance is complex and unlike general liability insurance, lacks insurance industry standardization. The current marketplace includes only a small number of insurers capable of writing a full range of environmental coverage and supporting those policies with claims and loss control services. Each insurer typically creates its own policy forms and creates names for its coverage in accordance with its marketing objectives. Thus, two insurers may use different names to describe essentially the same coverage. To add to the complexity, different policy forms can be significantly modified by endorsement or combined to provide packages of different types of environmental insurance that share a common policy limit. Some environmental coverage is available only as part of specialty insurance packages. Because of the complexity of environmental insurance, it is recommended that credentialed insurance agents with specific training in environmental insurance be consulted during the procurement of this insurance. These specialized insurance agents can be identified through the Internet under the words "mold insurance." Many of these environmental insurance specialists are wholesale insurance brokers who can work with generalist insurance agents throughout North America.

Insurance markets in different countries may treat the loss exposures related to mold differently than the insurance policies used in North America. It is recommended that restorers monitor the insurance they carry on their business to assure they have coverage for mold related damages. Coverage restrictions can appear in the form of mold exclusions or pollution exclusions. These restrictions can be addressed with the assistance of the restorer's specialized insurance agent or insurance provider.

There may be a tendency for restorers to attempt to restrict the coverage purchased in order to save money on premiums. Some of the more popular strategies to do this involve insuring only jobs in which the client is demanding mold coverage while leaving the restorer or remediator uninsured for other jobs, creating a subsidiary to do mold remediation while the remainder of the business remains uninsured for mold, or insuring only their mold remediation jobs while leaving all of the other services provided by the restorer or remediation contractor uninsured. From an insurance standpoint these strategies are never recommended. They leave coverage gaps for the business and can increase the effective rate paid for the insurance purchased.

In general, the most efficient purchase strategy for environmental insurance is to aggregate as much loss exposure onto one policy as possible. Although the focus on mold remediation insurance may only be on self-performed mold remediation projects, a project mold claim might also originate from a water damage restoration project gone awry, subcontracted remediation, from environmental consultants engaged on the project, or from drying, plumbing, roofing and window work. Since the incremental cost to insure the entire restoration or mold remediation firm and all aspects of its projects and operations can be reasonable when compared to the initial premium, the additional coverage gained and the reduced business exposure, it can be cost effective for restorers and remediators to aggregate coverage for all aspects of their operations into one policy.

Obtaining Contractors Pollution Liability (CPL) insurance does not replace or negate the need of the restorer for Commercial General Liability (CGL) Insurance, which provides coverage for aspects and potential claims of the business of the restorer other than pollution or mold. It is recommended that the restorer obtain sufficient Commercial General Liability insurance for the work they are performing. Considerations include coverage of the business work facilities, damage to structures or property being restored including contents in the care, custody and control of the restorer, injury to persons including occupants, and defense costs, among others. Some insurers offer CGL/CPL combination policies to provide a more complete insurance package for the insured. Nearly all CPL policies are written on a claims-made basis, and most CGL policies are written on an occurrence basis. However, combination policies are offered with CPL coverage on either a claims-made or occurrence basis, and the CGL portion on either a claims-made or occurrence basis. Separate limits can be specified if the insured needs higher limits for the pollution or the general liability exposures. Both types of coverage are subject to a single aggregate limit and typically a single deductible (when both CPL and CGL claims are involved).

Using combination policies has several advantages. The first is that they provide the coverage needed by the insured to adequately protect it against pollution and mold claims. Another advantage is that they can eliminate inter-insurer coverage disputes that might otherwise occur if two different insurers provided the coverage. Combination policies also provide uniform defense for claims because disputes will not arise over which insurer has the duty to defend. A combination policy is typically less expensive than if two or more coverage forms are purchased separately, primarily because the coverage in a combination policy is subject to a single aggregate limit. Although this makes the policy less costly, it has the drawback of offering only one limit when the purchase of separate policies would provide two limits. However, only one deductible applies in the combination form, whereas the use of separate policies would result in the application of two deductibles.

In some jurisdictions mold remediators and mold assessors are required by law to obtain and maintain certain types of insurance in certain minimum amounts. Restorers shall determine and comply with any governmental insurance requirements related to their business operations.

While not exhaustive, it is recommended that restorers consider the following actions:

- obtain and maintain adequate insurance for the restoration and remediation business;
- make changes to their insurance program on a timely basis. Do not let the actions of a general liability underwriter non-renewing the company's insurance policies put the firm in a crisis mode;
- try to avoid all general liability claims. Restoration firms with high general liability claim frequency may not be able to find insurance at all. One claim, even if it is measured in the tens of thousands of dollars may be ignored by the underwriters. It is the frequency of claims that raises concern among underwriters;
- run a tight financial ship. Environmental underwriters will likely be interested in the firm's financial performance;
- prepare an accurate application. The application may be seen as a warranty statement on behalf of the contractor and is often incorporated into the policy itself. Therefore the application may be referenced during a claim in order to establish that accurate information was provided to the underwriter prior to purchasing coverage;
- work with an expert in environmental insurance in addition to your local insurance agent. Using a specialty broker with experience in environmental insurance policies ensures that appropriate coverage is placed for the best possible price thereby maximizing coverage and minimizing costs for contractors;
- pay particular attention to potential differences in the insurance coverage being provided by different policies, e.g., Commercial General Liability (CGL) insurance versus Contractors Pollution Liability (CPL) insurance. Some policies may exclude significant causes of loss that other policies cover. A credentialed environmental specialist insurance broker can assist in these evaluations of coverage. For restoration contractors some of the items of concern can be:
    - Does the policy cover both Bodily Injury and Property Damage Claims?;
    - Are there exclusions in the policy that may restrict these coverage grants for core business operations?;
    - Does the policy exclude claims against the named insured for claims arising out of the work of subcontractors?; and
    - Does the policy exclude claims arising from the preparation of opinions or reports?
- if a restorer has no insurance coverage for mold, it is recommended that the restorer disclose this fact to the client in writing.

Assessor Insurance

Although this document is not intended to directly address the methodology for contaminant assessment, restorers can perform inspection and evaluation services related to mold, sewage or other contaminant remediation activities. In some circumstances, restorers may have divisions or subsidiaries that are also qualified to provide mold or contaminant assessment or other services related to remediation, such as those that may be provided by an Indoor Environmental Professional, as described in this document. In other circumstances, the restorer may work with an independent IEP on contaminant remediation projects.

Restorers can face potential liability from their inspection and evaluation services. Assessors can face potential liability from negligent professional errors, acts or omissions. Claims against such vendors can include allegations that they have failed to identify contaminants, that their characterization of the site contains errors, that the design of the protocols for contamination remediation is faulty, that they have made mistakes in analysis of samples, or that they have otherwise failed to perform in accordance with the standards of their profession. The restorer's insurance policy obtained to provide liability coverage for the restoration business might not cover or might exclude contaminant inspection, evaluation and assessment services provided by qualified restorers and related to remediation services also provided by the business, creating a gap in insurance coverage.

Virtually all General Liability and Contractor Pollution liability insurance policies contain exclusions for claims arising out of Professional Services. Professional Services exclusions are not standardized, but usually eliminate coverage under the policy for claims arising from the preparation or approval of drawings, opinions, reports, plans, surveys, opinions, or designs. Because some of these activities may be provided by restorers, significant gaps in insurance coverage can be created by the Professional Services exclusion, especially if these services are offered on a fee for service basis.

There are three ways to correct for this potential gap in insurance coverage. First, if the restorer only prepares plans for jobs they will perform themselves, the effect of the professional liability exclusion is minimal. The best solution to the potential coverage gap created by the Professional Services exclusion in the General Liability and Contractors Pollution Liability policies is to amend the exclusion by endorsement so that it does not apply to the services provided by the restorer, which are incidental to the restoration business. It is likely an endorsement of this type will only be available from an insurance company with specialized insurance products for the restoration contracting business. If a firm provides Professional Services on a fee basis, then the need to purchase Professional Liability insurance in addition to General Liability insurance may be necessary.

Professional Errors and Omissions Liability (Professional E&O) insurance generally insures claims arising out of a professional error, act or omission. It is recommended that restorers and remediators performing microbial inspection and evaluation services determine if their existing insurance program covers the performance of such services, and if not, the Professional E&O insurance form would be appropriate for their operations. It is recommended that qualified contractors providing assessment services or offering their opinions professionally, such as those rendered by an IEP, consult with their attorneys or specialized risk management advisors to determine if Professional E&O insurance is important for the work they perform. In addition, it is recommended that restorers who engage independent assessment services, or the services typically provided by an IEP, investigate and determine that the vendor carries Professional Liability insurance, and if so, whether or not the insurance carried by that vendor is adequate. It is important to verify that all such policies cover the type of claims that might occur during a water damage restoration project, particularly claims for environmental injury and damages, including those caused by pollution and mold. However, given that such insurance is typically written on a claims-made basis, usually subject to a retroactive date and a substantial deductible, even after verification of the existence of such insurance at a point in time, there is no guarantee that insurance will be in force when a claim is made, or that the claim will be covered and paid by insurance. In such circumstances it may be necessary to purchase "tail" coverage to extend the insurance beyond the claims-made period.

Other Insurance

The conduct of business as a restoration firm requires consideration of several other types of insurance coverage.

Worker Compensation/Industrial/Employee Insurance Requirements: Restoration firms shall meet legal requirements to provide worker compensation coverage for businesses having employees.

Automobile Insurance: It is recommended, and in many jurisdictions required by law, that restoration firms using vehicles in business obtain commercial automobile liability insurance.

Caveat

The insurance industry, as it relates to the water damage restoration and remediation industries, is rapidly evolving. Therefore, the insurance information and guidance presented in this Standard, although accurate when published, is subject to constant change as time passes. Environmental insurances were not originally developed for restoration contractors; therefore many modifications to insurance policies are being made to adapt them to the needs of firms in the restoration business. Wide variations in the quality of the coverage provided by various policies continue to exist. It is incumbent upon the restorer to stay abreast of insurance industry developments impacting their business. It is advisable that restorers develop and maintain a relationship with a qualified insurance professional to assist in this regard.

Chapter 10

Inspections, Preliminary Determination and Pre-Restoration Evaluations

INTRODUCTION

At the start of a restoration project, restorers are often compelled to make initial judgments between taking immediate action to begin quickly removing water and start the drying process, versus the need to accurately identify and control hazards and contaminants. Restorers should conduct the following activities at the beginning of the project:

- information gathering;
- initial response;
- safety and health issue resolution;
- pre-restoration inspection;
- arriving at the preliminary determination;
- pre-restoration evaluations; and
- work planning

The ANSI/IICRC S500 *Standard and Reference Guide for Professional Water Damage Restoration* has been written to provide methods and procedures for restorers to safely restore property damaged from water intrusion. The processes in a project do not always follow a linear progression and may occur in varying orders; even simultaneously. The order of the processes presented in this chapter is by no means a mandatory order, although there are steps that should occur early in the initial response. Each project can present a unique set of circumstances that should be considered when establishing the order of the procedures discussed in this chapter.

QUALIFICATIONS

Restorers are expected to be qualified by education, training, certification and experience to appropriately execute a key set of core skills. Restorers shall only perform services they are licensed, certified or registered to provide when required by local, state, provincial or federal laws and regulations. If situations arise where there is a need to perform services beyond their expertise, restorers should hire specialized experts or other support services, or recommend to their customer that the appropriate specialized expert be retained, in a timely manner. Restorers should also address occupant questions when the subject is within the scope of their authority and ability.

DOCUMENTATION

Throughout the project, the restorer should establish, implement, and consistently follow methods and procedures for documenting all relevant information. This information can affect and provide support for project administration, planning, execution, and cost. In addition, pre-existing conditions (e.g., evidence of wear, use, physical damage, previous water intrusions, staining, odors) should be documented and communicated to materially interested parties. Refer to Chapter 9, *Administrative Procedures, Project Documentation and Risk Management*.

DEFINITIONS

Before beginning the inspection, restorers should have an understanding of the category of water, classes of water, and other factors that influence the appropriate response.

Category of Water

The categories of water, as defined by this document, refer to the range of potential contamination in water, considering both its originating source and its quality after it contacts materials present on the job site. Time and temperature can accelerate or retard the amplification of contaminants, thereby affecting its category. Restorers should consider potential contamination, defined as the presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment; and can produce adverse health effects, cause damage to structure and contents or adversely affect the operation or function of building systems.

Category 1: Category 1 water originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. Examples of Category 1 water sources can include, but are not limited to: broken water supply lines; tub or sink overflows with no contaminants; appliance malfunctions involving water-supply lines; melting ice or snow; falling rainwater; broken toilet tanks, or toilet bowls that do not contain contaminants or additives.

Category 1 water can deteriorate to Category 2 or 3. Category 1 water that flows into an uncontaminated building does not constitute an immediate change in the category. However, Category 1 water that flows into a contaminated building can constitute an immediate change in the category. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water. Odors can indicate that Category 1 water has deteriorated.

Category 2: Category 2 water contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Category 2 water can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). Examples of category 2 water can include, but are not limited to: discharge from dishwashers or washing machines; overflows from washing machines; overflows from toilet bowls on the room side of the trap with urine but no feces; seepage due to hydrostatic pressure; broken aquariums; and punctured water beds.

Category 2 water can deteriorate to Category 3. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water.

Category 3: Category 3 water is grossly contaminated and can contain pathogenic, toxigenic, or other harmful agents. Examples of Category 3 water can include, but are not limited to: sewage; toilet backflows that originate from beyond the toilet trap regardless of visible content or color; all other forms of contaminated water resulting from flooding from seawater; rising water from rivers or streams; and other contaminated water entering or affecting the indoor environment, such as wind-driven rain from hurricanes, tropical storms, or other weather-related events if they carry contaminants (e.g., silt, organic matter, pesticides, or toxic organic substances).

Regulated, Hazardous Materials and Mold: If a regulated or hazardous material is part of a water damage restoration project, then a specialized expert may be necessary to assist in damage assessment. Restorers shall comply with applicable federal, state, provincial and local laws and regulations. Regulated materials posing potential or recognized health risks can include, but are not limited to: arsenic, mercury, lead, asbestos, polychlorinated biphenyls (PCBs), bulk or regulated use pesticides, fuels, solvents, caustic chemicals and radiological residues. For situations involving visible or suspected mold, refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. The presence of any of these substances does not constitute a change in category; but regulated materials shall be properly abated by qualified abatement contractors, and mold should be remediated by qualified mold remediators

Class of Water Intrusion

Restorers should estimate the amount of humidity control needed to begin the drying process. A component of the humidity control requirement is the evaporation load (i.e., Class of water).

The term "Class of water" is a classification of the estimated evaporation load and is used when calculating the initial humidity control (e.g., dehumidification, ventilation). It is based on the approximate amount of wet surface area and the permeance and porosity of the affected materials. Initial information to determine Class should be gathered during the inspection process. The Classes are divided into four separate descriptions, Class 1, 2, 3, and 4.

Class 1 - (least amount of water absorption and evaporation load): Water intrusion where semi-porous materials (e.g., unfinished wood, concrete, brick, OSB) have absorbed minimal moisture; ~5% or less of the combined floor, wall and ceiling surface area in the space is wet, porous material (e.g., carpet, gypsum board, fiber-fill insulation, CMU, textiles)

Class 2 - (significant amount of water absorption and evaporation load): Water intrusion where wet, porous materials involving more than ~5% to ~40% of the combined floor, wall and ceiling surface area in the space.

Class 3 - (greatest amount of water absorption and evaporation load): Water intrusion where wet, porous materials involving ~40% or more of the combined floor, wall and ceiling surface area in the space.

Class 4 - (deeply held or bound water): a water intrusion that involves a significant amount of water and absorption into porous and semi-porous materials or assemblies (e.g., gym floors, structural cavities) that have a low rate of evaporation due to deeply held or bound water. Drying may require special methods, longer drying times, or substantial water vapor pressure differentials.

Other Factors to Consider When Estimating Drying Capacity

Other factors can impact the drying environment. Restorers should understand and consider these factors when estimating the drying capacity needed to prevent additional damages and begin the drying process. These factors include:

- influence of heating, ventilating, and air conditioning (HVAC) systems;
- build-out density of the affected area;
- building construction complexity; and
- influence of outdoor weather

See Chapter 13 *Structural Restoration.*

INITIAL CONTACT AND INFORMATION GATHERING

The information gathering process begins with the initial contact between the restorer and the property owner or authorized agent. In addition to administrative information found in Chapter 9 *Administrative Procedures, Project Documentation, and Risk Management*, the restorer should gather information to allow for an effective mobilization and response. Inaccurate or incomplete information can impact the ability for the restorer to take appropriate measures during the initial response. This information can include, but is not limited to:

- structure type and use;
- source, date and time of water intrusion;
- status of water source control;
- general size of affected areas (e.g., number of rooms, floors);
- suspect or known contaminants;
- history of building usage;
- history of previous water damage;
- types of materials affected (e.g., flooring, walls, framing);

- age of structure;
- changes in structure design; and
- number of occupants.

The restorer can make assumptions using the information above to mobilize a proper response. Once the restorer arrives at the worksite and performs an initial inspection these assumptions can change. The information gathered helps to establish a moisture inspection strategy and evaluate the existence of moisture problems that have caused or can lead to structural, system or content damage or contamination. Contaminants (e.g., fungal or bacterial) can be visible or hidden. Where mold growth is discovered or is suspected refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation.*

INITIAL RESPONSE, INSPECTION AND PRELIMINARY DETERMINATION

During the initial response, the information gathering process should continue with a site walkthrough and customer and occupant interviews. At a minimum, the restorer should conduct the following activities during the initial response:

- conduct a site specific safety survey;
- identify customer priorities and concerns;
- verify the source of water intrusion;
- identify the extent of the water migration;
- arrive at a preliminary determination;
- identify pre-existing damage;
- identify immediate secondary damage concerns; and
- establish drying standards and drying goals.

Safety and Health Hazards

Safety and health hazards shall be documented. As hazards are identified, appropriate actions shall be implemented to resolve the hazard, or minimize the potential for injury or other safety risks. Actions may include the involvement of a specialized expert. Refer to Chapter 8, *Safety and Health.*

Identify Priorities and Concerns

During the initial inspection, it is recommended that the restorer consider the priorities and concerns of the materially interested parties. The type of structure, contents affected, building use, occupancy, and the impact associated with the loss-of-use can significantly influence priorities and concerns. Refer to Chapter 11, *Limitations, Complexities, Complications and Conflicts.*

Extent of Water Migration

Restorers should evaluate and document the extent of water migration in structure, systems and contents, using the appropriate moisture detection equipment which can include, but is not limited to:

- moisture sensors;
- thermo-hygrometers;
- invasive and non-invasive moisture meters; and
- thermal imaging devices.

Since water can flow under walls, and come from above, restorers should inspect adjoining rooms even when no water is visible on the surface of floor coverings. The amount of surface area to inspect within a building can make it inefficient to detect moisture using moisture meters alone. Thermal imaging devices can be used to show possible water flow patterns in a building in hard to reach places, increasing the efficiency of documenting affected areas and water migration. Thermal imaging cameras can be useful as they show surface temperature variations commonly associated with moisture, but should always be verified by a moisture meter.

Pre-existing Damage

Throughout the inspection process, restorers should inspect for pre-existing damage issues. Pre-existing damage is the wetting or impairment of the appearance or function of the material from direct or indirect exposure to water or other conditions not related to the current water intrusion. Examples of pre-existing damage can include, but are not limited to: dry rot, chronic water leaks, urine contamination, and visible mold growth. Indications of pre-existing conditions can include, but are not limited to:

- malodors;
- visible evidence of staining and deterioration; and
- evidence of damage unrelated to water (e.g., wear, use, lack of maintenance).

Secondary Damage

Throughout the drying process, restorers should inspect for water related secondary damage issues. Secondary damage is defined as the wetting or impairment of the appearance or function of a material from prolonged indirect exposure to water or indirect exposure to contamination carried by or resulting from the water, which is reversible or permanent. Restorers should inspect for excessive humidity and elevated moisture content in areas adjacent to the affected area.

Dry Standards and Drying Goals

Dry standards are a reasonable approximation of the moisture content or level of materials prior to a water intrusion. An acceptable method to establish a dry standard is to evaluate the moisture content or level of similar materials in unaffected areas. When unaffected materials are not present, the restorer may use a reference from similar structures, experience from similar drying projects, and knowledge of the geographical area. The dry standards are then used by the restorer to establish acceptable drying goals.

Drying goals are a target moisture content or level of materials established by the restorer that are based on the dry standards. Individuals establishing drying goals should have a working knowledge of the instrumentation used and local influences on normal moisture content or level in building materials.

Drying goals may be at, or above the dry standard and should be documented as they relate to specific materials. The restorer should establish drying goals that would be expected to:

- inhibit microbial growth; and
- return materials to an acceptable moisture content or level.

According to ACGIH's *Bioaerosols: Assessment and Control* book in section 10.3.3, "Practically speaking, if a_w can be kept below ~0.75, microbial growth will be limited; below an a_w of 0.65, virtually no microbial growth will occur on even the most susceptible materials." In practical terms, the restorer's task is to dry all materials to be at equilibrium with an environment well below this threshold (i.e., 0.60 a_w). Refer to Chapter 5, *Psychrometry and Drying Technology*.

Water activity can be approximated with the use of a thermo-hygrometer and a small containment, such as a 1' x 1' clear 6 mil plastic barrier. The thermo-hygrometer is placed in contact with the material, then contained to the material surface with the plastic barrier until it is acclimated. A thermo-hygrometer can be considered acclimated when there is no significant change in relative humidity over a 15 minute period (i.e., ≤1%).

Returning materials to an acceptable moisture content or level can be accomplished by setting a drying goal that returns materials to a close approximation of their dry standard. In the case of solid wood products, the drying goal should be within 4 percentage points of its normal moisture content or dry standard, but in all cases, below the point that would support microbial growth (i.e., less than 16% MC). For other materials, it is recommended the drying goal be within 10% of the dry standard, yet not support microbial amplification. To illustrate this, if the measured dry standard is 20 points, then the drying goal would be determined as 22 points.

Preliminary Determination

The "preliminary determination" is the determination of the Category of water. If the preliminary determination is that the water is Category 1, then the restorer can proceed without contamination controls (e.g., erecting containment barriers, initial cleaning, establishing pressure differentials) and worker protection. With regard to Category 2 or 3 water intrusions, remediation should occur prior to drying. Restorers should use contamination controls and appropriate worker protection. Where necessary, an indoor environmental professional (IEP) should be used to assess the levels of contamination.

In many cases an assessment by an IEP on a water damage restoration project is not necessary. However, if the inspection shows that one or more of the following elevated risk situations are present or the water is Category 2 or 3, the restorer should consider the use of an IEP (refer to Chapter 12, *Specialized Experts*). Considerations can include, but are not limited to:

- occupants are high risk individuals; (refer to Chapter 3, *Health Effects from Indoor Exposure to Microbial Contamination in Water Damaged Buildings*);
- a public health issue exists (e.g., elderly care or child care facility, public buildings, hospitals);
- a risk of adverse health effects on workers or occupants;
- occupants express a need to identify a suspected contaminant;
- contaminants are believed to have been aerosolized; or
- there is a need to determine that the water actually contains contamination.

The preliminary determination prepares the restorer to perform a pre-restoration evaluation.

Performing the initial moisture inspection

An initial moisture inspection should be conducted to identify the full extent of water intrusion, including the identification of affected assemblies, building materials, and the edge of water migration. Normally, this process begins at the source of water intrusion. Water migration can then be traced across and beneath carpeted surfaces with a moisture sensor. Hard surfaces such as wood flooring, gypsum wallboard, resilient flooring and plaster should be inspected. This can initially be accomplished using a non-invasive (non-penetrating) moisture meter. Thermal imaging cameras can be used to help identify areas of potential migration followed by appropriate moisture detection instruments, especially on projects with complex or multiple areas of water intrusion.

The initial inspection should continue in all directions from the source of water intrusion until the restorer identifies and documents the extent of migration. As affected assemblies are discovered, the restorer should identify and document the building materials that comprise the assembly and the impact of the water on each material. In some cases limitations and complexities (refer to Chapter 11 *Limitations, Complications, Complexities and Conflicts*) can hinder the identification of materials and assemblies. Identification of building materials within an assembly can be accomplished through several methods (e.g., building drawings, existing access openings, inspection holes, partial disassembly, invasive moisture meters). The extent of moisture migration should be documented using one or more appropriate methods including at a minimum a moisture map (i.e., a diagram of the structure indicating the areas affected by migrating water).

The initial inspection process should include establishing a dry standard for affected materials by measuring unaffected samples of the same material. The dry standard should be documented, and used to establish a drying goal for salvable affected materials. Results of the initial moisture inspection should be used to establish a monitoring method (i.e., the same meter and setting) to be followed for subsequent follow up visits to the project (i.e., daily). The results of the inspection should be documented (e.g., meter, setting, types of material).

Restorers should use the appropriate meter or instrument during inspections and follow the manufacturer instructions. An understanding of meter operation and limitations is critical to accurate measurements. Restorers using infrared thermography equipment in surveying buildings for moisture damage should receive proper training on its use. Areas identified with the infrared camera as suspect for being wet should be verified by further testing with a moisture meter.

Thermal Imaging Cameras (infrared camera) area used to detect surface temperature differences and do not directly detect moisture or measure through materials. Restorers using infrared thermography equipment in surveying buildings for moisture damage should receive proper training on its use.

Infrared thermometers measure the average temperature on a spot at the surface of the material. The size of the sample area is determined by the distance-to-spot ratio (D:S). An infrared thermometer can be used to determine temperature differentials. The surface temperature difference can indicate evaporative cooling of wet materials. Cooler surfaces do not always indicate evaporative cooling. For this reason, all suspect areas should be verified with a moisture meter.

Restorers should use the appropriate meter or instrument during inspections and follow the manufacturer instructions. An understanding of meter operation and limitations is critical to accurate measurements. Restorers using infrared thermography equipment in surveying buildings for moisture damage should receive proper training on its use. Areas identified with the infrared camera as suspect for being wet should be verified by further testing with a moisture meter.

PRE-RESTORATION EVALUATION

Following the preliminary determination, the restorer should conduct a pre-restoration evaluation. Pre-restoration evaluations establish recommended corrective actions based on information and evidence collected during the inspection process and conclusions derived from the preliminary determination. The information gathered from the pre-restoration evaluation is then used to develop the work plan, drying plan, safety and health plan, and to identify the need for specialized experts that may be required to clean and dry the structure, building systems and contents to an acceptable drying goal. Information gathered shall include safety and health hazards and the approximate age of the building. Factors considered in the pre-restoration evaluation process can include but are not limited to:

- emergency response actions;
- building materials and assemblies;
- contents and fixtures;
- HVAC, plumbing and electrical systems; and
- below-grade, substructure and unfinished spaces.

Evaluating Emergency Response Actions

Restorers shall identify and manage potential safety and health hazards. During the inspection process, restorers shall make a reasonable effort to identify potentially hazardous materials that could impact building occupants or might be disturbed. Whenever occupants or other workers are present during the initial inspection, restorers should communicate known potential hazards (refer to Chapter 8, *Safety and Health*). Restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection or handling of hazardous or regulated materials, such as asbestos or lead-based paints.

Evaluating Building Materials and Assemblies

Determining the composition of affected materials and assemblies helps establish and implement an appropriate restoration strategy. The construction, permeability, placement of vapor retarders, number of layers, degree of saturation, presence of contamination, degree of physical damage, and the presence of interstitial spaces should be considered when evaluating materials and assemblies.

If materials are restorable, the restorer should use appropriate measuring devices to obtain and document moisture readings, and compare them to the drying goals. All building materials that are likely to be affected, including multiple layers in a single assembly, should be inspected.

Evaluating Contents

Determining the material composition of affected contents helps establish a moisture inspection strategy and implement an appropriate restoration strategy. The construction, permeability, degree of saturation and the presence of contamination should be considered when evaluating contents. Affected contents should be evaluated. Refer to Chapter 15, *Contents Evaluation and Restoration*.

Evaluating HVAC Systems

Determining the material composition of affected HVAC systems helps establish a moisture inspection strategy and implement an appropriate restoration strategy. The construction, presence of moisture and contamination should be considered when evaluating HVAC systems. Affected HVAC systems should be evaluated by a qualified individual. Refer to Chapter 14, *Heating, Ventilating and Air Conditioning (HVAC) Restoration*.

Evaluating Below-Grade, Substructure And Unfinished Spaces

Depending on the type of construction, water can collect in below-grade, substructure or unfinished spaces (e.g., basements, crawlspaces, mechanical chase, and attics). These areas should be evaluated. Below-grade, substructure and unfinished spaces can present unique challenges and may involve special evaluation procedures. The inspection and evaluation process shall be conducted according to federal, state, local or provincial laws and regulations. Restorers should consult with a specialized expert when appropriate.

Below-grade, substructure and unfinished spaces can contain safety and health hazards. Safety issues for entrants to consider include, but are not limited to: electrical shock hazards, puncture wounds and bites from rodents, insects or small animals, oxygen deprived atmospheres and airborne contaminants. If a hazardous condition is known or suspected, the restorer should remove the hazard if possible, and wear appropriate foot, hand and body protection, as well as appropriate respiratory protection. Refer to Chapter 8, *Safety and Health.*

Many Below-grade, substructure and unfinished spaces are considered a confined space. Before entering, accessibility issues for a confined space shall be addressed. Some confined spaces are classified as "permit-required" spaces. Refer to Chapter 8, *Safety and Health.*

Once safety and health issues have been addressed, the below-grade, substructure and unfinished space inspection can begin and evaluations can be made. Items that can be useful when inspecting these areas include a flashlight, safety harness and rope, drop lights with GFCI cords, GFCI extension cords, a mechanics creeper, thermo-hygrometers, moisture meters, plastic sheeting and drop cloths.

A water intrusion can be a single, short duration event; however, the amount of flow into the space can be significant. The restorer should evaluate the Category of Water, Class of Water Intrusion specific to the space, size of the affected area, and the composition and moisture content of structural materials (e.g., joists, subflooring).

Several conditions can be present in a below-grade, substructure and unfinished spaces that can influence the inspection and evaluation process. These conditions can include, but are not limited to the:

- volume of standing water;
- dimensions of the work area;
- size and location of access openings;
- presence of HVAC duct work;
- presence of either a plastic moisture barrier or a low-density-fill concrete cap over the soil, sometimes referred to as "rat proofing";
- presence of pests;
- presence of pea gravel or other ground cover;
- presence of debris; and
- presence of contamination (e.g., sewage, mold).

PROJECT WORK PLANS

The information gathered from the pre-restoration evaluation is used to develop work plans. Refer to Chapter 9, *Administrative Procedures, Project Documentation and Risk Management.* The structural restoration procedures that follow the development of work plans are discussed in Chapter 13, *Structural Restoration*, and in Chapter 15, *Contents Evaluation, Restoration and Remediation.*

ONGOING INSPECTIONS AND MONITORING

Once the project has been controlled and the correction of the damage has begun, the restorer should continue gathering information through ongoing inspections and monitoring. The monitoring process can include, but is not limited to: recording temperature and relative humidity readings and other calculated psychrometric values, checking the moisture levels of materials and updating progress reports.

Because differences in calibration occur from one instrument to another, restorers should use the same meter throughout a project or establish an in house method to verify that the meters used are within a reasonable tolerance of each other. Refer to Chapter 6, *Equipment, Instruments, and Tools*.

Restorers should record and monitor relevant moisture measurements daily, preferably at the same time of day, until drying goals have been met and documented. The frequency of monitoring may be adjusted by the agreed scope of work, potential for secondary damage, job site accessibility, or by agreement between the materially interested parties. Such adjustments should be documented.

