IIRC S760

Standard for Professional Wildfire Investigations and Restoration of Impacts to Structures, Systems, and Contents

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. It is impractical to prescribe procedures that apply to every wildfire investigation and restoration situation. In certain circumstances, deviation from portions of this Standard may be appropriate. Carelessness is unacceptable and common sense, and professional judgment are to be exercised in all cases. *Should* and *Shall* have been italicized to illustrate the specific definition throughout this document.

***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. **To further indicate when this term is used in this document, that it carries this specific definition, it has been italicized**.

***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. **To further indicate when this term is used in this document, that it carries this specific definition, it has been italicized**.

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 remediation methods and procedures from the less critical, by characterizing the former as the perceived and recommended "standard of care." The IICRC S760 consensus body 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 is not intended to be either exhaustive or inclusive of all pertinent requirements, methods or procedures that might be appropriate on a particular wildfire investigation and restoration project. Ultimately, it is the responsibility of the restorer to verify on a case-by-case basis that application of this Standard is appropriate.

A Scope, Purpose, and Application

A1 Scope

This collaborative standard describes practical principles, methods, and processes to investigate, evaluate, and restore the interior and exterior of structures and improvements, and contents impacted by wildfire smoke emissions. In addition, this standard will also describe the basic principles governing wildfire particle and residue infiltration, distribution, and eventual settlement on surfaces. The goal of this standard is to aid the competent professional, restorer, and other trades and professions involved in restoration, in defining the scope of a project and preparation of a work plan. This standard also establishes post-restorative methods and processes to evaluate the execution of the scope of work and verify the cleanliness of structures and contents impacted from wildfire smoke.

Wildfire smoke impact evaluation and restoration consist of the following components for which procedures are described in this Standard:

- Principles of Wildfire Smoke Damage Restoration;
- Composition of Wildfire Smoke;
- Safety and Health;
- Limitations, Complexities, Complications, and Conflicts;
- Restorer Qualifications, Administrative Procedures, and Project Documentation;
- Preliminary Determination and In-Field Testing;
- Sampling Methods and Strategies;
- Analytical and Quantification Methods;
- Analysis, Use, and Interpretation of Data for Wildfire Impact;
- Restoration of Wildfire Smoke Impacted Structures and Improvements;
- Restoration of Wildfire Impacted Contents;
- Restoration of Wildfire Impacted HVAC Systems; and
- Post-Restoration Evaluation and Verification.

A2 Purpose

It is the purpose of this standard to define criteria and methodology for the investigation, assessment, and restoration of wildfire smoke-impacted structures and contents, and for establishing wildfire smoke impact restoration work plans and procedures.

This standard is not intended to be either exhaustive or inclusive of all pertinent requirements, methods, or procedures that might be appropriate for a particular wildfire smoke impact investigation and restoration project. Restorers and competent professionals *should* use professional judgment throughout each and every project. A project might have unique circumstances that may infrequently allow for a deviation from the standard. Prior to deviation from the standard of care (i.e., "*shall*" or "*should*") the restorer and competent professional *should* document the circumstances that led to such a decision, notify the materially interested parties, and in the absence of a timely objection, document the communication before proceeding. This Standard does not specifically address the protocols and procedures for investigation or restoration when potentially hazardous, regulated materials are present or likely to be present in wildfire smoke-impacted 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 certain biological contaminants. For hazardous regulated materials, follow applicable laws and regulations.

A3 Application

This standard is intended for individuals involved in the investigation, assessment, and restoration of structures and contents impacted by a wildfire smoke event. Recognizing the potential challenges and complexities in completing work, the standard combines content and methodologies with a practical perspective, integrating a multidisciplinary scientific approach.

B Definitions

Acceptance Criteria: benchmarks, standards, conditions, and measures of parameters that have been previously established as indicators that restoration has been satisfactorily completed.

Aciniform: something having the ability or affinity to cluster (gather) and form grape-like clusters.

Aciniform Soot: carbonaceous agglomerates formed by the condensation of gases from combusted products into aciniform (grape-like) particle patterns at elevated temperatures. The particle aggregates are primarily composed of organic carbon. Aciniform soot is not diagnostic of wildfire though it is a major constituent of the smoke.

Aerodynamic Diameter: The theoretical diameter of a nonspherical particle having the same terminal settling velocity as an equally dense, spherical particle of such diameter.

AHJ (Authority Having Jurisdiction): Authority Having Jurisdiction is that person or organization empowered by codes, standards, or regulation to address a particular topic or matter of implementation.

Ash: (1) residual mineral salts and plant crystals remaining after combustion and removal of carbonaceous material from burned vegetation. Ash is a combination of soluble and non-soluble minerals. (2) the mineral content of a product remaining after complete combustion. (3) a powdery substance left behind after a fire. (4) the end-product of incomplete combustion, which will be mostly mineral, but usually still contain an amount of combustible organic or other oxidizable residues.

Assemblage Indicator Particles: combustion particles with specific morphological or chemical properties that are characteristic of a specific fire source or origin.

Assemblage Indicators (Wildfire): combustion particles, or chemical properties, or specific spatial or morphological depositional patterns that are characteristic of wildfire. Assemblage indicators can include: charred wood/plant indigenous to the area where the fire took place, fire retardant, carbon/soot coated quartz or mineral grains, burned or heat altered clay minerals from the soil, and pyrolyzed calcium oxalate or silica phytoliths from various plants and trees.

Assemblage: the collection of information related to a fire-damaged building or a wildfire-impacted structure, which includes but is not limited to the visual inspection and assessment, photos, customer interview, hypothesis modeling, sampling, and laboratory analysis.

Assessment: (1) the evaluation of impact, damage, or contamination after a loss or incident. (2) the evaluation and interpretation of measurements and other information to provide a basis for decision-making. (3) evaluation of the potential impact from, the possible consequences of, and methods for minimizing the risks associated with a particular contaminant or hazard using a systematic approach by a competent professional.

Background Conditions: the quantification of wildfire smoke residue or contaminant considered to be typical of a normal indoor environment unaffected by wildfire smoke.

Baseline: a benchmark that is used as a foundation for measuring or comparing current and past values. In wildfire impact assessment, the percentage, concentration, or level of char or ash are statistically representative of structures that have not been affected by wildfire smoke in a particular database.

Building Damage: (1) the direct impaction of a fire or wildfire that causes heat damage to building materials and finishes. (2) the direct impaction of a fire or wildfire by smoke, soot, ash, chemical or a biological component.

Burn: (1) to undergo rapid combustion or consume fuel in such a way as to give off heat, gases, and, usually light. (2) to cause or undergo combustion or be consumed partly or wholly by fire.

Burned Phytoliths: thermally modified phytoliths and idioblasts that are genetically controlled mineral deposits made by the plant. Their shape is retained through pyrolysis but characteristic thermally induced changes in their optical properties are evident under the light microscope.

Carbon Black: (1) a submicron black carbon powder commercially produced under controlled conditions by burning hydrocarbons at temperatures exceeding 1315.5 degrees Celsius /2400 degrees Fahrenheit in insufficient air; it is composed of colloidal carbon of well-defined aciniform morphology. (2) a powdered form of carbon. Carbon black in powder form is used for its mechanical properties and pigmentation effects in many automotive products, printers as well as rubbers inks, and dyes. (3) the manufactured material produced from controlled combustion or thermal decomposition of hydrocarbons. Carbon black is also called acetylene black, channel black, furnace black, lampblack, or thermal black. A type of carbon black is toner printer ink.

Carbon: (1) organic substances in all life. When heated carbon compounds are released. (2) a chemical element that is present in organic and inorganic forms. Organic carbon is found in all life forms, including living and dead vegetation, as well as in man-made materials and products derived from fossil fuels, such as plastics, and synthetic fabrics. When these natural or synthetic materials are burned, they release carbon compounds in gaseous and solid forms, such as carbon monoxide and carbon dioxide gases, soot, and char particles in smoke. (See ash, char, smoke, and soot).

Carbonized Material: A solid decomposition product of natural or synthetic origin that maintains, at least in part, its original form.

Cellular (or Dry) Sponge: A cellular rubber cleaning material which when drawn across a substrate will remove non-adhered soils by dislodging and retaining soil particles within the matrix of the rubber. These sponges are commonly used in the fire restoration industry for removal of dry, loose fire residues on porous and semi porous building surfaces. Sometimes referred to as a “Dry Cellular Sponge”, or as a “chem, dry, rubber, soot, or chemical sponges” Although used sometimes with “chem or chemical”, these sponges contain no active chemicals.

Char (Pyrolyzed Vegetation): char (biochar) is the amount of biomass, which remains after heating as a stable substance, whereas pyrolysis is the thermal decomposition of materials at elevated temperatures.

Char (specific to ASTM Method D6602 Standard Practice for Sampling and Testing of Possible Carbon Black Fugitive Emissions Or Other Environmental Particulate, Or Both): Particulate greater than or equal to “1-micron in size” (1µm) made by incomplete combustion which may not deagglomerate or disperse by ordinary techniques, may contain material, which is not black, and may contain some of the original material’s cell structure and inorganic materials.

Char (Wildfire Vegetation): char is the amount of biomass, which remains after the pyrolysis of vegetation primarily composed of twigs, leaves, bark, and grasses, which remains behind after the wildfire.

Cleaning: the process of removing unwanted substances, where the material or finish has the absence of dirt and impurities.

Competent Person: Competent Person by the way of training and/or experience, a competent person is knowledgeable of applicable standards, is capable of identifying workplace hazards relating to the specific operation and has the authority to correct them. Some standards add additional specific requirements which must be met by the competent person.

Competent Professional: is an individual who A) possesses a relevant degree, certification, or professional standing in Occupational/Environmental Health and Safety (OEHS), Industrial Hygiene (IH) or related science/engineering/public health and a minimum of two (2) years relevant experience or; B) through demonstrated formal training and extensive knowledge in the Subject Matter, and a minimum of five (5) years' experience, has the ability to recognize, evaluate and solve problems relating to the work or the project.

Composite Sample: a sample collected from multiple surfaces using the same sampler. The reported sample result is an aggregate of the sampled surfaces. Not all sample media can be used for composite sampling. Composite sampling must be collected within the same wildfire smoke impact level to yield valid and comparable results.

Condensation and Ghosting: the principle that particles tend to deposit or condense on cooler surfaces.

Contaminated Smoke: materials and finishes that are impacted by chemicals, VOCs, PAHs, and other substances that constitute smoke.

Contaminated, Soot, Ash, and Char: the presence of wildfire particulate matter in a structure or its contents including upholstery, electronics, and electrical equipment which may be capable of causing damage to materials and finishes.

Contaminated: (1) the presence of an undesired or unhealthy substance. (2) a material or environment that contains known or potentially harmful substances such as asbestos, lead-based paint, toxins, and toxic agents at levels that can cause adverse health effects to exposed individuals or sensitive populations.

Damage to Property: (1) physical injury to tangible property, including all resulting loss of use of that property. All such loss of use *shall* be deemed to occur at the time of the physical injury that caused it. (ISO liability policy) (2) loss of use of tangible property that is not physically injured. All such loss of use *shall* be deemed to occur at the time of the occurrence that caused it. (ISO liability policy) (See: ISO).

Damage: loss of a material or surface by contamination, oxidation, abrasion, moisture, or heat. (Kutz, M. "*Handbook of Environmental Degradation of Materials*," 2016).

Decision Criteria: assessment categories for the purpose of differentiating between typical and impacted conditions.

Depositional Patterns: the surface patterns and in situ particle association produced on the original building surface or contents by settled combustion particles or (in the case of soot) the condensation of semi-volatile organic compounds.

Diffusion: particles moving to a surface as a result of molecular effects. It may be the result of proximity, electrostatics, or a thermal gradient.

Electrophoresis: particles attracted to a surface by electrostatic effects.

Evaluation: is the process of examining a problem or condition so that it can be understood and diagnosed. (1) evaluation by the restorer includes site characterization, incident history, occupant interview, visual inspection, in-field testing, and decision criteria. (2) evaluation by a competent professional includes all the above with the addition of sampling and laboratory analysis if required.

Filtration: particles are removed from a fluid flowing through a screen, a filter, or some other obstruction with holes or gaps too small to allow particles above a certain size to pass.

Fire: the process of combustion characterized by the emission of heat and fire effluent and usually accompanied by smoke, flame, glowing or a combination thereof.

Impacted: the results of being affected.

Impaction Smoke: the transference and deposition of smoke, soot, and chemical byproducts into a building through convection (heat transfer and mass particulate transfer by wind turbulence).

Impaction: (1) particle deposition on surfaces subjected to increased air velocities. temperature differentials, turbulence, and the stack effect. (2) particles are driven to a surface by fluid flow but impact the surface due to inertia.

Impingement: the ability of smoke odors and vapors in a gaseous state to embed themselves into porous materials through the force of high vapor pressure transfer and mass heat. Impinging airborne smoke odors and impinged drywall occur with heat transference that can lock in odors once surfaces cool.

Infield Evaluation by a Restorer: the preliminary evaluation of a building (its exterior, infrastructure, finishes, and contents) by a qualified restorer, where they conduct occupant interviews and establish wildfire impact levels through a) visual inspection; b) odor detection; c) infield evaluation such as surface wipes using dry wipes or a cellulose sponge and; d) if available, review sample and analysis results.