The information gathered during ongoing inspections and monitoring can lead the restorer to adjust the placement of drying equipment and modify drying capacity. Where progress is not acceptable, the restorers should take corrective action. The ongoing inspection process can lead to the discovery of a complication. As complications arise, restorers should document the nature of the complication, the impact on the restoration process and scope, and communicate with materially interested parties. Refer to Chapter 11 *Limitations, Complications, Complexities and Conflicts.* Restorers should continue the drying process until drying goals have been verified and documented. Refer to Chapter 13, *Structural Restoration.*

Chapter 11

Limitations, Complexities, Complications and Conflicts

INTRODUCTION

Restorers can be faced with project conditions that present challenges. These challenges can produce limitations, complexities, complications or conflicts. Restorers should have an understanding of these issues and communicate them to appropriate parties. The following is a definition of each of these challenges.

Limitation means the act of limiting or the state of being limited, constrained or restricted. For purposes of this document, a "limitation" is a restriction placed by others upon the restorer resulting in a limit on the scope of work, the work plan or the outcomes that are expected.

Complexity means involved or intricate. For purposes of this document, a "complexity" is any condition causing the project to become more difficult or detailed, but does not prevent work from being performed adequately.

Complication means the act of becoming complex, intricate or perplexing. For purposes of this document, a "complication" is generally any condition that arises after the start of work causing or necessitating a change in the scope of activities.

Conflict means a state of disharmony between persons, ideas or interests. For purposes of this document, a "conflict" is a limitation, complexity or complication resulting in a disagreement between the parties involved about how the restoration project is to be performed.

Before beginning non-emergency work, known or anticipated limitations and complexities, and their consequences, should be understood, discussed and approved in writing by the restorer and the owner or owner's agent. The following is a discussion of each of these challenges.

LIMITATIONS

Limitations are restrictions placed upon the restorer by another party that results in a limit on the scope of work, the work plan or the outcomes that are expected, and can include but are not limited to one or more of the following:

- the source of the water intrusion has not been corrected;
- funds are limited;
- the appropriate use of containment is not allowed on contaminated water losses;

- the restorer is told to extract Category 3 water but not remove and discard contaminated porous material such as gypsum board or insulation; and
- the restorer is told to return contaminated contents without returning them to a sanitary condition.

Only the owner or owner's agent, not the restorer or others, can impose limitations on the performance of a project. If an attempt to impose a limitation is initiated by any other materially interested party, the owner or owner's agent should be advised and provide approval before the limitation takes effect. Limitations that allow for services to be rendered in compliance with this standard should be clearly defined in writing. Limitations placed on any project that are inconsistent with this standard can result in a conflict.

COMPLEXITIES

Complexities are conditions causing a project to become more difficult or detailed, but do not prevent work from being performed adequately, and can include but are not limited to one or more of the following:

- inconvenient or limited space or path for entry and exit serving the work area or building;
- the restoration occurs after business hours or within a specified time period;
- work needs to proceed during adverse weather;
- the restoration includes a permit required confined space;
- the business will be in operation or the space requiring work will be occupied during restoration;
- access to the restoration area is desired by occupants;
- a lack of available storage space for equipment, supplies, and debris; and
- a project site location is complicated due to building-specific uses (e.g., a clean room, intensive care unit or immune-compromised patient ward in a hospital).

COMPLICATIONS

Complications are conditions that arise after the start of work causing or necessitating a change in the scope of activities, and can include but are not limited to one or more of the following:

- mold is found requiring an expanded scope of work (see current edition of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*);
- unexpected changes occur in weather conditions;
- there are unanticipated delays;
- the client needs the restoration work completed sooner than originally planned;

- additional water loss, burglary, fire or other disaster occurs while the restorer has possession of the building or area to be restored; and
- hazardous or regulated materials are discovered after work has begun.

The owner or owner's agent should be notified in writing as soon as practical regarding any complications that develop. The presence of project complications can necessitate a written change order.

CONFLICTS

Limitations, complexities or complications that result in a disagreement between the parties involved about how the restoration project is to be performed are called conflicts. When limitations, complexities or complications develop or are placed on the project by the owner or owner's agent, which prevent compliance with this standard, restorers can choose to negotiate an acceptable agreement, decline the project, stop work, or accept the project with appropriate releases and disclaimers. Conflict resolution should be documented. For further information refer to Chapter 9: *Administrative Procedures, Project Documentation and Risk Management.*

RELATED ISSUES

The presence of limitations, complexities, complications and conflicts on a water damage restoration project can create additional consequences and ramifications. These related issues include the potential for work stoppages, insurance coverage questions, and the need for change orders.

Hazardous or Regulated Materials

The presence of a hazardous or regulated material on a project site can present a limitation, complexity or complication. The presence or potential presence of a hazardous or regulated material on a project site shall be carefully evaluated to determine if the restorer and its employees are qualified to work in that environment. Some hazardous or regulated materials require hazmat training; others require more specific training and licensing or may necessitate engaging a qualified specialized expert. The presence of hazardous or regulated materials on a project site may necessitate engaging a qualified specialized expert.

Insurance

Restorers should be aware that the terms and conditions of their insurance coverage can create project limitations and complications. The extent of applicable insurance coverage, as further prescribed by the insurance exclusions in the policy, can exclude certain work activities from the insurance coverage (e.g., regulated, hazardous materials, mold). If the applicable insurance does not cover the work anticipated at commencement of the project, a limitation can result. If a complication develops or is discovered after commencement of project work, it is possible that resultant changes in the scope of work might not be covered by the insurance policy of the restorer. Providing restoration services without insurance, or providing such services that exceed the scope of existing insurance coverage, can potentially expose the restorer or other materially interested parties to risk. In some jurisdictions, restorers are required to maintain insurance coverage as a condition to performing restoration services. Restorers shall determine whether or not insurance coverage is required for their operations.

Change Orders

Contractual disputes can develop if contract additions or modifications are made during performance of the work, and not adequately documented. In order to protect all parties to a restoration contract, substantive changes in the scope of work, time frame, price or method of payment or other material provision of a contract should be documented in a written change order that details the changes. The change order should be dated and signed by all parties to the contract, and each party should be given a copy of the change order as soon as reasonably practical.

Work Stoppage

In some situations, limitations, complexities, complications or conflicts can necessitate work stoppage. In the event an illegal or unreasonably dangerous limitation, complexity or complication exists, occurs or is discovered on a restoration project, the condition shall be resolved or the project shall be refused or the work shall be stopped.

Restorers shall avoid any situation that results in an activity that is illegal or is likely to result in injury or adverse safety or health consequences for workers. Restorers should avoid any situation that results in an activity that is likely to result in injury or adverse safety or health consequences for occupants.

The reason for a work stoppage and the significant events leading to such a decision should be documented. It is recommended that a work stoppage decision be reviewed by a qualified attorney.

Chapter 12

Specialized Experts

INTRODUCTION

Restorers, as a company, should be collectively qualified by education, training and experience to appropriately execute a key set of "core skills" on water damage restoration projects. Restorers should perform only those services they are qualified to perform. If there are situations that arise where there is a need to perform services beyond the expertise of the restorer, specialized experts, whether from within or outside the company, should be used. When the service of a specialized expert is needed, restorers should hire, or recommend in a timely manner that the client hire, the appropriate specialized expert.

A list of specialized experts that may be considered by a restorer performing water damage restoration, and the issues that can lead to considering their involvement, are noted below. Although this list is provided to assist restorers, it is not intended to suggest or require that a specialized expert is necessary in every situation.

While specialized experts are occasionally used on routine residential or commercial water restoration projects, they are more likely to be used in situations involving: complex moisture intrusions involving sewage, catastrophic flooding, mud accumulation, asbestos, lead-based paint, visible mold growth, building safety, and the need for specialty trades. Specialized experts include, but are not limited to:

- engineering (e.g., building science, electrical, HVAC mechanical systems, soils or landscape, construction, materials, structural);
- specialty trades (e.g., plumbing, electrical, roofing, masonry, carpentry, waterproofing, landscape grading, glazing, floor installation);
- hazardous materials abatement or remediation (e.g., asbestos, lead, fuel oil);
- safety and health (e.g., Certified Safety Professional (CSP), Certified Industrial Hygienist (CIH, CAIH), indoor environmental professional (IEP), safety engineer);
- contents (e.g., antiquities, art conservation, electronics, documents, moving and storage); or
- other experts (e.g., drying consultants, mold remediators, leak detection services, thermographers).

Projects which can require additional information beyond the restorer's ability can include, but are not limited to:

- extensive or complex structural damage;
- long term moisture problems resulting in a musty, moldy or other abnormal odor in the absence of visible microbial growth;

- the need to document the presence of visible microbial growth;
- the need to document the presence of pre-existing conditions;
- the need for thermal imaging and photo documentation;
- plumbing, electrical and roofing problems;
- complex sewage backflows;
- the presence of regulated or hazardous materials (e.g., asbestos, lead, fuel oil);
- complex drying situations;
- issues involving worker and occupant safety and health;, or
- the need for project oversight (e.g., administration, supervision, management and auditing of project closure).

Other reasons an unbiased, independent specialized expert may be engaged include, but are not limited to:

- when requested by any authorized party;
- drying verification;
- building code issues;
- manufacturer warranty issues;
- cause and origin of construction and/or manufacturer defects; or
- evaluations including work plan, drying plan, and safety plan;

If a pre-restoration or pre-remediation assessment are needed, then an independent specialized expert that meets the description of indoor environmental professional (IEP) should be used. Microbial post-restoration or post-remediation verifications, if needed, should be conducted by an indoor environmental professional.

When the contamination in Category 3 water includes micro-organisms, such as with sewage, floods, mud or mold, then restorers should consider the use of the specific specialized expert defined and described in this document as an indoor environmental professional (IEP).

INDOOR ENVIRONMENTAL PROFESSIONAL (IEP)

The term indoor environmental professional (IEP), was originally introduced in the IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*, for the purpose of identifying an individual with the education, training and experience to determine mold Conditions 1, 2 and 3, assess shifts in the fungal ecology of buildings, systems and contents, and to verify their return to a Condition 1 status. As used in this document, the same general descriptions and qualifications have been expanded to include the skills needed to assess other microorganisms, specifically those organisms associated with sewage backflow, mud slides and flooding.

Indoor environmental professional skills include performing an assessment of contaminated property, systems and contents, creating a sampling strategy, sampling the indoor environment, interpreting laboratory data, and, if necessary confirming Category 1, 2 or 3 water for the purpose of establishing a scope of work and verifying the return of the environment to an acceptable or otherwise non-contaminated status. If mold is present or suspected, then refer to the current edition of IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*.

Assessments by an IEP can include, but are not limited to:

- pre-restoration and pre-remediation assessment of Category 3 water, when:
  - occupants are high risk individuals; (refer to Chapter 3, *Health Effects from Indoor Exposure to Microbial Contamination in Water Damaged Buildings*)
  - a public health issue exists (e.g., elderly care or child care facility, public buildings);
  - there is a need to determine the identity of a suspected contaminant;
  - contaminants are believed to have been aerosolized; or
  - there is a need to determine, rather than assume, that the water actually contains microbial contamination.
- post-remediation verification after microbial cleanup; and
- lead, asbestos, or other regulated indoor environmental issues are present.

WORKING WITH A SPECIALIZED EXPERT

From the perspective of the restorer, the primary functions of the specialized expert are to determine issues and make assessments beyond the knowledge base and core skill set of the restoration company, to provide an independent second opinion about the restorer's plan of action, or for verification. . Regardless, restorers shall follow applicable federal, state, provincial and local law and regulations.

The relationship of a specialized expert to the various parties can become quite complex depending on the reason they were hired and why the specialized expert accepted the assignment. While it is preferred that specialized experts be independent and unbiased resources, there can be contractual, adversarial and unforeseen conflicts of interest that can limit or even prevent that from happening. However, an independent, unbiased opinion is essential when a specialized expert is hired to provide a second opinion. Other relationship issues can include:

- **Confidentiality:** A company owes a duty to its client, which can include confidentiality. When a specialized expert is retained by someone other than the restorer, there might be a limit to the information that the specialized expert can provide to the restorer. Ideally, a specialized expert will be authorized by the client to share information with all parties. The EPA's *Mold Remediation in Schools and Commercial Buildings*, for example, encourages communication with occupants to help alleviate concerns and suspicions. However, in cases involving litigation, it can be difficult to share or obtain information.

- **Reliance:** In some cases restorers rely on a specialized expert to determine the scope of work and other essential tasks. However, relying on the training, experience, reputation or credentials of a specialized expert might not absolve the restorer of legal risk or other responsibilities.
- **Overlap:** There can be circumstances when the normal activities of a restorer overlap or conflict with those of a specialized expert. In those circumstances, the restorer can reach the point where a decision should be made about whether to continue the inspection and not perform the restoration, or to transfer responsibility for further inspection and assessment to a specialized expert.

Using the services of a specialized expert increases the cost of a restoration project. However, since the safety and health of occupants and workers is a paramount principle of restoration, and since contaminated water and associated health impacts remain uncertain, restorers should engage the services of a specialized expert when necessary, including an IEP when appropriate, to protect the safety and health of occupants and workers, or when necessary to effectively complete a restoration project. Federal, provincial, state, and local laws requiring the use of a specialized expert shall be followed.

Additional factors that influence the decision of whether and when to involve specialized experts are addressed in Chapter 10, *Inspections, Preliminary Determination and Pre-Restoration Evaluations*.

Chapter 13

Structural Restoration

INTRODUCTION

The purpose of this Chapter is to provide procedural guidance and assist restorers in applying principles of water damage restoration. The five principles are: provide for the safety and health of workers and occupants, document and inspect the project, mitigate further damage, clean and dry affected areas, complete the restoration and repairs. This chapter is divided into four sections:

1. Initial Restoration Procedures;
2. Remediation Procedures for Category 2 or 3;
3. Biocide Application; and
4. Drying and Completion Procedures for Category 1

If the preliminary determination is that the water is Category 1, then the restorer can proceed without contamination controls (e.g., erecting containment barriers, initial cleaning, establishing pressure differentials) and worker protection. With regard to Category 2 or 3 water intrusions, remediation should occur prior to drying.

INITIAL RESTORATION PROCEDURES

Rapid Response

Mitigation procedures should begin as soon as safely possible following the initial moisture intrusion. If building materials and structural assemblies are exposed to water and water vapor for extended periods, moisture penetrates into them more deeply. Materials that absorb water slowly tend to release it slowly. The more water they absorb, the more time, effort and expense is required to dry them. With extended exposure to moisture, some materials undergo permanent damage that could have been partially or completely prevented with a more rapid response. In addition, in most environments the extended presence of water or excessive humidity can lead to microbial (e.g., bacteria and mold) amplification that can cause general deterioration of environmental conditions over time, potentially leading to significant health and safety hazards for workers and occupants.

Administrative Procedures

Administrative procedures involve those steps that restorers take to initiate and maintain communication with materially interested parties involved in the drying project. It specifically includes scheduling and documentation systems designed to keep materially interested parties informed. An important component of the coordination process is reaching agreement on what drying goals are and what constitutes project completion. Certain aspects of job coordination should take place before work begins, such as documenting informed consent for chemical application and signing a work authorization and contract. Restorers shall use a work authorization and contract that meets legal requirements in the jobsite jurisdiction. See Chapter 9, *Administrative Procedures, Risk Management and Project Documentation*.

Inspection

The restorer responding to a water intrusion should have training, knowledge, experience and a set of core skills relevant to water damage restoration (i.e., skills required to meet the standard of care for a restorer as referenced elsewhere in this document). The restorer or another qualified individual should gather information, conduct an inspection, make a preliminary determination, communicate to materially interested parties, provide initial restoration procedures, and know when to involve others who can assist in decision making and the performance of tasks. When appropriate, the response can include implementing emergency response actions. Initial damage mitigation priorities are determined by the requirements and circumstances of each project. Factors to consider include, but are not limited to the items discussed in Chapter 10, *Inspections, Preliminary Determinations and Pre-Restoration Evaluations*.

Health and Safety Considerations

Potential safety and health hazards shall be identified and, to the extent possible, eliminated or managed before implementing restoration procedures. Before entering a structure, the building's structural integrity, and the potential for electrical shock hazards and gas leaks, shall be evaluated. Such evaluation or assessment may require a specialized expert, such as a structural engineer. Customers should be warned of imminent hazards that are discovered. When hazards or potential hazards are discovered, appropriate steps, such as posting warning signs, shall be taken to inform workers and occupants. For further information, see Chapter 8, Safety and Health.

Examining water source

Before restoration begins, the source or sources of moisture intrusion should be located and eliminated, repaired or contained to the extent practical. In some cases it may be appropriate to mitigate the spread of damage by starting procedures, such as extraction, to prevent further water migration, even before the source is found and contained or repaired. The exact steps necessary to stabilize a given project and the order of priority in which they might be implemented vary by project.

Determining the Category of water

The categories of water, as defined in Section 10.4.1, refer to the range of potential contamination in water, considering both its originating source and its quality after it contacts materials present on the job site. Time and temperature may accelerate or retard the amplification of contaminants, thereby affecting its category. Restorers should consider potential contamination, defined as the presence of undesired substances; the identity, location and quantity of which are not reflective of a normal indoor environment; and may produce adverse health effects, cause damage to structure and contents and/or adversely affect the operation or function of building systems.

Category 1 - Category 1 water originates from a sanitary water source and does not pose substantial risk from dermal, ingestion, or inhalation exposure. Examples of Category 1 water sources can include, but are not limited to: broken water supply lines; tub or sink overflows with no contaminants; appliance malfunctions involving water-supply lines; melting ice or snow; falling rainwater; broken toilet tanks, and toilet bowls that do not contain contaminants or additives.

Category 1 water can deteriorate to Category 2 or 3. Category 1 water that flows into an uncontaminated building does not constitute an immediate change in the category. However, Category 1 water that flows into a contaminated building can constitute an immediate change in the category. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water. Odors can indicate that Category 1 water has deteriorated.

Category 2 - Category 2 water contains significant contamination and has the potential to cause discomfort or sickness if contacted or consumed by humans. Category 2 water can contain potentially unsafe levels of microorganisms or nutrients for microorganisms, as well as other organic or inorganic matter (chemical or biological). Examples of category 2 water can include, but are not limited to: discharge from dishwashers or washing machines; overflows from washing machines; overflows from toilet bowls on the room side of the trap with some urine but no feces; seepage due to hydrostatic pressure; broken aquariums and punctured water beds.

Category 2 water can deteriorate to Category 3. Once microbial organisms become wet from the water intrusion, depending upon the length of time that they remain wet and the temperature, they can begin to grow in numbers and can change the category of the water.

Category 3 - Category 3 water is grossly contaminated and can contain pathogenic, toxigenic or other harmful agents. Examples of Category 3 water can include, but are not limited to: sewage; toilet backflows that originate from beyond the toilet trap regardless of visible content or color; all forms of flooding from seawater; rising water from rivers or streams; and other contaminated water entering or affecting the indoor environment, such as wind-driven rain from hurricanes, tropical storms, or other weather-related events if they carry contaminants (e.g., silt, organic matter, pesticides, or toxic organic substances)

Regulated, Hazardous Materials and Mold - If a regulated or hazardous material is part of a water damage restoration project, then a specialized expert may be necessary to assist in damage assessment. Restorers shall comply with applicable federal, state, provincial and local laws and regulations. Regulated materials posing potential or recognized health risks can include, but are not limited to: arsenic, mercury, lead, asbestos, polychlorinated biphenyls (PCBs), pesticides, fuels, solvents, caustic chemicals and radiological residues. For situations involving visible or suspected mold, refer to the current version of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*. The presence of any of these substances does not constitute a change in category; but restorers shall abate regulated materials, or should remediate mold prior to drying.

Determining the Class of Water Intrusion

Restorers should estimate the amount of humidity control needed to begin the drying process. A component of the humidity control requirement is the evaporation load (i.e., Class of water).

The term "Class of water" as defined in Section 10.4.3, is a classification of the estimated evaporation load and is only used when calculating the initial humidity control (e.g., dehumidification, ventilation). It is based on the approximate amount of wet surface area and the permeance and porosity of the affected materials. Initial information to determine Class should be gathered during the inspection process. The Classes are divided into four separate descriptions, Class 1, 2, 3, and 4. The determination of class may be dependent upon the restorability of wet materials and access to wet substrates. Depending upon the project, this determination may occur at a different point of the initial restoration procedures.

Class 1 - (least amount of water absorption and evaporation load): Water intrusion where semi-porous materials (e.g., unfinished wood, concrete, brick, OSB) have absorbed minimal moisture; ~5% or less of the combined floor, wall and ceiling surface area in the space is wet, porous material (e.g., carpet, gypsum board, fiber-fill insulation, CMU, textiles)

Class 2 - (significant amount of water absorption and evaporation load): Water intrusion where wet, porous materials involving more than ~5% to ~40% of the combined floor, wall and ceiling surface area in the space.

Class 3 - (greatest amount of water absorption and evaporation load): Water intrusion where wet, porous materials involving ~40% or more of the combined floor, wall and ceiling surface area in the space.

Class 4 - (deeply held or bound water): a water intrusion that involves a significant amount of water and absorption into porous and semi-porous materials or assemblies (e.g., gym floors, structural cavities) that have a low rate of evaporation due to deeply held or bound water. Drying may require special methods, longer drying times, or substantial water vapor pressure differentials.

Evaluating for Restorability

Information obtained from the preliminary determination and during the inspection should be used to evaluate the restorability of materials on the project. Based on this evaluation, a work plan can be developed to address the affected materials and protect the unaffected materials. For more information on the evaluation of specific materials and assemblies, refer to Chapter 17, *Materials and Assemblies*.

Job Coordination

It is recommended that certain aspects of job coordination take place at or near the start of the water restoration project. Coordination steps may include communicating with the property owner or authorized agent about anticipated procedures to be performed. Restorers should execute a valid contract before beginning mitigation procedures and obtain informed consent for antimicrobial biocide application, if used. Due to the time-critical nature of many emergency services, some aspects of proper job coordination are often delayed until mitigation services are performed and the drying system is operational.

The restorer should develop a scope of work and a drying plan to accomplish the scope. The process for determining the scope of work involves a number of parties, who may include, but are not limited to: the restorer, property owners, insurance representatives, specialized experts and other materially interested parties. The areas addressed by the drying plan can include, but are not limited to:

- floor covering materials (carpet, hardwood, resilient, ceramic, etc.), cushion or underlay (pad);
- structural components (ceilings, walls, insulation, framing, vapor retarders or barriers, subfloor and underlay materials);
- affected contents and furnishings (fabrics, furniture, appliances, electronics, miscellaneous decorative items, furnishings and collectables, etc.);
- basements, crawlspaces, attics, unfinished storage areas, chases and structural voids;
- Heating, Ventilation, and Air Conditioning (HVAC) ductwork and mechanical components; and
- electrical fixtures, outlets and switches, lights, ceiling fans.

Contents

Steps should be taken as quickly as practical to minimize damage to contents. This includes, but is not limited to protecting contents from moisture absorption, which can result in stain release, discoloration of finish, splitting of wood components in direct contact with wet surfaces (legs, bases), staining, rusting, ringing or other forms of moisture damage. If contents restrict access to walls, ceiling or other areas, the restorer should manipulate them (e.g., move, relocate, discard). For further information, refer to Chapter 15, *Contents Evaluation and Restoration*.

Note: For Category 1 drying procedures, proceed to *Drying and Completion of the Restoration Process (Category 1 and Post Remediation Category 2 and 3)*

REMEDIATION PROCEDURES FOR CATEGORY 2 OR 3

This section covers procedures for remediation of areas that contain or are believed to contain one or more types of contaminants. Contaminants are defined as the presence of undesired substances the identity, location and quantity of which are not reflective of a normal indoor environment and can produce adverse health effects; and can cause damage to structure or contents; and can adversely affect the operation or function of building systems. Contaminated environments can result from:

- Category 2 or 3 water;
- Condition 2 or 3 mold contamination (use procedures outlined in IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*);

- Trauma or crime scene; or
- Hazardous or Regulated Materials (e.g., lead, asbestos, PCBs, chemical spills, drug labs, fuel oil spills) (refer to Chapter 8, *Safety and Health)*.

An environment can be contaminated as a result of pre-existing conditions. The remediation procedures should not vary regardless of whether contaminants are the result of water intrusion or pre-existing conditions. Restorers shall inspect the structure for the presence and location of contaminants, as part of their site safety survey. Restorers shall develop a safety plan outlining how workers will be protected against hazards. Restorers should take appropriate steps to disclose known or suspected contaminants to other materially interested parties, and recommend appropriate precautions.

Restorer, Occupant Protection

Before entering structures that are known or suspected to be contaminated, either for inspections or restoration activities, restorers shall be equipped with appropriate personal protective equipment (PPE) for the situation encountered; see Chapter 8, *Safety and Health*. Restorers can make recommendations regarding personal protection to persons entering structures, as appropriate. Restorers should refer occupants with questions regarding health issues to qualified medical professionals for advice.

Engineering Controls: Containment and Managed Airflow

Contaminants should not be allowed to spread into areas known or believed to be uncontaminated. Information provided in this section generally assumes the contamination level is severe (i.e., Category 3 water). The procedures in this section may be scaled back, as appropriate, for less severely contaminated environments. Contaminants can be spread in many ways:

- Solid and liquid contaminants can be: tracked on feet, spread on wheels or bases of equipment, carried on contents, bulk materials, or debris during manipulation or removal; and
- Airborne contaminants (e.g., volatile organic compounds, aerosolized liquid, particulates) can be spread by natural circulation, an installed mechanical system, or by using air moving equipment (e.g., air movers, air filtration devices (AFDs) used as air scrubbers). When drawing moist air out of potentially contaminated cavities using negative pressure, an in-line HEPA filter should be used to remove contamination before exhausting the air into the room.

In Category 2 and 3 environments, restorers should implement procedures to minimize the spread of contaminants. This can be accomplished by isolating contaminated areas, erecting containment, and employing appropriate work practices.

The most effective way to ensure that gaseous and aerosolized contaminants do not spread is to isolate work areas by establishing critical barriers or by erecting containment (plastic sheeting) and maintaining adequate negative air pressure within contained work areas while maintaining a minimum of 4 air changes per hour (ACH). The primary purpose of this level of ventilation is to prevent buildup of excessive aerosolized contaminants by continuously diluting them with uncontaminated makeup air. Additionally, negative pressure of .02" w.g. (5 pascals) is normally considered adequate to prevent the escape of contaminants. The amount of negative pressure is a function of restriction on incoming air in relation to the volume of air exhausted, so it is usually necessary to erect isolation or containment barriers to maintain appropriate negative pressure.

For details on the setup and maintenance of containment and airflow management, restorers should consult the current edition of the IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*. The principles of containment found therein, although specifically addressing mold contamination, are generally applicable to environments in which aerosolizing of other types of contaminants is likely.

AFDs used in contaminated areas should be sealed at the air intake side upon turning off to avoid releasing contaminants. Filters should be replaced as necessary following manufacturer's guidelines to maintain performance efficiency. Restorers should ensure that contaminated equipment is cleaned and decontaminated, or contained prior to moving through unaffected areas, transported, or used on subsequent jobs. Refer to the latest edition of IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*, for further guidance on using AFDs in mold contaminated areas.

Bulk Material Removal and Water Extraction

Bulk contamination (e.g., solid waste, silt, debris) should be removed to expose structural surfaces or assemblies for further inspection and evaluation, prior to demolition or detailed cleaning. When extracting contaminated water or vacuuming contaminated dry material, restorers should take appropriate steps to prevent contaminants from becoming aerosolized in work areas or other parts of a building by using HEPA vacuum systems or directing a vacuum's exhaust to unoccupied areas of the building's exterior.

Tools and equipment should be cleaned and decontaminated on the job site before being loaded for transport away from the site. Wastewater shall be handled, transported and disposed of in accordance with all local, state, provincial or federal laws and regulations.

Pre-remediation Evaluation and Assessment

Following the bulk removal of contaminants and water extraction, restorers should evaluate remaining materials and assemblies as specified in Chapter 10, *Inspections, Preliminary Determinations, and Pre-restoration Evaluation*s. Further assessment may be necessary and should be performed by an indoor environmental professional (IEP) or other specialized expert as dictated by the situation.

Humidity Control in Contaminated Structures

The priority for restorers is to complete remediation activities before restorative drying. However, the restorer should control the humidity in contaminated buildings to minimize moisture migration, potential secondary damage, and microbial amplification. This may be implemented before, during, or after decontamination. Restorers should limit the velocity of airflow across surfaces to limit aerosolization of contaminants. Restorers should also maintain negative pressure in relation to uncontaminated areas. Restorers should complete the drying process after the remediation has been completed.

Approaches to achieving the increased humidity control while minimizing turbulent airflows at surfaces include, but are not limited to:

- Increasing the size of the dehumidification capacity and distributing the process air in multiple outlets (e.g., ducts) or diffusers;
- Using negative air machine(s) (NAM), using appropriate CFM to maintain needed pressure differential; or
- Set up a buffer zone outside the primary contained area that serves as the primary make-up air source. Air in this space is drawn into the contained area using AFDs. Properly installed, this system conserves dehumidified air while still maintaining negative pressure in the contaminated area.

Approaches to reducing the level of potential contaminants that can become aerosolized include, but are not limited to:

- removing potentially contaminated materials as quickly as possible;
- cleaning exposed salvable surfaces;
- using source containment (e.g., adhesive sheeting, poly sheeting, building house-wrap);
- using AFDs to constantly filter contaminants from the air;
- drying the material from behind using structural cavity drying system (SCDS); and
- using SCDS on negative pressure and exhausting to the outside or into an AFD.

Demolition and Controlled Removal of Unsalvable Components or Assemblies

During demolition, contaminants can be easily dislodged or aerosolized. Restorers should minimize dust generation and aerosolization by using appropriate engineering controls. For example, contaminated carpet can be covered with polyethylene sheeting before removal. Engineering controls may include:

- using source-control systems, such as HEPA vacuuming surfaces, or covering with polyethylene plastic to isolate contaminants before removal;
- controlling humidity as described above;
- using controlled demolition techniques (e.g., electric saw with vacuum attachment);
- bagging or wrapping wet materials immediately in heavy-gauge polyethylene and removing them from the building for proper disposal; and
- cutting, rather than tearing or breaking materials into pieces.

The cutting depth of saw blades should be set so that they do not penetrate past wallboard materials. This can avoid possible damage of plumbing, electrical or other components within the cavity. Wet or contaminated insulation should be removed carefully and bagged immediately, preferably in 6-mil disposable polyethylene bags. A razor knife or utility knife is recommended for cutting rather than tearing or breaking it into pieces.

Contaminated materials should be double bagged if they are going to pass through uncontaminated areas of the building. Sharp items capable of puncturing polyethylene material should be packaged before being bagged or wrapped in manner that prevents them from penetrating packaging material. Contaminated materials, such as building framing, casements, cabinets, tubs, showers, doors, and appliances may not require bagging or wrapping, if removal can be accomplished by direct access to an outside secure disposal location, and handling such materials does not pose a cross-contamination source during removal.

Pockets of Saturation

Restorers should open assemblies (e.g., walls, stairs, flooring, wall base areas, voids, built-ins) to access pockets of saturation and remove unsalvable, contaminated materials and components. Exposed materials that remain in place should be cleaned and decontaminated, as appropriate.

HVAC System Components

In projects where Category 2 or 3 water has directly entered HVAC systems, especially where internal insulation is present, it probably will not be possible or practical to disassemble, clean and completely decontaminate HVAC ductwork, systems, and possibly even mechanical components. In these situations, the HVAC system should be contained and disassembled, and affected HVAC system components should be removed. Restorers should plan for component cleaning, using a specialized HVAC contractor as appropriate, followed by system replacement, after structural restoration and remediation has been completed. Restorers should consult specialized experts when HVAC system removal, restoration or replacement is complex or outside their area of expertise. Refer to Chapter 14, *Heating, Ventilation, Air Conditioning Restoration.*

Cleaning and Decontaminating Salvable Components

Decontamination should be accomplished to the extent possible by cleaning. Restorers should employ cleaning methods that minimize aerosolizing contaminants while maximizing complete removal. However, pressure washing to flush contaminants from salvable components may be appropriate. Wastewater from cleaning processes should be collected and properly disposed. Refer to Chapter 17, *Materials and Assemblies*. It is recommended that when decontamination cannot be practically completed by cleaning alone, that appropriate antimicrobial biocide or mechanical means be employed.

BIOCIDE APPLICATION

Antimicrobial Biocide Risk Management

Restorers who use antimicrobial biocides shall be trained in the safe and effective use of biocides. Safety data sheets (SDS) for chemicals used during a water restoration project shall be maintained on the job site and made available to materially interested parties upon request. Restorers should obtain a written informed consent from the customer before antimicrobial biocides are applied, and occupants should be evacuated prior to application. Restorers shall follow label directions and comply with Federal, State, Provincial and local regulations; refer to Chapter 7, *Antimicrobial Biocide Technology* for detailed information about antimicrobial biocide use.

Customer "Right to Know" when using Antimicrobial Biocide

Restorers should brief customers before antimicrobial biocides are applied. This can include providing customers with the product information label and obtaining informed consent of product use in writing. If a customer requests the product label or safety data the restorer shall provide it. Written documentation of the antimicrobial biocide type, application method, time and quantity, location, and other antimicrobial biocide application details should be recorded and maintained for each antimicrobial biocide application. Refer to Chapter 7, *Antimicrobial Biocide Technology*.

Biocide Use, Safety and Liability Considerations

Antimicrobial biocides can harm humans, pets and wildlife if used improperly. When using antimicrobial biocides in water damage restoration activities, for efficacy, safety and legal liability reasons, follow label directions carefully and explicitly. In some countries, such as the United States, it is a violation of law to use these products in a manner inconsistent with the label. In order to minimize potential liability, restorers shall:

- Comply with applicable training, safety, use and licensing requirements in their respective jurisdictions;
- Train and supervise employees and agents handling biocides;
- Ensure that proper PPE is available to restorers who are engaged in antimicrobial biocide use and application;
- Apply products that have been tested and registered by appropriate governmental agencies;
- Not use such products in any heating, ventilation, air-conditioning, or refrigeration systems unless:
    - the product is specifically approved by the appropriate federal/state regulatory authority;
    - trained heating, ventilation, air-conditioning, or refrigeration systems technicians apply it and remove its residual;
    - the heating, ventilation, air-conditioning, or refrigeration systems system is not operating; and

- occupants and animals have been evacuated;

- Apply products strictly in accordance with label directions; and
- Dispose of remaining antimicrobial biocides according to label directions.

In addition, restorers should:

- Discuss potential risks and benefits with the customer, make available product information including the label and the SDS, and obtain a written informed consent with the customer's signature before applying any antimicrobial biocide. Inquire about any pre-existing health conditions that might require special precautions. Advise customers to remove occupants and animals from the product application site, particularly children and those with compromised health;
- When antimicrobial biocides are used, document all relevant biocide application details;
- Refrain from making statements or representations to the customer beyond those stated on the product label or in the efficacy claims made by the product and approved by the applicable government agency;
- Determine whether or not the local government agencies where the antimicrobial biocide is to be applied has adopted laws or regulations further restricting or regulating the use of the specific antimicrobial biocide in question, and if so, follow those specific use restrictions and regulations;
- Ask questions when in doubt. Consult the appropriate federal, state, provincial, or local governmental agency. In the United States, the Antimicrobial Division within the Office of Pesticide Programs of the USEPA, the respective state agricultural department, or other state agency with pesticide jurisdiction, should be consulted when there is a question about a specific antimicrobial biocide product, or its use and regulation; and
- Clean treated surfaces of antimicrobial biocide residues as part of the remediation process.

Post Restoration/Remediation Verification

Restorers should consider engaging specialized experts who qualify as indoor environmental professionals (IEPs) to assess indoor environments and verify restoration or remediation effectiveness in areas or structures that have been affected by contamination, particularly in Category 3 water, when occupants are high risk individuals, or if a public health issue exists. An independent IEP should conduct required post-restoration or post-remediation verifications; see Chapter 12, *Specialized Experts*.

DRYING AND COMPLETION OF THE RESTORATION PROCESS (CATEGORY 1 AND POST REMEDIATION CATEGORY 2 AND 3)

Controlling Spread of Water (excess water removal)

Excess water should be absorbed, drained, pumped or vacuum-extracted. Effective extraction is a critical component of efficient structural drying, since water that is not physically removed from the structure will need to be removed by evaporation, a much slower, costlier and more energy-intensive process. The purpose of controlling spreading water is to contain potential damage to the smallest area possible. Excess water removal may be required on multiple levels, in basements, crawlspaces, stairwells, interstitial spaces, HVAC systems, raceways or elevator shafts. Repeatedly extracting materials and components may be required as water seeps out of inaccessible areas, especially in multi-story water restoration projects.

Controlling Initial Humidity

Humidity within the structure should be controlled as soon as practical, just as steps are taken to control the spread of water. The procedures associated with initial extraction and other work activities can significantly increase humidity within a structure, especially if vacuum extraction methods that exhaust into the structure are used. Even more humidity is added when airmovers used in a drying system are turned on initially, since they significantly increase the rate of evaporation from wet surfaces.

While a humidity spike is not uncommon at the outset of a drying project, if it lasts more than a few hours, that may indicate that equipment is not operating or that additional ventilation or dehumidification is required.

Ventilating the structure during the initial stages of processing may be an effective way to reduce the build up of excess humidity. If conditions are not suitable for using exterior air to control initial humidity, dehumidification equipment can be used to control the rapid rise in RH that inevitably occurs when airmovers are turned on. When dehumidification equipment is used in this way, it is recommended that equipment with sufficient performance and capacity be installed as soon as appropriate after arrival. This gives the dehumidification equipment time to begin reducing humidity within the structure, while other initial control processes, such as extraction, are underway.

Demolition, as Necessary, to Accelerate Drying

It is recommended that consideration be given to whether demolishing and removing structural materials is appropriate in setting up the initial drying system. Circumstances under which this may be appropriate can include, but are not limited to:

- Unrestorable structural components, such as drywall, cabinets, carpet and cushion. If materials are not restorable, physically removing them from the environment near the start of the drying process reduces the moisture load, and therefore, the time and equipment required to dry materials that are salvable. It is sometimes appropriate to retain removed materials for examination by interested parties and/or to photo-document their condition before removal;
- The materials themselves may not be damaged, but their presence can slow drying of more critical materials or assemblies behind or below them. Examples may include

but are not limited to: vinyl wallpaper over wet drywall, sheet vinyl flooring over wet subflooring, wet walls behind cabinets, or wet carpet and pad over strip wood flooring; and

- Sagging ceiling drywall is not restorable and represents a significant safety hazard since it could collapse unexpectedly. In addition, ceiling drywall can trap moisture and its presence slows drying of materials above it. It should be demolished and removed as soon as practical. Also, other materials that pose a safety hazard should be removed.

Note: Demolition should be done safely. Removed materials should be disposed of properly. In some jurisdictions, firms performing demolition or other work practices may require licensing. Also, it is important to note potential asbestos containing materials (PACM), or materials containing lead; see Chapter 8, *Safety and Health*.

Final Extraction Process

Multiple final extractions of salvable materials often are required to decrease drying time, especially for porous materials, such as carpet and cushion. Excess water that may have been inaccessible during the initial extraction process often seeps out of systems or assemblies into locations or materials where it can be extracted later.

Extracted waste water shall be disposed of in accordance with applicable laws and regulations. Normally this means disposal into a sanitary sewer system or, especially where HAZMAT may be involved, at a licensed disposal facility.

Determining and Implementing the Appropriate Drying System

Using Outside Air in the Drying Process

When considering the use of outside air in the drying process, restorers should determine if the outside environment is favorable to their drying effort or can be used as a means of quickly reducing the humidity levels in the space temporarily. The decision on the approach to use is generally based on:

- Prevailing weather conditions anticipated over the course of the project,
- Humidity levels inside the affected area that are present or can be maintained and
- Job logistics or other concerns (e.g., ability to maintain security, expected energy loss, owner preferences, potential outdoor pollutants).

The three approaches are:

1. **Open Drying System:** An open approach to drying introduces outdoor air without mechanical dehumidification to reduce indoor humidity or remove evaporated water vapor. This ventilation can be beneficial when outdoor humidity is significantly lower than indoor humidity, especially at the very beginning of the job. It is accomplished by intentional exchange or ventilation of indoor air with the outside air.

When employing an open approach, drier air from outdoors can require manipulation. This manipulation is usually by adding heat through the building's installed system or supplemental sources to maintain appropriate indoor temperatures while drawing in drier outdoor air. Additionally, this approach can require filtering the incoming air to ensure indoor air quality remains acceptable.

The key to using the outdoor air successfully is to exchange the indoor air at a sufficient rate so that evaporating water vapor will not raise the indoor humidity. This rate of exchange can be evaluated by closely monitoring changes in indoor humidity levels (i.e., humidity ratio). If indoor humidity level increases, (1) a greater rate of exchange may help, (2) supplemental dehumidification can be installed, converting to a combination drying system or (3) the outdoor air exchange can be stopped, converting to a closed drying system.

2. **Closed Drying System:** Closed drying systems are commonly used as it provides the greatest amount of control over the drying environment and the best protection from varying outdoor conditions while preserving building security. Restorers should isolate the building or affected area from the outside and install dehumidification equipment. When appropriate, the existing building's HVAC system may provide some dehumidification. Though in many cases, it is not sufficient to achieve optimum conditions for restorative drying. A closed approach is recommended when outdoor humidity levels (i.e., humidity ratio) are not significantly lower than indoor. A closed approach is also employed when building security, changing weather patterns, energy loss, outdoor pollutants, available ventilation or other issues cannot be overcome.

3. **Combination Drying System:** A third approach is to use a combination of the above, especially at the beginning of a project when indoor humidity levels are at their highest. Restorers may consider ventilating the moist air to the outside while bringing in the drier air. This is often done at the time debris removal, extraction and initial cleaning is performed, as security is not typically an issue during the early stage of a project while restorer is actively working onsite. Once closed up, drying equipment can then be used to create the conditions needed.

Restorers may also consider a continuous use of outdoor air while dehumidification systems are deployed, when conditions are appropriate. This can be necessary when access to outdoor air is limited or at risk of interruption.

Air exchange and heat drying equipment may be used in conjunction with dehumidification to provide dry, warm air to a space while maintaining security and filtering the incoming air. This combination should be considered when the use of an air exchange and heat system alone is insufficient to maintain proper drying conditions.

Reducing Humidity through Ventilation

If the humidity ratio of the air outside is lower than the inside, the outside air can be used to reduce the indoor humidity through passive (e.g., opening a window or door) or mechanical (e.g., exhaust fans, ventilation drying systems, heated air exchange systems) ventilation of the workspace. Some processes add energy to promote the rate of evaporation, thereby elevating the indoor humidity ratio. These processes are less dependent upon a lower outdoor humidity ratio.

Depressurizing the workspace can lower humidity ratio by drawing in drier, outdoor air. Depressurization methods can include, but are not limited to:

- using installed exhaust fans (e.g., bath, kitchen, fresh air exchange systems);
- exhausting air to the outside using an air mover or AFD; or
- opening the flu to a fireplace.

Note: Excessive depressurization or the improper placement of air moving equipment (e.g., air movers, AFDs) within a structure can create safety hazards by potentially causing backdrafting of combustion appliances, such as water heaters or furnaces, and thereby create possible carbon monoxide hazards, or contamination problems by pulling contaminants into the structure from crawlspaces or other areas.

Using the Installed HVAC System as a Drying Resource

Restorers can use the installed HVAC system as a resource; provided contaminants will not be spread or the drying effort will not be negatively impacted. The HVAC system can add to or remove energy from the environment being dried. When sensible energy is added (i.e., heating), it can enhance surface evaporation as well as vapor diffusion within the building materials. When energy is removed (i.e., cooling), it can be used to prevent overheating the space or allow occupants to remain in the work area. Further, if conditions warrant the air conditioning system's use, the latent cooling will provide additional moisture removal to augment the drying system. Refer to Chapter 5 *Psychrometry and Drying Technology*.

Installed HVAC systems are engineered primarily for the normal thermal and moisture load of a building, rather than the additional heat and moisture load typically encountered as a result of water damage. Therefore, they are not considered engineered dehumidification systems. Although HVAC systems can help restorers gain control of ambient humidity, they generally do not create the conditions necessary for drying of the building and contents. In addition, they may not be able to control ambient humidity quickly enough to prevent secondary damage.

Controlling Airflow, Humidity, and Temperature to Promote Drying

Restorers should control airflow (i.e., volume, velocity), humidity (i.e., dehumidification, ventilation) and temperature (i.e., vapor pressure differential) to work towards the drying goals. These conditions should be managed through the various stages of drying as follows:

1st Stage - Constant Rate (Surface Evaporation) - liquid water is present at the surface and evaporates into the air over the material at a constant, unhindered rate

2nd Stage - Falling Rate (Capillary Action) – liquid water moves between pores to the surface and is also evaporated from the meniscus of each pore
3rd Stage - Falling Rate (Vapor Diffusion) – water vapor moves by differences in moisture gradients within the material and between the material and surrounding air

- **Controlling Airflow**

Airmovers are used to circulate air throughout the workspace to ensure drier air is continually displacing the evaporating moisture at the surface of wet or damp materials. Several different types of airmovers (e.g., centrifugal, axial) are available, as discussed in Chapter 6, *Equipment, Instruments and Tools*.

During the initial stage (constant rate, refer to Chapter 5, *Psychrometry and Drying Technology*) of drying, the increased rate of evaporation caused by airmovers is directly related to the airspeed across the wet surface. Airmovers used during this stage should be set up so that continuous rapid airflow is provided across wet surfaces. In many structural drying situations, one of the most difficult areas to dry is the lower part of the wall where it meets the floor. The restorer should install airmovers to deliver air along the lower portion of the wall and the edge of the floor, in a circular fashion. Airmovers should be installed at an angle (e.g., 5-45°) that provides a constant, sensible flow of air along the entire length of all affected walls. In addition, airmovers should be added to direct flow across the open areas of the room or space if the size of the room or the presence of contents prevents sensible airflow across the entire floor surface.

Airmovers should also be used to ensure circulation of air throughout the workspace as needed. To accomplish this, the restorer should install at least one airmover in each affected room or space, to include bay windows, hallways, rooms, insets and offsets. The restorer should also consider the addition of airmovers to ensure airflow in and out of structural cavities and voids whenever water has affected the materials in these spaces.

In Class 1 and 2 water intrusions, restorers should install one airmover for every 50 to 70 SF of affected floor space, ensuring at least one airmover in each affected room or space at a minimum. The calculated number of airmovers should be installed to address both affected wall surfaces (e.g., an airmover every 10-16 lineal feet) and the affected field of the floor. Restorers should place an additional airmover for each offset or inset that impedes airflow across wet surfaces (e.g., wall sections that are greater than 18-24 inches). Narrow or odd shaped rooms or spaces may require an additional airmover to adequately address affected wall surfaces, especially during the constant rate drying stage.

In Class 3 water intrusion, restorers should place additional airmovers to ensure sufficient airflow across wet ceiling or upper wall surfaces (e.g., one additional airmover for every 150 square feet of these surfaces).

The quantity of airmovers needed to accomplish these goals will vary between projects, depending upon the build out density, amount and type of contents and the location of wet or damp surfaces.

When Class 4 materials enter the falling rate drying stage, airflow should be reduced (e.g., one airmover that will deliver between 150 to 500 fpm for every 100 to 150 square feet of wet surface), provided remaining wet or damp surfaces continue to receive sensible air flow and circulation is maintained throughout the workspace. In addition, the vapor pressure differential should be increased (e.g., increase temperature of wet materials; reduce humidity of the surrounding air; or a combination of both). Refer to Chapter 5, *Psychrometry and Drying Technology* for more information on falling rate drying adjustments.

Directed airflow is used in the restorative drying process to accomplish two objectives:

1. To circulate air throughout the workspace to ensure drier air continually displaces more humid air. Air should be circulated to all effected interstitial cavities, such as wall and ceiling voids, beneath cabinetry and underneath and within wood flooring systems. Airflow can be directed using various equipment or techniques (e.g., temporary ducting, stairwells, air movers, structural cavity drying systems).
2. To direct air at material surfaces in order to displace the evaporating surface moisture within the boundary layer of air and transfer energy to the surface moisture and materials. The boundary layer is a thin layer of air at the surface of materials that due to surface friction does not move at the full speed of the surrounding airflow. This layer needs to be continuously displaced to enhance evaporation.

Airmoving devices inherently tend to aerosolize soils and particulates present in the environment. As water evaporates from surfaces and materials, such as carpet, more particles often become aerosolized, creating possible health, safety, comfort and cleanliness issues. To minimize or control aerosolization of particles, restorers should consider implementing the following:

To reduce the amount of soil or particulates that can become aerosolized before activating airmoving devices, materials and surfaces (e.g., carpet, hard surface floors, exposed subfloors) restorers should perform a preliminary cleaning.

Where preliminary cleaning is not sufficient or there are high-risk occupants, restorers can install one or more air filtration devices or AFDs, as a negative air machine.

- **Controlling Humidity and Determining Initial Dehumidification Capacity**

When a closed drying system, using mechanical dehumidification equipment is planned, restorers should establish an initial dehumidification capacity. Three recommendations for initial sizing of dehumidification are offered: (1) Simple Calculation for refrigerant or desiccant dehumidifiers, (2) Detailed Method for Low Grain Refrigerant dehumidifiers and (3) Detailed method for desiccant dehumidifiers. The detailed methods may be used to take into account significant building or weather impact factors for determining initial dehumidification capacity needed.

The restorer should document factors considered to determine the initial dehumidification capacity. Considerations may include but are not limited to:

- Types of building materials, assembly and build-out characteristics
- Class and size of the affected area
- Prevailing weather conditions over the course of the drying effort
- Power available on the project
- Type and size of drying equipment available

Two examples of calculation methods to determine initial dehumidification capacity can be found in the Reference Guide (refer to Chapter 13, *Structural Restoration).* Following the implementation of an initial calculation, the restorer should consider other factors that may require adjustments. This information may include but is not limited to:

- an imposed deadline to complete the drying process;
- power is known to be less than adequate to serve the indicated inventory of equipment;
- the building will be occupied during the drying process; potentially causing equipment cut-off, frequent opening of doors, higher moisture load;
- weather fronts expected to be moving through;
- an unusual schedule within which the restorer must work (e.g., retail store that wants to remain open each day); and
- required pressure differential to achieve contaminant control.

For purposes of convenience, the two methods presented will be called "Simple Calculation" and "Detailed Calculation". The restorer may use either method for initial determination of dehumidification. After the initial installation, appropriate adjustments in dehumidification equipment capacity should be made based on subsequent monitoring readings. When Class 4 materials enter the falling rate drying stage, airflow should be reduced, and the vapor pressure differential should be increased (e.g., increase temperature of wet materials; reduce humidity of the surrounding air; or a combination of both). Refer to Chapter 5, *Psychrometry and Drying Technology* for more information on falling rate drying adjustments.

Simple Calculation

Initial dehumidifier capacity is calculated using the formula discussed below:

Step 1: Calculate the cubic feet (ft^3) of air in the area being dried by multiplying its length x width x height.

Step 2: Determine the Class of the water-damaged environment.

Step 3: Using the IICRC initial dehumidification capacity for Simple Calculation table below, select an appropriate factor and calculate the minimum dehumidification capacity for initial setup of a closed drying system

- Refrigerant Pint Method: Divide the factor into the cubic footage of the area being dried. This yields the total number of pints of dehumidification capacity needed initially to begin the drying project. Example: 1500 sf Class 2 water project @ 12,000 ft^3 ÷ 50 pints (LGR) = 240 pints per day at AHAM rating.
- Desiccant CFM Method: Multiply the cubic footage of the affected area by the factor, then divide the result by 60. This yields the total CFM of process air needed initially to begin the drying project. Example: 1500 square foot Class 2 project with 8' ceiling; at 12,000 cubic feet x 2 ACH ÷ 60 = 400 Process CFM.

Initial Dehumidification Factors for Simple Calculation				
Type of Dehumidifier*	Class 1	Class 2	Class 3	Class 4
Conventional Refrigerant	100	40	30	N/A
Low Grain Refrigerant (LGR)	100	50	40	40
Desiccant	1 ACH	2 ACH	3 ACH	3 ACH

*This chart has recommended figures used to determine initial dehumidifier requirements. They may change based on psychrometric readings and types of materials present. Technician discretion is advised.

Note: The recommendations arrived at using this process form a starting point that is based on research and observation in IICRC-approved Applied Structural Drying houses. Psychrometric readings recorded on the Daily Humidity Record dictate decisions about on-going dehumidifier capacity throughout the drying process. Adjustments may be necessary.

Detailed Calculation Factors

Calculating the drying capacity using the detailed calculation requires the understanding of several factors related to the structure and surrounding weather conditions. Below is a description of the factors considered by the detailed calculation methods.

Build-Out Density: impacts the ability to create lower vapor pressure air in all areas of the space as well as the amount of affected wall material that may need to be addressed.

- Very open: as in a factory, warehouse, convention center, large ballroom, sports complex, box store or theater;
- Fairly open: as in a school with large classrooms or open office areas (e.g., open space with cubicles), department store;
- Average: as in most homes, traditional office buildings or hotels; and

- Very dense: as in an executive office suite with many small (e.g., 10’ x 10’) offices and few open common areas, medical offices or dormitory.

Building construction and finishes: impacts the drying of the structure and contents.

a) Standard: Standard material and construction, such as: primarily carpet/pad over concrete or plywood subfloor or commercial glue-down, single-layer drywall, little to no insulation in interior walls and construction is standard; either wood or metal framing, mostly painted walls and builder-grade wood or vinyl baseboards.
b) High-end/Complex: High-end materials and complex construction, such as: extensive carpet over heavy pad, multiple layer or high density wall assemblies, insulation and/or sound-attenuation may be present in interior walls, construction includes some fire-rated walls, complex assemblies (e.g., multiple layer flooring systems, chase walls) and higher-end finishes (e.g., vinyl wall-coverings, architectural-grade paneling and wood trim details).

Class of Water Intrusion: the estimated evaporation load used when calculating the initial humidity control requirements.

HVAC Impact: can impact the project if system is present, operable and can be beneficial to the drying process.

- Beneficial: the system is present, operable and will help maintain conditions favorable to the drying process.
- Non-Beneficial: the system is not present, not operable or will not assist in maintaining conditions favorable to the drying process.

Prevailing weather: impact will vary significantly from one climatic region to another and from one season to the next. Such variations may require that restorers use different equipment and techniques when drying similar wet structures during different times of year, or in different regions.

a) Estimate the expected impact. Examples provided are approximate:
    - Favorable: Anticipated to aid drying (e.g., less than 40 gpp or 43°F DP);
    - Neutral: Anticipated to have minimal impact on drying (e.g., between 40 and 60 gpp, or 43° and 53°F DP); and
    - Unfavorable: Anticipated to hinder drying (e.g., above 60 gpp, or 53°F DP).
b) Estimate the building envelope’s ability to keep the outside conditions from adversely influencing the drying environment (i.e., infiltration):
    - Tight: Drying conditions can be controlled without significant influence by the outdoors;
    - Moderate: Drying conditions will be influenced somewhat by the outdoors; and
    - Loose: Drying conditions will be significantly influenced by the outdoors.

Note: Some of the overall considerations for choosing tight, moderate or loose would be:

- Number of occupants and trades people on site (e.g., opening doors, windows, work processes);
- Damage to the buildings envelope (e.g., windows, roof, outer sheeting);
- General construction (e.g., barriers, insulation, age); and
- Outdoor wind speed (i.e., higher wind speeds increase filtration rates).

Detailed Low Grain Refrigerant Calculation

Initial dehumidifier capacity can be calculated using the formula discussed below:

1) Calculate the cubic feet (ft^3) of air in the area being dried by multiplying its length x width x height. Divide the total cubic footage of the area being dried by 70 to determine the base number of pints per day required.
2) Consider the Build-Out Density and select the appropriate factor.
3) Consider the building construction and finishes present and select the appropriate factor.
4) Determine the Class of the water-damaged environment, and select the appropriate factor.
5) Consider HVAC System impact, and select the appropriate factor.
6) Consider the impact prevailing weather is likely to have on the drying process, and select the appropriate factor.
7) Multiply factors from steps 2 through 6, and enter the final number in the multiplier field. Finally, multiply this number by the base pints per day to determine the adjusted pints per day. This number represents the target initial drying capacity needed for Low Grain Refrigerant dehumidifiers.

Detailed Refrigerant Calculation

					Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	
Building or Area Name	Length	Width	Height	Cubic Feet	Base Pints per Day	Build-out Density	Building Construction	Class of Water	HVAC	Weather Impact	Multiplier	Adjusted Pints per Day

Building Factors			
Base Pints per Day			
	Divide by standard factor		70
Build-out Density		(X)	Multiplier
	Very open		0.6
	Fairly open		0.8
	Average		1.0
	Dense		1.2
Building Construction			
	Standard		1.0
	High-end		1.5
Class of Water Saturation & Evaporation			
	Class 1		1.0
	Class 2		1.5
	Class 3		2.0
	Class 4		2.3
Will HVAC support the drying process?			
	Yes		1.0
	No		1.3

Weather Impact Factor		Prevailing Weather Conditions		
		Favorable	Neutral	Unfavorable
Tightness of Building Envelope	Tight	1.0	1.0	1.2
	Moderate	0.9	1.1	1.4
	Loose	0.8	1.2	1.6

Enter Weather Impact Factor here: ______

Detailed Desiccant Calculation

Initial dehumidifier capacity can be calculated using the formula discussed below:

1) Calculate the cubic feet (ft^3) of air in the area being dried by multiplying its length x width x height. Divide the total cubic footage of the area being dried by 60 to determine the base CFM required.
2) Consider the Build-Out Density and select the appropriate factor.
3) Consider the building construction and finishes present and select the appropriate factor.
4) Determine the Class of the water-damaged environment, and select the appropriate factor.
5) Consider HVAC System impact, and select the appropriate factor.
6) Consider the impact prevailing weather is likely to have on the drying process, and select the appropriate factor.
7) Multiply factors from steps 2 through 6, and enter the final number in the multiplier field. Finally, multiply this number by the base CFM to determine the adjusted CFM. This number represents the target initial drying capacity needed for desiccant dehumidifiers.

Detailed Desiccant Calculation

Building or Area Name	Length	Width	Height	Cubic Feet	Step 1 CFM for 1 ACH	Step 2 Build-out Density	Step 3 Building Construction	Step 4 Class of Water	Step 5 HVAC	Step 6 Weather Impact	Step 7 Multiplier	Adjusted CFM

Building Factors

Build-out Density		(X)	Multiplier
	Very open		0.6
	Fairly open		0.8
	Average		1.0
	Dense		1.2
Building Construction			
	Standard		1.0
	High-end		1.5
Class of Water Saturation & Evaporation			
	Class 1		1.0
	Class 2		1.5
	Class 3		2.0
	Class 4		2.3
Will HVAC support the drying process?			
	Yes		1.0
	No		1.3

Weather Impact Factor		Prevailing Weather Conditions		
		Favorable	Neutral	Unfavorable
Tightness of Building Envelope	Tight	1.0	1.0	1.2
	Moderate	0.9	1.1	1.4
	Loose	0.8	1.2	1.6

Enter Weather Impact Factor here: ______

- **Controlling Temperature to Accelerate Evaporation**

The temperature within a work area, and the temperature of wet materials themselves, also impacts the rate of evaporation significantly. Increasing the temperature of wet materials can be accomplished by using the sensible energy gained by airmovers, dehumidification or heating equipment. The greater the temperature of wet materials, the more energy is available for evaporation to occur.

Water in its vapor phase (gas) has much higher energy than water in its liquid phase. Therefore, significant energy is required for rapid evaporation. To acquire this energy, liquid water absorbs heat from surrounding materials and air when it evaporates. Cooler environments and materials tend to produce slower evaporation, even when high airflow and low humidity levels are present.

Adding Energy to Materials to Promote Drying

Radiant heat lamps, thermal energy transfer, and other systems employing direct heat application can be used to increase the temperature of wet materials or assemblies. Note: It is imperative that restorers applying heat directly to materials be aware of potential fire hazards. Additional direct heat can accelerate drying of materials, especially dense, less-permeable materials. As discussed in this chapter, setting up structural cavity drying systems can significantly increase the interior temperature of wall and other structural assemblies, thereby accelerating the rate of evaporation.

Restorers should consider the impact of high temperatures on building components and contents. Manufacturer's instructions and safety precautions shall be followed to reduce the potential for fire hazards and occupant safety issues. Restorers should be familiar with drying equipment and how ambient temperatures affect their performance. Considerations for using temperature to accelerate evaporation can include:

- Using refrigerant dehumidification equipment that is generally most efficient at drying a structure when the ambient temperature range is approximately 70-90°F (21-32°C).
- Controlling temperature when using desiccant dehumidifiers while considering and understanding the principles of psychrometry and the operational parameters of the particular equipment being used.
- Using heat drying systems with outside air usually being flushed through the structure continuously, using either positive or negative pressure to provide ventilation. If using these systems with high-heat, low-grain dehumidifiers, such flushing usually is not necessary. However, undesirable side effects can result when using either positive or negative pressure.

After the initial installation, appropriate adjustments in heat producing equipment should be made based on subsequent monitoring readings. When Class 4 materials enter the falling rate drying stage, airflow should be reduced, and the vapor pressure differential should be increased (e.g., increase temperature of wet materials; reduce humidity of the surrounding air; or a combination of both). Refer to Chapter 5, *Psychrometry and Drying Technology* for more information on falling rate drying adjustments.

On-going Inspections and Monitoring

Normally, psychrometric conditions and MC measurements should be recorded at least daily. Relevant moisture measurements normally include: temperature and relative humidity outside and in affected and unaffected areas, and at dehumidifier outlets. Also, the moisture content of materials should be taken and recorded. Occasionally, restorers may want to consider a second visit on the first day after the drying equipment is set up and running. This would allow them to evaluate the performance of equipment, and to ensure that it is functioning correctly. Without monitoring and in-process inspections, substantial secondary damage may occur if dehumidifiers malfunction or shut down as a result of blown circuit breakers, or if a balanced drying system does not exist.

It is recommended the restorer use the same meter and at the same location, until drying goals have been met and documented. The frequency of monitoring may need to be increased or decreased based on many factors including but not limited to: the amount of moisture present, potential secondary damage that may result from slow drying, and job site location and accessibility.

On each visit, if monitoring does not confirm satisfactory drying, restorers should adjust drying procedures and equipment placement, or possibly add or change equipment to increase drying capability. In some cases, limited intrusive measures are necessary to further expose structural materials for more efficient drying.

If using circular airflow to dry walls, each airmover typically is moved forward three to four feet daily.

If using dehumidifiers in a closed drying system, the greatest dehumidification capacity is needed at the start of the project, when surface and free water is evaporating rapidly. As this water is removed, the remaining water is bound within the materials and the rate of evaporation usually decreases. With this decreased evaporating moisture load, targeted vapor pressure differential can potentially be maintained using less dehumidification capacity. This is only if the targeted vapor pressure differential can be maintained, considering other variables (e.g., infiltration rate, prevailing weather conditions).

Heaters of various types and air conditioning units, as discussed in Chapter 6, Equipment, Instruments and Tools, are often useful to assist in controlling temperature and humidity in the area being dried. Appropriate conditions often vary with the particular materials being dried and other factors, such as the need to maintain conditions comfortable for continued occupancy. Restorers should consider the impact of high temperatures on building components and contents. Manufacturer's instructions and safety precautions shall be followed to reduce the potential for fire hazards and occupant safety issues.

Verifying Drying Goals

Restorers should use appropriate moisture meters to measure and record the moisture content of specific structural materials and contents. Drying equipment should remain in operation on site until drying goals have been verified and documented. It is recommended that appropriate adjustments be made to the drying system on each monitoring visit, based on visual observations, moisture meter readings and measured psychrometric conditions.

In some circumstances, a materially interested party may request or require that a specialized expert with specific training and experience in water damage restoration inspect a structure to confirm that drying has been successfully completed.