Infield Evaluation by a Competent Professional: the preliminary evaluation of a building (its exterior, infrastructure, finishes, and contents) by a competent professional, where they establish wildfire smoke impact levels including a) visual inspection; b) odor detection; c) infield evaluation such as surface wipes using dry wipes or a cellulose sponge; d) occupant interview; e) and when necessary, sampling and laboratory results.

Infiltration: the transference of particles through pathways by diffusion and both pressure and temperature differentials.

Latent Damage: damage not yet apparent but which may occur over time, such as ash that is capable of corroding electrical and electronic components weeks and months later.

Micro Vacuum: a collection device consisting of a suction pump and filter media used to collect settled particles from a surface for analysis.

Mixed Inorganic Mineral Dust/Soil: organic soil includes plant and animal materials, whereas inorganics do not contain carbon. Inorganic contaminants include toxic metals and different types of minerals in the soil, such as sand, clay to crystalline silica. In a wildfire, during and after combustion, wildfire-driven wind brings with it the groundmass (biomass) of loose particulate matter and burned materials from trees, forests, ground cover, and burned buildings. The mixed organic and inorganic materials in the remnants of the burn can become airborne and enter the infrastructure of buildings, their ventilation system, attic, and crawlspace.

Natural Minerals: a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition and physical properties. Natural minerals from soils frequently show signs of weathering, adhering clay minerals, and biogenic deposits. When exposed to the temperature of a wildfire the adhering materials tend to become brick-red due to iron in the clay and biogenic deposits.

Numerical Guideline: a guideline for interpreting numerical laboratory reports, which can be provided by a consensus body or based on professional judgment. Numerical data cannot be interpreted without reference to a numerical guideline. The concentration of a contaminant that is used to distinguish between levels of impact, and to support decision criteria such as low-moderate-high, or acceptable-unacceptable.

Occupant Interview: (1) a formal or informal interview with occupants, learning the history of the building, contents, and environment before a wildfire, and conditions that exist afterward, including the building, contents, and environment, along with documenting potential occupant health concerns. (2) the questioning of occupants about the cause and origin of a fire or wildfire.

Odor: A description of the smell of a substance: 1) the sensations and mental images perceived by means of the olfactory organ in contact with a particular gas phase substance; 2) a scent or a substance that affects the sense of smell. 3) That property of a substance that affects the sense of smell, any smell, scent, or perfume.

Opaque Particles (laboratory analysis term): particulate matter that is not transparent when viewed through a light microscope using a defined form of transmitted light. The particle may or may not transmit light but appears black with the form of illumination used and with the particle mounted for observation.

Plant Fragments or Parts (laboratory analysis term): Microscopic fragments of leaf parts, stalks, bark, blossoms, fruiting bodies, pubescence, tracheid, parenchyma, or other parts identifiable by their morphology. These structures may be preserved in charred or ash form.

Polarized Light Microscopy (PLM): the use of polarized light to characterize anisotropic electron bonds in a material. A polarized light microscope typically has the capability to use two polarizing filters, one below the stage of the microscope, called the polarizer, and one in the body tube of the microscope called the analyzer. One or both can be removed from the light path through the microscope and at least one is rotatable in the path.

Pre-Loss Condition: (1) the condition of structural elements, building systems, or contents prior to exposure to wildfire smoke from the subject incident. (2) The pre-loss condition (which may be unknown to the restorer and competent professional) is the appearance, condition, and potential presence of background combustion sources consistent with the building utilization which existed prior to the loss.

Primary Analytical Method: the method against which the effectiveness of other methods is evaluated.

Re-entrainment: deposited particles that can be resuspended through mechanical action or air currents.

Reflected Darkfield Illumination: a type of illumination for a light microscope where the illumination beam is directed onto the slide at an angle greater that the angular aperture of the objective being used.

Secondary Damage: the damage that can be caused after the initial damage. The effects of initial fire and smoke damage can be compounded by firefighting efforts, including water damage and chemicals used to extinguish the fire. Secondary damage is often not as immediately apparent as primary damage.

Sedimentation: the gravity-driven deposition of particles onto a surface. Larger particles settle faster than smaller particles. The settling velocity is based on an exponential difference in their aerodynamic size.

Semi-Volatile Organic Compounds (SVOC): an organic compound that is sufficiently volatile to exist in vapor form when heated but that readily condenses to liquid or solid form under typical room temperature. Most SVOCs have a boiling point between 460 and 750 °F (240 - 400 °C). Some examples of SVOCs include dioxins, polychlorinated biphenyls (PCBs), and poly aromatic hydrocarbon (PAH) compounds. Products that may include SVOCs are many pesticides, oil-based products, and fire retardants. They may be a natural byproduct of combustion, or they may be created post-combustion. SVOCs may condense or be adsorbed onto particulate matter or surfaces.

Smoke Damage: an alteration resulting in a loss in appearance, utility, life expectancy or value.

Smoke Impact: the deposition or condensation of wildfire related particles or residue on surfaces.

Smoke: the incomplete combustion of carbonaceous materials in a wildfire including trees and vegetation. (1) smoke consists of small organic particles of carbon, oily tar-like substances, liquid droplets, and gases such as CO, CO_2, vapors, such as VOCs, PAHs, benzene, aldehydes (including formaldehyde), and acrolein. (2) the individual compounds present in smoke number in the thousands. Smoke composition depends on multiple factors, including the fuel type and moisture content, the fire temperature, wind conditions and other weather-related influences, whether the smoke is fresh or "aged," and other variables. (3) different types of wood and vegetation are composed of varying amounts of cellulose, lignin, tannins, and other polyphenols, oils, fats, resins, waxes, and starches, which produce different compounds when burned ("*Wildfire Smoke: A Guide for Public Health Officials*," 2019).

Soil: the aggregate of weathered minerals, decaying organic material, and sub-surface life forms in which plants grow.

Soot/Black Carbon: (1) fine black particles composed principally of organic carbon that is produced by incomplete combustion. (2) fine particles (often black) formed from the incomplete combustion of fuels. Soot can be powdery, oily, or tar-like depending on the type of fuel being burnt. (3) the unwanted byproduct from incomplete combustion or pyrolysis of carbon-containing materials. (4) a submicron black powder is generally produced as an unwanted byproduct of combustion or pyrolysis. It consists of various quantities of carbonaceous and inorganic solids in conjunction with absorbed or occluded organic tars and resins. (5) Impure carbon particles resulting from the incomplete combustion of the gas-phase combustion process. morphology of soot particles is similar to carbon black, fine micron/submicron-sized particles.

- specific ash characteristics - vegetation type, size distribution, phytoliths;
- specific char characteristic - vegetation type, size distribution;
- specific firestorm related-debris - burned soil particles and clays, burned plant parts and pollen; and
- specific soot depositional patterns - the aciniform cluster or chaining patterns produced by the condensation of heated organic residues produced during vegetation pyrolysis.

Sponge: See Cellular (or Dry) sponge.

Static Attraction and Agglomeration: smaller particles tend to be attracted to other particles and surfaces through opposing static charges.

Strategy: the application of a systematic, coordinated approach to all the elements of the site inspection; including the walkthrough inspection, occupant interview, in-field methods, and preliminary determination.

Subject Matter: in the post wildfire building environment includes one or more of the following consistent with the assigned scope of work: A) Environmental health and safety (EHS)/Industrial Hygiene (IH), B) building science and damage assessment, C) environmental monitoring, sampling, and analysis D) building remediation/restoration, and E) post remediation verification.

Tapelift: (1) the primary sampling method for the evaluation of char, ash, soot and other signature particles, the primary indicators of wildfire debris impact. (2) the use of adhesive tape to collect a sample of particles from a surface.

Thermophoresis: Particle migration in a thermal gradient. (Thermo-; related to temperature, and phor-; to go or bear, and -sis; act of: to move as a result of temperature).

Visual Inspection (Impact): the process of 1) evaluating a structure prior to beginning restoration work looking for conditions that, if not corrected during the project, can lead to incomplete restoration or non-completion of the project; and 2) examining the work area for evidence that the project has been completed successfully.

Visual Inspection (Damage): (1) a hands-on inspection process that assesses general conditions as well as damaging conditions affecting a building or material. (2) the inspection of a loss with or without the aid or benefit of measuring instruments and testing equipment.

Visual Inspection (Exploratory): the hands-on inspection process that investigates suspected hidden building material damage through dismantling or visual assessment of conditions.

Visual Inspection: Any visual inspection or evaluation process that provides a visual account of something. (1) a hands-on inspection process that assesses general conditions as well as particular conditions affecting a building or material. (2) the inspection of a loss without the aid or benefit of measuring instruments or testing equipment.

Visual Observation: the "direct" process of using eyes to observe surfaces that may have been impacted by wildfire smoke, char, ash, and vegetative matter. Visual observation requires a direct line of sight to a material or surface, where one has adequate sunlight or incandescent light to see. In addition, a visual observation inspection *should* be as close to a surface or material as possible to identify the types of particulate matter.

Volatile Organic Compounds (VOC): organic chemicals with a boiling point range of 50-100 °F (240-260 °C).

White-Glove Test: the use of a white glove, cloth, wiper, or swab to test for the presence of dark-colored particles on a surface.

Wildfire Smoke Impact Levels:

Level 0 (Background):

- Property (exterior, interior, contents) has no visible or evidentiary impact from wildfire heat, smoke, or particulate and no odors associated with the wildfire burn are perceived.

Level 1 (Light):

- Property (exterior, interior, contents) may have wildfire residues that may be detected through visual observation but limited to points of entry (e.g., windowsills/tracks, door thresholds, proximate flooring);
- Odors associated with the wildfire burn may be detected as faint or intermittent

Level 2 (Moderate):

- Property (exterior, interior, contents) has noticeable wildfire residue detected through visual observation and is present on multiple interior surfaces and spaces;
- Odors associated with the wildfire burn may be noticeable in designated areas.

Level 3 (Heavy):

- Property (exterior, interior, contents) visual observation confirmed, wildfire residue is widespread;
- Thermal damage to the exterior and/or interior surfaces may be present;
- Odors associated with the wildfire burn are noticeable and may be irritating.

Wipe Sampling: wipe sampling can be used for the chemical analysis of organic compounds associated with wildfire deposits.

Wildfire Signature/Indicator Particles: unique particles up drafted in the plume mostly from charred remains of the leaves and bark of the trees and shrubs and the plant fragments of grasses and herbs. May include pyrolyzed phytoliths, charred pollens, burned soil, fire-retardant spheres, and other remnants of the uncontrolled burn. It is these unique particles which help characterize and distinguish a wildfire event from other sources during a forensic examination.

1 Principles of Wildfire Smoke Damage Restoration

The goal of wildfire residue cleanup or restoration is to return the property to a pre-loss condition. There are general principles used in the restoration of wildfire smoke-damaged structures and materials. Applying these principles may require a multi-disciplinary approach involving professionals from several fields of expertise to properly identify and evaluate the impact of wildfire debris, cleaning, and restoration of structures and contents.

1.1 Safety and Health Provisions

Prior to entering any structure within or adjacent to the fire perimeter, a qualified individual *shall* conduct a hazard and risk assessment for potential structural fire damage which may pose a safety risk to the restorer. Appropriate safety procedures and personal protective equipment (PPE) *shall* be used to protect restorers. A reasonable effort *should* be made to inform Materially Interested Parties (MIPs) of any identified health and safety issues.

1.2 Initial Inspection and Documentation

Relevant data and information collected prior to and throughout the project by the restorer *should* be well documented, cataloged, and retained by the restorer for reporting purposes. The documentation *should* include data and information collected during the inspection of the property, structural heat/fire damages, accumulations of wildfire residues, and other fire-related damages. The primary objective of the initial inspection is to assess the presence and extent of residual wildfire debris on surfaces exposed to smoke from the wildfire event. The initial inspection *should* include detailed sensory observations (e.g., odor evaluation, visible/physical impact) and may require evaluation by a competent professional to confirm source identification and establish background levels.

1.3 Development of the Restoration Work Plan (RWP)

The restorer *should* develop a scope of work based on their preliminary determination, information gathering, occupant interviews and inspection findings which may include all or some of the following:

- removal and replacement of building components damaged by wildfire-related heat;
- cleaning of wildfire residue impacted surfaces and contents;
- restoration and deodorization of salvageable building materials, contents, and using specialized equipment and processes beyond initial cleaning; and
- when applicable, include performance specifications developed with the client.

1.4 Isolation of Work Areas

Where appropriate, the restorer *should* separate and isolate work areas using engineering controls to prevent the spread of wildfire particles during cleaning.

1.5 Cleaning, Restoration, or Removal of Wildfire-Impacted Materials

There is no single approach to cleaning that fits all wildfire impact situations. When determining the extent of required wildfire cleaning and restoration, the restorer *should* progress with a stepwise approach from the least aggressive to more aggressive methods. In some instances, cleanup may be limited to basic surface cleaning only.

1.6 Post-Restoration Evaluation

Following wildfire smoke damage restoration, a post-restoration evaluation *should* be performed by the restorer to confirm the completion of the cleaning and/or restoration according to the scope of work.