Post Restorative Drying Evaluation

Restorers should evaluate structural materials, assemblies, and contents that have been cleaned and dried to ensure pre-determined goals have met. In some cases, items that have been dried may need additional services including cleaning, repair or additional appearance enhancement. In some circumstances, structural materials, assemblies, and contents cannot be successfully restored and replacement or reconstruction is necessary, despite a restorer's effort to salvage the items.

Reconstruction/Repair

After completing thorough drying and other procedures discussed above, qualified and properly licensed persons should perform authorized and necessary structural repairs, reconstruction or cleaning.

Final Cleaning

Throughout the restoration and reconstruction process, foot traffic and settling of aerosolized particles results in the accumulation of soils on surfaces. Some materials, such as carpeting, accentuate this concern due to wicking of soils to the surface of pile yarns. To remove these accumulated soils, and minor microbial amplification that has occurred, along with odors that have developed, restorers should clean structural surfaces before re-occupancy or after reconstruction, using methods appropriate for particular materials and types of soil.

Contents Move-back

The final step in the restoration process is usually returning contents to their proper location in the structure; refer to Chapter 16, *Large or Catastrophic Restoration Projects.*

Chapter 14

Heating, Ventilating and Air Conditioning (HVAC) Restoration

THE RELATIONSHIP BETWEEN A BUILDING AND ITS HVAC SYSTEM

Heating, Ventilating and Air-Conditioning (HVAC) systems, when directly contacted by water, can cease to operate, or they can function inefficiently or spread excess humidity throughout both affected and unaffected areas of a structure. If contacted directly by Category 2 or 3 water, they can spread contamination to unaffected areas. Even if an HVAC system is not directly contacted by water, when operating, it can spread humidity or contamination from affected to unaffected areas. Further, microbial growth from other causes can be carried to the interior of HVAC system components where it can accumulate and degrade HVAC component operation.

In addition, HVAC systems can have a major impact on controlling the conditions that lead to secondary damage. The design, installation, operation and maintenance of HVAC systems can be important factors in controlling microbial growth and dissemination. This can lead to the spread of contamination by the system and increase the scope of the microbial problem by dispersing contaminants throughout a building.

Types of HVAC systems include residential, commercial and industrial. In a typical system, the fan or blower circulates air from occupied space through the air filter, return grills, return ducting, heating or cooling coils, and through the supply ducting into occupied space. The system's mechanical components can be located in various areas of the occupied space, outdoors, or in other locations. Residential systems vary in configuration and type from one part of North America to another; however, within each region HVAC systems are generally similar in design.

Contaminated HVAC systems should not be used for dehumidification purposes during water damage restoration. The restorer shall comply with any applicable laws or regulations prior to servicing an HVAC system.

In addition to the HVAC system, it is useful to understand other mechanical systems in a building, including: plumbing; heating, ventilating, and air conditioning (HVAC) systems; gas appliances; chimneys; fireplaces; air-exchange systems; vents in kitchens and baths; clothes dryer vents; recessed light fixtures and central vacuums. These systems can create varying pressure differentials (i.e., positive, negative, neutral); which should be considered during restoration projects. For more information on the environment's impact on the HVAC system, refer to Chapter 13. *Structural Restoration*.

Overview of HVAC Operations and Particulate Implications

Up-flow Systems

In a vertically-mounted, up-flow system, air is drawn through the bottom of the system and discharged out the top. Typically, these systems are located within the conditioned portion of the residence, in a basement or within a closet constructed of wood and drywall materials. In addition, the return-air plenum often is a part of this enclosure, with openings covered by a metal grill. Organic construction materials can provide an excellent food source for microbial contamination if moisture from the HVAC is allowed to accumulate on or penetrate into them.

Down-flow Systems

In a down-flow system, the air being conditioned enters the unit from the top and is discharged out the bottom of the air handler. Often, vertical down-flow systems are installed in a closet or garage, with the ductwork installed in a crawlspace under the occupied space. Because of the location of these components, conditions can be favorable for moisture to infiltrate or accumulate within mechanical system components, thereby leading to microbial growth. Generally, these types of systems are difficult to service, because working conditions are confined and access is often limited. In order to access the air ducts it may be necessary to have a licensed HVAC contractor remove the air handler or the air conditioning coil.

Horizontal Systems

Horizontal systems are designed to allow air to flow from left to right or right to left. These systems often are found in attics or underneath houses. They are designed to be used in-line with corresponding return and supply main trunk lines. Major considerations when working on these types of units include: the ambient temperature surrounding the unit, general service access to the unit and associated ductwork, safety difficulties while working in confined attic spaces (such as drywall breakthrough and ceiling cracking), and the possibility of moisture collection progressing to an advanced stage before being detected.

Ductwork

HVAC ductwork systems can consist of several types of materials including: fiberglass duct board, galvanized metal duct with interior fiberglass linings, galvanized metal duct with fiberglass exterior wrap, fabric duct, and insulated flexible duct. Ductwork consisting of a non-porous internal surface (usually galvanized sheet metal) generally responds well to cleaning when visible microbial growth is present. Galvanized sheet metal can withstand the aggressive cleaning techniques necessary for removing Condition 3 contamination (actual mold growth and associated spores: refer to current edition of the IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*) or other types of microbial contamination. However sections of internally lined ductwork, duct board or flexible ductwork with microbial contamination cannot be successfully cleaned; therefore, sections of such ducting with Condition 3 contamination or Category 3 water (e.g., sewage) should be removed and replaced with new materials.

Commercial HVAC Systems and Components

Commercial mechanical systems incorporate more variations and combinations of HVAC system design and components, compared to residential systems. Typical commercial systems may include, but are not limited to, single-zone, multi-zone, single-duct variable-volume, double-duct or dual-duct, and induction systems. Commercial systems are larger and more complex to inspect and service than residential systems. Commercial systems have additional components, including mixing boxes, chillers, and variable air volume (VAV) boxes.

When a building containing widespread Condition 3 contamination or Category 3 water is remediated, special attention should be given to restoring HVAC system that supports the building's indoor environment. Also, HVAC systems should be inspected as described in this section and returned to acceptable status (normal ecology) as part of the overall restoration project. It is recommended that the client's HVAC service contractor identify HVAC deficiencies for immediate correction. Otherwise, microorganisms can grow again, and adversely affect environmental conditions within the building.

In some cases, there can be microbial growth in HVAC systems without an identifiable source of water. This can be caused by the interaction of the building and its HVAC or ventilation system, or other causes. Part of the purpose of an HVAC system is to create psychrometric conditions that prevent the formation of condensation films on surfaces within the building. Condensation films can form when the temperature of a surface is below the dew point of surrounding air. Although condensation is often associated with hot and humid climates and air with high moisture content, the right combination of conditions can result in condensation forming, regardless of geographic region or location.

In addition to the HVAC system, the building and its construction techniques can create the potential for condensation. Building pressurization, selection and placement of vapor barriers, unexpected events such as flooding, infiltration of moist air, poorly or improperly controlled air movement, and even the selection and method of installing building materials can impact condensation. A complete discussion of building science and conditions that can lead to condensation films is beyond the scope of this standard. For further information on building science, refer to Chapter 4, *Building and Material Science*.

Causes of visible or suspected microbial growth should be identified and moisture sources controlled, before restoring or remediating either building components or the HVAC system. An indoor environmental professional (IEP) should perform this assessment. Building design or construction-related moisture accumulation can often be beyond the capacity of properly designed, maintained and operated HVAC system. These issues raise serious questions about the project scope and overall loss responsibility. Water damage restoration or microbial remediation does not include activities that would modify either a building or its mechanical systems from their original design. Property owners should be advised of known conditions that place the future integrity of the building at risk.

EVALUATING HVAC SYSTEMS

Affected HVAC systems should be inspected for cleanliness and returned to acceptable status as part of structural restoration. The National Air Duct Cleaners Association (NADCA) standard, *Assessment, Cleaning and Restoration of HVAC Systems* (ACR current version), includes specifications for acceptable levels of cleanliness for HVAC systems, and appropriate inspection techniques. Often, it is recommended that HVAC system drying and cleaning be performed after other building restoration procedures are complete, to avoid cross-migration of soils or particulate contaminants into mechanical systems. When this is not possible and the environment is contaminated (e.g., settled spores, bacteria, or visible microbial growth), HVAC system components should be isolated from the environment as part of the overall building restoration strategy.

Restored HVAC system components that are potentially exposed to recontamination during on-going building drying and restoration activities should be re-inspected after building demolition procedures and reconstruction activities are complete. This re-inspection should be conducted before removing pressure differential containments or isolation engineering controls, if erected. It may be necessary to provide temporary heating, cooling and other environmental controls within areas undergoing restoration, when they are not being served by their normal mechanical systems. Often, the condition of makeup air drawn through the containment provides satisfactory working conditions. In other cases it is recommended that supplemental heating, cooling or dehumidification systems be arranged to provide adequate environmental control in affected areas. When supplemental systems are utilized inside critical containments, decontamination procedures should be implemented, such as bagging or wrapping equipment used, before removing it from the workspace.

In addition to a cleanliness inspection, a complete engineering assessment of the design and condition of the entire HVAC system may be performed, depending on the conditions that exist in the restoration project. This is especially important if: temperature and/or relative humidity conditions cannot be maintained within affected areas in compliance with the requirements of American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) Standards 62.1 *Ventilation for Acceptable Air Quality* and 62.2 *Ventilation and Acceptable Indoor Air Quality in Low-rise Residential Buildings*; temperatures, RH or airflow varies between different areas of the building, or mechanical components are not in good condition or repair. There are four reasons this is important to the success of a restoration project:

- the original system design may not have been adequate to maintain optimum indoor environmental (or psychrometric) conditions in the building;
- expansions, renovations or changes in the use of the original space may have rendered the HVAC system design inadequate for the current needs of the building and its occupants;
- the system may not have been installed as designed or commissioned, so as to assure that its operation met the design objectives; and
- mechanical deterioration and/or physical damage to system components may have degraded their performance to the point at which they cannot provide the needed level of air flow or capacity.

The description of what constitutes an adequate engineering evaluation of HVAC system, condition and capacity is beyond the scope of this standard. It is recommended that qualified engineering professionals or licensed HVAC contractors be consulted for such an evaluation. The Air Conditioning Contractors of America (ACCA), National Air Filtration Association (NAFA), American Society of Heating and Air-Conditioning Engineers (ASHRAE), North American Insulation Manufacturers Association (NAIMA), and Sheet Metal and Air Conditioning Contractors' National Association (SMACNA), and their published guidance documents, provide construction standards and design guidance for proper sizing, design and layout of HVAC systems. Regardless of compliance with the latest HVAC system guidance, at a minimum an HVAC system shall conform to applicable building codes.

Many airborne spores are typically in the range of one to five micrometers in diameter, but they may appear in clumps or in growth structures two to ten times that size. Airborne microbial fragments, such as hyphae, may be much smaller, measured in sub-micron sizes, and they also may agglomerate forming larger clumps. Conventional HVAC system filters of MERV 6 rating or less are not effective at stopping the distribution of particles in this size range throughout an HVAC system. In systems with filters of MERV ratings of 11 or higher, a substantial amount of bioaerosol is captured. Completely containing or eliminating contamination in HVAC systems requires HEPA filtration, which is 99.97% efficient in removal of particles at 0.3 micron aerodynamic diameter, and more efficient in particles both larger and smaller.

Filtration is important in decreasing the spread of microbial spores from one part of a building to another. Filtration upgrades should be considered in buildings that have experienced Condition 3 contamination (actual mold growth and associated spores) or Category 3 water as part of a strategy to prevent future problems. In many cases, existing filter housings or tracks will accommodate upgraded filtration. In others, modifications should be made to the HVAC system layout to accommodate upgraded filtration. Whenever modifications are made to an HVAC system to accommodate upgraded filtration, airflow restrictions below design levels should not occur.

HVAC System Cleaning and NADCA Assessment, Cleaning and Restoration of HVAC Systems (ACR)

Once the HVAC system's condition has been assessed for cleanliness, and mechanical corrections and/or enhancements have been completed, cleaning should be carried out in accordance with procedures described in NADCA ACR current version, which is incorporated herein by reference, or in similar industry standards

Contamination Considerations

Determining the extent of contamination present in an HVAC system can be challenging. Cleanliness verification methods are described in the NADCA ACR current version. These methods include visual inspections, surface comparison tests and the NADCA vacuum test. The minimum requirement is that the systems must be visibly clean as described in the NADCA ACR current version. Multiple cleanings may be required to achieve satisfactory results.

The complex nature of HVAC system construction provides interior reservoirs for spores, viable organism collection and other contamination. There can be numerous amplification sites in HVAC system interior components that may or may not be of concern. Specialized experts procuring and interpreting samples should be IEPs with specific training in identifying contamination issues within HVAC systems.

All portions of each heating and cooling coil assembly should be cleaned in accordance with NADCA ACR current version section 7. Both upstream and downstream sides of each coil section should be accessed for cleaning. Where limited access is provided between close proximity or zero-tolerance heating coils in an air-handling unit, cleaning may require removal and/or replacement. Coils, that are not accumulated microbial growth or other contamination, can restrict airflow and have reduced latent capacity (i.e., ability to remove moisture). Such coils are at risk for contributing to future microbial growth.

After the coils have been cleaned, an inspection should be performed. However, visual inspections of coil surfaces can be misleading; therefore, it is recommended a static pressure drop test be performed before and after the cleaning process to demonstrate the effectiveness of such efforts. This type of measurement, which can be performed using a magnehelic gauge, or manometer, is a more accurate indicator for the presence of debris that has either been removed or remains within the coil.

The **reconditioning** efforts typically result in a static pressure drop sufficient to allow the HVAC system to operate within 10% of its nominal, or design (if known) volumetric flow and can be verified by an appropriate air test and balance procedure. However, other factors such as air leakage, fan blade condition, compromised duct, and permanently impacted coils (which are not capable of being fully cleaned), can have an effect on the overall static capability and subsequent performance of the HVAC system.

Special attention should be given to inspecting fan blades and blower wheels. Bacterial and fungal growth on these components can lead to rusting or pitting, and premature metallurgic decay. A heavily-fouled blower wheel is only capable of a fraction of the air movement of a wheel with smooth, clean surfaces. Where components are badly pitted, a decision will have to be made between the probable loss in efficiency and the required capital expenditure of replacement.

Accumulated contamination or microbial growth is difficult to clean from coil fin surfaces. Restorers often are tempted to use aggressive cleaning agents (high and low-pH), because of difficulty in removing soil. Overly aggressive cleaners, such as those containing acids or caustics, can damage heat-transfer surfaces. Damage can range from surface pitting, which interferes with flow of condensate from fin surfaces, to accelerated structural deterioration of HVAC system components. Residues from cleaners also can add contamination to air flowing over coil surfaces, if not completely rinsed. Excess water pressure used during cleaning can also damage fin structures. Pressure as low as 100 psi can deform coil fins if solution flow rate and volume is high enough. Refer to NADCA ACR current version for more information.

CONCLUSION

Since HVAC systems circulate the air that workers and occupants breathe when the system is operating both during and after restoration, it is a critical component in the overall water damage restoration work plan. Category 1 water should be drained or vacuumed thoroughly from HVAC ductwork, systems and mechanical components as soon as practical. Once excess water has been removed, the system should be thoroughly dried. In situations where Category 2 or 3 water has directly entered HVAC systems, especially where internal insulation or fiberglass duct board is present, it might not be possible or practical to decontaminate HVAC ductwork, systems, and possibly even mechanical components. Mechanical and other system components should be evaluated, and cleaned, as necessary, following NADCA ACR current version.

Chapter 15

Contents Evaluation and Restoration

INTRODUCTION

For purposes of this document the term "contents" generally is defined as personal property and fixtures that are not included in the building plans of a structure. These could include appliances, clothing, electronics, furniture, food, and many other items.

When a water intrusion occurs, often it is not just the structure that is impacted but the contents as well. An appropriate response is often the difference between successful restoration or repair, or costly replacement. When water intrusion occurs, many items that have become affected by moisture are not damaged initially. Affected contents should be evaluated and, if restorable, appropriate mitigation procedures be taken to preserve them from further damage, including secondary damage.

This process begins with a visual inspection, including documentation, to determine the extent of the damage. Contents should be inventoried and documented before being removed from the building. The restorable water damaged contents are cleaned by various methods and dried to appropriate moisture content. In many cases damaged items require storage until a professional evaluation is made and confirmation of the need for repair or replacement is determined. Disposal of non-restorable contents should be handled by the protocols described below. Finally, certain types of contents require special handling and procedures.

OVERVIEW OF THE CONTENTS RESTORATION PROCESS

Effective restoration of contents from a water intrusion generally includes, but is not limited to, the following tasks:

- determine the Category (1, 2 or 3) of water and separate contents by their likely restorability;
- determine the composition of affected materials. Porosity also can help determine restorability. General categories of contents are defined as follows:
    - Porous: Materials that absorb or adsorb water quickly, (e.g., clothing and other textiles, padded or upholstered items, leather, taxidermy, paper goods and many types of fine art);
    - Semi-porous: Materials that absorb or adsorb water slowly, can support microbial growth, (e.g., unfinished wood, concrete, brick, OSB) and
    - Non-porous: Materials that do not absorb or adsorb moisture easily, (e.g., finished wood, glass, plastic, metal).
- provide options related to the relative cost of cleaning versus the cost of replacement;

- determine whether to clean and store contents on-site or in-plant;
- determine the method of cleaning;
- dry to acceptable moisture content levels;
- determine those contents requiring restoration by specialty restoration professionals, (e.g., fine art, electronics, rare books, priceless keepsakes);
- communicate with materially interested parties to make final determinations on restorability;
- inform all materially parties and obtain written authorization before disposal; and
- properly dispose of non-restorable contents.

INSPECTION AND EVALUATION FOR RESTORABILITY

The restorability of contents is dependent upon several factors, including but not limited to:

- Category of water;
- time of exposure;
- basic material composition;
- cost of restoration;
- value or cost of replacement; and
- types of value (e.g., sentimental, legal, artistic, cultural, historical).

The type of service required for each content item may be categorized in one of three ways:

1. restore: Items that will be dried, and if required, cleaned or resurfaced, and returned to the client in an acceptable condition, if possible.
2. dispose: Items that will not be cleaned because the owner has no interest in salvaging and/or the value does not justify the cost of restoration (see Disposal section).
3. preserve: Items that are irreplaceable but cannot be properly restored to an acceptable condition.

Materially interested parties should participate in decisions about whether to restore or dispose of contents. Recommendations supplied by a specialized expert can be beneficial in making these decisions, especially when high-value items are involved.

Time of Exposure

The longer the time from the initial moisture exposure to completion of the restoration process, the less likely the contents can be restored. Prolonged exposure to moisture can result in swelling, cracking, color migration, material degradation or microbial amplification. Restorers should separate, contain, and document items that have been affected by mold according to standards set forth in the current edition of the IICRC S520, *Standard and Reference Guide for Professional Mold Remediation*.

Removing Contents from Affected Areas

Before moving affected contents to another location, the restorer or a specialized expert should:

- inspect all contents prior to inventory, if practical;
- determine and document the condition of contents, which can include actual or perceived value;
- photo-document high-value or damaged items; and
- consider the possibility of drying contents in the affected area.

Inventory, Packing, Transport and Storage

Restorers should, prior to the pack out of contents, prepare a detailed inventory containing the following information, at a minimum:

- description;
- quantity;
- condition;
- location within the structure; and

  an inventory number for each item, box, or group of items.

Clients should sign a form accepting the inventory as representative of the existence and actual damage or condition of the contents before restorers assume responsibility for contents transport and processing. A photo inventory is recommended by first taking a picture of the initial documentation to capture the name and address of the client. Next take a picture of the front of the building as a visual reference to make it easier for the site manager to recall the jobsite for any future inquiries. Further, a list of photos can include, but is not limited to, occupants, exterior and interior, contents, demolition materials (if any), equipment placement, meter readings, and any other photos that would clearly depict the conditions and outcome of the water intrusion. Some restorers may use video recorders instead of photos to more accurately capture the visual documentation. Regardless of which media is chosen; a copy should stay with the job records and be kept in a secure place in the event future review is necessary.

Contents should be packed, transported and stored using appropriate measures to minimize breakage, damage, loss, or contamination of affected contents. It is recommended that vehicles, equipment, storage vaults or facilities be clean and orderly so that there is less potential for additional problems arising while contents are offsite.

Temporary storage conditions should be environmentally controlled while contents are in the restorer's custody to minimize conditions favorable to any type of contamination. Affected contents should be cleaned and dried, and cleaned contents should be stored in a clean area that is separate from the area where any uncleaned contents are stored. In some cases it may be necessary to add desiccant material to packaged contents to adsorb moisture and prevent moisture-related damage. Cleaned and dried contents should not be returned to the structure until complete restoration of the affected area has been achieved.

Drying or Cleaning First

In each loss, once a determination is made to restore an item, decisions should be made about whether to dry or clean the item first. Generally, if the item has been affected by Category 1 water, it is dried first, re-evaluated, and cleaned. If the water is Category 2 or 3, the item should be cleaned first and then dried. This helps remove as much contamination as possible and controls the spread of contaminants during the drying process.

Drying of Contents

To stop potential damage and return contents to an acceptable condition, steps should be taken to return items to a normal level of moisture content. Usually, this is accomplished by physically removing excess water from the surface. Additional moisture can be removed by using dehumidification, controlling temperature, and by directing airflow across the affected items.

Consider drying affected contents in the area of the moisture intrusion in conjunction with drying the affected structure. This helps minimize cost and inconvenience for occupants. However, if the amount and type of damage to the structure prevents drying contents in the area of the moisture intrusion, or if contents require special handling, specialized drying chambers can be created to process the contents outside the affected area.

Specialized drying chambers can be as simple as another room separated by containment where the humidity, airflow and temperature can be used in a controlled manner to dry contents, and as complex as mobile freeze drying trailers used for books, documents, and electronic media.

Cleaning Contents

Cleaning is the traditional activity of removing contaminants and other undesired substances from an affected environment or surface to reduce damage or potential harm to human health or valuable materials. The goal of contents restoration is to clean items by maximizing the physical removal of soil, contaminates and odors.

Contents restoration implies returning items to as close to an acceptable condition as possible. It does not necessarily mean that an item has been improved in appearance. There are factors involving client expectations that could be addressed. It is recommended that appropriate appearance enhancement processes, as discussed below, be applied to items after their return to an acceptable condition.

As with structural restoration, additional damage can be discovered or created during the contents restoration process. When additional damage to contents is discovered, restorers should notify supervisors, so that it can be documented, and that materially interested parties can be informed within a reasonable period of time.

Contents can be cleaned either on-site or in-plant. There are advantages and disadvantages to each alternative listed depending on the specifics involved in a project. Some or all of the following can apply.

On-site versus In-plant

Advantages of on-site cleaning include:

- items remain in the client's control;
- expenses of packing, transport and storage are eliminated;
- normally, there is less chance of breakage or "mysterious disappearance;" and
- an on-site cleaning system, as discussed below, can be set up to process items before being moved to an unaffected area.

Disadvantages of on-site cleaning include:

- it may extend the wait time before start of the structural restoration;
- cleaning systems set up on-site can be significantly less efficient than well-designed plant facilities; and
- contents not removed from affected areas can require several "rounds" of cleaning, similar to structural materials.

Advantages of in-plant cleaning include:

- minimizing the time before structural restoration begins;
- allowing the use of specialty cleaning systems that cannot be set up onsite, and
- allowing structure and contents restoration to proceed simultaneously, potentially reducing total job time.

Disadvantages of in-plant cleaning include:

- significant costs are associated with inventory, packing, transport and storage;
- it increases the possibility of breakage, "mysterious disappearance" or accusations of theft; and
- the restorer assumes responsibility for the contents.

Regardless of whether contents are cleaned on-site or in-plant, appropriate precautions should be taken to prevent the spread of contaminants, such as dust and dirt from affected areas into unaffected or uncontaminated areas.

Outdoors

It is recommended that restorers take relevant factors into consideration before deciding to perform contents cleaning outdoors (e.g., weather, safety to workers and contents, possible public alarm at the sight of people attired in PPE).

When cleaning affected contents outdoors, cleaning should be performed at a distance from a structure to create a safe working environment. When cleaning out doors, restorers should use appropriate measures to protect the contents from any further damage. If restorers determine, after application of the General Duty Clause, that there is a risk to employees, then restoration workers handling or working near contaminated contents shall wear appropriate PPE; refer to Chapter 8, *Safety and Health.*

CLEANING METHODS

When selecting a cleaning method, it is important to choose the best method for the situation. Knowing the material composition, the Category of water, and the location where contents are to be cleaned, is instrumental in selecting the proper method. A combination of methods can be necessary to facilitate contents restoration. These methods may be used before or after drying, as required.

Air-based Methods

- HEPA-vacuuming, or vacuuming with other units that exhaust a safe distance outside the structure;
- air washing is a method that uses an air stream to blow contaminants or moisture off surfaces, which can result in aerosolization, creating potential exposure for workers and occupants. This method shall not be used except outdoors, or in laminar-airflow, high-volume cleaning chambers, or in other situations where engineering controls are adequate to prevent excessive concentration of contaminants and minimize spreading of contamination in a Category 2 or 3 water. Air washing has the potential to drive contaminants and fragments deeper into porous materials (e.g., padded or upholstered items).

Liquid-based Methods

The Liquid-based cleaning methods rely on water combined with physical or mechanical cleaning processes to dislodge contamination. The following are examples of liquid-based cleaning methods:

- immersion cleaning with an appropriate cleaning agent;
- ultrasonic cleaning;
- washing with an appropriate cleaning agent;
- steam cleaning with live steam systems;
- cleaning with non-water-based liquid solutions;
- low-pressure flushing;

- high-pressure washing is a method that causes "splattering," resulting in aerosolization and an increase in RH. High-pressure washing techniques should be limited to situations in which aerosolization is not a critical factor (e.g., outdoors); and
- hot water extraction with truck-mounted or portable units.

Appearance Enhancement

There are many methods that are effective in improving the appearance of contents. Although removing contaminants and drying to an acceptable drying goal are the primary focus of contents restoration, there are client expectations that also should be addressed. It is recommended that contents be "appearance enhanced" to the extent practical before being returned to the client. This can include, but is not limited to, refinishing, polishing, waxing, and buffing using such products as:

- chemical strippers;
- rubout products for finishes;
- toners and bleaches;
- stains, glazes, and grain fillers;
- solvent-based finishes;
- gold leafing kits;
- touch-up products; and
- finishing and waxing products.

Cleaning Porous, Semi-Porous and Non-Porous Contents

Because of the nature of porous contents, particularly textiles, it is important to note the Category of water and the presence of contamination. Special care should be taken when unaffected contents are stored with affected contents to control potential cross contamination. Dry soil removal by thorough vacuuming and/or brushing with a soft bristle brush are the most commonly used methods for cleaning porous contents after being dried to an acceptable drying goal. A liquid-based or abrasive method may be necessary after the dry soil extraction has been performed. Rapid drying and any practical appearance enhancement follow cleaning methods. Also, distinguishing between Category 2 and Category 3 water may require visual inspection by a qualified restorer.

Porous and Semi-Porous Contents

Discussed below are general guidelines, by Category of water, for restoring porous and semi-porous items that are affected during a water intrusion. These contents can include, but are not limited to:

- books, documents and manuscripts;
- family records, scrapbooks and photographs;

- clothing, fabrics and other textile items;
- area rugs, tapestries and loose carpet;
- upholstery and mattresses;
- wicker furniture and similar items;
- paintings, sculptures and other art; and
- unfinished or unsealed wood.

Category 1 and 2 Water

After carefully examining items for restorability, the proper cleaning method selected should be based on material composition and manufacturer instructions. Knowing the type of affected material is important in determining the type of restoration needed, such as multiple launderings.

For fabrics with heavy odor, a deodorization process, such as confined use of ozone or application of deodorizers, can be desirable prior to or following laundering or dry cleaning and drying to an acceptable goal.

Category 3 Water

Restorers should dispose of most porous and semi-porous contents affected by Category 3 water (e.g., padded or upholstered items), due to the inability to clean all areas of saturation, along with staining, discoloration or fiber damage. However, clothing and other household fabrics may be restorable with submersion washing in appropriate detergents. High-value or irreplaceable items of sentimental value, may justify cleaning and restoration using specialized techniques discussed later in this chapter. The restorer should recommend to the client that post remediation verification by an indoor environmental professional (IEP) be performed.

Non-Porous Contents

All items should be examined first for restorability. Some glass and plastic items can be etched or stained by long-term exposure to water and associated microbial growth. Metal items can be unrestorable due to corrosion, which can be accelerated by acids produced by fungal growth; refer to *IICRC S520 Standard and Reference Guide for Professional Mold Remediation*. Discussed below are general guidelines by Category of water for restoring non-porous items affected during a water intrusion.

Category 1 and 2 Water

Usually, cleaning can be accomplished by using one or more of the following cleaning methods:

- detergent washing and rinsing;
- ultrasonic cleaning;
- damp wiping with a cleaning agent; or

- other suitable processes for the particular item.

Category 3 Water

If an item is non-porous and there are no indications that bonded materials have absorbed water, cleaning procedures are the same as those for Category 1 and 2. After thorough cleaning, restorers should remove cleaning residue and follow up with rapid drying and appearance enhancement, if necessary. If bonded materials have been affected, by water intrusion and are deemed non-restorable, the item should be discarded following guidelines for non-restorable contents discussed later in this chapter. It may be advisable to review the owner's manual for water damaged contents, if applicable and available, for special or recommended cleaning methods or considerations that could affect warranty or restorability.

HIGH-VALUE AND IRREPLACEABLE CONTENTS

High-value contents are those with high monetary value or replacement cost. Irreplaceable contents are those with unusual historical, sentimental, cultural, artistic, legal or other value. Specialized cleaning and restoration techniques may be appropriate for these contents. Such procedures can be as simple as repeated cleanings, using standard practice as described above, or can require the use of specialized experts.

For many categories of high-value and irreplaceable contents, specialty restoration services are available. Some restorers may provide these services in-house, while others may out-source the work. Specialty restoration services include, but are not limited to:

- art restoration or conservation for paintings, valuable books, works of art on paper, documents, objects, frames, tapestries and other textiles;
- collectable doll restoration;
- freeze drying for valuable books and documents;
- area rug cleaning and repair;
- electronics and machinery restoration;
- data recovery; and
- musical instrument restoration.

Cleaning processes should start with soil and contaminant removal. If heavy odors exist, multiple cleanings and deodorizing attempts may be needed. Post remediation verification by an indoor environmental professional (IEP) should be performed and documented to ensure decontamination before the item is returned to the client. Organic materials, such as leather objects, animal trophy heads, and similar items, are highly susceptible to mold growth after water damage, and might not be restorable; refer to current version of the *IICRC S520 Standard and Reference Guide for Professional Mold Remediation.* Such additional or specialty restoration procedures might not return these items to an acceptable condition. Depending on the item restored and the level of contamination, a specialized expert may be necessary to determine whether or not an item has been restored. If items are not restorable, materially interested parties should be consulted to determine an acceptable course of action with respect to the disposition of the items.

UNRESTORABLE CONTENTS

Unrestorable contents should be inventoried, photo-documented, and removed or disposed in compliance with the removal and disposal recommendations later in this chapter. Unrestorable contents should not be disposed without the permission of the client or other materially interested parties, as applicable. These parties authorize disposal by signing an appropriate form listing the items. It is recommended that unrestorable contents be removed from the work area before restoration services begin. When returning contents that have not been restored to an acceptable condition, restorers should inform the client of the circumstances involved, advise them in writing of the potential consequences of accepting contaminated contents and attempt to obtain a written waiver and release of liability for those potential consequences.

DISPOSAL

It is recommended that waste materials be moved from the work area to a waste container in a manner that minimizes the possibility of cross-contamination of unaffected areas. It is recommended that sharp items capable of puncturing poly material be packaged in such a way as to prevent penetrating the material before being bagged or wrapped to prevent leakage. It is recommended that bags not be dropped, thrown or handled roughly.