2 Composition of Wildfire Smoke

Introduction

Restorers and competent professionals *should* understand that the composition of wildfire smoke varies with fuel, fire intensity, distance, and time. Grassland fires are fast-moving and less intense than woodland fires. Grassland fuels are higher in cellulose than woodland fuels. The ash from grassland fires is high in silica. The ash from woodland fires is high in calcium and potassium. The particles of ash and char from a grass fire are very different from those from a woodland fire. The composition of the hot plume is very different from the plume after cooling with time or distance from the fire.

Restorers and competent professionals *should* understand that the contaminants that make up smoke emissions generated by the combustion of biomass fuels are related to the primary fuels involved in wildfires. Wildfire smoke is a complex mixture of gases, vapors, and particles. These include carbon dioxide, water vapor, carbon monoxide, hydrocarbon gases, soot, char, ash, and soil minerals. Individual chemical compounds and particle types present in smoke number in the thousands.

The composition of every type of gas and particle created by combustion changes over time and distance due to environmental conditions. Smoke generated at the time of combustion is not the smoke that enters a building. Volatile gases condense as the temperature of the plume decreases. They are absorbed or adsorbed into or onto particles in the plume. Some are chemically changed or destroyed. Sunlight destroys many of the chemicals over time. Particles agglomerate and deposit on surfaces by diffusion, impaction, sedimentation, or mechanical filtration which decreases the airborne particle concentration.

Distance and time are inextricably linked. High winds increase the dispersion of the plumes and change chemical composition calm conditions will concentrate the plume even at short distances. Visible particles may be absent in the smoke near the fire and settle out of the plume hundreds of miles away.

2.1 Generation of Wildfire Emissions

2.1.1 Wildfire Combustion Process

Restorers and competent professionals *should* understand the essential elements of the combustion process and the basic chemical and physical properties, fire characteristics, and types of contaminants generated by biomass fires. The generation of wildfire smoke is the result of combustion. Combustion of wildfire fuels occurs in four phases: pre-heating, flaming, fully developed, and smoldering. During the pre-heating phase, fuels are heated, moisture is driven out of the fuel as water vapor, and combustible gases and particulate matter are generated by the initial decomposition of the solid fuel. This thermal decomposition, referred to as pyrolysis occurs prior to the flaming combustion of solid fuels.

Particulate matter fragments generated during the pyrolysis phase range from about 6 nanometers to a few micrometers in size. During the flaming phase of the fire, pyrolyzed gases and vapors ignite and a flame front develops. As the energy of the fire grows the rate of pyrolysis increases and enters the fully developed phase. Additional fuels for rapid fire growth and increasing energy release become available. The result is a self-perpetuating flaming fire that will continue to burn until the fuel or oxygen is consumed, or the fuel cools and the fire is extinguished. Plant materials exposed to increasing radiative energy created by the fire release resins and other combustible gases prior to flaming.

The production of volatiles within the plant creates pressures capable of fragmenting the plants and ejecting charred fragments into the air. This fragmenting process can generate large burning fragments that can travel over great distances. Smaller fragments, most below fifty micrometers may become part of the smoke plume. The final phase, smoldering, tends to generate primarily ash and significant amounts of carbon monoxide. The bonds holding ash fragments to the plant surface are weak and ash has a high surface area relative to mass. Small disturbances, such as fragmentation of the plant material, wind, and thermal updraft, can release significant quantities of ash particles into the air. Initially, ash tends to be from half a micrometer to many millimeters in the longest dimension. Over time and depending on environmental conditions ash will oxidize or disintegrate.

Wildfire fuels are cellulose based primarily hydrogen bonded to carbon. Hydrogen burns first and most efficiently. This rapidly decreases the available oxygen and results in incomplete combustion of the carbon residue. Plant cell structure is often retained by the remaining carbon in the form of char. These carbon residues are hot and will continue to burn if more oxygen is available before they cool. The end product is ash which may still retain some cell structure or characteristic inert plant residues, such as phytoliths.

The actual fuel for the flames is the pyrolysis gases generated by the heated solid fuel. Some of these gases persist as free gases or combine with particles in the smoke. They are a component of the smoke odor and will slowly emit from char long after the smoke itself is gone.

2.1.2 Fuel Types

Restorers *should* understand the difference between fuels involved in a wildfire, other biomass fires, and those involved in structural fires. Wildfire and biomass fires burn in the open and contain very little nitrogen or sulfur compounds. These are significant differences in terms of the reduced hazards from the combustion of plant materials compared to emissions from structural fires. This document presents information on biomass fuels involved in wildfires. For additional information on fuels involved in structural fires, refer to *IICRC S700 Standard for Professional Fire and Smoke Damage Restoration* (Note: this is a draft Standard which is expected to be published at the same time as the S760).

Wildfires primarily involve plant material (i.e., trees, grasses, shrubs, leaves, pine needles, and ground debris). Two important components of plant cell walls are cellulose (plant polysaccharide made of linked D-glucose units) and lignin (cross-linked phenolic polymers) found at the highest levels in woody plants.

Wildfires can move into the wildland urban interface (WUI), burning homes and structures and thereby consuming man-made materials in addition to natural fuels. Man-made structures serve as fuel and can introduce various additional non-cellulose-based fuels such as nitrogen and sulfur containing plastics and compounds containing metals not found normally in wildfire smoke.

2.2 Wildfire Generated Volatile, Semi-Volatile, and Gaseous Compounds

When biomass is subject to temperatures exceeding 300ºC (572ºF) gases are generated that are the fuel that initiates the flaming phase of the fire. Many of these pyrolysis gases are rapidly consumed in the flame and reduced to water, carbon dioxide, carbon monoxide, and carbon, depending on the availability of oxygen. Other gases are more stable and may survive the flames in part. These gases become the “volatile organic compounds” (VOCs) and “semi-volatile organic compounds” (SVOCs) that are part of the smoke plume. The pyrolysis of cellulose produces levoglucosan, a volatile organic compound (VOC) and universal indicator of biomass burning. Furans, pyrans, and light oxygenates are also generated. Lignin pyrolysis primarily forms methoxy-substituted phenols, specifically guaiacols and syringols as VOCs.

Wildfires produce a wide range of classes of organic compounds, including aliphatic and aromatic hydrocarbons, polycyclic aromatic hydrocarbons (PAHs), and oxygenated compounds, such as aldehydes, acids, esters, and alcohols. The mixture of light, moderate, and heavy VOCs and SVOCs, and the relative proportion of light or heavy VOCs indicates the age and/or dissipation of wildfire residuals that can be compared with the timeline of the fire event. Typically, light to moderate VOCs exist only for a short time after a fire. They have half-lives in the order of minutes. Heavier VOCs and SVOCs have half-lives of hours to days in the atmosphere but can persist for months in association with the particles generated by the fire and deposited in indoor environments. Removal of the wildfire residual particles is generally sufficient to remove these compounds from an indoor environment.

Structures in close proximity to the hot plume of a wildfire can be impacted by settled particles and a lacquer-like coating from condensed vapors. The condensed residues are visible on inspection of the structure and may tightly bond particles to the surface.

2.2.1 Wildfire Generated Particulate Matter

Particulate matter is solid matter created by gas-to-particle conversion, evaporative residues, charred and ash structures generated by pyrolysis, and oxidized soils lofted into the thermal updraft of the fire.

Soot is created by gas-to-particle conversion as a product of pyrolysis. It is generated in great quantities during wildfires, typically blown off in the crown of wildfire, and is not a primary indicator in the indoor environment. Soot from vehicle exhaust, furnaces, agricultural burns, wood waste burns, fireplaces, barbeques, or backyard fire pits, candles, and other combustion sources can produce aciniform soot. Many soot particles will agglomerate with larger char or ash particles in the plume. Soot is a ubiquitous background component indoors and outdoors.

Wildfires tend to burn the parts of the plants that have the greatest exposure to oxygen. The leaves, bark, and twigs are the most exposed parts of woody plants. Grasses and other non-woody plants tend to have a relatively high surface area exposed to oxygen. These growth patterns result in the generation of uniquely identifiable char and ash particles.

Char is the carbon framework of the plant structure that has burned. It is more reflective than composted plant material due to the loss of hydrogen characteristic of plant material exposed to temperatures above 400º C (752ºF). The residual structure and reflectivity identify char as distinct from composing biomass. The structure identifies the char as being primarily from the plants and parts of plants typically burned by wildfire.

Ash particles from grasses are primarily silica and are relatively inert as dust. The silica phytoliths from grasses are often characteristic of the sub-family level. Ash particles from other plants and trees contain more calcium and potassium compounds. These particles often contain a useful indication of structure. Calcium tends to be the residue from the calcium oxalate phytoliths. The shape of the calcium oxalate phytoliths and the changes in their optical properties due to exposure to high temperatures makes them very useful in identifying the plant type of origin and heat exposure.

The alkaline properties of biomass ash are largely due to the potassium compounds they contain. These potassium compounds may be corrosive to some materials. They need to be “wet” to be corrosive. In the presence of moisture, they react with carbon dioxide in the air as well. Once reacted with carbon dioxide they are no longer corrosive. The possible extent of corrosion is dependent upon the total mass of ash present, the extent to which it has already reacted with carbon dioxide, and its actual contact area with the reactive surface.

Other particulate matter includes oxidized dust from soils lofted into the thermal updraft and carried upward with the smoke and small spheres of fire retardant that may become part of the local plume.

2.3 Aging of Wildfire Smoke, Far-Field Exposure

By the time the plume has cooled below 100ºC (212ºF), it has changed. Condensable organic compounds have condensed or are intimately associated with particles in the plume. They will no longer condense on cool surfaces that they encounter. Hygroscopic salts in the ash have attracted moisture and are reacting with the carbon dioxide in the plume. Larger particles are beginning to settle out of the plume as a result of gravity. At the same time drag is lofting the particles and keeping them in the plume. Gravity is acting on the particle mass while drag is working on the particle surface area. Ash and char particles with the longest dimension as great as a centimeter may be carried hundreds of miles.

The atmospheric loading of particles from the wildfire may be quite high. Particles larger than 100 micrometers may be tracked into structures or drawn in by ventilation systems. Particles smaller than about 15 micrometers enter structures through small gaps around windows, doors, and other leak paths. The PM_{10} and $PM_{2.5}$ levels indoors may approach the values outdoors. As the value outdoors drops so also does the value indoors. Outdoors the smoke residue is quickly mixed into the soil. Indoors it persists on surfaces until removed by cleaning.

2.4 Wildfire Signature Assemblages

Leaves have characteristic stomata, venation, pubescence, phytoliths, and other structures. Bark has unique patterns and cell structures and phytoliths that mark the plant of origin. Different plants have different structures that mark the type of trees, grasses, shrubs, or other plants burning.

Wildfire smoke is identified by the variety of particles it contains. The assemblage of particle types becomes the marker for wildfire. It is recommended that restorers maintain a basic understanding of wildfire signature assemblages because those assemblages can be used to identify the source of combustion particles (e.g., specific wildfire environments).

2.4.1 Variety of Plants Represented

One of the unique features of wildfire smoke is that it carries particles characteristic of all the plants in the biome that are burning. Wildfire smoke can be distinguished from fireplace smoke, firepit smoke, agricultural burns, other biomass burns, and structural fires. As wildfire burns through an area the fuels may change but they all represent a natural biome. These natural biomes contain a variety of plants. This variety is represented in the particles of char and ash in the plume.

2.4.2 Parts of Plants Represented

Wildfires burn leaves, twigs, and bark primarily. There is some charred wood, but it is generally not the dominant char. Leaves contain numerous structures that are unique and common in the smoke from wildfires. These include stomata, venation, plant hairs, silica, calcium oxalate phytoliths, resin beads, and sclerophyllous cell structures, all in their charred or ached form. Bark also has a unique function and structure that marks its char and ash. The outer layers of the bark insulate the delicate inner structures that transport moisture and nutrients and that create new growth. Lenticels allow air exchange. Calcium oxalate phytoliths discourage boring insects. Wheel-and-spoke structures provide insulative air gaps. Cork cells and other structures provide a tough shield layer for the woody core. Twigs include a relatively thick bark layer over accessible woody tissue due to their small diameter. Much of the charred wood in the wildfire smoke comes from the burning of twigs. These structures create a unique assemblage that identifies wildfire smoke.

2.4.3 Associated particles (Burnt soils and Fire Retardant)

Intense wildfires generate their own weather and strong winds. These fire storms carry soil into the flame, oxidize it to brick-red, and it becomes part of the plume. This burnt clay becomes another marker for wildfire smoke. When airdropped fire retardants are applied a fine cloud of particles can be seen separating from the bulk of the material. This thin pink cloud contains millions of small spheres of fire retardant. These can also become part of the plume.

3 Safety and Health

This Standard has not been written to address work-related safety and health practices associated with performing professional wildfire smoke impact investigations and restoration. Restorers and competent professionals *shall* understand and adhere to all applicable health and safety regulations related to the country or locale in which they work. Examples of subjects addressed by regulatory requirements can include, but are not limited to:

- site-specific safety surveys;
- hazard/risk assessments;
- emergency action and fire prevention plans;
- personal protective equipment;
- respiratory protection programs;
- asbestos;
- lead-based paint;
- respirable crystalline silica and particulate matter;
- heat disorders and health effects;
- bloodborne pathogen exposure control plans;
- confined space work;
- written hazard communication programs;
- lockout/tagout procedures and electrical safety orders;
- fall protection;
- hearing conservation plans;
- working surfaces (e.g., floors, ladders, scaffolds); and
- corporate health and safety plans.