If timely disposal of affected contents is not possible, it is recommended that staged debris be stored in a reasonably secure location. Generally, no special disposal provisions are recommended for water-damaged materials; however, federal, state, provincial and local disposal laws and regulations apply. If waste-materials are contaminated, then procedures listed above should be followed.

SPECIFIC HANDLING RECOMMENDATIONS

Sculptures, Artwork and Other High-Value Collectables

Consider establishing an on-going business relationship with a nearby art storage facility to pick up and care for high-value sculptures, paintings, photographs and other high-value collectables. Restorers should take a complete inventory of the affected items to be removed and have the property owners sign the inventory.

Inventories should include the artist, title, subject, date, size, medium, inscriptions or markings, distinguishing features, condition history, the value if known and a photographic image. A copy of this inventory should be kept in a secure location at a site separate from the collection in the event of any potential harm that may occur to the collection itself. A professional conservator will also keep a copy of the records.

Books and Documents

Water-damaged paper goods can include books, manuscripts, family records, scrapbooks, keepsakes and collectibles. On average, such paper goods can absorb up to 60% of their weight in additional water. Major damage to these items takes place within the first 4-8 hours. These items should be removed if exposed to high humidity or if contaminated during drying. Recovery efforts using sublimation (vacuum freeze-drying) can be up to 99% effective.

When sending affected paper goods to a specialist use cardboard banker's boxes for packing the books and documents. Label boxes with your company name and contact information. Handle the wet materials carefully to avoid additional damage while rinsing off mud and dirt using clean water. Pack books with the spine down and documents upright in the boxes. Books should be packed in one layer with no other contents items packed on top. When palletizing boxes, stack them no more than three high to prevent crushing the bottom box during shipping to the sublimation specialist.

Restorers should freeze uncoated paper within 24 hours, or as soon as reasonably possible, to minimize the potential for damage and/or mold growth. Coated-paper should be interleaved with an appropriate sheet product and frozen within 8 to 12 hours to reduce the potential for blocking of pages. Low temperature blast freezers produce smaller ice crystals during the freezing process and can produce better results.

Electronic Media

It is recommended that media recovery specialists, whose primary business is software-related media or video, handle the restoration of affected media as quickly as possible. These experts use the proper chemicals and techniques to examine, retrieve and preserve information stored on such media. If the affected media's value or importance outweighs the cost of specialized restoration, then the procedures listed for books and documents should be followed.

It is recommended that the restorer contact and partner with these specialists ahead of time to obtain the procedures that need to be followed in order to properly prepare the media for transporting. Typically initial steps taken by the restorer would include:

- packaging the media in tightly sealed plastic bags;
- labeling and inventorying the bags;
- freezing the inventory as soon as possible;
- placing the bags with the frozen media in a sturdy container labeled with your company's mailing address and contact information; and
- shipping it to the specialist with the media in a frozen state.

Draperies

Draperies that have not been directly affected should be placed on hangers or removed from the immediate area of the moisture intrusion. If any of the synthetic material items have become wet, it is usually best to wet out the entire panel and then place in a dryer for uniform drying.

Draperies made with natural fibers can shrink and/or develop water stains or sizing rings that might not be correctable. Commercial laundries that specialize in drapery cleaning might be able to steam and re-stretch the fabric. Note that many draperies have become weakened from use and exposure to sunlight and might not withstand restoration procedures.

Mattress, Box Springs and Pillows

If deemed salvageable by the restorer, mattresses, box springs and pillows that have been affected by Category 1 water can be extracted, cleaned and dried. Mattresses, box springs, pillows and fabrics containing stuffer materials that have become contaminated with Category 2 water may not be restorable, while the same contents contaminated with Category 3 water should not be restored regardless of value. Proper disposal of these materials can include bagging in plastic and removal to an appropriate disposal site.

Upholstered Furniture

Upholstered furniture, throw pillows and stuffed fabrics that have become wet with Category 1 water usually can be cleaned and dried, if response is timely. Stuffed fabric furnishings that are wet with Category 2 water may not be restorable, while items contaminated with Category 3 water should be removed and properly disposed. In the case of irreplaceable or high-value furnishings, it is recommended that materially interested parties be involved in making this decision.

Upholstery and fabric cleaning procedures are found in IICRC S300, *Standard and Reference Guide for Professional Upholstery Cleaning.* Thorough moisture extraction and rapid drying are critical if restoration procedures are to be successful. As with clothing and soft goods, deodorization of severely affected contents may be conducted with appropriate techniques. One or more repeat cleanings may be needed to remove odors and further reduce contaminant levels. Rapid drying and appearance enhancement, as practical, can follow cleaning.

Case Goods

Affected case goods (e.g., bookcases, chests of drawers, dining or bedroom furniture) should be blocked up and wiped dry with an absorbent towel to limit potential damage. Case goods made of soft or hard wood can typically be restored by cleaning, drying to normal moisture content and using cream refinishers to remove white discolorations from excessive moisture. If necessary, it is recommended that furniture requiring light or full refinishing be referred to a specialized expert.

If the case goods are made of compressed wood and have already swelled, it is recommended that the restorer consult with the client and other materially interested parties to determine the course of action. Normally, these case goods are non-restorable and should be discarded. In the case of Category 3 water, case goods made of compressed wood should be discarded at an appropriate disposal site.

Pianos and Musical Instruments

The construction components of a piano and its internal mechanisms are subject to instability and variation because of its surroundings. Typical piano construction includes a cast iron plate, reinforced beams, hardwood multi-ply bridges and pin-blocks, and steel strings. The recommended ambient relative humidity range for pianos is 35% to 55%.

The objective in restoring a piano affected by a water intrusion is to return the instrument to its quality of sound, the precision and sensitivity of its action, and its appearance and value.

Restorers should retain a specialized expert to transport or restore a water-damaged piano. If it becomes necessary for the restorer to transport the piano off-site, it should be carefully padded and placed sideways on a professional skid-board for moving. The legs and pedal assembly (lyre) should be removed and carefully padded, additional blankets should be added for extra protection, and the piano should be secured in an appropriately equipped vehicle for transportation. It is recommended that the owner of the piano visit the piano restoration company upon completion of the restoration to inspect the piano before having it returned to the client's premises.

Other portable instruments that have been directly or indirectly affected by a water intrusion should be documented and inventoried by the restorer and either dried in the affected area or referred to a specialized expert for restoration. If an instrument has high value, restorers should ensure that it is delivered into the care of a specialized expert who is acceptable to the client, as soon as possible.

Pool and Snooker Tables

When pool or snooker tables are affected by a water intrusion the restorer needs to be aware that there are degrees of restoration that could affect the value of the table. The more restoration, the less pristine of an original and the less it will hold and increase its value. An antique pool table could be entirely rebuilt with all new marquetry and veneers, in which case its authenticity and collectible value could be decreased.

Restoration could be as simple as drying the table in the affected area to normal moisture content. More elaborate steps could include a new billiard cloth, re-leveling, re-rubbering the rails, applying hot oil and wax finish, honing the slate, and replacing damaged sections or pockets by a table restoration expert that is acceptable to the client.

Area Rugs, Loose Carpeting and Tapestries

Cleaning procedures for area rugs and carpet are found in the latest edition of IICRC S100, *Standard and Reference Guide for Professional Cleaning of Textile Floorcovering.* Thorough moisture extraction and rapid drying are critical if restoration is to be successful. As with clothing and soft goods, deodorization can be conducted with appropriate techniques. One or more repeat cleanings might be needed to remove odors and further reduce contaminant levels. Appearance enhancement, as practical, follows cleaning.

It is recommended that area rugs and tapestries be cleaned at an in-plant facility by a specialized expert. Spreading contaminants during cleaning can be a potential problem.

Submersion cleaning of area rugs under water is less likely to aerosolize contaminants. If a high-value area rug or tapestry is saturated with Category 3 water and there is a decision to attempt salvage, it should be cleaned with submersion pre-cleaning, followed by saturation with appropriate antimicrobial biocide and a secondary submersion cleaning. The severity of contamination in the case of Category 3 water may necessitate involving an IEP for post-restoration testing to ensure complete decontamination. Documentation of complete decontamination should be obtained from the IEP and included in job records. Furthermore, loose carpeting affected with Category 3 water should be discarded and replaced, as with installed carpet, due to the cost and unfeasibility of restoration.

Clothing, Bedspreads and Other Porous Articles

Wet clothing should be separated into darks, colors and whites, and laundered according to the recommended care labels. Using a detergent in the laundering process facilitates removing contaminants. Laundry sanitizers may be added, if textile manufacturer directions permit. They help reduce microorganisms, and may significantly reduce odors. For fabrics that are not chlorine bleach safe, adding oxygen bleaches, such as sodium perborate or sodium percarbonate can provide similar benefits, if permitted by manufacturer directions. Increasing the water temperature also can enhance the laundering process. Care should be taken not to exceed the manufacturer's water temperature recommendations.

When dry-cleaning, restorers should follow manufacturer label directions, and standards of care for the dry cleaning industry, based on fabric or material type. In addition to traditional solvent-based processes, new liquid carbon dioxide dry cleaning and other alternatives are available, and can be better suited for some items. As with laundering, the primary goal of dry cleaning is the physical removal of contaminants and associated odors, rather than microbial kill. Repeat laundering or dry cleaning may be needed to satisfactorily eliminate microbial odors, as well as to provide an additional measure of assurance of maximum contaminant removal. The decision to perform multiple launderings or dry cleanings involves professional judgment in consultation with the property owner or other materially interested parties.

Furs and Animal Trophies

If fur clothing or items are affected by Category 1 water, it is recommended that restorers shake off excess moisture and let the fur dry naturally by hanging it in the affected area. The heat and low humidity generated in the course of normal structural drying will dry out the fur to its original texture. If the fur is drenched, blotting from the inside (not the fur side) with clean white towels is recommended. Do not to rub or squeeze the lining in the process. Using moth or cedar balls for deodorizing near a fur coat during drying is not recommended, as the smell often adheres to fur and creates unpleasant odors that can be difficult to remove.

After drying a fur, it may need further care by a professional to condition and re-glaze the animal skin. Glazing is a process that replenishes essential oils necessary to maintain the fur's longevity.

When animal skins and hunting or fishing trophies are affected by a water intrusion, these items should be documented and inventoried, then sent to a taxidermist for restoration. Usually, these items are specially treated and can have stuffing material that needs to be replaced to prevent on-going damage. Restoration could include re-casing, creating new scenery or ground work, and appearance repairs including, but not limited to, new eyes, new fins, recapping, and recoloring.

Appliances and Electronics

If direct wetting of appliances and electronics takes place, evaluation and restoration by a qualified electrical or electronics specialist should be accomplished. Restorers should remove electronic components from high-humidity environments as soon as practical. Only a short period of time exists between initial wetting or exposure to high humidity and the onset of damage that could necessitate replacement of costly equipment. It is recommended to test, evaluate and clean appliances, electronic and other electrical equipment before major damage occurs. These items can include, but are not limited to:

- televisions;
- stereo equipment and speakers;
- computer-related equipment (e.g., servers, personal computers, monitors, printers, scanners, speakers, miscellaneous hardware);
- appliances (e.g., refrigerators, freezers, ranges, washing machines, dryers, water coolers);
- small appliances (e.g., toasters, coffee makers, convection ovens, microwaves, air filters, fans, clocks, telephones); and
- power equipment and tools.

Aquariums

If aquariums need to be moved or removed from an area that has been affected by a water intrusion, fish or other inhabitants should be removed by the client and the tank should be emptied to avoid unnecessary stress and possible failure of tank seals. If the client is untrained in the proper removal or is uncomfortable about it, then a specialized expert should be retained to care for the inhabitants until restoration is complete. When structural restoration is complete, aquariums can be re-set and prepared, and the inhabitants can be returned.

If aquariums do not need to be removed, then restorers should work with clients to plan a schedule of maintenance for inhabitants during restoration. Also, aquariums should be fitted with a protective covering to eliminate the possibility of contaminants entering or water evaporating out of the aquarium.

Firearms and Ammunition

If firearms and ammunition are discovered at the worksite, restorers should immediately inform clients. When safe to do so, clients should collect firearms and ammunition in work area and move them out for closer evaluation. If there is no one available to collect firearms or ammunition, restorers should communicate with company management for instructions. Firearms should not be handled by someone who is unfamiliar with safety protocols, to eliminate the possibility of an unintentional discharge of a weapon.

If firearm restoration is necessary, it is recommended it be performed by a reputable and qualified firearms restoration firm. Restorers shall comply with applicable laws and ordinances for handling and transporting firearms. Sources for finding firearms restoration professionals may be obtained through recommendations from local law enforcement agencies or gun clubs.

Safety precautions shall be taken if ammunition has visibly deteriorated, so as not to create the potential for physical harm to individuals on site. When appropriate, officials (e.g., police or bomb squad) should be contacted to determine whether or not ammunition may become unstable during movement. Ammunition can be checked by a specialized firearms expert for deterioration and safety before returning it to clients for use.

ISO 3175 - Textiles -- Professional care, drycleaning and wetcleaning of fabrics and garments, International Organization for Standardization (ISO), Geneva 20, Switzerland, website: www.iso.ch

Chapter 16

Large or Catastrophic Restoration Projects

INTRODUCTION

Large projects generally involve four basic types of structures: commercial, industrial, institutional, and complex residential. Large projects involve many building materials, components, systems and methods of construction different from those found in typical residential structures. Differences in large projects are especially apparent in the size and intricacy of mechanical and HVAC systems and electrical systems, the presence of low voltage and special wiring systems (e.g., fire suppression, security systems) and in more complex building materials and construction methods. Large projects also involve challenges related to public access, security, authority, or organizational hierarchy.

Large projects are handled differently from other water damage restoration projects and usually require a higher level of project management or administration. The management and administration might be accomplished in-house or outsourced to a specialized expert. Questions that should be asked at the beginning of a large project include, but are not limited to:

- Is the use of the structure or facility commercial, industrial, institutional, or complex residential?
- Who are the materially interested parties that are involved?
- Is the project complex enough to necessitate the use of one or more specialized experts?
- Is public safety and health a concern?
- Are property owners self insured or do they have a substantial deductible?
- Are the impacted areas extensive, involve multiple buildings or are special security areas involved?
- Was the project a sudden, accidental, natural or weather related occurrence?
- Is there a third party agency involved (e.g., government, a multinational or corporate office in another location)?
- Does the structure contain high-value, sensitive or historical materials or contents that require special insurance coverage, additional security, procedures or personnel to perform specific restoration services?

TYPES OF STRUCTURES

Large projects generally involve four basic types of structures: commercial, industrial, institutional, and complex residential. Large projects can result from improper maintenance, casualty (e.g., accidents, failure of building components), intentional acts (e.g., vandalism) and weather-related events.

Commercial: Structures, buildings or facilities where the use is primarily for retail, office, mixed-use and warehousing. These structures usually have limited power availability, partitions or demising walls, and have multiple finished surfaces and fixtures.

Industrial: Structures, buildings or facilities where the use is primarily for manufacturing, foundry, and distribution. These structures usually have heavy power availability, few partitions or finished surfaces.

Institutional: Structures, buildings or facilities where the use is primarily for public facilities such as schools, hospitals, municipal buildings, sports complexes, airports, libraries or other governmental facilities. These structures can have power availability, public access and security challenges, or various layers of authority and organizational hierarchy.

Complex Residential: These residential facilities include: townhouses, condominiums, apartment complexes, hotels, multi-family dwellings, or large single-family mansions or estates. These structures may have multiple owners and insurance policies, and common construction components and accessibility challenges.

BUILDING SYSTEMS

Because of the wide variety of uses of large structures, there are a wide variety of building components and systems which are not found in typical residential construction. Many building materials and methods of construction in large structures are different from those used in residential structures.

Mechanical and HVAC Systems

Mechanical and HVAC systems in large projects are generally larger in size and more intricate in design than residential systems. A specialized expert may be necessary when dealing with a commercial mechanical or HVAC system; see Chapter 12, *Specialized Experts*. Large project HVAC systems can be roof-mounted, ceiling-mounted; or they may be located in an area completely separate from the area of water intrusion. These systems can have several intermediate heating and cooling elements and several air distribution systems. They can also have electronically controlled climate sensors, dampers, fire dampers, barometric pressure relief systems, fire suppression, exhaust and fresh air systems, as well as other systems of which the restorer should be aware when working with or around such systems. Insulation can be on the interior or the exterior. The duct work can be fixed or flexible and can be constructed from a variety material. Commercial mechanical and HVAC systems are to be carefully evaluated and handled by restorers or specialized experts; refer to Chapter 16, *Large or Catastrophic Restoration Projects.*

Other commercial mechanical systems (e.g., plumbing, fire suppression, electrical, gas) can be dramatically different from residential systems, and may vary depending upon building use. These systems can have fault sensors, pressure switches and electronic distribution systems. Many systems are monitored by in-house or third party monitoring services, which detect faults, system failures and manual tampering. Monitoring systems should be controlled or shut down before working around or servicing them. Failure to do so can result in costly repairs and unnecessary procedures to reset or recharge the system.

Electrical, Low Voltage and Special Wiring Systems

Similar to mechanical and HVAC systems, commercial electrical systems are larger and more intricate than residential systems, and include low voltage and special wiring. A specialized expert might be necessary when dealing with commercial electrical, low-voltage or special wiring systems; see Chapter 12, *Specialized Experts*. Special wiring systems can include: CAT 5 or other computer wiring, fiber-optic wiring, alarm and security systems, coax cabling and other wiring or cable systems. Low-voltage wiring can sometimes be particularly difficult to work with since many systems are wired to special transformers and relays.

The greatest variability in a commercial environment is the electrical system. Depending upon the use, a system can have single and/or 3-phase power distribution, voltage can vary from 110 to 460, and breakers can be 1 to 300 amps, or more. A commercial structure can require the use of ground fault circuit interrupters (GFCI). Using of portable generators might be advisable when performing restoration services, when the amount of available power is known or suspected to be insufficient for the project. Also, portable generators can be necessary when access to the in-house power supply is restricted or prohibited.

Building Materials and Systems

Commercial, industrial, institutional, and complex residential structures vary greatly in composition, construction and materials. Ceilings can have open steel or wood framing, drywall or plaster, acoustic ceiling tiles, among others. Walls can consist of different structural compositions such as drywall, plaster or brick over steel, wood or masonry, and be insulated or non-insulated. While the most common flooring materials are carpet, vinyl composition tile (VCT), or concrete, there are many new specialty materials being introduced to the market that can necessitate special treatment during the restoration process. It is recommended that restorers stay informed about the latest construction methods and materials.

ADMINISTRATION

Cost and Pricing Methods

The cost and pricing methods below are commonly used in the administration of large projects. The increased need for equipment, products, materials and labor in large projects can create extraordinary demands on restorers and their vendors. These methods include:

Cost-plus-overhead-and-profit: This method involves tracking the actual cost of labor, materials or products, equipment cost or rental, and subcontracted invoices. The sum of these costs plus a predetermined margin of overhead and profit, constitute the total cost of performing services. The advantages of this method include: eliminating the need for a predetermined or published price guideline, and eliminating the need to spend time on measuring and making decisions on a scope that can change many times throughout the project. The disadvantages include: lower margin of profit, and the uncertainty that might result without an advance agreed-upon scope of work, and the necessity to renegotiate overages that might exceed the previously-set budget for time, materials, equipment and subcontract costs.

Time-and-materials: This method involves tracking the actual cost of labor, materials or products, equipment cost or rental, and subcontracted invoices. The data are then compiled and assigned an amount based on a predetermined or published pricelist. Data collected early in a project can be broken down into units which can then be used to estimate the total potential cost of a project. This allows restorers to concurrently establish a budget to follow. The advantages of this method include: streamlined data compilation for auditing and estimating; a balanced margin of profit; creation of a budget to aid in the processing of payments on the project, and avoiding the need to spend time on measuring and making decisions on a scope that can change many times throughout the project. The disadvantages of this method include: the uncertainty that might result without an advance agreed-upon scope of work, and the need for a predetermined or published price guideline.

Measured Estimate or Bid: This method involves measuring and inventorying the project, and calculating the exact scope and price for performing the services. Changes involving scope or price during the course of the project should be documented by a written change order, signed by an authorized party and the restorer.

Advantages of this estimating method include: more precision in estimating and implementing a project; lower administration cost during the project; a fixed budget and margin of profit, and the development of a scope agreed-upon in advance. Disadvantages of this method include: a greater expenditure of time on project estimating prior to the services being performed; higher likelihood of work stoppage for processing potential change orders; an incentive to increase the rate of production, which might compromise service quality, and reduced opportunity for restorers to apply professional judgment when implementing and completing a project.

For projects performed on a cost-plus-overhead-and-profit basis, or time-and-materials basis, administration may be completed by in-house daily reports of time, material and products usage, and equipment rental and subcontract expenses. These reports are collected by an on-sight project manager or administrator. The report is then compiled for auditing and billing.

The administration required to mobilize, implement and complete a large project can be extensive, especially if the project is performed on a cost-plus-overhead-and-profit basis, or a time-and-materials basis. Regularly scheduled monitoring, inspection and evaluations are more crucial when processing a large project because of size, complexity and potential variables. Many times a large project is administered or audited by a third party, ensuring transparency and fairness in billing. Even when projects are based on a measured estimate or bid, proper coordination of administrative practices during a large project is essential.

Payment Schedules

To expedite large project administration, payment (draw) schedules are required to finance the project through completion. A payment schedule is a means of payment for portions of the project at regular intervals. These schedules should be predetermined, agreed upon and incorporated within the project contract. The type of payment schedule is usually dependent on the size, complexity and method of handling the project.

In the case of a measured estimate or bid, the schedule may be based on weighted percentages of the estimate during the course of the project, such as an initial payment, a number of equal interval payments and a final payment contingent upon successful completion. In the case of a cost-plus-overhead-and-profit project or time-and-materials basis, the schedule may consist of a down payment, interval payments based on invoices for work completed and a final payment based on substantial completion.

The funds for a project can be escrowed by a third party, the customer or an insurance company. In many situations, draw schedules are required so as not to affect on-going cash-flow needs of the restorer.

Communication

As with any other project, communication is one of the most important factors in successfully completing a large project. The difference is in the extent and frequency of communication necessary to complete it. In a typical residential water damage restoration project, the restorer should communicate with the owner or owner's representative, restorer's crews, subcontractors and specialized experts, and possibly an insurance company representative. On large projects, however, there often is an on-site manager for the restorer, a facilities manager, a board of directors, an insurance auditor, legal counsel, and other materially interested parties. A communication structure or "tree" should be established and strictly adhered to before, during and after completing a large project.

In the case of catastrophic large projects, (e.g., widespread flooding, hurricanes and tornadoes) federal, state and local government agencies can be involved. Examples in the United States include: Federal Emergency Management Agency (FEMA), state or local boards of health, building inspectors, and Housing and Urban Development (HUD). Many of these agencies offer loans, grants and other aid to victims of disasters. In many cases, when dealing with these agencies, legal counsel or certified public accountants may be necessary to file the correct documents allowing for prompt service and payment.

Project Documentation

Consistent documentation at regular intervals during a large project is essential. Many of the daily logs, notes and reports are similar to those outlined in Chapter 9, *Administrative Procedures, Project Documentation and Risk Management*. In addition to limiting liability for restorers, documentation is necessary for communicating, billing and reporting to the customer. The amount of documentation necessary to administrate a large project is often the primary justification for an on-site, full-time or third-party administrator. The expense associated with documentation should be considered in estimating the cost or billing for a large project.

SECURITY

Large restoration projects require special security considerations, including, but not limited to: working in commercial buildings that already have a full-time security staff; projects where restorers out-source security; projects where the restorer's staff provides a safety watch without activity documentation; and government or high-security projects where personnel must pass security clearance to work in restricted project areas.

Full-Time Staff Security

Generally, commercial buildings and large corporations have a full-time security system in place, which includes security personnel on-location around the clock. Restorers can be required to work with building security in large projects. Security companies usually issue security badges and obtain general information about the restoration company, and make sure that appropriate insurance certificates are filed with the building manager. The restorer should comply with the rules and policies of building security or third-party security provider.

Security contracted by Restorer

There are also many large project job sites where the building does not have security in place. On these projects, restorers may want to consider hiring an outside company to assist in securing the project site. When considering security outsourcing, restorers should evaluate whether or not it is prudent for security to be outsourced, the experience and qualifications of the security company (e.g., indoor or outdoor security or other special needs), and the necessity for the security company to be licensed and bonded. Restorers should work with the building owner or manager, the insurance company and other materially interested parties regarding the financial aspects of hiring and securing a large project site.

Monitoring provided by Restorer

In many large projects, restorers may want to use a safety-watch option. This is an option in which restorers actually provide around-the-clock monitoring without record keeping. The purpose of this lower level of security is to monitor for potential operational problems and unauthorized attempts to enter the premises or remove equipment.

Regulated Security Areas

If the large project is a regulated security site, information on all employees may be requested for background investigation of project employees. When providing such information, restorers shall comply with applicable data-protection or privacy laws and regulations. Investigations can include: criminal background, homeland security, and credit checks of restoration company owners, as well as those entering the site on the company's behalf.

Restorers may be required to provide training about working in high-level security areas, on how to observe specialized security policies, and on complying with applicable regulations.

LABOR

In-House and Contract Employees

While it is preferable to use well-trained in-house employees, many times on large projects contract employees in the form of temporary labor, trained restorers from other restoration firms, part-time or seasonal help, as well as on-call or as-needed employees are necessary. Frequently, it is not financially feasible to maintain a permanent staff large enough to handle large projects.

The ability of restorers to manage people, such as employees, contract employees and subcontractors, is important to the successful completion of a large project. Therefore, it is recommended that restorers performing large projects maintain a well-trained, full-time staff with the skills required to manage a quantity of contract employees, as well as the technical competence to handle their assigned portion of a large project.

Subcontractors

Many times subcontractors are needed to staff a large project. A large project restorer should consult a legal professional to draft a formal subcontract agreement for use when engaging subcontractors. There are many differences between subcontractors and contract employees, including the degree of control asserted over them. Subcontractors are independent contractors having greater discretion and control over the conduct of their activities than employees. Subcontractors can indemnify a restorer for acts and omissions, including those caused by negligence, and they usually carry insurance covering their operations.

EQUIPMENT

Owned versus Non-owned Equipment

It is usually preferable to use equipment owned by the restorer. However, it is unlikely that any large project restorer will have enough equipment to handle multiple large projects simultaneously. Therefore, using equipment from various sources, such as equipment sharing plans with other restorers, short-term leases, job-specific rentals, or obtaining equipment from other sources might be necessary. Often on large projects the required size and number of pieces of equipment is much greater than that required on residential projects. Tracking equipment can be a challenge. Equipment inventory, tracking and movement systems should be used to maintain efficiency and effectiveness on large projects.

WORKING OUT OF STATE, PROVINCE OR COUNTRY

When working on large projects outside the restorer's home state, province or country, restorers shall comply with pertinent federal, state, provincial, and local laws and regulations applicable to their activities in those areas. Restorer insurance requirements, including those for general liability, worker compensation, and pollution liability, can vary by jurisdiction. Licensing and permits, as well as laws regulating the conduct of a restoration business, also can be different between jurisdictions.

Generally, laws and regulations applicable in the jurisdiction where a large project is located apply to restorers performing services there even when they are based in a different jurisdiction. Restorers shall comply with business regulations, licensing and insurance requirements applicable in jurisdictions in which they conduct business.

Chapter 17

Materials and Assemblies

The purpose of this Section is to provide details about the various materials and assemblies that are in buildings. As discussed in Chapter 4, *Building and Material Science*, buildings are constructed in such a way that the restorer cannot consider specific materials without regard to others as they are designed to work together in various structural, flooring, roofing and mechanical assemblies. This Section will discuss many materials and assemblies, how a moisture intrusion can affect them and will summarize typical procedures for Category 1, 2 & 3 water sources. This Section is divided into three parts:
Evaluating the restorability of building materials and assemblies
Descriptions of restoration procedures
Summary table of materials, assemblies and restoration procedures

Evaluating the Restorability of Building Materials and Assemblies

Restorers should consider several criteria when determining that materials or parts of an assembly are restorable. Additionally, restorers should understand the effects of moisture on building materials and assemblies. Answers to the following questions in the affirmative can indicate restoring parts or assemblies is recommended. Questions to consider can include but are not limited to:

- Is it Category 1 water?
- Can drying goals likely be achieved and confirmed?
- Can the assembly be adequately dried without partial removal?
- Will the assembly return to its original structural integrity?
- Can affected components be dried more cost-effectively than replacement?
- Can visible staining or discoloration be eliminated?
- Can lingering malodors be eliminated?
- Can adequate inspection be accomplished without invasive techniques?
- Do the materials show no evidence of prior damage?

In order to answer some of these questions, it is critical that the restorer understand fully the construction of assemblies, including the presence of interstitial spaces, vapor barriers, integrity of the top finish-coat or other finish material. While some materials can be readily restored, they may require removal in order to access other components. Understanding the materials and assembly will help the restorer determine a successful approach to drying.

Any one of the questions above could be a determining factor for restoration versus replacement. Most of this information is obtained during the initial inspection. When materials are determined restorable but contamination issues exist restorers should employ the appropriate remediation procedures prior to drying efforts defined in this Section (Refer to Chapter 13 *Structural Restoration*)

Descriptions of Restoration Procedures

In the table that follows, a description of the material or assembly will be given with a series of letters that refer to the following procedures. For a complete description of the procedures, restorers can refer to Chapters 4, 11 and 13 of this Reference Guide.

Restorability:

- Restorable – This material or assembly is restorable if flaws or cosmetic effects are insignificant and acceptable.
- Generally restorable – This material or assembly can be restored if it is structurally sound, cleanable and can be returned to acceptable condition. In some cases, the materials may not be damaged, but their presence can slow drying of more critical materials or assemblies behind or below them (e.g., vinyl wallpaper over wet drywall, sheet vinyl flooring over wet subflooring).
- Generally unrestorable – This material or assembly may be unrestorable due to (1) quick developing impacts of moisture sorption, (2) inability to adequately clean or sanitize or (3) inability to ensure achievement of drying goals throughout the assembly.
- Unrestorable - This material or assembly should not be restored due to (1) quick developing impacts of moisture sorption, (2) inability to adequately clean or sanitize or (3) inability to ensure achievement of drying goals throughout the assembly.

Bulk water removal (Extraction):

Pump bulk water – Pumps (i.e., submersible or surface) with sufficient lift and volume capacity can be used to remove standing water from floors and structural components. Wastewater shall be handled, transported and disposed of in accordance with all local, state, provincial or federal laws and regulations.

Extract/Remove water – Water can be efficiently removed from the structure, systems, and contents using surface extraction (e.g., truckmount, portable, squeegee, mop). When using truckmount or portable extraction equipment for removing water from soft goods, equipment with sufficient vacuum capability (lift and airflow) is necessary. These units can also be used for removing deep standing water when pumps are not available. Wastewater shall be handled, transported and disposed of in accordance with all local, state, provincial or federal laws and regulations.

Follow-up extraction can be needed due to seepage – Repeatedly extracting water from materials and components can be required as water seeps out of inaccessible areas, especially in multi-story water restoration projects.

Cleaning

Cleaning is the process of locating, identifying, containing, removing and properly disposing of unwanted substances from an environment or material consistent with this Standard. Restorers should evaluate and clean materials within the work area as needed. The three basic levels of cleaning are (a) initial/bulk cleaning, (b) detailed cleaning and (c) final cleaning.

Initial/bulk removal of debris, unsalvageable or contaminated materials – the process of removing bulk debris, soil or materials from the work area. This process can include but is not limited to: the removal of unsalvageable, removal of materials to gain access to expedite drying; or bulk contamination (e.g., sewage).

Perform controlled demolition, as needed – During demolition, contaminants can be easily dislodged or aerosolized. Restorers should minimize dust generation and aerosolization by using appropriate demolition practices (e.g., source-controls, vacuum attachment on saws, bagging wet materials immediately).