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 Occupational Safety and Health Administration (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 in the United States *shall* comply with applicable sections of both the OSHA General Industry Standards and the Construction Industry Standards. Furthermore, individual state and local governments can have additional safety and health requirements that are more restrictive than the Federal Occupational Safety and Health Administration. Each state in the United States is required to use Federal OSHA as a minimum statutory requirement, but many states impose even more protections. Employers *shall* comply with these safety and health regulatory requirements.

4 Limitations, Complexities, Complications, and Conflicts

Restorers can be faced with conditions that present challenges to the assessment process, producing limitations, complications, complexities, or conflicts. Restorers *should* have a thorough understanding of these issues and communicate them to appropriate parties.

4.1 Limitations

A limitation is a restriction imposed by Materially Interested Parties (MIPs) or others upon a restorer that results in a limit on the restoration, the restorer's activities, or the outcomes that are expected. Before beginning restoration work, known or anticipated limitations and their consequences *should* be understood, discussed, and approved in writing by restorers and the owner or owner's agent.

4.2 Complexities

A complexity is a condition that causes a project to be more difficult or detailed but does not prevent the restorer from performing work adequately. Before beginning restoration work, known complexities and their consequences *should* be understood, discussed, and approved in writing by the restorer, and owner or owner's agent.

4.3 Complications

A complication is a condition that arises after the start of work and causes or necessitates a change in the scope of activities because the project becomes more complex, intricate, or perplexing. The owner or owner's agent *should* be notified in writing as soon as practical regarding complications that develop. The presence of project complications can necessitate a written change order.

4.4 Conflicts

Conflicts are limitations, complexities, or complications that result in a disagreement between the parties involved about how the restoration project is to be performed. Mutual agreements to resolve conflicts *should* be documented in writing, and releases, waivers, and disclaimers *should* be reviewed by legal counsel.

5 Restorer Qualifications, Administrative Procedures, and Project Documentation

5.1 Education and Training

Restorers *should* be proficient in the investigation, identification, and restoration of wildfire and smoke related impact. Proficiency is obtained through specialized education, training, and field experience which includes, but is not limited to, wildfire and smoke impact investigation, decontamination cleaning methods, contractual and legal requirements, improving indoor environmental quality, and smoke odor management.

Restorers acquire requisite restoration skills through industry technical training programs, certification programs, and experience. It is recommended that restorers be familiar with current and past construction methods, materials, and building assemblies.

Education and training on fire – related residue, identification, investigation, and removal techniques are available through internationally recognized certification and training bodies such as:

- Institute of Inspection, Cleaning, and Restoration Certification (IICRC);
- Restoration Industry Association (RIA);
- Indoor Air Quality Association (IAQA);
- American Council for Accredited Certification (ACAC); and
- American Industrial Hygiene Association (AIHA).

The restorer *should* be appropriately licensed and insured as required. In addition, the restorer *shall* comply with all jurisdictional health and safety regulations.

5.2 Administrative Procedures and Documentation

Since an interested party can affect the restorer's ability to provide services or meet legal requirements, restorers *should* identify and understand the needs and expectations of Materially Interested Parties (MIPs) as they relate to the subject project.

MIPs can include, but are not limited to:

- property owner;
- policyholder;
- insurance company;
- mortgage company;
- restoration contractor;
- property management companies;
- tribal housing authorities/Native American Council;
- HOA/COA;
- tenants;
- tenant's Insurance Company;
- Authorities Having Jurisdiction (AHJ) for environmental compliance and other regulations;
- Cause and Origin competent professionals (C&O);
- Third Party Administrators (TPAs);
- Third Party Consultants (TPCs); and
- legal representative or designated agent.

It is recommended that restorers establish, implement, and consistently follow project administration methods and procedures, including but not limited to updating RWP and protocols. Competent project administration promotes the delivery of high-quality wildfire smoke impact restoration services and increases the likelihood of having satisfied clients. Wildfire smoke impacts restoration project administration typically includes, but is not necessarily limited to:

- provide an accurate and impartial description of the wildfire smoke impact and its effects;
- 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 and disciplines with MIP; and
- professional and ethical practices and business orientation.

Restorers *should* be skilled in preparing an accurate and comprehensive Restoration Work Plan (RWP) to address all phases of the restoration project which may include but not limited to the following:

- damage assessment;
- mitigation;
- source removal;
- air conveyance systems; and
- deodorization.

Restorers *should* be knowledgeable about the effects of property insurance on the restoration process, including but not limited to the following:

- types of coverage;
- deductible amounts;
- rights of subrogation;
- terms of payment; and
- claims handling procedures.

5.3 Licensing and Regulatory Agencies

Restorers *shall* comply with all licensing requirements set forth by the AHJ in the jurisdiction in which the services are provided.

Restorers *shall* comply with all requirements set forth by the regulatory agencies within the jurisdiction where the services are provided. Failure to comply with these agencies may result in fines or other consequences.

5.4 Insurance

Restoration contractors *shall* comply with all insurance requirements established by the AHJ for each element of their operation. This may include insurance coverage for their employees, property, automobile fleet, and liability. Restorers *should* ensure that their sub-trades have appropriate insurance coverage as required.

Restorers *should* seek the advice of an insurance professional who is familiar with their operations and can assist in developing an insurance program that may include, but is not limited to, the following:

- general liability;
- automobile liability;
- umbrella or excess liability;
- Workers’ Compensation (firms with employees);
- pollution insurance (firms that provide water mitigation with wildfire impact restoration;
- professional liability (errors and omissions);
- bailees (firms that handle contents);
- Inland Marine (firms that handle contents);
- cyber (firms that store private information, use credit cards, or banking info);
- property (firms that own buildings, or lease space); and

- surety bond insurance.

5.5 Ethics

The restorer's assessment of the damage from a wildfire loss, and the associated costs of restoration services will have influenced the outcome of a project (i.e., insurance claim settlement). In the course of doing this work, restorers *should* be truthful, impartial, and ethical at all times. Industry organizations (e.g., IICRC, RIA) have written codes of ethics to which restorers who perform wildfire damage restoration *should* adhere to.

5.6 Impartiality

Restorers *should* maintain strict impartiality in their professional opinions regarding wildfire event impact and its effects. In the course of doing this type of work, the restorer may be subject to conflicting pressures from the client, MIPs, and other outside forces. Restorers *should* not be influenced or persuaded by others to alter their scope of repair or weaken their commitment to impartiality. Conflicts will arise when restorer impartiality is challenged. Restorers *should* decline projects when they suspect unethical or illegal practices may occur. Refer to *Section 4: Limitations, Complexities, Complications, and Conflicts* for additional information on disagreements between parties.

5.7 Pre-Existing Conditions

In the course of an inspection, restorers may encounter building distress, construction defects, code deficiencies, and other pre-existing conditions (e.g., smoke or staining) which may be unrelated to the damage resulting from the subject loss. Since the restorer's assessment and their documents (i.e., photos, and other documentations) may influence an insurance settlement, court award, or tax deduction, the Restoration Work Plan *should* accurately address the damage resulting from the subject loss. Work or improvements not related to the wildfire damage *should* be clearly noted as such.

5.8 Professional Judgement

The restorers' opinions *should* be based on their own professional judgment. Refer to *Section 9: Analysis, Use, and Interpretation of Data for Wildfire Impact* for more information. Restoration is not always consistent with historic practices and guidelines. Alternative procedures are often available for identical conditions. Professional judgement *should* be used to provide a cost-effective repair without sacrificing occupant health, warranty, quality, value, and long-term performance.

5.9 Transparency with Affiliations

It is recommended that the restorer disclose any affiliation with third parties that may influence the scope of work.

5.10 Transparency with Financial Arrangements

Cost allowances or discounts involved in the restoration of a property *should* be clearly communicated to the client in writing. The restorer *should* include all financial details that pertain to the project in the estimate, contract, change orders and other documents presented by the restorer. Subsequent changes in the scope or price adjustments *should* be documented and communicated to the client and the appropriate MIPs prior to the commencement of work or costs being incurred.

5.11 Bias in Estimating

The restorer's description of the wildfire impact and its effects *should* be accurate and impartial. In the immediate aftermath of a wildfire event, the perception of wildfire damage and its effects may be exaggerated by underqualified or unethical persons. A restorer minimizing the significance of wildfire impact can be equally harmful. Property owners may be influenced by opinions or technical terminology presented as facts, designed to obtain a contract, or increase the amount of a claim. A misrepresentation of facts can result in an allegation of fraud.

An understated description of damage may result in the property owner agreeing to an inadequate settlement or scope only to find that supplemental work will be required to adequately repair the impact. It is unethical for restorers to knowingly underestimate the scope to obtain a contract. Understatements of an impact sometimes arise from an incomplete inspection or a lack of knowledge and experience. While legitimate differences of opinion may arise over the significance of impact, the presence of impact *should* be a matter of demonstrable fact.

Restorers *should* avoid offering opinions unless they are relevant to the situation and factually accurate. Experience in a particular restoration discipline does not automatically confer expertise in other areas. Opinions relating to occupancy, health, legal advice, insurance coverage, and other client concerns *should* be left to persons with specialized knowledge of those subjects.

5.12 Restorers vs. General Building and Other Cleaning Contractors

Restorers and MIPs *should* recognize distinctions exist between wildfire impact restoration and general cleaning and building service trades, most importantly, the ability to recognize and respond to property impact caused by the wildfire event. In new construction or remodeling projects, emphasis is often placed on building design rather than repairs, whereas restoration is focused on the intent to return the property to its pre-event condition.

Restorers *should* understand that there are four major factors that differentiate general building contractors from specialized restoration contractors:

1. An understanding of the impact that wildfire modalities can have on a building.
2. The knowledge of treatments required to accurately address the event and remedy the resulting impact.
3. The ability to distinguish impact from a specific wildfire event from unrelated buildings or pre-existing conditions.
4. Performing a job *should* include an understanding of the loss process and the involvement of third parties such as insurance companies or Third-Party Administrators (TPAs).

Underqualified restorers who lack the knowledge and understanding of the nature and behavior of wildfire smoke impact are less likely to identify impacted surfaces while inadvertently overlooking relevant areas of impact (e.g., concealed spaces, soffits, sub-floors, attics, dryer vents, kitchen hood vents, points of entry)**.** Attempts to remove wildfire smoke residues by undertrained personnel could result in permanent damage to certain building surfaces that could otherwise have been successfully restored by more qualified restoration technicians. In addition, restorers that provide emergency services, but do not understand the nuances of the property insurance process (e.g., cause and origin investigation, rights of subrogation), are more likely to unknowingly discard potential evidence.

5.13 Service Agreement (Contract)

Restorers *should* enter into a written agreement before performing emergency services and starting a restoration project. Restorers *should* seek legal counsel for the development of their contracts to form an enforceable agreement under the laws of the applicable jurisdiction.

Emergency work is often performed on a time and materials basis using a signed contract. Non-emergency (e.g., full restoration) projects, where the restoration contractor will have provided the client with a written and priced work plan *should* require a signed work contract. The pricing method by which work is performed *should* be consistent with the type of contract proposed.

Examples of pricing methods used in wildfire smoke restoration *should* include, but are not limited to:

- time and material - T&M (i.e., rate and material - R&M)
- unit cost;
- lump sum; and
- hybrid.

5.14 Service Agreements - Emergency

Restorers who perform emergency services *should* have an enforceable written agreement prior to the commencement of work. This agreement *should* be executed by the property owner or designated agent to authorize and agree to a limited scope of services. The language of the authorization *should* include but is not limited to the following:

- a clear explanation and understanding of the party responsible for payment;
- the intent of the work (e.g., mitigate damage, stabilization services, temporary weatherproofing, prevent unauthorized intrusion);
- permission to enter the property, and to proceed with the intended work;
- terms of payment and costing method; and
- remedies for unpaid charges and associated legal fees.

5.15 Work Contracts

Non-emergency work *should* be performed with a fully executed contract between the restorer and the customer, or their agent. Projects vary in size and scope and can have unique issues and complications. What constitutes an adequate written contract for any given project or jurisdiction is beyond the scope of this Standard. It is recommended that restorers consult legal counsel to develop contracts. It is recommended that contracts include but are not limited to the following, at a minimum:

- a clear identification of, and contact information for, the contracting parties;
- the property address;
- 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 (i.e., scope of work);
- any known limitations, exclusions, assumptions, complexities, or potential complications of the project;
- the party responsible for obtaining permits required for the work, if applicable;
- the project start date and projected timeframe for completion of the work;
- the price being charged for the work, and if applicable, costing methods;
- the terms and schedule for payment;
- change orders or variations to the contract considerations;
- warranties and disclaimer provisions, if any;
- exclusion of liability clause for consequential damage;
- the terms upon which the contract may be terminated;
- a Force Majeure clause; a dispute resolution clause; and
- assignment of benefits, if applicable.

5.15.1 Changes to Contracts

Substantive or material changes from the original contract *should* be documented in a written and detailed change order, which includes a description of the changes to the RWP, time for performance, price or fees, and method of payment. It is recommended that the customer's designated agent and the restorer accept the change order in writing. Change orders represent additions to or deletions of work specified in the original contract. The restorer *should* obtain approval for any supplemental estimate and/or change order work prior to commencement.

Changes to contracts may result from undiscovered conditions such as hidden or latent damage, conditions, or circumstances previously unseen or unknown. Discovery can occur at any time during the assessment and most frequently occurs during the demolition or deconstruction phase of work.

5.15.2 Communication

Communication between all MIPs is paramount in wildfire smoke restoration projects. It is recommended that MIPs agree on the purpose and subjects of project communication, the frequency and mode of communication, and with whom communications will be distributed. It is recommended that any limitations, or complexities that could affect the project be discussed, documented in writing, and distributed to the appropriate MIPs. Refer to *Section 4: Limitations, Complexities, Complications, and Conflicts (LCCC)* for additional information.

Restorers *should* not give advice, education, or warnings on subjects outside their areas of professional expertise or licensing (e.g., legal, insurance policy, engineering).

5.15.3 Confidentiality Disclosure Agreement (CDA) or Non-Disclosure Agreement (NDA)

Restorers *should* maintain the confidentiality of their client's affairs.

The ownership and management of the company performing the work *should* ensure that this principle is understood and respected by all personnel involved in the project. If the client requests specific documentation to support this principle, restorers *should* seek legal advice prior to signing any CDA or NDA.

5.16 Documentation

5.16.1 Inspection and Damage Assessment

The restorer *should* understand that on certain emergency work, the window of opportunity for inspection and assessment may be limited or restricted. Restorers *should* memorialize verbal instructions in writing on the services that need to be performed on an emergency basis, and generally describe and define them in the emergency service agreement, as soon as practical.

All projects *should* be inspected and assessed to the extent possible before any work is performed. This inspection will allow the restorer to document the procedures required to address the damage, the resources to be used, the schedule in which such procedures and resources are to be applied, and the methods and means by which the restoration will be determined to be successful.

5.16.2 Estimating Documentation

Relevant data *should* be obtained to the extent it will enable the restorer to calculate the cost of services, regardless of the pricing method (e.g., rate and materials, unit cost, lump sum). The estimate *should* include a description of the tasks to be performed on a specific site to address specific conditions identified during direct inspections and assessment of the impact.

The data the restorer collects *should* reflect the nature of the work based on the pricing method. For example, rate and materials pricing will require an estimated quantity of material to be used and duration of time the project will take, and unit cost pricing will require site-specific details (e.g., accurate measurements of areas, listings of per item tasks, inventory of contents). Lump sum pricing generally requires bids from subcontractors.

5.16.3 The Restoration Work Plan (RWP)

Following the assessment of the wildfire smoke impact, restorers *should* prepare a description of how the project will be performed. Wildfire smoke impact assessment will determine the boundaries and levels of fire, smoke, and odor impact. Documentation of the RWP *should* include but is not limited to:

- forecasting, obtaining, and managing resources;
- establishing and maintaining engineering controls;
- a plan for communication with the client and MIPs;
- a written description of the work that corresponds to the particular phase of the project;
- a schedule, or sequencing, of the order in which the services are provided;
- a plan outlining the order in which areas/levels of the building will be addressed;
- a plan for the disposition of contents, if applicable;
- a schedule of progress inspections (e.g., visual, odor); and
- sign-offs for work completed based on pre-established acceptance criteria.

5.16.4 Project Support Documentation

Documentation *should* take place at all phases of the restoration project to include written descriptions, detailed photographs, and observations to include but not be limited to:

- initial assessment;
- emergency response;
- thorough damage assessment – full restoration;
- information gathering
- AHJ inspection reports;
- visual observations; and
- odor perception.

The extent of project documentation and recordkeeping varies with each restoration project. Restorers *should* record information relevant to the project over the duration of the project to protect their interests in addition to the interest of the property owner and other MIPs.

This information is also valuable if there is a need to review or reconstruct the restoration process or project at some time after completion. To properly develop and document a wildfire smoke restoration project, it is recommended that the restorer 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 all communications to reduce the potential for misunderstanding and miscommunication.

5.16.5 Initial Assessment Documentation

Wildfire smoke impact areas *should* be evaluated for safe access by a competent person prior to commencement of work. Any areas deemed unsafe to access that have been cordoned off with signage and caution tape *should* be documented. The restorer or emergency response manager *should* perform site inspection and assessment of which emergency services are required as soon as possible and the order in which they are to be performed. This assessment and list of procedures *should* be documented in the emergency phase of the RWP.

In certain circumstances, for example, when immediate emergency response is required, in lieu of a written emergency phase RWP, the direction for emergency work can be communicated verbally by the emergency response manager to restoration personnel. Field notes and photographs *should* be taken at the time the services are provided to have a record of the work that was performed.

5.16.6 Information Gathering

All relevant information regarding the wildfire event *should* be obtained and documented by the restorer including but not limited to:

- names and contact information of all MIPs;
- information regarding the property: property address, building type, age, usage, drawings, and plans, if available;
- information about the nature of the wildfire including firefighting activities and methods;
- need for any type of mitigation; and
- condition of utilities (e.g., functional electricity, water, gas); on or off.

5.16.7 Client, or other MIPs' Opinions

Subjective opinions of impact (e.g., observed changes in surface appearance, detection of wildfire smoke odors) described by others *should* be documented in a accurate and impartial manner and considered for inclusion in the development of the RWP.

5.16.8 Photographic Documentation

Photographs *should* be taken to document building impact including the impact from the wildfire event as well as obvious unrelated pre-existing conditions of disrepair and damage, when possible. The window of opportunity for this type of documentation may be limited and therefore *should* be prioritized. It is recommended to include photos of the exterior of the building as well as overall pictures of areas with potential impact prior to the commencement of work.

5.16.9 Specialized Photographic Documentation

It is recommended that restorers familiarize themselves with the resources that are available to photograph building impact. Advancements in emerging technologies allow restorers to document the damages using smartphones, infrared, and 3D cameras. Drones can be utilized to provide aerial photographs.

Many of these technologies allow the restorer to provide 360-degree digital views and in some instances may be used to complete or aid in the completion of sketch drawings and measurements.

5.16.10 Emergency Services Documentation

Restorers *should* document information about the loss and conditions of the building prior to providing emergency response services. A qualified representative (e.g., emergency response manager) from the restoration company *shall* inspect the building to identify and document areas of involvement and priorities for mitigation and building stabilization.

5.16.11 Full Restoration Wildfire Event Damage Assessment Documentation for the RWP

Following any emergency work, if required, the restorer *should* proceed with the development of full restoration RWP. The restorer *should* begin to gather and maintain information; field observations, surface evaluations, recommendations from specialized trades (e.g., HVAC), reports from experts, photographs, and building drawings/plans to prepare the RWP.

5.16.12 Documenting Damage as Part of the Full Restoration Assessment

Restorers *should* perform the necessary observations and collect field data to make a preliminary determination as to the absence or presence of wildfire smoke residues. Restorers *shall* be aware of the potential for regulated hazardous materials to be present in buildings and perform their work in a manner consistent with regulations established by the AHJ. All documented relevant information obtained by the restorer during the performance of the observations and field data *should* be utilized in the preparation of the RWP. This documented information *should* also be retained by the restorer and be used to support and defend the RWP, if necessary. The results of these observations and field data will determine the following:

- boundaries of impact (e.g., affected and unaffected areas);

- level of impact;
- disposition of contents; and
- degree of restorability.

5.16.13 Third-Party Sampling/Laboratory Analysis and Other Third Parties

The primary objective of sampling as part of restoration is to confirm the presence or absence of wildfire contaminants above background levels, and/or pre-loss conditions. However, other goals can be supported by sampling, such as to:

- determine the scope of restoration needed;
- identify hidden contaminants;
- identify or document corrosive conditions;
- for insurance or legal documentation; or
- to address MIP concerns.

Reports made available by third parties *should* be considered by the restorer in the development of the RWP.

Refer to *Section 7: Sampling Methods and Strategies* for additional information.

5.17 Other Reports and Documentation

It is recommended that the restorer be aware of and adjust to project documentation requests and requirements from MIPs. Restorers *should* be prepared to provide documentation to support the contracted tasks outlined in the RWP (e.g., rate and material labor logs, and equipment usage logs). It is recommended that restorers inform MIPs that charges may be incurred for administrative time spent that is not related to the execution and completion of the RWP (e.g., detailed inventories of non-salvageable contents, photos of packed boxes confirming the box was packed to capacity, detailed floor diagrams on losses that involve only contents).

5.17.1 Documentation To Be Obtained and Maintained by Restorers

Records and documents *shall* be retained for a period of time following the completion of the project as dictated by the AHJ.

The documents and records that have been generated by, or provided to the restorer, *should* be maintained and may include the following but are not limited to:

- surface testing sample results;
- project related reports made available to the restorer;
- written wildfire impact restoration recommendations and technical specifications from specialized experts, inspectors, and others acting in the capacity of consultants;
- permits;
- contracts, change orders, deviations, payment schedules;
- detailed work or activity logs, including descriptions of what and when services were performed, and who performed the work or activities;
- estimates, invoices and payment receipts;
- subcontractor estimates, invoices, and payment receipts; and
- lien notices and lien releases, if any.

5.17.2 Record Keeping for Time and Materials (T&M) Proposals

Work performed on a time and materials basis (e.g., emergency work, pack outs), *should* be thoroughly and accurately documented to support invoicing. Restorers *should* keep separate records for labor (time), subcontractor documentation, materials, Personal Protective Equipment (PPE), consumables, and equipment used on projects. Restorers *should* assign field project documentation responsibilities to specific, potentially dedicated people depending on the size and complexity of the project to ensure the accuracy of the documentation. This person(s) *should* also sign off on any record-keeping documentation upon completion and retainage.

5.17.3 Time-Keeping Documentation

Restorers *should* record the time of employees while actively working on the project. Projects invoiced on a rate and material basis will require such information. Time records may include, but are not limited to:

- worker name and company identification information;
- date of service;
- job title or duties;
- mobilization;
- time in and time out for a specific task;
- description for the task being performed;
- total time worked;
- verification 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 the restorer consults with qualified legal or accounting professionals on this issue.

5.17.4 Mobilization and Logistics

When the deployment of personnel is required, restorers *should* maintain records of job-related costs that do include time spent physically working on the project. These costs include but are not limited to:

- travel;
- per diem;
- lodging;
- security;
- project management and supervision;
- specific project insurance; and
- communications.

5.17.5 Equipment, Material, PPE, and Consumables Usage Documentation

A list of equipment, materials, and consumables used on a specific job *should* be created and maintained. Projects invoiced on a time and material basis 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 function, capacity, and type of equipment;
- the make, model, and identification number for the piece of equipment;
- the date, time, and location the piece of equipment was put into service and removed from service; and
- time logs indicating on and off of air filtration equipment.

A materials log (e.g., PPE, consumables, supplies) can include, but is not limited to:

- product identity and function;
- the quantity and unit of measure of the material used;
- the date of usage;
- the locations of the product used on the project; and

- regulatory documents and orders (e.g., SDS).

5.18 Documentation of Limitations, Deviations, and Disclaimers

The client or customer may request or decline services that prevent the restorer from complying with wildfire event RWP, or the requirements and recommendations of this Standard. In these situations, the restorer *should* document any deviation from the work plan.

It is recognized that wildfire restoration projects are unique and that in certain circumstances, experience, and professional judgment may justify deviation from this Standard. It is the responsibility of the restorer to determine and verify on a case-by-case basis that the application of this Standard is appropriate. When material deviation from this Standard is warranted, it is recommended that the restorer document the situation and circumstances.

5.19 Risk Management

A risk is defined as an uncertain event or condition that, if it occurs, has a negative effect on a project's objectives. Risk is inherent in any project. Restorers *should* assess risks continually throughout the course of a project and develop a risk management plan to address them. Some examples of risks include but are not limited to:

- safety (e.g., workers, occupants);
- legal liabilities (e.g., workmanship, property damage);
- financial (e.g., finance project and getting paid);
- natural causes/disasters (e.g., flooding, power outages); and
- hidden and unpredictable (unsafe building conditions, access to materials and labor).

Strategies to manage risk include but are not limited to:

- avoidance (e.g., contract clauses);
- control, mitigate, modify or reduce (e.g., contract work specifications);
- accept or retain (e.g., adjust levels of liability insurance to anticipate the potential risk); and
- transfer/share (e.g., insure).

Restorers *should* seek advice from a risk management professional or refer to risk management resources for assistance in the development of a risk management plan. Refer to *Section 4: Limitations, Complexities Complications, and Conflicts* for additional information.

6 Preliminary Determination and In-Field Evaluation

The scope of this section includes protocols for restorers in the inspection and evaluation of sites, structures, building systems, and contents impacted by wildfire smoke residues on readily accessible surfaces that can be detected by visual inspection, odor, or in-field methods.

The preliminary determination is a statement of conclusions and recommendations derived from the restorer's walkthrough inspection. Restorers *should* understand their preliminary determination provides the basis for developing the work plan, protocols, and specifications, including the assignment of smoke impact levels (refer to 6.3 *Preliminary Wildfire Smoke Impact Levels*); and the potential need for specialized experts such as a competent professional, HVAC vendor, or other professional.