Control potential spread of contaminants - Contaminants should not be allowed to spread into areas known or believed to be uncontaminated by employing appropriate engineering controls (e.g., air filtration devices, containment). Contaminants can be spread in many ways (e.g., tracked on feet, natural circulation, HVAC, air movers).

Biocide can be applied, as appropriate - Initial decontamination should be accomplished to the extent possible by cleaning. Restorers should employ cleaning methods that minimize aerosolizing contaminants while maximizing complete removal. It is recommended that when decontamination cannot be practically completed by cleaning alone, that appropriate antimicrobial biocides or mechanical means be employed.

Detailed cleaning by damp wiping – The process of thoroughly removing soils and contaminants from the work area. Wiping or mopping with a towel, sponge or mop that has been wrung out tightly after being immersed in a clean solution containing mild detergent, disinfectant or sanitizing agent. Depending on label directions, rinsing with clear water may be required.

Detailed cleaning by hot water extraction – hot water extraction is a method of removing soils and contaminants using pressurized hot water. Almost immediately thereafter, injected water is extracted to physically remove soils and excess moisture.

Detailed cleaning by vacuuming – This is the process of removing dry soils and contaminants by using an upright or canister equipment operating through suction, often incorporating mechanical agitation (e.g., brush, beater bar).

Detailed cleaning by HEPA vacuuming - The process of removing dry soils and contaminants from the work area, by using HEPA-rated vacuum equipment that prevents contaminants from becoming aerosolized in work areas or other parts of a building.

Detailed cleaning by low-pressure techniques - The process of removing soils and contaminants by using low-pressure (20-60 psi) flushing, usually followed by extraction. Low-pressure flushing typically produces larger droplets, which reduces air suspension time (drift) and the potential for inhalation.

Detailed cleaning by high-pressure techniques - The process of removing soils and contaminants by using high-pressure (>60 psi) flushing, usually followed by water removal. Restorers are cautioned that it can cause “splattering” resulting in aerosolization of contaminants and an increase in humidity. High-pressure washing techniques should be limited to situations in which aerosolization is not a critical factor (e.g., outdoors) and damage to structural components is unlikely.

Final appearance cleaning using appropriate method(s) - The process of removing residual soils or materials from the work area to improve appearance and prepare for re-occupancy.

Drying

Drying is the process of removing moisture from materials and involves the sciences of psychrometry and moisture mechanics in materials. Restorers should understand the science of drying and implement the principles of drying during a restoration project.

Open assemblies to access pockets of saturation - Restorers should open assemblies (e.g., walls, stairs, flooring, wall base areas, voids, built-ins) to access pockets of saturation. Methods of opening assemblies can include but are not limited to drilling hole(s) or removing other components of the construction.

Maintain water vapor pressure differential in all phases of the process – Restorers should maintain water vapor pressure differential in the affected area during all phases of the drying process by controlling the humidity in the surrounding air through dehumidification or ventilation. Restorers can add energy to wet materials, increasing internal water vapor pressure and providing energy for the phase change of water.

Increase the internal water vapor pressure of materials during falling rate drying period - For Class 4 materials (e.g., concrete, stone, timbers) restorers should increase the internal water vapor pressure by adding more energy into wet materials.

Airflow

- Implement cross-contamination controls – Restorers should take precautions to prevent the spread of contaminants from an affected area to an unaffected area by use of one or more controls (e.g., containment, pressure differential, AFDs). This should be done for air exiting interstitial spaces when structural cavity drying systems are in use.

- Achieve aggressive airflow during early stage – Higher airflow during the constant rate stage of drying, the period of highest moisture availability and evaporation, is especially beneficial for porous and permeable materials (e.g., gypsum board, fiber-fill insulation,). For Category 2 or 3, aggressive airflow should only be used after remediation.

- Maintain sensible airflow during all stages of drying – Airflow at the surface of wet materials is needed during the entire drying process to displace the evaporating surface moisture and to transfer energy (i.e., heat) into the materials.

- Reduce airflow during later phase – Reduced airflow during the falling rate of drying, the period of lowest moisture availability and evaporation, is beneficial. This is especially true for Class 4 materials (e.g., concrete, stone, timbers) as a high rate of airflow can retard the drying process by decreasing the wetted pore surfaces or shrinking the pore in the overly dry surface layer thus reducing moisture movement within the material.

- Introduce airflow within the structural cavity (i.e., interstitial space) – Airflow should be delivered to wet surfaces inside interstitial spaces (e.g., wall cavities, internal chases, under cabinets). This can often be achieved more effectively through the use of structural cavity drying systems that create a positive or negative pressure causing filtration (i.e., infiltration, exfiltration) through the structural assembly.

Comments/Cautions:

- Minimize aerosolization of contaminants - Restorers should limit the velocity of airflow across surfaces to limit aerosolization of contaminants. When extracting contaminated water or vacuuming contaminated dry material, restorers should take appropriate steps to prevent contaminants from becoming aerosolized in work areas or other parts of a building by using HEPA vacuum systems or directing a vacuum's exhaust to unoccupied areas of the building's exterior.

- Use specialized expert, as appropriate - Restorers should perform only those services they are qualified to perform. If there are situations that arise where there is a need to perform services beyond the expertise of the restorer, specialized experts, whether from within or outside the company, should be used. When the service of a specialized expert is needed, restorers should hire, or recommend in a timely manner that the client hire, the appropriate specialized expert.

- Should receive clearance by specialized expert - Upon completion of the work, consider using third party verification or clearance testing, particularly in problematic situations.

Summary Table of Materials, Assemblies and Restoration Procedures

The following table describes various materials and assemblies divided into the following construction categories:

- Structural & Framing Assemblies;
- Wall & Ceiling Assemblies;
- Floors & Floor Finishes;
- Mechanical, Electrical & HVAC Systems;
- Insulation & Fireproofing; and
- Special Assemblies.

It provides summarized procedures for specific materials and assemblies, but the restorer is cautioned that this is not a comprehensive procedure for the entire project. For general procedures to follow during inspection, hazard identification, executing the drying plan and other project activities the restorer should be familiar with and in compliance with the entire standard of care and applicable regulations. In general, in the sections of this table that discuss assemblies, the reader is asked to refer to the appropriate section for specific materials noted or referred to in the assembly information.

Procedures are summarized for Category 1, 2 & 3 water sources in the order and manner listed above in Section 4.0 Description of Restoration Procedures.

Example: The procedures for a typical wall assembly that includes single-layer of gypsum board on both sides with insulation inside for Category 1 would be:

Restorability: B – generally restorable
Extraction: B – Extract water, dispose wastewater properly
C – Follow-up extraction can be needed due to seepage
Cleaning: B – Perform controlled demolition as needed
E – Detailed cleaning by damp-wiping
G – Detailed cleaning by vacuuming
K – Final cleaning using appropriate method(s)
Drying: A – Open assemblies to access pockets of saturation
B – Maintain water vapor pressure differential in all phases
Airflow: B – Apply aggressive airflow during early phase
C – Maintain sensible airflow during all phases
E – Introduce airflow within the structural cavity
Comments: Identify the type of insulation in cavity and the level of moisture. Remove materials as needed.

Table 1: Summary Table of Materials, Assemblies and Restoration Procedures

Assembly	Characteristics	Category 1	Category 2	Category 3
Structural Steel	- Structural steel (SS) has formed the framework of many commercial buildings since the latter half of the 19th century and along with the advent of reinforced concrete construction (RCC) gave rise to the modern high-rise building. - It can be the primary support structure of the building making up walls, floor and roof construction; or in conjunction with RCC can be a part of the support structure. - It is often times fire-protected using spray-on coatings, drywall cladding or mineral wool wrap. Though the steel is not generally affected by a water intrusion, fireproofing materials can be damaged if not inspected and restored properly. (See fire-proofing, multiple drywall layers or mineral wool)	Restorability: A Extraction: NA Cleaning: AEGJ Comment: inspect fire-proofing, and restore as necessary	Restorability: A Extraction: NA Cleaning: ACDEGJ Comment: inspect fire-proofing, and restore as necessary	Restorability: A Extraction: NA Cleaning: ACDEGJ Comment: inspect fire-proofing, and restore as necessary
Light-gauge Steel	- Light-gauge (LG) steel is used in the majority of commercial buildings, as well as an increasing number of residential homes. - It is roll-formed from 12-24-gauge galvanized steel into studs, tracks, U-channels, furring strips and L-headers, assembled by pop-rivets and screws. The framing has various openings to accommodate electrical and plumbing runs. These openings also allow air to readily pass within the walls and ceiling areas. - This material is generally not significantly impacted in most water intrusions, but two issues can arise: (1) the bottom floor channel can hold water, potentially needing extraction and (2) in situations where the intrusion is from sea water, the salts can corrode fasteners potentially reducing their holding ability.	Restorability: A Extraction: B Cleaning: AEGJ	Restorability: A Extraction: B Cleaning: ACDEGJ	Restorability: A Extraction: B Cleaning: ACDEGJ
Heavy-framing (e.g., timber framing)	- Timber framing, (aka post and beam construction) is the method of creating framed structures of heavy timbers joined into an assembly using various complex joining techniques, including joints, pegged mortise and tenon joints, wood pegs and bolted-through steel plates. Diagonal bracing is used to prevent racking, or movement of structural vertical beams or posts. Timber framing will often be encountered in historic buildings, older churches, schools, factories and other buildings converted from barns or warehouses. This method is most prevalent in the industrial Northeast, western mountain states and Pacific Northwest. Wood timber absorbs and releases water relatively slowly. - Timbers are produced with dimensions of greater than 5"x5" and may be kiln-dried to below 19% or may be sold without being dried.[27] - Note: in countries outside North America, timbers often refer to any wood framing, dimensional lumber.	Restorability: A Extraction: B Cleaning: GIK Drying: BC Airflow: CD	Restorability: A Extraction: B Cleaning: CDHIK Drying: BC Airflow: CD	Restorability: A Extraction: B Cleaning: CDHIK Drying: BC Airflow: CD

[27] American Softwood Lumber Standards, Product Standard 20-10 (ALSC PS20-10), National Institute of Standards & Technology (NIST), June 2010 ...

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Restorers drying saturated timber-framed buildings might encounter issues related to drying stresses created as a result of differences in radial, tangential, and longitudinal shrinkage. Timbers that are saturated should be dried slowly and monitored regularly to reduce the potential for stress cracks and damage.[28]			
Light-framing (e.g., residential wood framing)	- Light-frame construction, consists of dimensional lumber milled from softwoods (e.g., spruce, fir, pine) or structural composite lumber (SCL) manufactured by layering dried and graded wood veneers, strands or flakes with moisture resistant adhesives into blocks of material which are then re-sawn into specified sizes. [29] For restoration purposes, they are typically treated as any other solid lumber. - Dimensional and SCL lumber is assembled as vertical (e.g., studs, posts), horizontal (e.g., plates, beams, joists) and diagonal (e.g., rafters, bracing) members that gives a building most of its' vertical strength. - Wood framing normally is held together with metal fasteners, which can be subject to corrosion when wet over time, with a possible reduction in holding strength. - Wood framing can swell or warp when wet, but usually returns to its approximate size and shape when dry.	Restorability: A Extraction: B Cleaning: GIK Drying: BC Airflow: CD	Restorability: A Extraction: B Cleaning: CDHIK Drying: BC Airflow: CD	Restorability: A Extraction: B Cleaning: CDHIK Drying: BC Airflow: CD
Engineered Wood (e.g., plywood, OSB)	- Engineered woods (aka composite wood, man-made wood) are products used in the construction industry manufactured by binding wood fibers, particles or veneers together with various resins and adhesives to make structural framing members, flat panels and trim pieces for many uses. - In the construction industry they are classified as veneer-based panels (e.g., plywood), laminated veneer lumber (e.g., Microllam®, Versalam®, glulam) or composites (e.g., fiberboard, particle board, oriented strand board). - Plywood is a veneer-based product that is classified as either Exposure 1 (intended for applications not permanently exposed to weather) or Exterior plywood (suitable for repeated wetting and drying, or long-term exposure to weather).[30] - OSB is a wood composite made of three layers of wood strands that is then treated with various resins and cured under hot-presses. Generally, it has performance characteristics similar to structural plywood. - Plywood and OSB has a higher moisture resistance than most other wood composites.[31] These materials can usually be wetted and remain wet for several days before structural integrity	Restorability: B Extraction: B Cleaning: BGK Drying: ABC Airflow: BC Comments: If material is a substrate to other finish materials, check for moisture damage. If	Restorability: B* Extraction: B Cleaning: BCDHK Drying: ABC Airflow: ABC Comments: If material is a substrate to other finish materials, check for moisture damage. If	Restorability: B* Extraction: B Cleaning: BCDHK Drying: ABC Airflow: ABC Comments: If material is a substrate to other finish materials, check for moisture damage. If

[28] Wood Handbook – Wood as an Engineering Material. Forest Products Laboratory. 2010, 13-7
[29] Engineered Wood Construction Guide, The Engineered Wood Association 2011, page 29
[30] Wood Handbook – Wood as an Engineering Material. Forest Products Laboratory. 2010, page 11-7

Assembly	Characteristics	Category 1	Category 2	Category 3
	becomes an issue. - Often, subfloor materials have multiple layers (e.g., plywood over OSB). This increases the stiffness of the flooring assembly and creates a smoother surface over which finish flooring can be installed. Drying is complicated when layers of minimally porous building paper, poly or other materials are inserted between subfloor layers to minimize squeaking, to serve as a vapor barrier, or for other reasons. - *OSB or plywood can be considered semi-porous for restoration purposes.	significantly damaged and unable to dry, remove and replace.	significantly damaged and unable to dry and decontaminate, remove and replace.	damaged and unable to dry and decontaminate, remove and replace.
Engineered Wood (MDF, particle board)	- Engineered woods in this category or much less water resistant than plywood or OSB. - Particleboard (aka K3 in Canada, pressed wood) is manufactured of small particles or sawdust that are hot-pressed and sanded smooth to accept laminated plastics, veneers or paint. It can be found in floors, underlayment, furniture, countertops and cabinetry. Depending on resins used, they have very low or low moisture resistance. Generally manufactured to 4-8% MC. - Fiberboard (dry-processed) may be low, medium or high density, depending on degree of heat and pressure used. - Wood chips are wet-treated to reduce them to very small cellulosic fibers, then are bonded under pressure, offering very smooth surfaces, clean machining, but have the lowest moisture resistance of all engineered wood products. They are usually found in furniture, underlayment and ready-to-assemble cabinets. Generally manufactured to 4-8%MC. - Hardboard (wet-processed), may be tempered or un-tempered and is actually an extension of paper manufacturing technology. They have little to no added resins, using only the lignin within the fibers as a binder under heat and pressure. Tempered hardboard has added oils prior to heat pressing that provides added surface hardness and some additional moisture resistance. Hardboard can be found in prefinished paneling, house siding, floor underlayment and concrete form boards.[32]	Restorability: C Extraction: B Cleaning: BGK Drying: ABC Airflow: BC Comments: If material is a substrate to other finish materials, check for moisture damage. If significantly damaged and unable to dry, remove and replace.	Restorability: C Extraction: B Cleaning: BCDHK Drying: ABC Airflow: ABC Comments: If material is a substrate to other finish materials, check for moisture damage. If significantly damaged and unable to dry and decontaminate, remove and replace.	Restorability: C Extraction: B Cleaning: BCDHK Drying: ABC Airflow: ABC Comments: If material is a substrate to other finish materials, check for moisture damage. If damaged and unable to dry and decontaminate, remove and replace.
Brick	- Brick is usually of a sand/clay mixture with other additives that are formed, dried and fired to produce one of the strongest and longest-lasting building materials available. - Brick is primarily used as an exterior finish and therefore not a significant issue in most water intrusions. If it is a part of the interior construction it is often painted or sealed, thus retarding moisture migration into it.	Restorability: A Extraction: B Cleaning: GIJK	Restorability: A Extraction: B Cleaning: C*D*HIJK	Restorability: A Extraction: B Cleaning: C*D*HIJK

[31] Wood Handbook, Wood as an Engineering Material. Forest Products Laboratory. 2010page 11-3+
[32] Wood Handbook, Wood as an Engineering Material. Forest Products Laboratory. 2010pages 11-7+

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Though brick can be porous or semi-porous (rarely exceeding 35% porosity); due to the manufacturing process. Their pore system is irregular and twisted inhibiting moisture migration through them.[33] - If moisture has migrated deeply into the brick and accelerated drying is needed, it will usually require creating a significant water vapor pressure differential between materials and surrounding air with energy added to the materials during the falling rate drying period. Drying dense, semi-permeable materials like brick will generally take longer. - For sub-grade walls, see section below on Subgrade walls, basements.	Drying: BC Airflow: CD	Drying: BC Airflow: CD Comments: *Applies primarily to interior surfaces	Drying: BC Airflow: CD Comments: * Applies primarily to interior surfaces
Concrete Masonry Unit (i.e., CMU, structural clay tile)	- CMU may also be called cement block, cinder block or breezeblock and starts as a mixture of Portland cement, gravel, water and can contain various admixtures (e.g., air-entraining agents, water-repellants, coloring pigments). They have very low water-cement ratios and are force-dried to attain in a couple of days the hydration and strength that standard concrete achieves in a month. - They are relatively economical, versatile, and fire-resistant and have a natural sound absorbency due to the internal voids. They are used in many residential and commercial buildings and may be the primary load-bearing structure of the building in the exterior as well as interior walls. - Standard CMU blocks are porous and permeable, but are usually a part of an exterior wall that includes air/moisture barriers. If used for interior walls, it is usually painted or covered with furring channel and gypsum board. - In older buildings (1940s-60s), an occasional practice was to fill the voids in exterior CMU block walls with loose-fill insulation (e.g., perlite, vermiculite), which could significantly impact the drying approach and time. - Prior to CMUs a common building material was structural clay tile (aka structural terra cotta, speed-tile, hollow structural tile) for bearing and non-bearing walls. They were extensively used for interior walls and fireproof wrapping around steel columns in high-rise buildings, schools, government buildings, airports and high-end residential properties up until the mid-50s. They were lightweight, fireproof, quickly installed and were often finished with plaster or glazed tile. Generally, they are porous and permeable though the finish material can inhibit water migration into the material.[34]	Restorability: A Extraction: BC Cleaning: GIJK Drying: ABC Airflow: CDE Comments: If voids are filled, consider use of SCDS	Restorability: A Extraction: BC Cleaning: C*D*HIJK Drying: ABC Airflow: ACDE Comments: If voids are filled, consider use of SCDS * Applies primarily to interior surfaces	Restorability: A Extraction: BC Cleaning: C*D*HIJK Drying: ABC Airflow: ACDE Comments: If voids are filled, consider use of SCDS * Applies primarily to interior surfaces
Wall & Ceiling Assemblies				
Gypsum Board (aka wallboard,	- Gypsum board is the generic name for a wide-range of panel products that consist of a noncombustible core, composed primarily of gypsum, and a paper surfacing on the face, back and	Restorability: B	Restorability: B	Restorability: D

[33] Hall, Christopher and Hoff, William. Water Transport in Brick, Stone and Concrete 2nd Edition. (Spon Press, New York, NY 2012), 2, 8
[34] Friedman, Donald. Historical Building Construction: Design, Materials & Technology. (New York: W.W.Norton & Co, 1995). 26, 42, 58-62.

Assembly	Characteristics	Category 1	Category 2	Category 3
drywall, plasterboard, Sheetrock©	long edges. All gypsum panel products contain a calcined gypsum core; however, the facing can be a variety of different materials (e.g., paper, fiberglass mat, foil, decorative vinyl) - Gypsum board comes in standard 48" wide panels but a variety of thicknesses (e.g., 1/4", 1/2", 5/8"), lengths (e.g., 8', 10', 12'), fire-resistance ratings (Type X), sag-resistance, sound isolation ratings and core characteristics (e.g., standard, water-resistant, mold-resistant, flexible). In most residential construction, ½" is used, while in higher-end and commercial construction 5/8" is typical. [35] - In light commercial and residential construction, single-ply gypsum board systems are the most commonly used while multi-ply systems having two or more layers will often be found in commercial buildings to increase sound isolation and fire resistance. - When wet, gypsum board loses most of its structural integrity, but upon drying its strength returns, though generally becoming somewhat more brittle. In Category 1 & 2 intrusions where there is no visible swelling or nail-popping gypsum wallboard can be restorable.	Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE	Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments: When there is a question as to the level of contamination, refer to Section 10.6.7. Other issues of restorability might include materials behind the drywall, which may not be restorable.	Extraction: BC Cleaning: ABC Drying: Airflow:
Ceilings; Gypsum Board	- See Gypsum board above for material characteristics. - Sagging or completely saturated ceiling drywall is not restorable and represents a significant safety hazard since it could release and fall unexpectedly.	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE Comments:	Restorability: B Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments: When there is a question as to the level of contamination, refer to Section 10.6.7.	Restorability: D Extraction: BC Cleaning: ABC Drying: Airflow: Comments:

[35] Gypsum Association. http://www.gypsum.org/using-gypsum-board-for-walls-and-ceilings/using-gypsum-board-for-walls-and-ceilings-section-i/

Assembly	Characteristics	Category 1	Category 2	Category 3
			Other issues of restorability might include materials behind the drywall, which may not be restorable.	
Ceilings; Suspended or Lay-in Tile	- Suspended tile ceilings are usually a secondary ceiling system that includes a metal grid-work attached to the structural ceiling above with 2'x2' or 2'x4' lightweight panel fills inserted into the grids. Panels may be metal, plastic, mineral fibers or light fixtures and HVAC air grills. Additionally, fiberglass insulation or sound attenuation batts can often be installed above the ceiling tiles. - Suspended ceilings are quite common in commercial buildings as they provide sound attenuation, hide electrical/mechanical gear, facilitates re-models of office spaces and allow for quick replacement in event of water damage. - Water entering from above will usually saturate the panels, causing them to sag and drop to the floor. This can often create an overhead hazard. However, unlike many residential projects where water entering from above causes extensive damage with water migrating quickly to edges and walls; water entering above a suspended ceiling usually causes the ceiling to drop, resulting in less extensive water migration from above. - The older the installation, the greater is the likelihood of encountering asbestos. As these panels can become friable easily, replacement must be done according to all applicable regulations. - If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials.	Restorability: B*C** Extraction: Cleaning: AG Drying: AB Airflow: BC Comments: *metal, plastic or other impermeable materials **the most common tile type is mineral fiber composition which will rapidly sustain visible and structural damage, requiring replacement	Restorability: B*C** Extraction: Cleaning: A Drying: Airflow: Comments: *metal, plastic or other impermeable materials **the most common tile type is mineral fiber composition which will rapidly sustain visible and structural damage, requiring replacement	Restorability: B*D** Extraction: Cleaning: A Drying: Airflow: Comments: *metal, plastic or other impermeable materials **the most common tile type is mineral fiber composition and should not be restored
Walls; Single-layer Gypsum	- See Gypsum board above for material characteristics. - Drywall can be restorable if the water is Category 1 or 2, there is no obvious swelling, seams are intact, and there is no indication of fungal growth. Drywall should be replaced when contaminated with Category 3 water, damage is obvious (e.g., swelling, seam sagging, separation), fungal growth is present on paper coverings on either side, or when blown-in insulation materials behind the drywall have likely packed down. - In residential light-framed (e.g., wood-framed) buildings, the gypsum board is usually attached	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE	Restorability: B Extraction: BC Cleaning: ABCDHK Drying: AB Airflow:	Restorability: D Extraction: B Cleaning: ABC Drying: Airflow:

Assembly	Characteristics	Category 1	Category 2	Category 3
	with nails or screws providing a fairly good seal against water migration into the wall cavity, unless the height of water reaches several inches. - In commercial light-framed (i.e., metal-framed) buildings, the gypsum and metal framing is less tight allowing water to rise to the level inside the wall cavity to the same height as in the space. Usually, the water level inside the wall cavity will be the same as in the room.		ABCE Comments: When there is a question as to the level of contamination, refer to Section 10.6.7. Other issues of restorability might include materials behind the drywall, which may not be restorable.	
Walls; Insulated	- For description of different types of insulation see discussion in "Insulation & Fire-proofing" - Restorers should inspect walls for the presence of insulation and evaluate if drying is preferable to removal of finished wall material (e.g., gypsum board, plaster) and removal/replacement of the insulation would be quicker and more desirable. - Insulation will typically be found in all exterior walls, ceilings and sometimes under floors in crawlspaces and basements. If wet, it should be dried or replaced to return its insulating value to pre-intrusion condition. - The type of insulation present and the category of water are the primary determinants of the restorability of the insulation. Typical materials and installation methods are as follows: o Paper-faced (e.g., fiberglass, mineral wool) batts, stapled into the wood framing. If minimally wet it usually can be dried o Un-faced (e.g., fiberglass, mineral wool) batts, held by friction and poly-vapor barrier. If minimally wet, it usually can be dried o Loose-fill (e.g., fiberglass, mineral wool, cellulose) blown in after drywall installed. If wet, it usually settles, making drying difficult. If settling is significant, it can compromise the insulating quality at the top of the wall cavity, requiring replacement. o Blown-in material (e.g., fiberglass, cellulose, foam beads). If wet, it usually settles, making drying difficult. If settling is significant, it can compromise the insulating quality at the top of the wall cavity, requiring replacement. o Spray-on (e.g., expanding foam, polystyrene, urea, cellulose) is usually sprayed on prior to drywall installation and may be closed-cell or open-cell. If wet, it is recommended that the restorer inspects to determine the moisture level of the insulation and consults with a	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE Comments: Identify the type of insulation in cavity and the level of moisture; remove materials as needed	Restorability: B Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments: Identify the type of insulation in cavity and the level of moisture and contamination; remove materials as needed When there is a question as to the level of	Restorability: D Extraction: B Cleaning: ABC Drying: Airflow: Comments: Remove all contaminated materials

Assembly	Characteristics	Category 1	Category 2	Category 3
	building expert as to drying approach. Wetting of sprayed-on cellulosic insulation can cause it to release and settle. - If finished wall material (e.g., gypsum board, plaster) requires replacement, restorers should commence removal first; then properly dry exposed wood framing to the predetermined drying goal prior to new drywall replacement.		contamination, refer to Section 10.6.7. Other issues of restorability might include materials behind the drywall, which may not be restorable.	
Walls; Multiple Layers, Sound Attenuated	- See Gypsum board above for material characteristics. - Commercial construction frequently involves multi-ply systems having two or more layers of gypsum board to increase sound isolation, fire rating or abuse-resistance. Multiple layers of gypsum board present additional challenges to the restorer. - Restorers should evaluate the particular construction in order to determine the best drying/restoration approach. - If finished wall material (e.g., gypsum board, plaster) requires replacement, restorers should commence removal first; then properly dry exposed wood framing to the predetermined drying goal prior to new drywall replacement. - Multiple wet layers of materials can impede the drying effort. In multi-layer systems, if removal is needed it is recommended to be done in a staggered manner. For example, the outer layer might be cut at 4' above finished floor and the 2nd layer cut at 2' above finished floor. This facilitates the replacement and refinish of the drywall to restore fire-resistance, etc. - Sound-attenuation materials installed in walls are porous and difficult to dry. Unless minimally wet, it can require removal and replacement of the gypsum and sound attenuation layers.	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE Comments:	Restorability: C Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments:	Restorability: D Extraction: B Cleaning: ABC Drying: Airflow: Comments: Remove all contaminated materials
Walls; Fire-rated	- Commercial construction frequently involves the use of fire-rated gypsum board, multiple layers of gypsum board or insulation to achieve a 1, 2 or 3 hour fire rating. These requirements present additional challenges to the restorer as the need to dry the assembly exists as well as the requirement to renew the fire rating. - Usually this can be done by minimally invading the drywall layers, then patching them with fire-rated caulk or patching methods. Restorers are referred to the Gypsum Association's bulletin GA-225-08 for details. - Fire-rated walls are commonly determined by their location (e.g., between living space & garage, between offices & warehouse areas, between tenants, around stairwells, elevators and mechanical rooms). They can also be identified from a review of building construction plans	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE Comments: Any opening of fire-rated	Restorability: B Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments: Any opening	Restorability: D Extraction: B Cleaning: ABC Drying: Airflow: Comments: Remove all contaminated

Assembly	Characteristics	Category 1	Category 2	Category 3
	and sometimes have labels placed directly on the walls, usually in inconspicuous locations. - If finished wall material (e.g., gypsum board, plaster) requires replacement, restorers should commence removal first; then properly dry exposed wood framing to the predetermined drying goal prior to new drywall replacement.	walls shall be properly repaired to restore the fire rating.	of fire-rated walls shall be properly repaired to restore the fire rating.	materials. Any opening of fire-rated walls shall be properly repaired to restore the fire rating.
Walls; Plaster	- Plaster finishes are usually gypsum-based or cement-based products that can be applied to any of the following base-products (1) wood-lath, (2) expanded metal lath or (3) gypsum lath (a type of gypsum wallboard). - In historical building, wood-lath substrates are often encountered requiring a more controlled drying process to prevent rapid shrinkage and potential damage to the plaster. This issue does not exist on metal lath or gypsum-based plasterboard substrates. - Plaster finishes are semi-porous and semi-permeable, meaning they saturate slowly and dry slowly. Plaster does not support microbial growth but the binder (e.g., horse-hair) or debris that may be present on the surface or inside the wall cavity can. Water that migrates into the wall system can be removed using structural cavity drying equipment on negative pressure. Scarifying the outer surface of the plaster can sometimes accelerate the evaporation process. - Additionally, restorers are cautioned that materials sometimes present in cementitious-based plaster mix can cause non-penetrating meters to give misleading readings that indicate excessive moisture. - If finished wall material (e.g., gypsum board, plaster) requires replacement, then properly dry exposed wood framing to the predetermined drying goal prior to new drywall replacement	Restorability: A Extraction: BC Cleaning: ABEGK Drying: ABC Airflow: CDE Comments:	Restorability: A Extraction: BC Cleaning: ABCDEIK Drying: ABC Airflow: ACDE Comments:	Restorability: BC* Extraction: BC Cleaning: ABCDEIK Drying: ABC Airflow: ACDE Comments: *For most gypsum lath substrates
Walls; Tile, Marble, Ceramic, Terra-cotta, Quarry, Travertine	- Ceramic tile is often installed on the walls of bathrooms and kitchens where a durable and moisture-resistant finish is needed. Ceramic tile on walls can be installed over a substrate of expanded metal lath, water-resistant gypsum lath or cement board. Tile can be installed over water-resistant gypsum board (i.e., green board) or even standard gypsum board. In many cases the substrate is not substantially damaged after water intrusions due to the semi-porous and semi-permeable nature of the finish material. - If the wall cavity requires drying, structural cavity drying systems are can be used to access the area with air or opening the finished wall on the opposite side of the cavity.	Restorability: A Extraction: B Cleaning: AEIK Drying: BC Airflow: CDE Comments:	Restorability: A Extraction: B Cleaning: ACDEIK Drying: BC Airflow: ACDE Comments:	Restorability: B* Extraction: B Cleaning: ACDEIK Drying: BC Airflow: ACDE Comments: *The restorability of the material

Assembly	Characteristics	Category 1	Category 2	Category 3
				can depend on the restorability of the substrate
Wallpaper (e.g., Vinyl, Textile)	- Wallpaper comes in a variety of materials (e.g., linen, grass-cloth, vinyl) and is usually pre-pasted and can be semi- or non-permeable. - Wallpaper generally retards moisture evaporating to the room-side. Drying approaches that can be considered by the restorer include but are not limited to: o Removing it by carefully peeling it upward and pinning it thus exposing the wet substrate to dry air o Using structural cavity drying equipment to deliver dry, warm air to the inside of the wall cavity o Perforating the wall covering to facilitate evaporating moisture o Gaining access to the backside of the wet gypsum board layer by opening or removing part of the opposing side of the wall cavity.	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE Comments:	Restorability: B Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments:	Restorability: D* Extraction: B Cleaning: ABC Drying: Airflow: Comments: *The restorability of the material can depend on the restorability of the substrate
Paneling; Wood	- Paneling varies in terms of materials and finishes, and the particular construction details will determine the method of restoration and the likelihood of success. Restorers should inspect the construction to determine the best drying approach. - Paneling that is essentially vinyl wallpaper laminated to inexpensive lauan plywood will generally not be suitable for restorative drying. - Paneling that begins with higher-quality plywood and then is stained and finished on-site can be restored if paneling is structurally sound. Restorers can remove the plywood paneling intact, dry the wall behind and the paneling separately, and then, reinstall paneling sections. It may also be possible to disengage paneling at seams and the bottom of panels for drying. Often, restoration decisions are influenced by the cost or availability of replacement materials.	Restorability: B Extraction: BC Cleaning: ABEGK Drying: AB Airflow: BCE Comments:	Restorability: B Extraction: BC Cleaning: ABCDHK Drying: AB Airflow: ABCE Comments:	Restorability: C* Extraction: B Cleaning: ABC Drying: Airflow: Comments: Remove all contaminated materials *The restorability of the material can depend on the restorability of the substrate

Assembly	Characteristics	Category 1	Category 2	Category 3
Paint (all types)	- Different coatings and multiple layers of coatings can significantly retard the drying effort of the assembly. Following are examples of the permeance ratings of different coatings. - Perm* ratings examples: o ½" gypsum board, unfinished – 34.2 perms o ½" gypsum board, 2-coats flat latex – 28.3 perms o ½" gypsum board, 2 coats gloss enamel (oil-based) – 1.0 perm o 5/8" gypsum board, unfinished – 26.6 perms[36] *Perms are grains per sq. ft. per inch of water vapor pressure difference per hour. Tests performed according to ASTM-E96 (desiccant method).	Restorability: B Cleaning: EGK *The restorability of the material can depend on the restorability of the substrate	Restorability: B Cleaning: DEGHK *The restorability of the material can depend on the restorability of the substrate	Restorability: B Cleaning: DEGHK *The restorability of the material can depend on the restorability of the substrate
Floors & Floor Finishes				
Carpet (all types)	- Carpet is the most common floor covering in homes and businesses and is manufactured in a variety of types (e.g., tufted, woven, PVC-backed tile, unitary). In most residential installations tufted or woven carpet is stretch-installed over cushion. PVC-backed tile can be loose-laid or glued to the substrate. Unitary carpet does not have a secondary backing but has an integrated cushion and is normally glued down in commercial installations. (For more information on carpet and installations refer to the latest edition of *IICRC S100 Standard and Reference Guide on Professional Cleaning of Textile Floorcovering*) - Examples for carpet installations can include but are not limited to carpet/pad installed over hardwood-strip flooring, plywood or OSB. It is also not unusual to find carpet installed over existing floor finishes like vinyl, linoleum or finished hardwood. - Most carpets in homes consist of an upper layer of pile attached to primary and secondary backing materials. The pile may be natural fibers (e.g., wool, cotton, silk) or synthetic (e.g., nylon, polypropylene, polyester). The carpet can be installed over a cushioned pad/underlayment (e.g., jute, rubber, urethane) or can be glued directly to the substrate (e.g., concrete, plywood). - Restorers should determine the particular construction, layers and present condition of the affected materials to determine their salvability and appropriate drying method. - Restorers should evaluate the installation of the carpet and pad system to determine the extent of water intrusion under the carpet and pad and into the substrate. Some carpet installations (e.g., direct glued, closed cell polyurethane, rubber) can inhibit water migration into the subfloor. Other materials or installations can allow rapid permeation of water into the substrate. - The substrate should be evaluated to determine the extent of cleaning and drying needed to	Restorability: B Extraction: BC Cleaning: AFGK Drying: B Airflow: BC Comments: Ensure humidity control prior to aggressive air movement. Can consider in-place drying, full-floating or partial floating techniques	Restorability: B Extraction: BC Cleaning: ABCDFK Drying: B Airflow: BC Comments: Ensure humidity control prior to aggressive air movement. The pad should be removed and restorers can consider on location drying of carpet.	Restorability: D Extraction: B Cleaning: N/A Drying: N/A Airflow: N/A Comments: After carpet & pad are removed, evaluate the substrate for drying and cleaning.