When preparing the preliminary determination, the restorer *should* evaluate all relevant information including but not limited to:

- present condition of building components, finishes, and contents;
- damage or defects unrelated or pre-existing to the wildfire event;
- photo documentation; and
- available competent professional or other specialist reports.

If the preliminary determination results in a dispute between MIPs or indicates that a potential hazard to workers, occupants, site personnel, may exist, the restorer *should* recommend the use of a competent professional to perform an assessment.

Examples of potential risk factors include, but are not limited to:

- buildings in which susceptible individuals (e.g., asthmatics, immunocompromised, elderly, and very young) may be exposed;
- reported or confirmed adverse health effects; and
- evidence suggesting the need to further investigate suspected hazardous or toxic contaminants.

6.1 Site or Walkthrough Inspection

The restorer *should* understand the site or walkthrough inspection primarily involves the gathering of information (e.g., occupant interview, visual inspection, odor detection, and in-field evaluation methods) which is used by the restorer to develop the preliminary determination. In addition, the restorer *should* attempt to obtain available environmental reports, remediation plans or protocols, and other pertinent information during the site or walkthrough inspection.

The initial site or walkthrough inspection *should* be conducted by the restorer to identify the extent of wildfire smoke intrusion, including the identification of any impacted exterior surfaces, penetrations, sources of intrusions, and affected building materials and assemblies.

Examples of smoke intrusion points (points of entry) include, but are not limited to:

- vents;
- conduits;
- louvers;
- chimneys;
- windows;
- doors;
- attics;
- crawl spaces; and
- building envelope.

The site and walkthrough inspection may be conducted with MIPs. The site and walkthrough inspection conducted by the restorer *should* include but not be limited to:

- identifying areas of priorities and concerns;
- identifying possible alternative combustion sources;
- identifying likely pathways of wildfire smoke intrusion;
- determine potential wildfire smoke impact areas;
- identifying pre-existing damage (if possible); and
- identifying potential for secondary damage.

Restorers *should* recognize inspections occur at a specific point in time and the mix of smoke residues and conditions may continue to evolve and change over time. Therefore, the results of a walkthrough inspection may only reflect conditions that were present at the time of the inspection.

6.1.1 Information Gathering/Occupant Interviews

The collection of relevant data prior to or during the site or walkthrough inspection, including the statements of building occupants and other observers, is a fundamental component of wildfire residue impact investigations. Building occupants can provide useful information that may supplement the visual inspection.

Data collected by the restorer *should* include, but not be limited to:

- date(s) and name of wildfire occurrence;
- location and proximity of wildfire relative to the property, and
- occupant observations during the wildfire.

Additional useful information may include:

- prevalent wind direction(s);
- relevant information from reliable sources (e.g., fire department, news media outlets, satellite imagery, video);
- windows or doors open or closed;
- operation of HVAC - on or off;
- cleaning or restoration performed to date;
- building and site characterization;
- cataloging of other potential combustion residue sources (e.g., smoking, fireplace, or candle use); and
- condition of utilities.

Restorers *should* encourage MIPs to provide accurate and relevant information when preparing the preliminary determination and work plan.

6.1.2 Visual Inspection

The restorer *should* understand that the visual inspection of the subject property is the most important part of any investigation. In the immediate aftermath of a wildfire event, determining the level of impact at a structure located in the burn zone or adjacent to the fire perimeter may not be difficult due to the presence of visibly identifiable combustion particles (e.g., char & ash). However, surface particles found at properties located farther away from the wildfire or investigated after a significant period of time may be difficult to assign to wildfire impact since the residues may be confused with other particles typically found in household dust.

6.1.3 Odor Detection

Restorers *should* be aware of several factors which can reduce an individual's ability to detect barely perceptible smoke-related odors, including increasing age, colds, dental and sinus issues, smoking, and some medications. Smoke odors, while subjective, can be an indicator of wildfire residue's impact on a structure.

Depending on wind directions and proximity to the fire perimeter, restorers and occupants may notice varying degrees of wildfire residue odors both inside and outside of the structure. Wildfire residue odors may emanate from the structure, building contents, and from residual burned material in the exterior environment. Smoke odors are known to be emitted by combustion products and often are proportional to the presence of charred material. Even though no single wildfire residue odor exists, a general burnt odor like a fireplace or wood fire is a common indicator. In addition, the subjective nature of odors means that odors alone may be difficult to assign to wildfire impacts.

6.1.4 In-Field Evaluation Methods

The restorer *should* understand the in-field evaluation methods discussed are limited to those expected to be commonly used by the restorer in performing the site or walkthrough inspection and are not normally subjected to microscopic examination. In-field evaluation methods are less subjective than visual inspection and odor perception.

Wipe tests (e.g., white cloth or cotton glove, cellulose sponge, white cosmetic sponge, or similar media) *should* be used to initially determine whether wildfire debris is present or absent. The restorer *should* understand a positive test does not identify the discoloration as confirmation of wildfire smoke residue, since other particulate materials, dirt, and dust can also give a positive test. However, a negative (unremarkable) discoloration test would indicate residual wildfire smoke residue was not identified. When wildfire smoke residues are not visually observed in suspected areas, the restorer *should* test representative surfaces by wiping across the surface and visually inspecting for grey, brown, or black discolorations as a preliminary indication of wildfire smoke residue deposition. The restorer *should* document notable discolorations to test media. The restorer may be responsible for a complete cleaning of any space within their scope of work unless otherwise excluded. For example, when wildfire residue removal procedures are used, underlying pre-existing and unrelated residues (soils) may also be removed.

The restorer *should* be aware some surfaces, notably metal (e.g., aluminum, lead, graphite, iron, steel, or carbon) may discolor a glove or white cloth even if they are completely clean of any residues as these surfaces, when abraded, release particles of the base substrate. Further, these tests are also very sensitive to the pressure and aggressiveness of the person doing the test. Repeated abrasion (even in the same location) or excessive pressure may cause discoloration of the cloth or glove while a gentler approach will not.

When wildfire residue is visually observed, the restorer's investigation *should* focus on determining and documenting wildfire smoke impact levels (refer to *Section 6.3 Preliminary Wildfire Smoke Impact Levels*) on various surfaces in the interior and exterior of the subject property.

6.2 Factors Governing the Severity of Impact from Wildfire Smoke

As the wildfire smoke settles out of the air, its particles settle on surfaces inside and outside wildfire zones. Restorers *should* understand the severity of impact on structures from wildfire smoke is a function of factors and variables including, but not limited to:

- distance from the active burn area;
- time elapsed since the fire event;
- wind direction and weather conditions during and after the fire event;
- orientation of points of entry;
- topography of the subject area;
- building orientation relative to the fire;
- appurtenant structures and built obstructions (e.g., retaining walls, patios, decks, other structures);

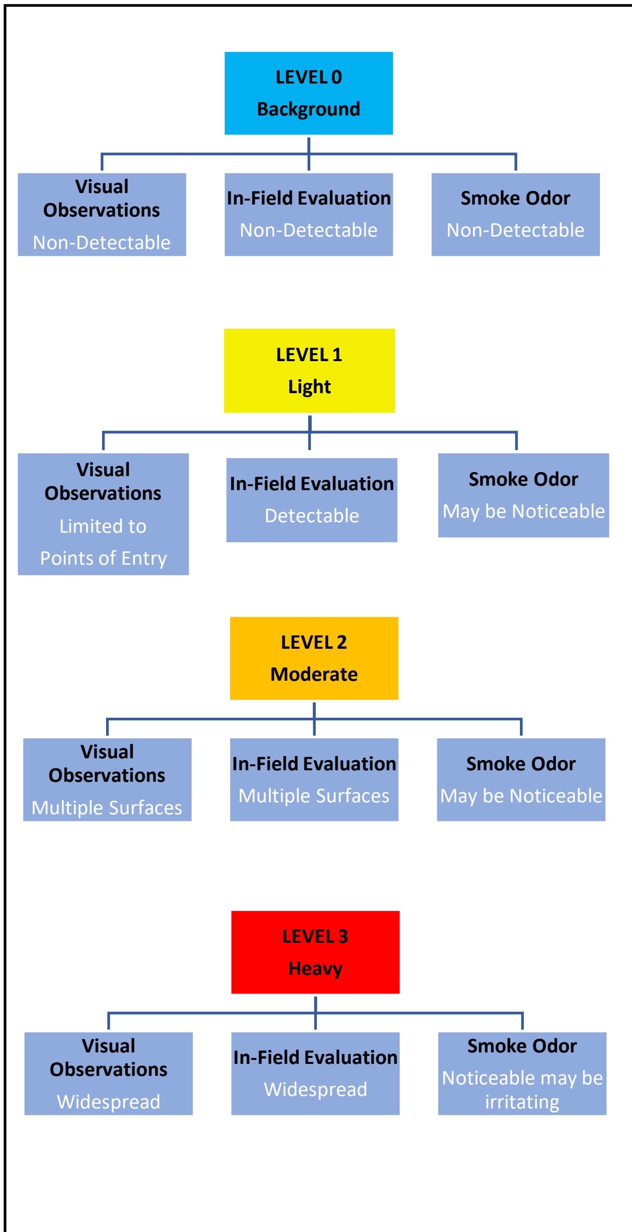
- air infiltration into the structure; and
- occupant activities including cleaning

6.3 Preliminary Wildfire Smoke Impact Levels

Through levels of training, education, and hands-on experience, qualified restorers *should* develop proficiency in identifying and restoring wildfire and smoke impact. The level of proficiency will determine the restorer's ability to produce successful restoration results at the various levels of wildfire impact. The interior spaces in a structure, as well as exterior areas, *should* be classified according to their degree of impact by suspect wildfire smoke as it closely relates to the project scope, restoration procedures, and cleaning methods used. Refer to *Section 10: Restoration of Wildfire Smoke Impacted Structures and Improvements* and *Section 11: Restoration of Wildfire Smoke Impacted Contents*.

The wildfire smoke impact level classifications *should* be defined by the restorer during the Preliminary Determination based on the information obtained during the site or walkthrough inspection. Establishing preliminary wildfire smoke impact levels is primarily a function of visual observations, in-field evaluation, and perception of smoke odors by the restorer. These functions are recognized as an important and necessary element of the inspection and may be all that is required to resolve a wildfire smoke damage claim. However, restorers *should* anticipate the engagement of a third-party specialist such as a competent professional (as reasonably available) by one or more parties based on project requirements or to help resolve disputed claims, potential health hazards, conduct post-restoration verification (PRV) or other issues which may arise.

The four wildfire smoke impact levels below describe typical interior spaces and exterior areas and may not apply to unique situations (e.g., abundance of alternative combustion sources, proximity to busy roadways). The restorer *should* use the following classifications when describing the level of suspected wildfire smoke impact on the structure (exterior and interior) and contents:



Level 0 (Background)

- Property (exterior, interior, contents) has no visible or evidentiary impact from wildfire heat, smoke, or particulate and no odors associated with the wildfire burn are perceived.

Level 1 (Light):

- Property (exterior, interior, contents) may have wildfire residues that may be detected through visual observation but limited to points of entry (e.g., windowsills/tracks, door thresholds, proximate flooring);
- Odors associated with the wildfire burn may be detected as faint or intermittent

Level 2 (Moderate):

- Property (exterior, interior, contents) has noticeable wildfire residue detected through visual observation and are present on multiple interior surfaces and spaces;
- Odors associated with the wildfire burn may be noticeable in designated areas.

Level 3 (Heavy):

- Property (exterior, interior, contents) visual observation confirmed, wildfire residue is widespread;
- Thermal damage to the exterior and/or interior surfaces may be present;
- Odors associated with the wildfire burn are noticeable and may be irritating.

Table 1
Preliminary Wildfire Smoke Impact Levels (Quick Chart)

Table 2
Preliminary Wildfire Smoke Impact (Detail)

Visual observations - Wildfire residues produce distinct visual cues of impact to the surface(s).

In-Field Evaluation - A clean cotton round, cellulose sponge, or white cloth is wiped across a vertical surface and then visually examined for black streaks or dark contrast.

Smoke odor - Even though no single wildfire residue odor exists, a general burnt odor like a fireplace or wood fire is a common indicator. Smoke odor may be an indicator of wildfire impact.

7 Sampling Methods and Strategies

7.1 Introduction

The scope of this section is to describe the sampling methods that may be utilized by the competent professional in restoration projects to identify wildfire smoke contaminants, and to assess smoke impact level, and verify the achievement of the restoration objectives. In cases where the competent professional is engaged, they *should* conduct an independent investigation, which may include the collection of samples. Each method has advantages and disadvantages. This section identifies the major items that *should* be considered in selecting a sampling method. Methods for collecting wipe/cellulose sponge samples for visual in-field analysis during the walk-through inspection by the restorer to make a preliminary determination are covered in *Section 11.3: Preliminary Assessment and Determination*.

This section also includes a discussion of the sampling strategies that can be used to develop and implement an effective, representative, and defensible sampling plan to collect environmental samples.

7.2 Purpose

The purpose of this section is to provide guidance to the competent professional in planning and implementing a sampling plan at a wildfire restoration site. Samples may be collected for laboratory analysis to complement the restorer's preliminary assessment and inspection; to establish background levels; to determine the presence or absence of wildfire smoke contaminants; or where requested support the restoration project objective or perform a post-restoration verification (PRV) to verify completion of the scope of work. Refer to *Section 13: Post-Restoration Evaluation and Verification* for more information.

7.3 Sampling Objective

The primary objective of sampling as part of restoration work is to confirm the presence or absence of wildfire contaminants above background levels, and/or pre-loss conditions. However, other goals can be supported by sampling, such as to determine the level of restoration needed; identify hidden contaminants; identify or document corrosive conditions; for insurance or legal documentation; or to address client concerns. Sampling to assess occupant exposure potential, or to identify regulated hazardous materials may be warranted and may be performed but is beyond the scope of this standard. When structures in close proximity are burned, the sampling objective may need to be modified.

7.4 Advantages and Limitations of Sampling

A well-planned sampling strategy can add standardization to the assessment process by incorporating physical qualitative and quantitative evidence to the assessment procedure.

A preliminary visual, olfactory on-site inspection and expert professional judgment are critical elements for understanding the condition of the site. A site inspection *should* be conducted. In many cases, a qualitative site inspection may be sufficient to make a determination of the site's condition. In other instances, the inspection may be complemented by a sampling plan as part of the restoration scope of work. Sampling and analysis *should* be used as support information to augment the visual inspection results and *should* not be used alone.

The sampling and analytical data can help determine the scope of work by identifying differences in the impact on surfaces or areas of concern that may require additional or specialized restoration measures. Another benefit of sampling is that it can establish a baseline, and a restoration goal, which can be evaluated quantitatively at the end of the project to verify, and document that the scope of work has been achieved.

The goal of an effective sampling and analytical plan *should* be to maximize the information gathered and minimize cost. Complex structures and multi-story buildings may require the collection of more samples.

Access to sampling locations may limit the sampling plan's ability to find all the contaminants and evaluate the level of impact throughout the structure.

No published standards exist at this time for assessing the visual and other impacts of settled combustion particles or chemical residues. The sampling method used *should* be compatible with the analytical procedure used by the laboratory. Sample results reported by different laboratories may not be comparable.

7.5 Sampling Strategy

The purpose of sampling is to document a condition or answer a question related to the subject incident. An inspection *should* include site characterization, visual, and olfactory assessment, incident history, and, when possible, an occupant interview. The sampling strategy may complement the site evaluation.

Sampling may be recommended when the visual inspection is inconclusive.

Sampling is also recommended when a more quantitative evaluation of the condition is required. A visual inspection is a necessary and vital part of the inspection process, but it may not be sufficient in itself to detect all the wildfire smoke contaminants that may be present.

The extent of wildfire smoke impact may vary in different areas or components of the structure. Each different area *should* be assigned a Level of Wildfire Smoke Impact as described in *Section 10: Restoration of Wildfire Smoke Impacted Structures and Improvements*.

The sampling strategy describes the logic, rationale, methods, procedures, and processes for the collection, analysis, and interpretation of environmental samples. A sampling strategy can provide the competent professional with a framework for correlating the sample results with the inspection results; and can improve the ability to convert data into usable, actionable information. Different objectives may require the use of different sampling and laboratory procedures.

7.5.1 Sampling Plan

A well-designed and executed sampling plan supported by appropriate analytical procedures can help to confirm the presence or absence of elevated concentrations of wildfire smoke residue, clarify on-site observations, provide quantitative information for the specific location sampled, and verify differences between smoke impact areas.

The goal of the sampling plan is to establish the extent of wildfire residue impact at representative locations in order to determine the scope of restoration required. The sampling plan *should* have clearly defined objectives. The planned location, quantity, and types of samples *should* be considered:

- the size and design characteristics of the property;
- surface types, infiltration points, and airflow patterns; and
- smoke impact areas and the appearance of deposits on surfaces.

7.5.2 Outdoor Sampling

When necessary, exterior surface sampling may be useful for establishing the presence of wildfire impact. The locations sampled *should* be representative of where the impact may have occurred, or where infiltration into the indoor environment would most likely occur. Examples of these locations can include exterior windowsills or ledges, covered porch areas, attic spaces near vents, HVAC and other openings, or other horizontal surfaces. Outdoor surfaces protected from moisture may be generally more suitable for retaining evidence of exposure. Surfaces protected from the weather, such as a porch or awning, may be better locations for sampling.

When nearby structures are significantly damaged or consumed by wildfire, the sampling plan *should* consider the potential for the impact from additional combustion products which may have a different composition than wildfire smoke.

7.5.3 Indoor Sampling

Samples *should* be collected from representative surfaces to evaluate and document the extent of the impact. The competent professional *should* avoid sampling surfaces that may have been recently cleaned, if possible. Recently cleaned surfaces are not representative of the impact of the wildfire but may be used to evaluate the effectiveness of restoration. Refer to *Section 13 Post-Restoration Evaluation and Verification*.

Indoor sample locations *should* address the gradient and extent of potential impact from points of entry to interior areas. The plan *should* also address the potential for infiltration and airflow from attics and crawl spaces where relevant. The sampling plan *should* also address the nature of the complaint or claim (if for insurance or legal purposes). Representative locations for indoor sampling *should* include building surfaces, fixtures, and contents.

The time elapsed between the wildfire event and when sampling occurs *should* be considered when selecting sampling methods and locations. The chemistry of wildfire debris degrades and changes over time, as well as the dilution from other man-made, natural, and other vegetation burn sources. These factors make the preservation of the settled spatial integrity and a more detailed analysis of signature particles potentially associated with the subject fire event an even more important consideration.

The competent professional *should* document sampling locations that have been directed by the client or another third party.

7.5.4 Background Samples

Background samples from Level Impact 0 areas can serve as a baseline with which to compare the investigation sample results and to aid in data interpretation. Background levels may not reflect pristine conditions, and do not necessarily represent pre-release conditions, nor conditions in the absence of influence from sources at the site.

Background samples *should* be collected using the same method as the investigation samples, and *should* be analyzed by the same method, and laboratory as the investigation samples. Background samples *should* be identified in the sampling log in a manner that allows them to be distinguished from other samples.

The sampling plan *should* specify the number and locations of background samples taking into consideration the size of the site, potential pathways of wildfire smoke residue, and the presence of alternative combustion sources not related to the wildfire event. Multiple background samples collected from relatively homogeneous impact areas may be averaged provided that alternative combustion sources have been considered. When anthropogenic combustion sources such as fireplaces, candles, cigarette smoking, etc., are present, it may not be possible to obtain background samples.

Sampling locations that reflect the site's historical perspective, such as surfaces that have not been cleaned since the wildfire (e.g., interior closet shelving, tops of picture frames or mirrors), and areas that may be the least likely to have been impacted by the wildfire event can help document pre-wildfire background conditions.

The competent professional *should* determine if the investigation samples are lower, equal to, or higher than the site background samples in interpreting the sampling and analytical results.

7.6 Sample Collection Methods

The competent professional *should* select the suitable sampling method for the sampling plan, consistent with current industry practice and guidelines that are appropriate for the site conditions, project objectives, and hypothesis being tested.

The sampling method selected *should* be consistent with the laboratory's analytical method and *should* be appropriate to satisfy a particular goal. The competent professional *should* contact the laboratory to discuss technical details whenever using an unfamiliar sampling method, or when an unusual on-site situation is encountered. The sample preparation steps can affect the amount or characteristics of the material sampled.

7.6.1 Wildfire Sampling Methods

The method selected for sampling *should* be consistent with the laboratory's analytical approach and *should* be selected to satisfy a particular goal.

Tape lift sampling *should* be used as the primary collection method to identify the impact from wildfire debris. Tape lifts, when collected properly can preserve these fragile particles, their relative location, concentration, and effectively collect the particles on a surface. Other methods may be useful for characterizing the chemical and physical properties of the sample. The sampling media used *should* be coordinated with the laboratory selected to perform the analysis.

Surfaces with very heavy particle loading can be sampled but the particles collected *should* not be considered representative of the total particle population on the surface. Micro-vacuum or wipe samples can collect more of the particles on heavily loaded surfaces, but they may be selective in their collection efficiency. These methods may also destroy many of the fragile particles and remove all particle positional relationships. Micro-vacuum samples and wipe samples may be useful for pH measurements or trace metal analysis.

Composite samples *should* not be used for tape lift sampling, as it results in overloaded samples that are no longer representative of what is on any surface. Composite samples collected in the same smoke impact area may be an option when using other investigative techniques, and methods, such as micro-vac sampling of multiple surface areas, or wipe sampling for pH analysis.

7.6.2 Real-Time Measurements

The real-time measurements (i.e., particle counter, hydrocarbon analyzer, pH strips) provide a "snapshot in time" about the condition of the site at the time of sampling.

7.7 Sample Analysis

Analytical methods are described in *Section 8: Analytical and Quantification Methods.*

7.8 Data Interpretation Guidelines

There are currently no industry-accepted qualitative or quantitative standards for interpreting analytical results of wildfire smoke residue samples. Laboratories and competent professionals can often provide general guidelines based on their own historical data and reporting criteria.

The laboratory results are independent of field observations or site-specific conditions and are therefore secondary information that *should* not take the place of the on-site inspection and *should* not be used exclusively to assume normal or elevated conditions without further interpretation by the competent professional. It is important to note that a result reported from laboratory analysis by itself may not necessarily be an indicator of impact or damage. The competent professional *should* use professional judgment to interpret the sampling and analytical results in the context of all the data gathered as part of the site inspection to determine the condition of the site. It is important to note that different procedures may be used by different laboratories when performing the same analysis. Data interpretation guidelines are described in detail in *Section 9: Analysis, Use, and Interpretation of Data for Wildfire Impact*.

7.8.1 The Competent Professional's Report

The report by the competent professional *should* present all of the information gathered to support its conclusions; this includes the site inspection, sensory information, interviews, environmental data gathered, and any available sampling and laboratory data. The competent professional's report *should* also address sampling and analytical findings that are inconsistent with the on-site inspection. The competent professional's report *should* indicate the levels of wildfire smoke impact, the areas and contents needing restoration, and, in the case of post-restoration verification, whether the restoration objectives were achieved.

8 Analytical and Quantification Methods

This Section has been written in conjunction with the current edition of the Technical Guide for Wildfire Impact Assessments for the OEHS Professional by the American Industrial Hygiene Association (AIHA). The AIHA publication was developed by experts with background, training, and experience in various aspects of industrial hygiene and Occupational and Environmental Health and Safety (OEHS) ensuring that the material and methods addressed reflect prevailing industrial hygiene and OEHS practices. The main purpose of this section is to define primary and secondary analytical criteria, methodology, and procedures stated by the AIHA Technical Guide for Wildfire Impact Assessments. The restorer *should* understand that a thorough investigation supported by appropriate sampling and analytical methods can clarify on-site observations and provide quantitative information to support and validate the findings of the on-site evaluation.

8.1 Sampling Methods

The restoration contractor *should* understand sample collection methods have a profound impact on analytical procedures that can be applied and the results of the analysis. The restoration contractor *should* understand that the primary reasons to collect samples are to determine if the debris collected is related to the wildfire and to assess the magnitude of the exposure. *Table 1: Advantages and Disadvantages of Sampling Methods for Wildfire Particles* shows the advantages and disadvantages of each sampling method.

8.1.1 Tape lifts

Tape lifts and light microscopical analysis are the primary methods to qualitatively and quantitatively detect and report the impact from wildfire smoke residues. Tape lifts preserve the spatial integrity and characteristic features of combustion residues. The tape used *should* allow for both the use of transmitted polarized and reflected darkfield properties of combustion particles. The media must be compatible with the laboratory analytical procedures used. Consult with the chosen laboratory.

8.1.2 Wipes

Wipes are available either dry or alcohol moistened. Dry wipes are much less effective at collecting particles. Alcohol-moistened wipes are much more effective in collecting and retaining particles. Wipe sampling is an indirect procedure requiring multiple steps that result in a loss of identifying properties. Wipe samples destroy spatial integrity and smear fragile combustion particles. Alcohol dissolves some ash components and makes quantification unreliable. Prior to analysis, the laboratory must extract the particles from the wipe. Wipe samples are primary methods for surface chemistry such as metals analysis or detection of condensed organic compounds because these analytes can be more effectively extracted from the whole wipe.

8.1.3 Micro-Vacuum

Thick particle layers may be sampled by vacuum techniques. This technique may be useful to determine major and trapped sources for the particles. However, micro-vacuum does not preserve the relative positions of particles on the original surface.

8.1.4 Bulk Sample

Thick particle layers may be sampled by brushing or scraping particles from the surface into a container. This technique may be useful to determine major sources for the particles. However, a bulk sample does not preserve the relative positions of particles on the original surface.

8.2 Analysis of Wildfire Signature / Indicator Particles and Depositional Patterns

The restoration contractor *should* be aware that wildfire smoke residues are identified by the particles characteristic of the fuels burned by the fire. Wildfires burn primarily leaves, bark, and twigs. Charred wood has multiple sources, and by itself, is not a unique indicator of wildfire. Wood-burning fireplaces, wood stoves, and backyard fire pits are among the strongest sources of charred wood. The restoration contractor *should* know that ash is an expected constituent found in wildfire smoke residue. Ash includes indicator assemblage particles (e.g., phytoliths and minerals) key to the identification of wildfire residues.