[36] Leavitt, William and Grupe, Bob editors. The Gypsum Construction Handbook – 5th Edition. (USG Corporation, Chicago, IL, 2000). 477.

Assembly	Characteristics	Category 1	Category 2	Category 3
	facilitate reinstallation of the finished floor. - The materials themselves may not be damages, but their presence can slow drying of more critical materials or assemblies behind or below them. - The carpet or the underlay may be salvable but if its presence prevents the drying of the substrate, the undelay may be removed and carpet partially floated to facilitate drying. - When wet, carpet can lose 80-85% of its structural integrity and if handled improperly can delaminate. Significant areas of delamination can require replacement. - Conditions that can indicate removal or replacement of the carpet can include but not be limited to: o Carpet is delaminated, deteriorated, or shows widespread staining o Sub-floor is porous or in poor structural condition o Sub-floor requires specialized drying techniques o Prolonged drying of carpet presents unusual hardship to occupants o Type of installation: (1) stretched-in carpets over pad, (2) glued-down carpet with integrated pad or (3) glued-down carpet tiles with integrated pad) - Due to carpet's porosity and open texture, aerosolization of soils and contaminants can be a particular problem during the early stages of drying. Restorers can minimize this issue by (1) installing AFDs (2) wet extracting the face yarns of carpets or (3) minimizing airflow at the surfaces. - See Appendix A for instruction on proper carpet disengagement and reinstallation.			
Carpet Cushion (Pad, Underlay)	- Carpet cushion (pad, underlay) is any material placed under carpet to increase insulation, sound absorption, wear life (resiliency), and aesthetics (soft feel) when walked upon. The three major categories are: (1) urethane or polyurethane, (2) rubber or (3) felt or fiber. - The carpet cushion can have a semi-permeable or non-permeable skin on top that can inhibit the drying process. - Conditions that can indicate removal or replacement of the cushion can include but not be limited to: - Carpet cushion is a non-permeable layer (e.g., polyethylene film) or is organic (e.g., hair, jute) - Carpet cushion is contaminated with Category 2 or 3 water	Restorability: B Extraction: BC Cleaning: AFGK Drying: B Airflow: BC Comments: Ensure humidity control prior to aggressive air movement. Can consider in-place drying, full-	Restorability: C Extraction: B Cleaning: ABCDFK Drying: B Airflow: BC Comments: Contain debris to prevent potential cross-contamination	Restorability: D Extraction: B Cleaning: N/A Drying: N/A Airflow: N/A Comments: Contain debris to prevent potential cross-contamination

Assembly	Characteristics	Category 1	Category 2	Category 3
		floating or partial floating techniques. Salvability may be affected by the ability to dry the substrate		
Concrete; Standard & Lightweight	- Concrete is a mixture of cement (e.g., Portland cement), sand and aggregate (e.g., crushed rock, recycled concrete) with water in varying proportions and can also contain various chemical admixtures (e.g., plasticizers, retarders, sealers). Once placed, concrete hardens by hydration, not drying. The apparent drying that takes place during the first several weeks after placement is actually a result of the consumption of water due to chemical reactions. After that initial hydration, excess construction water is dried through capillary action, vapor diffusion and evaporation at the surface. This hydration actually continues for several years resulting in an increase in strength and a decrease in the porosity and permeability of the hardened mass.[37] - Concrete can form many different components of a building (e.g., below-grade foundation structure, slabs-on-grade, elevated floors, walls, roof structure), with each component having different mix characteristics. - While concrete is considered a semi-porous building material, its ability to sorb/desorb water depends on many variables, most of which the restorer may not be able to easily determine. Variables that impact this include but are not limited to the: [38] [39] [40] o Presence or lack of vapor barrier under the concrete o Original water/cement ratio o Chemical admixtures o Degree of air-entrainment or compaction at placement o Top-coat sealers applied o Curing method used after placement o Age of the concrete - Prior to applying restorative drying techniques to concrete floors, it is recommended that restorers evaluate if moisture has actually migrated into the floor and if so, if that is a problem that needs to be addressed. Restorers can do a quick test with a cup of water poured on the floor	Restorability: A Extraction: ABC Cleaning: AEIJK Drying: BC Airflow: CD Comments:	Restorability: A Extraction: ABC Cleaning: ACDEIJK Drying: BC Airflow: ACD Comments:	Restorability: A Extraction: ABC Cleaning: ACDEIJK Drying: BC Airflow: ACD Comments:

[37] Kanare, Howard. Concrete Floors and Moisture. (Portland Cement Association, Skokie, IL, 2005) 29-31.
[38] Suprenant, Bruce, Malish, Ward. “Are Your Slabs Dry Enough for Floor Covering.” Concrete Construction. (August 1993): 671-674.
[39] Hedenblad, Goran. Drying of Construction Water in Concrete. (Swedish Council for Building Research, Stockholm, Sweden, 1997). Note, 10-11.
[40] Kanare, Howard. Concrete Floors and Moisture. (Portland Cement Association, Skokie, IL, 2005) 32-33, 38.

Assembly	Characteristics	Category 1	Category 2	Category 3
	to determine the sorption characteristics of the concrete and if a topcoat sealer has been applied. - If restorers quickly minimize the moisture available, through initial extraction and rapid evaporation followed by ventilation or dehumidification, they can typically return concrete to acceptable drying goals while performing other drying efforts. - Water can migrate under floor coverings, around the perimeter of installations or between concrete and framing. The hidden issues with wet concrete can become evident well after the project is completed and new finish materials have been reinstalled. Flooring and the sub-structural assemblies should be inspected to determine the extent of moisture migration and/or damage - In situations where water has migrated deeply into the concrete and restorative drying must be done to facilitate the reinstallation of moisture sensitive floor coverings, it should be expected that drying times could be significantly longer.[41] - Concrete is not a good substrate for microbial growth as it is inorganic, highly alkaline, and typically cooler (core temperature of 55-65°F in most parts of the country). Growth that may appear to be fungal growth is either (1) feeding on an organic coating, adhesive or dirt buildup, or (2) is not fungal growth at all but is crystalized salts called efflorescence that has migrated through the concrete to the surface. [42] - Restorers are cautioned that measuring and validating that a concrete floor is sufficiently dry to ensure suitability for the installation of moisture sensitive or impervious floors (e.g., hardwood, bamboo, roll vinyl, VCT) should be done by a competent and qualified expert in accordance with applicable standards (e.g., ASTM F1969, F2170) in order for the customer's floor to be warranted.[43] - Measuring moisture levels in concrete can be performed either qualitatively (e.g., plastic sheet method, radio-frequency meter) or quantitatively (moisture vapor emission rate, relative humidity measurement). It is recommended that restorers use a method that will achieve end results that are acceptable with the customer. - Lightweight concrete is typically used for elevated floors and can be installed on plywood or ribbed steel decking. The mixed aggregate (e.g., slag, perlite, vermiculite, expanded shale) can hold much more water than ordinary aggregates causing drying to take as much as twice as long to achieve drying goals.[44] - General comments about rate of concrete drying: [45]			

[41] Hall, Christopher and Hoff, William. Water Transport in Brick, Stone and Concrete 2nd Edition. (Spon Press, New York, NY 2012)276-277.
[42] Kanare, Howard. Concrete Floors and Moisture, (Portland Cement Association 2005) 9, 25.
[43] Kanare, Howard. Concrete Floors and Moisture, (Portland Cement Association 2005) 43.
[44] Kanare, Howard. Concrete Floors and Moisture, (Portland Cement Association 2005) 61.
[45] Suprenant, Bruce, Malish, Ward. "Are Your Slabs Dry Enough for Floor Covering." Concrete Construction. (August 1993): 671-674.

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Concrete slabs on-grade tends to release moisture more slowly than most other building materials. - Lightweight and post-tensioned concrete releases moisture more slowly than slabs on-grade.			
Vinyl Sheet & Vinyl Composition Tile	- Resilient vinyl floors can be in roll sheets (e.g., 6', 9', 12' widths), individual tiles (e.g., 9"x9", 12"x12", 18"x18") or in planks (e.g., simulated hardwood sizes) and may be glue-down, self-adhesive or snapped together dry. The types of installations will generally determine the degree of water migration under the floor. - Moisture does not generally damage vinyl material directly but can soften adhesives used in the installation. Restorers should evaluate the degree of migration of the water and the degree of damage to the substrate or adhesive. Moisture that has migrated to large areas of the subfloor can indicate removal of the finish floor and restoration or replacement of the subfloor material. - Subfloor materials can be layered (e.g., particle board over plywood, hardboard over OSB) to increase the stiffness of the floor assembly or to provide a smooth surface for application of the finish floor. If one or both layers are wet, both materials can require removal and replacement - The materials themselves may not be damaged, but their presence can slow drying of more critical, porous or semi-porous materials or assemblies below them. Examples for vinyl sheet or tile installations can include but not be limited to materials laid over hardboard underlayment, hardwood-strip flooring or OSB. The adhesives used during their installation can also be softened (depending on the type adhesive), causing release from the substrate. - Non-penetrating moisture meters can be used to detect pockets of moisture as much as 2" deep under non-porous flooring (e.g., roll vinyl, VCT). - In older structures restorers should consider the possible presence of asbestos in flooring tile (often 9" square), sheet vinyl backings and adhesives. Asbestos-containing material (ACM) in reportable quantities shall be handled with appropriate asbestos abatement procedures. Disturbing or removing ACM normally requires the services of a licensed asbestos abatement contractor. - If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials.	Restorability: B Extraction: B Cleaning: BEK Drying: AB Airflow: C Comments: Inspect to determine if water has migrated under finish floor. If so, can it be dried properly? If not, then floor should be removed and substrate further evaluated for drying and cleaning.	Restorability: B Extraction: B Cleaning: BCDEK Drying: AB Airflow: C Comments: Inspect to determine if contaminated water has migrated under finish floor. If so, then floor should be removed and substrate evaluated for drying, cleaning and sanitizing.	Restorability: C Extraction: B Cleaning: BCDEK Drying: AB Airflow: C Comments: Inspect to determine if contaminated water has migrated under finish floor. If so, then floor should be removed and substrate evaluated for drying, cleaning and sanitizing.
Hardwood; Residential	- Hardwood floors in residential installations are generally manufactured to standards produced by: o Maple Flooring Manufacturers Association (MFMA) for hard maple, beech and birch;	Restorability: B Extraction: BC	Restorability: B Extraction: BC	Restorability: C Extraction: BC

Assembly	Characteristics	Category 1	Category 2	Category 3
	or o National Oak Flooring Manufacturers Association (NOFMA) for oak, ash, hickory and pecan. - Standard thicknesses for residential hardwoods range from 3 /8" (10mm) to 33/32" (26mm) and may have been installed prefinished or unfinished.[46] Restorers performing reconstruction are cautioned to follow all manufacturers' guidelines pertaining to acclimation time in the built environment and ensuring proper moisture contents of substrate and flooring material. - Solid hardwoods are typically kiln-dried to 6 to 9% MC when manufactured, but may change over the course of storage, transport and acclimation on-site. [47]Hardwoods can be 5-12%MC when installed depending on locale and seasonal conditions. - All hardwood floors experience moderate seasonal moisture content swings as a result of normal climate changes during the year. From summer to winter, swings of 3-4% MC are typical, depending on location. In a 15' wide room, this can amount to an overall expansion/contraction of the floor by as much as 2". As long as proper acclimation and floor installation is done, this movement usually presents little more than minor creaking sounds. - Solid hardwood flooring is generally nailed to a subfloor material, usually plywood or can be applied to a "sleeper" system of dimensional lumber (e.g., 1x4, 2/3, 2x4). Within the system there will often be a vapor barrier (e.g., polyethylene film, rosin paper) to reduce moisture migration into the finished floor. Most hardwood flooring has milled grooves on the unfinished side to help reduce deformations as moisture content changes. - Once the drying goals have been achieved additional time may be required to allow for re-acclimation to reach normal moisture content prior to refinishing. - Wood flooring can have various issues occurring after a water intrusion including but not limited to:[48] o Compression and Shrinkage gaps o Cupping and/or Crowning o Finish Issues o Mold and Dry Rot (a long-term potential issue) o Performance problems (e.g., bouncing, squeaking) o Heaving or buckling - The construction of the floor, including the presence of interstitial spaces, vapor barriers, and the general condition of the existing finish and floor will help determine the approach to drying. It is recommended that restorers consult with flooring inspectors, installers or refinishers when needed.	Cleaning: ABEGK Drying: ABC Airflow: CDE Comments:	Cleaning: ABCDEGK Drying: ABC Airflow: ACDE Comments: If Category 2 water has collected in interstitial spaces under the floor, finish flooring should be removed and subfloor evaluated for damage. If the substrate can be cleaned and sanitized, it should be dried to acceptable moisture content prior to replacement of finish flooring.	Cleaning: ABCDEGK Drying: ABC Airflow: ACDE Comments: If Category 3, water has collected in interstitial spaces under the floor, finish flooring should be removed and subfloor evaluated for damage. If the substrate can be cleaned and sanitized, it should be dried to acceptable moisture content prior to replacement of finish flooring.

[46] Wood Handbook 2010, 6-6.
[47] Wood Handbook 2010. Page 13-13.
[48] MFMA Bulletin on Moisture Infiltration, 2010.

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Methods of drying solid hardwood floors can include, but are not limited to: - Circulating air in the interstitial space under the hardwood floor, usually perpendicular to the lay of the installation and parallel to the lay of the "sleepers", if present. - Forcing air parallel to and through the milled grooves of the hardwood. - Circulating air across the surface of the floor - Applying negative air pressure to draw air through the floor assembly - Removal of baseboard, thresholds or other trim may be necessary to gain access to interstitial spaces.			
Hardwood; Gymnasium & Sports Floors	- Hardwood floors in gymnasium and sports floor installations are constructed substantially different than typical residential hardwood floors. They are generally manufactured to standards produced by the Maple Flooring Manufacturers Association (MFMA) for northern hard maple and makeup 70% of all sports floors in North America. Less common hardwoods used in sports floors are birch and beech. To meet MFMA performance ratings, the maple is kiln dried to 6-9% MC.[49] - High-performance hardwood floors can be found in basketball courts, fitness centers, racquetball/handball courts and theater stages, with each having unique construction methods. It is recommended that the original floor manufacturer, if known, be consulted on high-performance sports floors prior to attempting drying or restoration. - There are many methods of constructing indoor sports floors with new types being introduced yearly. Sports floors are installed as floating (i.e., unattached to the substrate) or anchored (i.e., attached to the substrate). Additionally, they can be manufactured and installed in such a way to allow air circulation under the floor or may have no interstitial space between it and the substrate. - The construction of the floor, including the presence of interstitial spaces, vapor barriers, and the general condition of the existing finish and floor will help determine the approach to drying. It is recommended that restorers consult with flooring inspectors, installers or refinishers when needed. - It is a common practice during floor installation to place metal washers temporarily between boards about every 24"to 48" of the width of the floor to give the hardwood additional expansion room. During seasonal changes, these very small changes help hide the overall expansion and contraction of the floor. By looking for these washer row gaps, a restorer can get a better sense of the degree of expansion of the floor. - All hardwood floors experience moderate seasonal moisture content swings as a result of normal climate changes during the year. From summer to winter, swings of 3-4% MC are	Restorability: B Extraction: BC Cleaning: ABEGK Drying: ABC Airflow: CDE Comments:	Restorability: B Extraction: BC Cleaning: ABCDEGK Drying: ABC Airflow: ACDE Comments: If Category 2, water has collected in interstitial spaces under the floor, finish flooring should be removed and subfloor evaluated for damage. If the substrate can be cleaned and sanitized, it should be dried to acceptable	Restorability: C Extraction: BC Cleaning: ABCDEGK Drying: ABC Airflow: ACDE Comments: If Category 3, water has collected in interstitial spaces under the floor, finish flooring should be removed and subfloor evaluated for damage. If the substrate can be cleaned and sanitized, it should be dried to acceptable

[49] National Wood Flooring Association (NWFA) website, www.nwfa.org

Assembly	Characteristics	Category 1	Category 2	Category 3
	typical, depending on location. In a regulation high school or college basketball court, (i.e., 50' wide), this can amount to an overall expansion/contraction of the floor by 7" or more if environment is uncontrolled. However, in most facilities climate-control is sufficient to minimize this type of fluctuation. - Wood flooring can have various issues occurring after a water intrusion including but not limited to:[50] o Compression and Shrinkage gaps o Cupping and/or Crowning o Finish Issues o Mold and Dry Rot (a long-term potential issue) o Performance problems (e.g., dead spots, bouncing, squeaking) o Heaving or buckling - Recommended methods of drying hardwood sports floors include but are not limited to: o Circulating air in the interstitial space under the hardwood floor, usually perpendicular to the lay of the installation and parallel to the lay of the "sleepers", if present. o Circulating air across the surface of the floor o Applying negative air pressure to draw air through the floor assembly - In some installations removal of floor trim may be necessary to gain access to interstitial spaces. It is recommended that restorers consult with flooring inspectors, installers or refinishers when needed.		moisture content prior to replacement of finish flooring.	moisture content prior to replacement of finish flooring.
Engineered Flooring; Hardwood, Cork, Bamboo	- Engineered hardwood flooring has an appearance similar to solid hardwood but is a multi-ply product that has a thin veneer of hardwood for the top layer that is factory-prefinished. - Typically, it is manufactured in planks, ¼"to ½" thick and 3"-6" wide. It has better dimensional stability than solid hardwood and can be (1) nailed to a wood substrate, (2) glued to various substrates or (3) snapped together to create a floating floor. - In the event of a water intrusion, it will tolerate moisture similar to plywood and if dried properly can be restorable. While the edges may swell slightly, the boards will not significantly cup and deform like solid wood. This slight swelling of the edges may or may not be acceptable to the customer. However, if water stays for extended period it can delaminate, requiring replacement - Cork is made from the bark of the cork oak tree, being repeatedly harvested every nine years. During manufacturing it is made into (1) tiles that can be glued down, (2) planks that can be glued-down or (3) planks that can be snapped together for a floating floor. Adhesives used for gluing down are usually urethane-based.	Restorability: B Extraction: B Cleaning: BEGK Drying: BC Airflow: CE Comments: Regardless of Category of water, If flooring swells, it is unrestorable.	Restorability: B* Extraction: B Cleaning: BCEHK Drying: BC Airflow: ACE Comments: *Cork is generally unrestorable for Category 2 & 3 water.	Restorability: C Extraction: B Cleaning: BCEHK Drying: BC Airflow: ACE Comments: Inspect to determine if contaminated water has migrated under finish floor. If so, then floor

[50] MFMA Bulletin on Moisture Infiltration, 2010

Assembly	Characteristics	Category 1	Category 2	Category 3

	- Bamboo is made from fast-growing bamboo grass and has many physical similarities to hardwoods. The manufactured bamboo flooring commonly found in North American markets is highly processed; creating a floor that is as hard or harder than most solid hardwoods on the market. They are available in planks that can be glued down or snapped together for a floating floor.
	- While most of the adhesives used for engineered flooring installations will hold up to water intrusions without softening, in a delayed response, the expansion or contraction of the wood can cause bond failure of the adhesive.[51]
	- Generally, engineered floors are not suitable for field refinishing.
	- Methods of drying engineered flooring can include, but are not limited to:
	  ○ Circulating air across the surface of the floor
	  ○ Applying negative air pressure to draw air through the floor assembly
				should be removed and substrate evaluated for drying, cleaning and sanitizing.

Laminate Flooring	- Laminate flooring has been a popular flooring material since its introduction in North America in the mid-90s. It is a multi-layered product/assembly consisting of (from bottom to top) an underlayment (e.g., thin foam, red rosin paper), a layer of melamine resin, a thicker layer of high-density fiberboard (the core), a decorative layer (e.g., wood, marble, stone) and the top transparent, protective wear layer. It either snaps or glues together and floats unattached to the substrate. - It does expand/contract with seasonal humidity changes, but as long as the installation was proper (i.e., acclimation to room environment, proper expansion gap around edges) and it is kept reasonably dry and maintained, it can give good service in average residential use.[52] - Some grades of laminate flooring add higher resin content, waxes and oils to slow moisture absorption. Most laminate product maintenance instructions discourage wet mopping or "submersion cleaning." Therefore, water intrusions can quickly lead to deterioration. Laminate products do not respond well to the vacuum floor drying systems used on other hard surface floors.[53] - The surface layer of laminate flooring systems are essentially non-porous; however, moisture can seep underneath and between seams and from around the perimeter. Because the fiberboard core is hygroscopic, water absorbed around the edges of planks or tiles can cause swelling and delaminating. Further, laminate flooring usually is installed over a cushion material or a plastic vapor barrier on concrete slabs. Restorers should check for subsurface moisture using an appropriate meter. If there is trapped moisture present in cushioning material or the subfloor, the flooring material should be replaced.	Restorability: C* Extraction: B Cleaning: BEGK Drying: BC Airflow: CE Comments: * If there is no physical or dimensional change, laminate flooring may be restorable.	Restorability: C Extraction: B Cleaning: BCEHK Drying: BC Airflow: ACE Comments: Inspect to determine if contaminated water has migrated under finish floor. If so, it is recommended the floor be removed and substrate evaluated for drying, cleaning and	Restorability: C Extraction: B Cleaning: BCEHK Drying: BC Airflow: ACE Comments: Inspect to determine if contaminated water has migrated under finish floor. If so, then floor should be removed and substrate evaluated for drying, cleaning and sanitizing.

[51] Moore, Mickey, Independent Wood Flooring Consultant (past Technical Director for the WFMA) personal interview, November 29, 2012.
[52] North American Laminate Flooring Association installation guide and website, www.nalfa.com.
[53] Moore, Mickey, Independent Wood Flooring Consultant (past Technical Director for the WFMA) personal interview, November 29, 2012.

Assembly	Characteristics	Category 1	Category 2	Category 3
			sanitizing.	

Tile; Wood Parquet	- Wood parquet flooring can be encountered in several styles and typically offer a long-term service life. Types of installation can include:
	  o Traditional solid wood strips (e.g., 3"x10", 4"x12") individually laid/glued then finished
	  o Solid wood pre-assembled into tiles glued down (unfinished and prefinished)
	  o Recycled solid wood strips and tiles (installed then refinished)
	  o Engineered wood tiles (prefinished only)
	- Parquet floors can be installed over concrete, resilient flooring, wood flooring, plywood/OSB and ceramic tile. For many years the adhesives used to install parquet was a bitumen product but in recent years manufacturers are specifying waterproof urethanes or polyvinyl acetates (PVA), a water-based adhesive.
	- While most of the adhesives used for engineered flooring installations will hold up to water intrusions without softening, in a delayed response, the expansion or contraction of the wood can cause bond failure of the adhesive.
		Restorability: B
		Extraction: BC
		Cleaning: BEGK
		Drying: BC
		Airflow: CDE
		Comments:
			Restorability: C*
			Extraction: BC
			Cleaning: BCEGK
			Drying: BC
			Airflow: ACDE
			Comments: Inspect to determine if contaminated water has migrated under the finished floor. If so, it is recommended the floor be removed and substrate evaluated for drying, cleaning and sanitizing.
			
			* If there is no physical or dimensional change, parquet flooring may be restorable.
				Restorability: C*
				Extraction: BC
				Cleaning: BCEGK
				Drying: BC
				Airflow: ACDE
				Comments: Inspect to determine if contaminated water has migrated under the finished floor. If so, it is recommended the floor be removed and substrate evaluated for drying, cleaning and sanitizing.
				
				* If there is no physical or dimensional change, parquet flooring may be restorable.

Tile; Ceramic, Terra-cotta, Quarry, Travertine	- Ceramic tile is manufactured from ceramic, stone or glass and may be glazed or unglazed. It is then fired in order to harden and can be used in floors, walls and bathrooms as a non-porous finish material.	Restorability: B Extraction: B	Restorability: B Extraction: B	Restorability: B Extraction: B

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Terra cotta is a clay-based material that is typically unglazed, and therefore porous to semi-porous requiring regular sealing. These low-density natural clay tiles are fired at a low temperature and are typically made in Mexico or Europe. - Quarry tile is a clay or shale-based material that is similar in appearance to terra cotta but much denser and more water/stain resistant. It is fired at higher temperatures than terra cotta and is used on floors. It is typically sealed periodically. - Travertine is a type of semi-porous limestone and is characterized by pitted holes and troughs that are usually filled with grout and sealed to provide a semi-porous finish. It is most used as tile floors or countertops. - With stone or tile flooring installed over wood subflooring materials, restorers can introduce hot, low-humidity air below the subfloor as well. - When tile is in place over a concrete or stone substrate, it is relatively moisture-resistant, especially when installed using mud-bed (mortar) methods. However, when installed over wood subfloor materials (plywood, OSB, particle board), or when using thin-set or mastic installation methods, it is often less resistant to extended exposure to water. - Some ceramic tile materials are permeable or semi-permeable, permitting some evaporation through the tile itself. Others, such as glazed or porcelain types, are more or less non-permeable, meaning water trapped in the substrate or under tiles can escape only through grout lines. Removing grout or grout sealants by a specialized flooring professional can help speed drying, although this can be difficult to accomplish without damaging tiles. - Efflorescence (accumulation of dissolved salts on the surface of tile or grout) often creates challenges when drying ceramic tile installations.	Cleaning: ABEK Drying: BC Airflow: CD Comments: If water has migrated under the flooring, evaluate the flooring and substrate for drying. If the floor is accessible from underneath, warm, dry air can be introduced.	Cleaning: ABCDEK Drying: BC Airflow: CD Comments: If water has migrated under the flooring, evaluate the flooring and substrate for drying, cleaning and sanitizing. If the floor is accessible from underneath, warm, dry air can be introduced.	Cleaning: ABCDEK Drying: BC Airflow: CDE Comments: If water has migrated under the flooring, evaluate the flooring and substrate for drying, cleaning and sanitizing. If the floor is accessible from underneath, warm, dry air can be introduced.
Tile; Asbestos	- When left intact and undisturbed, asbestos containing materials do not pose a health risk to people working or living in buildings. Asbestos containing material is not generally considered to be harmful unless it is releasing dust or fibers into the air where they can be inhaled or ingested. Tiles free of asbestos cannot be distinguished by their size alone – although asbestos tiles were commonly manufactured in 9-inch squares, before 1980. - Asbestos pipe and boiler insulation does not present a hazard unless the protective canvas covering is cut or damaged in such a way that the asbestos underneath is actually exposed to the air - *If restorers encounter ACM or PACM they shall stop activities that can cause the materials to become friable or aerosolized (e.g., dry sweeping, scraping, breaking). A qualified asbestos abatement contractor or Class III-Trained Employee shall be used to perform the abatement. Many states require that licensed inspectors perform asbestos inspections. - For more background information, refer to section below on Asbestos Containing Material. - If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are	Restorability: B* Extraction: B Cleaning: EIK* Drying: B Airflow: C Comments: * See Characteristics column. Restorers should check the substrate for moisture	Restorability: B* Extraction: B Cleaning: EIK* Drying: B Airflow: C Comments: * See Characteristics column. Restorers should check the substrate for moisture	Restorability: B* Extraction: B Cleaning: EIK* Drying: B Airflow: C Comments: * See Characteristics column. Restorers should check the substrate for moisture

Assembly	Characteristics	Category 1	Category 2	Category 3
	encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials.	damage. If it is wet and requires removal, qualified abatement personnel shall be used. Drying can be attempted from the underside of the floor, if accessible and warm, dry air can be introduced.	damage. If it is wet and requires removal, qualified abatement personnel shall be used. Drying can be attempted from the underside of the floor, if accessible and warm, dry air can be introduced.	damage. If it is wet and requires removal, qualified abatement personnel shall be used. Drying can be attempted from the underside of the floor, if accessible and warm, dry air can be introduced.
Stone; Granite, Marble, Slate, Solid Surface	- Granite, marble, slate, soapstone, solid surface (e.g., Corian©, Silestone©) and engineered stone are various types of materials found in residential and commercial buildings. They can be used for floors, countertops, sinks, bathrooms, shower surrounds and exterior facades (i.e., commercial). They are generally non-porous with varying degrees of hardness. Their appeal is due to their appearance and durability. - Moisture does not generally damage these materials but chemicals or contaminants in the water can cause discolorations and potential pitting or spalling. In most cases, these materials will be slow in drying, but result in little long-term damage. - An occasional issue is that moisture migration can cause an accumulation of dissolved salts (i.e., efflorescence) to appear on the surface or in the grout lines. These salts are due to alkaline salts being drawn to the surface. In some cases these salts can be expansive and result in degradation of the material or adhesives. - Cleaning stone: granite (no acidic cleaners), marble (pH neutral cleaners, no acids), slate (water cleanup, mild H_2O_2 solution), soapstone (mild soap and water cleanup), solid surface (soap and water cleanup, wipe dry). Some stone products are more porous than others and can require sealing. It is recommended a specialized expert be consulted if moisture contains contaminants. - When substrate is wood, it should be checked for moisture migration and if damaged, it is recommended that a specialized expert be consulted	Restorability: B Extraction: BC Cleaning: BEK Drying: BC Airflow: CD Comments: Inspect to determine if water has migrated under finish floor. If water has migrated under the flooring, evaluate the flooring and substrate for drying and cleaning.	Restorability: B Extraction: BC Cleaning: BCEK Drying: BC Airflow: CD Comments: Inspect to determine if contaminated water has migrated under finish floor. If water has migrated under the flooring, evaluate the flooring and substrate for drying,	Restorability: B Extraction: BC Cleaning: BCEK Drying: BC Airflow: CD Comments: Inspect to determine if contaminated water has migrated under finish floor. If water has migrated under the flooring, evaluate the flooring and substrate for drying,

Assembly	Characteristics	Category 1	Category 2	Category 3
			cleaning and sanitizing. If the floor is accessible from underneath, warm, dry air can be introduced.	cleaning and sanitizing. If the floor is accessible from underneath, warm, dry air can be introduced.
Mechanical, Electrical & HVAC Systems				
HVAC Components	- For fuller details of the operation and components of various HVAC installations and the implications after a water intrusion, refer to *Chapter 14 Heating, Ventilating and Air Conditioning (HVAC) Restoration*. - Since HVAC systems circulate the air that workers and occupants breathe when the system is operating both during and after restoration, it is a critical component in the overall water damage restoration work plan. Mechanical and other system components should be evaluated, and cleaned by qualified experts, as necessary, following NADCA ACR current version. - Restorers can use the installed HVAC system as a resource; provided contaminants will not be spread or the drying effort will not be negatively impacted. The HVAC system can add to or remove energy from the environment being dried. When sensible energy is added (i.e., heating), it can enhance surface evaporation as well as vapor diffusion within the building materials. When energy is removed (i.e., cooling), it can be used to prevent overheating the space or allow occupants to remain in the work area. Further, if conditions warrant the air conditioning system's use, the latent cooling will provide additional moisture removal to augment the drying system. - Installed HVAC systems are engineered primarily for the normal thermal and moisture load of a building, rather than the additional heat and moisture load typically encountered as a result of water damage. Therefore, they are not considered engineered dehumidification systems. Although HVAC systems can help restorers gain control of ambient humidity, they generally do not create the conditions necessary for drying of the building and contents. In addition, they may not be able to control ambient humidity quickly enough to prevent secondary damage. - Restorers should plan for component cleaning; using a specialized HVAC contractor as appropriate, followed by system replacement, after structural restoration and remediation has been completed. Restorers should consult specialized experts when HVAC system removal, restoration or replacement is complex or outside their area of expertise. - If contaminants are known or suspected to be present in the work area, supply, return vents and exhaust systems (e.g., bathroom, kitchen) located in this area should be contained to prevent possible contamination of the HVAC system during drying.	Restorability: B Extraction: ABC Cleaning: ABEGK Drying: AB Airflow: CE Comments: B	Restorability: C* Extraction: ABC Cleaning: ABCDEHK Drying: AB Airflow: ACE Comments: ABC	Restorability: C* Extraction: ABC Cleaning: ABCDEHK Drying: AB Airflow: ACE Comments: ABC

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Commercial mechanical systems incorporate more variations and combinations of HVAC system design and components then residential systems. Building engineer or a specialized expert may be necessary when dealing with a commercial mechanical or HVAC system.			
HVAC Duct; Internally & Externally Insulated	- HVAC ductwork systems can consist of several types of materials including: fiberglass duct board, galvanized metal duct with interior fiberglass linings, galvanized metal duct with fiberglass exterior wrap, fabric duct, and insulated flexible duct. Ductwork consisting of a non-porous internal surface (usually galvanized sheet metal) generally responds well to cleaning when visible microbial growth is present. Galvanized sheet metal can withstand the aggressive cleaning techniques necessary for removing Condition 3 contamination (actual mold growth and associated spores: refer to current edition of the IICRC S520 *Standard and Reference Guide for Professional Mold Remediation*) or other types of microbial contamination. However sections of internally lined ductwork, duct board or flexible ductwork with microbial contamination cannot be successfully cleaned; therefore, sections of such ducting with Condition 3 contamination or Category 3 water (e.g., sewage) should be removed and replaced with new materials. - Evaluate mechanical components in basements and crawlspaces for downward flowing water and wet components. Restorers should carefully inspect the HVAC system, particularly when floor vents are present in areas of water intrusion. - In some cases, ductwork and HVAC mechanical components can require complete disassembly by a qualified contractor for total restoration, particularly where electrical hazards exist. - Some supply vents and ductwork might be wrapped with asbestos requiring the services of an asbestos abatement firm. - When internally insulated ductwork is contaminated by Category 2 or 3 water, it should be removed and replaced with new ductwork, according to NADCA ACR 2006 standards. - If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials.	Restorability: B Extraction: ABC Cleaning: ABEGK Drying: AB Airflow: BCE Comments: B	Restorability: B*C** Extraction: ABC Cleaning: ABCEHK Drying: AB Airflow: ABCE Comments: ABC *metal ductwork, if cleanliness is verified by an IEP. **Flexduct, internally-lined ductboard or external insulation. Contaminated systems should not be used as a drying resource and should have supply & returns isolated.	Restorability: B*C** Extraction: ABC Cleaning: ABCEHK Drying: AB Airflow: ABCE Comments: ABC *metal ductwork , if cleanliness is verified by an IEP. **Flexduct, internally-lined ductboard or external insulation. - Contaminated systems should not be used as a drying resource and should have supply & returns isolated.
Elevators & Conveying Equipment	- Elevators (aka lifts) move people and freight vertically in buildings of various heights and may be any one or a combination of (1) hydraulic, (2) traction cable hoist, or (3) counterweight hoist. In most low-rise buildings of two to six floors hydraulic systems are used. Elevator systems consist of (1) a shaft or hoist way, (2) a cab for people or freight, (3) drive mechanism	Due to the elevator pit being in the lowest part of	See Category 3	Restorability: B* Extraction: ABC

Assembly	Characteristics	Category 1	Category 2	Category 3
	components (e.g., motor/pump, hydraulic cylinder, pulleys and cables) and (4) elevator pit & machine room to house the equipment. - The elevator pit and machine room is usually below grade and following a water intrusion can collect significant amounts of water. It may or may not be equipped with its own sump pump, and if present it may or may not be operating. - Any services provided (e.g., pump out, cleaning, debris removal) to the equipment, shaft, or pit should be performed under the guidance of the building engineer or contracted service provider. - An elevator pit is considered a confined space, restorers shall have documented safety training and signage prior to work. Depending on the work being performed, it can be considered a "permit required confined space" (PRCS) requiring additional procedures. - Prior to performing any work in an elevator pit, restorers shall ensure the safety of workers and the general public. The elevator shall be shutdown and locked out securely. Signs shall be posted notifying the public of maintenance work and an adequate supply of filtered and unfiltered air should be arranged through ventilation in the pit. - Qualified personnel shall perform elevator cleanup and maintenance in accordance with local regulations. These procedures are beyond the scope of this document. - In many states only licensed elevator personnel may enter and perform work in an elevator pit.	most buildings, it will collect considerable amounts of water and likely can contain other debris, trash, dead animals, etc. For that reason it should be considered Category 3 water in all cases.		Cleaning: ABCDHIJK Drying: AB Airflow: ACE Comments: ABC -Treat as Confined Space or PRCS. *In instances of saltwater contamination most components are unsalvable.
Electrical System	- Caution shall be used when entering a flooded or flood-damaged building. Restorers shall employ safe work practices. If necessary, a specialized expert should be employed. - Electrical systems and equipment exposed to water can be quickly compromised, especially if it is contaminated (e.g., sea-water, chemicals). Compromised systems should not be reenergized until evaluated by a specialized expert. - The National Electrical Manufacturers Association (NEMA) recommends that no electrical device (e.g., installed components, portable equipment, appliances) be used that has been wet until they have been inspected and serviced by a specialized expert. Their general recommendations include but are not limited to: o All breakers, fuses, disconnect switches; GFCI's, AFCI's, and surge protective devices that have been submerged must be replaced. There is no method of insuring these life safety devices will operate as intended when they are exposed to water. o All electrical equipment, panel boards, switchgear, motor control centers, boilers and boiler controls, electric motors, transformers, receptacles, switches, light fixtures, electric heaters and appliances such as water heaters, ovens, ranges, and dishwashers that have been submerged need to be replaced or repaired by the original manufacturer or an approved representative. o Electrical wiring may require replacement depending on the type of wire or cable and the extent of the damage.[1]	Restorability: B Extraction: ABC Cleaning: ABEIK Drying: ABC Airflow: CE Comments: B - Electrical components that have been submerged should be evaluated by a specialized expert.	Restorability: B Extraction: ABC Cleaning: ABCEIK Drying: ABC Airflow: ACE Comments: BC Electrical components that have been submerged should be evaluated by a specialized expert.	Restorability: B Extraction: ABC Cleaning: ABCEIK Drying: ABC Airflow: ACE Comments: BC Electrical components that have been submerged should be evaluated by a specialized expert.

Assembly	Characteristics	Category 1	Category 2	Category 3
Fire-suppression Systems	- Most fire sprinkler systems installed in residential and commercial buildings will be one of four types: 1. Wet-pipe is the most prevalent system (i.e., homes, most commercial buildings) where the supply line is filled with water/antifreeze mixture (i.e., non-hazardous and non-toxic propylene glycol, glycerin) and individual heads will activate when certain temperatures are reached. 2. Dry-pipe systems are usually installed in unheated buildings where freezing is a concern, individual heads will activate the pressurized-controlled system when certain temperature are reached 3. Pre-action systems are usually used where accidental activation is undesirable (e.g., museums, libraries, data centers) and are a hybrid of the preceding types. 4. Deluge systems are dry-pipe systems in which all heads activate when certain temperatures are sensed, thus sprinkling the entire area with great amounts of water. These are installed where special hazards or quick-developing fires hazards exist.[54] - Typical of all but deluge systems, smoke will not activate the heads and each head operates individually of others. - Generally, water intrusions would be considered a Category 1 source as the water will have an approved antifreeze solution that is non-hazardous and non-toxic. NFPA 13 permits glycerin-water and propylene glycol-water mixtures for use in antifreeze sprinkler systems connected to either potable or non-potable water supplies. Additionally, the water flowing through the pipe will quickly flush out any antifreeze, and diluting small amounts of rust or particulate. [55]	Comments: Any work performed on sprinkler systems should be done by qualified specialized experts.	Comments: Any work performed on sprinkler systems should be done by qualified specialized experts.	Comments: Any work performed on sprinkler systems should be done by qualified specialized experts.
Electrical Systems, Low Voltage – special wiring systems	- Special wiring systems can include: CAT-5 or other computer wiring, fiber-optic wiring, alarm and security systems, coax cabling and other wiring or cable systems. - Low-voltage electrical systems can sometimes be particularly difficult to work with since many systems are wired to special transformers and relays and a small amount of corrosion can be critical to proper operation. - The impact of water on metal surfaces is highly dependent on the metal type, contact time, and most importantly whether the metal was powered at the time of the event. Water impact to exposed metallic surfaces may be defined within five categories (in increasing levels of impact): o Water residue deposition o Hygroscopic dust activation	Restorability: * Extraction: C Cleaning: * Drying: ABC Airflow: BE Comments: BC *Depends on component, degree of damage, and	Restorability: * Extraction: C Cleaning: * Drying: ABC Airflow: ABE Comments: BC *Depends on component, degree of damage, and	Restorability: * Extraction: C Cleaning: * Drying: ABC Airflow: ABE Comments: BC *Depends on component, degree of damage, and

[54] Wikipedia contributors. "Fire sprinkler system." *Wikipedia, The Free Encyclopedia*. Wikipedia, The Free Encyclopedia, 14 Dec. 2012. Web. 18 Dec. 2012.
[55] National Fire Protection Association, *Standard for the Installation of Sprinkler Systems*, NFPA 13, Quincy, MA (2010 ed.)

Assembly	Characteristics	Category 1	Category 2	Category 3
	◦ Oxidative corrosion ◦ Galvanic corrosion ◦ Short-circuiting, heating and arcing - Deposited residue should be cleaned from metallic surfaces after a water intrusion, to reduce the potential long-term corrosion concern. - Equipment should be evaluated and reconditioned by qualified persons. [56]	cost-benefit analysis.	cost-benefit analysis.	cost-benefit analysis.
Asbestos Containing Materials	- Asbestos is a naturally occurring fibrous mineral used in building materials because of its heat and fire resistant properties. In a solid and undisturbed state, asbestos poses minimal hazards and is very resilient. When damaged and friable (dry and crumbly), however, asbestos may cause many serious health effects. - Asbestos may be found in many different products and many different places. Generally, any of the following materials installed before 1981 are presumed to contain asbestos:[57] ◦ Sprayed on fire proofing and insulation in buildings ◦ Insulation for pipes and boilers ◦ Wall and ceiling insulation ◦ Ceiling tiles ◦ Floor tiles ◦ Putties, caulks, and cements (such as in chemical carrying cement pipes) ◦ Wall and ceiling texture in older buildings and homes ◦ Joint compound in older buildings and homes ◦ Plasters - Many of these asbestos-containing materials (ACM) or presumed asbestos containing material (PACM) can be found in schools, businesses, and homes. - Asbestos is safe and legal to remain in homes or public buildings as long as the asbestos materials are in good condition and the asbestos cannot be released into the air. ACM will not release asbestos fibers unless it is disturbed or damaged in some way. - If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials. - Refer to Section 8.7 of this Standard for more information on Asbestos.	See individual material or component for specific procedures. Materials not addressed in their own section may be restorable if they are not a part of a system that has become compromised. If the ACM or PACM shows signs of compromise, a specialized expert should be used for further evaluation.	See individual material or component for specific procedures. Materials not addressed in their own section may be restorable if they are not a part of a system that has become compromised. If the ACM or PACM shows signs of compromise, a specialized expert should be used for further evaluation.	See individual material or component for specific procedures. Materials not addressed in their own section may be restorable if they are not a part of a system that has become compromised. If the ACM or PACM shows signs of compromise, a specialized expert should be used for further evaluation.
Insulation: General	- The effectiveness of insulation is measured using a scale of R-values. The higher the R-value, the greater the resistances to heat transfer. All building products have an R-value. The U.S. Department of Energy has published a model energy code that recommends minimum	See individual material or component for	See individual material or component for	See individual material or component for

[56] Krzyzanowski, Mark. White Paper " Water Leakage Event in Electronic and Mechanical System Damage Mechanisms", Equipment Damage Consultants LLC, www.egdamcon.com
[57] Asbestos Fact Sheet. http://web.princeton.edu/sites/ehs/workplacesafety/asbestosfactsheet.htm

Assembly	Characteristics	Category 1	Category 2	Category 3
	insulation requirements for different climates of the United States. Generally, these are prescriptive in nature. For example, climate zone 4 recommendations are: R38 for ceilings, R19 for walls, and R19 for crawlspaces or basement floors. - Basic principles explain the loss of insulation effectiveness. First, insulation works by trapping air or millions of tiny air bubbles. It is this air that insulates, just as air in a goose-down coat or comforter keeps a person warm. Second, water has much higher thermal conductivity than air. Moisture as a liquid or vapor can cause insulation to lose its ability to resist heat transfer. This means that moisture short-circuits the ability of insulation to perform its function in resisting heat transfer.	specific procedures.	specific procedures.	specific procedures.
Insulation; Asbestos	- Asbestos was commonly used in building materials for thermal insulation and fireproofing. Typically, it is found in hard-sheets, pipe wrap, boiler insulation, and in spray-applied uses. - Loose-fill inorganic vermiculite or expanded perlite can be found in concrete masonry unit (CMU) core blocks or other interstitial spaces. This material can contain asbestos and should be evaluated by appropriate specialized experts. - Abatement must be performed by a qualified contractor. - If asbestos containing material (ACM) or presumed asbestos containing material (PACM) are encountered, restorers shall comply with federal, state, provincial and local laws and regulations regarding the inspection and handling of these materials.	Restorability: B* Extraction: B Cleaning: * Drying: BC Airflow: AC Comments: *Restorability and cleaning should be determined by the assembly and not the specific material. Passive drying can be successful in some situations.	Restorability: C* Extraction: B Cleaning: * Drying: Airflow: AC Comments: *Restorability and cleaning should be determined by the assembly and not the specific material. .	Restorability: C* Extraction: B Cleaning: * Drying: Airflow: AC Comments: *Restorability and cleaning should be determined by the assembly and not the specific material. .
Insulation; Cellulose or Other Loose-fill Organic Material	- Cellulose insulation is very prevalent in buildings built during the period from 1970-1990 as well as in many retrofit installations. It was made from recycled newspaper, cardboard, cotton fabric and cornhusks. - Due to its lack of flame-resistance and tendency to settle thus decreasing its insulating value, its use has diminished; being replaced by fiberglass and other materials. In recent years, due to green-building initiatives and improvement in flame-retardancy, it is being installed more frequently. - If cellulose insulation becomes wet, several potential problems can occur:	Restorability: C Extraction: BC Cleaning: B Drying: AB Airflow: BE Comments:	Restorability: D Extraction: Cleaning: Drying: Airflow: Comments:	Restorability: D Extraction: Cleaning: Drying: Airflow: Comments:

Assembly	Characteristics	Category 1	Category 2	Category 3
	o Some of the chemicals added can corrode metal parts in contact with the insulation. o Chemicals can leach out of cellulosic insulation, thereby changing its fire-retardant properties. o The insulation can compact and lose its R-value. - Wet cellulose insulation should be removed, regardless of the Category of water, and, after structural drying, replaced with new material.			
Insulation; Mineral Wool, Fiberglass, Rock Wool	- Fiberglass insulation is produced from glass and is the most popular and prevalent insulation material in buildings today. It is manufactured into batts, blankets or loose-fill to be placed in walls, attics or under floors. Batts can be faced, usually with brown or foilized Kraft paper, or unfaced. - Mineral wool (aka rock wool, stone wool, slag wool) is a close relative of fiberglass insulation. All of these materials have a coarse, fibrous appearance and are available as batts and blankets. The most common type of mineral wool for residential applications is grey or grey-brown that comes in different thicknesses Insulation; mineral wool, fiberglass, rock wool and widths. Mineral wool insulations are used as thermal insulation in walls and attics and as acoustical insulation for residential walls and ceilings. - It is often used as pipe and duct wrap material in mechanical systems. - Drying characteristics are: o Unfaced batts can often be dried if only wet at the bottom, thus restoring their R-value. o Faced batts are more difficult to dry as the face inhibits airflow to the interior of the spun material o Loose-fill is usually blown-in and tends to compact over time and when wet, thus losing loft and R-value. This compaction can rarely be reversed. - Compacted or contaminated materials should be removed and replaced. - Insulation is considered porous when making decisions regarding drying or replacing. If insulation is saturated with Category 1 water and is potentially restorable, restoration may be attempted. Insulation saturated with Category 2 or 3 water should be replaced. It is critical that, on completion of drying, insulation and vapor retarders provide the function for which they were installed.	Restorability: B Extraction: BC Cleaning: B Drying: AB Airflow: BE Comments:	Restorability: C Extraction: Cleaning: Drying: Airflow: Comments:	Restorability: D Extraction: Cleaning: Drying: Airflow: Comments:
Insulation; Open-cell foam	- This insulation can be rigid sheets or is applied by a spray method and can hold water. - These materials might not be damaged, but their presence can slow drying of more critical materials or assemblies behind them.	Restorability: B Extraction: BC Cleaning: BGK Drying: AB Airflow: BE	Restorability: C Extraction: BC Cleaning: BC Drying: AB Airflow: ABE Comments:	Restorability: D Extraction: BC Cleaning: BC Drying: Airflow: Comments:

Assembly	Characteristics	Category 1	Category 2	Category 3
		Comments:		
Insulation; Closed-cell foam	- This insulation can be rigid sheets or is applied by a spray method and does not readily absorb water; generally retaining its R-value after a water intrusion. - These materials might not be damaged, but their presence can slow drying of more critical materials or assemblies behind them.	Restorability: B Extraction: BC Cleaning: BG Drying: AB Airflow: BE Comments:	Restorability: C Extraction: BC Cleaning: BCH Drying: AB Airflow: ABE Comments:	Restorability: C Extraction: BC Cleaning: BCH Drying: AB Airflow: ABE Comments:
Fire-proofing, Spray-on	- Spray-on fireproofing is often encountered in commercial buildings constructed with structural steel framing and corrugated metal decking. The material is either a paint coating (i.e., intumescent or endothermic) or a fibrous, cement-based product. - The materials used are non-organic and will therefore not support microbial growth though settled dirt and particulates can. - An infrared camera can be a useful tool for scanning structural fireproofing for moisture. - A water intrusion might cause the coating to release from the substrate. If so, this will require repair or replacement to restore the fire rating.	Restorability: B Extraction: NA Cleaning: G Drying: ABC Airflow: C Comments: Aggressive airflow can dislodge material from its substrate	Restorability: C Extraction: NA Cleaning: HI Drying: ABC Airflow: AC Comments: Aggressive cleaning activities and airflow can dislodge material from its substrate	Restorability: C Extraction: NA Cleaning: HI Drying: ABC Airflow: AC Comments: Aggressive cleaning activities and airflow can dislodge material from its substrate
Special Assemblies				

Assembly	Characteristics	Category 1	Category 2	Category 3
Cabinets, vanities, book cases, etc.	- Most modern cabinetry (i.e., built-in or attached) is manufactured of wood veneer, or plastic laminated over a MDF, or particle board core. These materials are susceptible to damage from contact with liquid water or extended contact with high humidity. Some cabinetry is constructed with a plywood core or even of solid wood, and are significantly more resistant to water damage. If practical, restorers may leave cabinets in place and dry walls effectively by circulating air in the interstitial space. In some cases, removal of cabinets may be needed so walls and floors can be dried effectively. Once structural repairs have been completed, cabinets can be re-installed. - Restorers should identify and eliminate moisture migration below or behind built-in cabinets or fixtures. A complete inspection can require drilling holes in inconspicuous areas and evaluating levels of moisture and drying options. - Depending on installation technique, removal of built-in fixtures will typically result in some degree of damage to the fixture. Removed fixtures may not be suitable for reinstall. - Holes can be drilled through the back of built-ins into wall cavities, and used to circulate air. If matching veneer is available, access holes can be covered with new material after drying is complete. - Access can be gained from an adjacent space (e.g., wall, floor or ceiling) to avoid removal of, or drilling in cabinetry. - If removal is necessary, it should be completed near the beginning of the project.	Restorability: B Extraction: BC Cleaning: ABEGK Drying: ABC Airflow: CE Comments: B	Restorability: B* Extraction: BC Cleaning: ABCDEHK Drying: ABC Airflow: ACE Comments: B *Cabinets made of particleboard or MDF are usually not restorable if saturated with Cat 2 or 3 water.	Restorability: B* Extraction: BC Cleaning: ABCDEHK Drying: ABC Airflow: ACE Comments: B *Cabinets made of particleboard or MDF are usually not restorable if saturated with Cat 2 or 3 water.
Trim Work	- Trim work includes baseboard (aka skirting), base shoe, door facings, crown mold, thresholds and other moldings applied to paneling or as a transition between different finish materials (e.g., wood to tile). Trim work can be manufactured of solid hardwood, solid softwood, finger-joint, MDF covered with plastic coating, or solid plastic. Depending on the component, it can be porous (e.g., MDF) to non-porous (e.g., plastic), and therefore its restorability varies also. - Access to the interstitial spaces can be gained by removal of the trim work. If trim work is removed any nails that are removed should be pulled through to the backside surface, rather than to the visible side. Trim comprised of engineered wood material (e.g., MDF) is more likely to sustain permanent damage, and therefore, it is generally unrestorable. Other trim can usually be cleaned and re-installed after proper drying and if structurally sound.	Restorability: B* Extraction: B Cleaning: BEGK Drying: AB Airflow: C Comments: B *MDF trim is usually not restorable.	Restorability: B* Extraction: B Cleaning: BCDEHK Drying: AB Airflow: AC Comments: AB *MDF trim is usually not restorable if saturated with Cat 2 or 3 water.	Restorability: B* Extraction: B Cleaning: BCDEHK Drying: AB Airflow: AC Comments: AB *MDF trim is usually not restorable if saturated with Cat 2 or 3 water.
Internal Chases (Ducting, Trash	- Various internal chases (e.g., HVAC ductwork, electrical busses, plumbing lines) and gravity chutes (e.g., laundry, garbage, mail) can be found in commercial buildings. They typically run	Restorability: B	Restorability: B*, **	Restorability: C*, **

Assembly	Characteristics	Category 1	Category 2	Category 3
Chute, Mail Chute)	from the top floor down to the basement or mechanical room area(s). These chases and chutes can be round, square or rectangular and of metal or gypsum board. All modern chases and chutes will be constructed to achieve a specified fire rating. - To achieve the fire rating, most chases involve multiple-layers of fire-rated drywall and if saturated can be very difficult to dry but even more expensive if demolition and replacement has to be done. Drying these spaces will typically require very dry, very warm air; usually installed in a push-pull manner. - Restorers are cautioned that chases and chutes can be a means of cross contamination if there are openings on each floor of the building that cannot be sealed. - In some cases chutes can provide an air delivery conduit throughout a building. Restorers are cautioned to allow for loss of air due to static pressure drop if using chutes for this purpose.	Extraction: BC Cleaning: BGK Drying: ABC Airflow: ABCE Comments:	Extraction: BC Cleaning: BCDHK Drying: ABC Airflow: ABCE Comments: *Due to the high cost of replacing these internal spaces, other alternatives (e.g., drying, encapsulating) can be considered in consultation with specialized experts and the building owner. ** For gypsum, refer to gypsum section of this table.	Extraction: BC Cleaning: BCDHK Drying: ABC Airflow: ABCE Comments: *Due to the high cost of replacing these internal spaces, other alternatives (e.g., drying, encapsulating) can be considered in consultation with specialized experts and the building owner. ** For gypsum, refer to gypsum section of this table.
Stairs & Mechanical Rooms	- Mechanical rooms (aka boiler room) can house a large variety of equipment, including but not limited to: HVAC, electrical distribution panels/transformers, water heaters, back-up generators, sprinkler controls and security systems. - They can be constructed of concrete, CMU or LG steel framing with fire-rated gypsum. The wall construction can include multiple layers of fire rated gypsum board as well as sound-attenuation layers. - Restorers should open assemblies (e.g., walls, stairs, flooring, wall base areas, voids, built-ins) to access pockets of saturation and remove unsalvable, contaminated materials and components. Exposed materials that remain in place should be cleaned and decontaminated, as appropriate.	Restorability: B Extraction: ABCD Cleaning: ABCGIJK Drying: ABC Airflow: ABDE Comments:	Restorability: B* Extraction: ABCD Cleaning: ABCDHIJK Drying: ABC Airflow: ABDE Comments:	Restorability: B* Extraction: ABCD Cleaning: ABCDHIJK Drying: ABC Airflow: ABDE Comments:

Assembly	Characteristics	Category 1	Category 2	Category 3
	- Stairwells that are fire exits shall not be blocked during open hours, unless cleared by local officials. They are typically constructed similar to mechanical rooms (e.g., concrete, CMU, fire rated gypsum board). Stairwell can potentially be used as duct access with the clearance of fire officials. Note that fire doors are usually alarmed.	Due to the variety of equipment, fixtures and construction multiple cleaning or drying approaches may be used.	Due to the variety of equipment, fixtures and construction multiple cleaning or drying approaches may be used. * For gypsum, refer to gypsum section of this table.	Due to the variety of equipment, fixtures and construction multiple cleaning or drying approaches may be used. * For gypsum, refer to gypsum section of this table.
Subgrade Walls (i.e., Basements)	- Basement walls can be fully surrounded below grade with minimal above grade exposure or partially below grade (usually on an uneven site) with one or more full or partial above grade walls (e.g., a daylight basement). Below grade portions of the basement are generally poured concrete or CMU.. Day-lighted portions are usually concrete or traditional framing. Typically the floor is a poured concrete slab. - Walls of finished basements will typically use furring strips (e.g., 1"X 2" lumber) to carry the wall finish and these spaces may or may not be insulated. Flooring is typically installed directly on the poured slab (e.g., carpet cushion and carpet), although a raised flooring system using a subfloor over sleepers is not uncommon. - Restorers should check for trapped moisture between decking and sub-floor materials, or on the vapor retarder over bat insulation in basements or crawlspaces installed between joists, and directly under subfloors. - Ventilation in basements is often substantially less than above ground finished spaces. - It is common for basements to have chronic moisture accumulation or intrusions from below slab ground moisture or failures of moisture management in sub grade walls. - Restorers shall consider the possibility of electrical shock and other hazards when entering a flooded basement. When appropriate, electrical power should be turned off at the meter.	Restorability: * Extraction: * Cleaning: * Drying: * Airflow: * Comments: , *Refer to the specific material in this table.	Restorability: * Extraction: * Cleaning: * Drying: * Airflow: * Comments: *Refer to the specific material in this table.	Restorability: * Extraction: * Cleaning: * Drying: * Airflow: * Comments: *Refer to the specific material in this table.
Crawlspaces	- Crawlspaces are typically formed by poured concrete foundations and can be partially above and extending below grade. The depth of a crawl space may be dictated by code. Crawlspaces generally have natural soil floors, although gravel or other fill is not atypical. Most crawlspaces have a vapor barrier installed. This vapor barrier can be expected to range	Restorability: * Extraction: * Cleaning: *	Restorability: * Extraction: * Cleaning: *	Restorability: * Extraction: * Cleaning: *

Assembly	Characteristics	Category 1	Category 2	Category 3
	from loose lay polyethylene plastic to more durable material installed to fit the footings or up the foundation walls and either mechanically fastened or sealed with a combination of mechanical fasteners and adhesive (e.g., a radon mitigation system). - Some crawlspaces will contain passive ventilation capability, characterized by adjustable ventilation openings at various places on the above grade portions of the foundation. - Crawlspaces using passive ventilation with or without a vapor barrier may be susceptible to chronic moisture conditions due to seasonal changes in temperature and humidity conditions. - Building and energy codes in some areas may require that the crawlspace incorporate active ventilation. Restorers should be knowledgeable about the operation of an active ventilation system prior to making any modifications to a system. - Restorers should check for moisture trapped by vapor retardant materials. - Crawlspaces often contain plumbing, HVAC and electrical systems. - Crawlspaces generally meet the definition of a confined space. Additionally, if it meets certain criteria, it shall be considered a permit required confined space. Refer to *Chapter 8: Safety and Health.*	Drying: * Airflow: * Comments: The drying effort should focus on the structure, rather than the soil. An appropriate vapor barrier can be installed once soil is sufficiently dry to work, to aid in drying the structure. *Refer to the specific material in this table.	Drying: * Airflow: * Comments: The drying effort should focus on the structure, rather than the soil. An appropriate vapor barrier can be installed once soil is sufficiently dry to work, to aid in drying the structure. *Refer to the specific material in this table.	Drying: * Airflow: * Comments: The drying effort should focus on the structure, rather than the soil. An appropriate vapor barrier in conjunction with passive or active ventilation can be installed once soil is sufficiently dry to work. Application of a biocide to soil is not effective. *Refer to the specific material in this table.

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