8.2.1 Light Microscopy Methods

Light microscopy is the primary method for the identification of wildfire particles. As specified in the AIHA "Technical Guide for Wildfire Impact Assessment", the microscope *should* be simultaneously configured with "bright-field transmitted, polarized light, and dark-field reflected illumination as a minimum capability". This allows the simultaneous determination of all transmitted and reflected light properties required to differentiate wildfire combustion particles from other anthropogenic sources.

8.2.2 Electron Microscopy (TEM or SEM)

Electron microscopy may be a useful accessory technique. Electron microscopy can be used as a secondary method to resolve individual sub-micron size aciniform soot particles when present and, when combined with energy-dispersive x-ray (EDS or EDX) provide additional analysis of particle elemental chemistry to differentiate interference corrosion particles from combustion sources.

Table 2: Advantages and Disadvantages of Analytical Equipment for Wildfire Samples shows the advantages and disadvantages of each analytical method.

8.3 Quantification Methods

Charred leaves, bark, twigs, and ash are constituents of wildfire smoke and its residues. The laboratory report *should* address all wildfire-related constituents. The primary quantification method *should* be based on tape lift samples. These samples *should* be collected from different surfaces inside and outside of the structure. Each surface is a micro-environment and is not representative of the whole site.

The restoration contractor *should* understand that there are three methods of quantification: Visual Area Estimate (VAE), numerical concentration per unit area, and the numerical concentration per unit area of assemblage (wildfire signature particles).

8.3.1 VAE Quantification

VAE Quantification is a measure of the relative contribution of different sources to the sampled surface. VAE is not a direct measure of the concentration of wildfire residues in a building. VAE may be used as an alternative method when the numerical concentration per unit area cannot be applied.

8.3.2 Numerical Concentration Per Unit Area

Numerical concentration per unit area provides specific information regarding the exposure of the sampled surface to combustion sources. It is generally accepted that the count of chars per unit area is not specific for wildfire by itself. The count must be compared to the background level of the char at this location. Determining the background can be problematic. The relative contribution of other non-combustion sources does not interfere with this analysis.

8.3.3 Assemblage Per Unit Area

Assemblage unit area is a measure of wildfire particle concentrations independent of other combustion or non-combustion sources. It is a measure of the area of the tape lift that must be examined to establish a source consistent with the wildfire. It does not require a measure of the background. The relative contribution of other non-combustion sources does not interfere with this analysis.

8.4 Interpretation of Laboratory Results

Laboratory data collected from representative locations *should* be used as secondary support information to the visual inspection and site-specific conditions documented by the competent professional or restorer. The competent professional may use the analysis methods described above in Section 8.2 to help classify the impact likely associated with the fire event. This information can also be used to help document successful cleaning or restoration. The data interpretation *should* consider both the sampling and analysis variability and potential anthropogenic background sources. There are advantages and limitations to each of these assessment methods, and the laboratory *should* be consulted regarding the limitations and appropriate use of their laboratory data. A detailed discussion of the interpretation of laboratory data is provided in Section 9 "Analysis, Use, and Interpretation of Data for Wildfire Impact.

Table 1 - Advantages and Disadvantages of Sampling Methods for Wildfire Particles

Characteristic	Tapelift	Dry Wipe
Surface Type	Surfaces, Hard to Fabric	Surfaces, Hard Non-Porous
Sample Area	Tape Area	Open
Collection Efficiency	98% For Typical Loading of Most Surfaces, Including Fabrics Surface Particles for thicker Loading	Strongly Size Dependent Not for Fabrics
Particle Damage	Little	Significant for Fragile Particles
Particle Integrity	Retained	Smeared
Particle Distribution	Retained	Lost
Size Distribution	Retained	Lost
Analysis Methods	Light Microscopy, SEM	Light Microscopy, SEM
Particle Characteristic	32 Different types of Features	33 Different types of Features
Chemicals, pH, etc.	Elements, Ions, pH Particle by Particle or Bulk	Elements, Ions, pH for Bulk Elements for Particles
Quantification	Source Strength per Unit Area Source Strength Relative to Other Sources	Source Strength Relative to Other Sources
Sample Integrity	Retained	Lost

Advantages and Disadvantages of Sampling Methods for Wildfire Particles

WET WIPE	MICRO-VAC	GRAB SAMPLE
Surfaces, Hard Non-Porous	Bulk	Bulk
Open	Open	Open
Strongly Size Dependent Not for Fabrics	Poor for Typical Loading Good for Thick Deposits	Poor for Typical Loading Good for Thick Deposits
Significant for Fragile Particles	Moderate	Moderate
Smeared and Dissolved	Moderate	Moderate
Lost	Lost	Lost
Lost	Retained For Thick Deposits	Retained For Thick Deposits
Light Microscopy, SEM	Light Microscopy, SEM	Light Microscopy, SEM
33 Different types of Features	33 Different types of Features	33 Different types of Features
Elements, Ions, pH for Bulk Elements for Particles	Elements, Ions, pH for Bulk Elements for Particles	Elements, Ions, pH for Bulk Elements for Particles
Source Strength Relative to Other Sources	Source Strength Relative to Other Sources	Source Strength Relative to Other Sources
Lost	Mostly Retained	Mostly Retained

Table 2 - Advantages and Disadvantages of Analytical Equipment for Wildfire Samples

Analyte	Light Microscope	SEM / EDS	TEM / EDS
Transmitted Color	Yes	No	No
Reflected Color	Yes	No	No
Surface Morphology	Yes	Yes	No
Surface Detail	Yes	Yes	No
Internal Structure	Yes	No	No
Reflectivity	Yes	No	No
Internal Light Scatter	Yes	No	No
Surface light Scatter	Yes	No	No
Electron Density	Yes	No	No
Anisotropy	Yes	No	No
Crystal Structure	Yes	No	No
Relative Conductivity	Yes	No	No
Relative Refractive Index	Yes	No	No
Charred Bark	Yes	No	No
Ashed Bark	Yes	No	No
Charred Leaf	Yes	No	No
Ashed Leaf	Yes	Some	No
Charred Wood	Yes	No	No
Ash	Most	Some	No
Silica Phytoliths	Yes	Yes	No
Calcium Oxalate Phytoliths	Yes	Yes	No
Thermal Transitions	Yes	Some	No
Elements	Some	Some (23)	No
Polyatomic Anions	No	No	No
Relative VOC's and SVOC's	No	No	No
Soot Agglomerates	Yes	No	No
Tire Wear	Yes	Yes	No
Wear Metal	Yes	Yes	No
Paint Flakes	Yes	Yes	No
Corrosion	Yes	Some	No
Compost	Yes	No	No
Slag	Yes	Yes	No
Thousands of Particles Examined	Yes	No	No
Carbon Black	No	No	Yes

9 Analysis, Use, and Interpretation of Data for Wildfire Impact

9.1 Introduction

In recognizing the need to establish a standardized methodology for data interpretation when evaluating wildfire smoke impact, this Section was jointly developed by a collaboration between the IICRC S760 Consensus Body and the American Industrial Hygiene Association (AIHA).

This Section *should* be used when a dispute arises as to the condition of the property or when visual observations as to the condition are inconclusive. This Section addresses the sampling, analysis, and data interpretation methods used to assess the impact from the settling of wildfire residues on structures and contents, and guidelines for acceptable cleanliness levels.

The purpose of this section is to provide the restorer, competent professional, and laboratories who may be involved in post wildfire investigations with standardized methods used for the testing and interpretation of laboratory data when provided within the restoration scope of work. The main goals *should* include the following:

- define analytical threshold(s) or benchmarks that likely indicate an increasing probability of impact to a surface;
- define threshold guidelines (inspection, sampling methods, and analytical benchmarks) that would trigger cleaning after a wildfire or in the event surface post-restoration verification is conducted; and
- define professional judgment guidelines for competent professionals and restorers.

9.2 Classifications

The classifications of wildfire combustion particles are described in detail in *Section 2: Composition of Wildfire Smoke*. Wildfire combustion particle classifications may include the following (in alphabetical order):

- aciniform soot: may include differentiation as small or large clusters/chain patterns (where possible);
- ash: differentiated as Vegetative and/or structure fire related (where possible);
- char: differentiated as Vegetative and/or Non-vegetative (where possible); and
- indicator particles: particles specific to the type of wildfire (e.g., charred debris from specific types of plants, plant phytoliths, burned clays).

Note: Indicator particles are used to differentiate wildfire sources from other man-made or background sources (e.g., controlled burns, fire pits, structure fires, protein fires, vehicular emissions).

The classifications may be expanded to include combustion particles related to structure fires when the structure is located within the mixed burn zone or is identified within the samples.

9.3 Combustion Associated Materials

The restorer and competent professional *should* understand that the sampled locations of infiltrated wildfire particles are representative of the following impact conditions including but not limited to:

- window track and door track samples usually are more closely correlated to exterior impact;
- interior windowsill and samples associated with possible intrusion through cracks in doorways typically indicate the highest levels of smoke intrusion;
- samples collected from deeper in the interior space can indicate the extent of smoke penetration; and
- contribution of background combustion residue from exterior sources will likely decrease with

distance from the point(s) of intrusion.

9.3.1 Background Sources

The restorer and competent professional *should* understand that combustion particles, in general, are ubiquitous components of environmental dust, and may originate from a wide variety of airborne sources (e.g., automobiles, controlled burning, fireplaces, cooking, or historical wildfires or structure fires). There are three major combustion particle classifications (e.g., ash, char, and soot) recognized by their morphological and chemical phases and controlled by the fuel source and combustion temperature. These classifications are described in detail in *Section 2: Composition of Wildfire Smoke*.

9.3.2 Wildfire Associated Sources

The restorer and competent professional *should* understand that particulate from wildfire-associated sources found to infiltrate into structures is primarily composed of ash, char, and particles from grasses, leaves, twigs, and bark. Wildfires or vegetation fires can be commonly differentiated from other background sources by a combination of particle morphology and the presence or absence of specific indicator/assemblage particles.

9.3.3 Mixed Burn Zone Associated Sources

The restorer and competent professional *should* understand that a mixed burn zone source consists of burned vegetative and man-made structural debris. Smoke from this zone may contain particles and residues from wildfire, structure fire, and other non-vegetative point sources. The particles from the smoke deposit on the exterior and interior surfaces of the structures of concern in the same manner as wildfire-only particulate. These other deposits may contain concentrations of hazardous materials, (e.g., heavy metals, semi-volatile organic compounds, asbestos) that require additional investigation and testing beyond the scope of this standard.

9.4 Primary, Secondary Sampling and Analysis Methods

9.4.1 Primary Sampling and Optical Microscopical Analysis Methods

Primary methods use direct-transfer sample collection techniques that best preserve the spatial integrity and fragile microscopic properties of the particles and accommodate the widest range of analytical methods to differentiate wildfire particles from other combustion sources. Therefore, tape lift samples *should* be used as the primary sampling method for the microscopic analysis of wildfire particles. Microscopic analysis *should* as a minimum capability include the simultaneous use of reflected light darkfield and transmitted polarized light illumination. Secondary sampling and analysis methods may be used in special situations where the primary methods cannot be employed or additional information regarding the sample is requested.

9.4.2 Secondary Sampling Methods

The restorer and competent professional *should* understand that secondary sampling methods for wildfire residue are indirect procedures that collect the sample particles on one media, and then transfer them to another media for microscopical or chemical analysis. A limitation of secondary methods is they do not preserve the spatial integrity, original particle morphology, or the patterns of surface deposition for the purpose of microscopical analysis. As a result, there can be a loss of information used to identify and quantify combustion particles. Secondary sampling methods used to collect wildfire particles and residues includes bulk, micro-vacuum, and wipe sampling. Secondary sampling methods are also those that are used for the collection of secondary parameters, such as pH, cations/anions, organics, or regulated hazardous materials.

9.4.3 Secondary Microscopical Analysis Methods

The restorer and competent professional *should* understand there are situations where additional secondary methods (e.g., Scanning and Transmission Electron Microscopy) may provide additional physical and chemical information. These analytical methods are beyond the scope of this standard and are briefly described in *Section 8: Analytical and Quantification Methods.* Situations, where these methods may provide additional information include, but are not limited to:

- a high background of particles with similar characteristics to combustion particulate when observed using an optical microscope with the capabilities described in *Section 8: Analytical and Quantification Methods;*
- particulate associated with a mixed burn zone that may contain hazardous materials (e.g., asbestos, heavy metals, organic compounds); and
- additional analysis of combustion particle elemental composition and differentiation of other background particles.

9.4.4 Other Sampling and Chemical Analytical Methods

Bulk, micro-vacuum dust, and wipes *should* be used as primary collection methods for organic and inorganic chemical analytical procedures where preservation of the particle spatial integrity is not required. Tape lifts are not recommended for non-microscopical analysis. Composited and homogenized samples may be used for chemical analysis (e.g., organic chemistry, metals, pH, cation/anion analysis). These methods are discussed further in *Section 9.8 Supplemental Chemical Analysis.*

9.5 Laboratory Data Presentation and Interpretation

The restorer and competent professional *should* understand that the methods used for the microscopical analysis and subsequent interpretation of combustion particle identification are different from the typical bulk chemical analysis methods used for other analytes. Per ISO 17025 (latest version), laboratories used for analysis *shall*, wherever possible, be accredited to ISO 17025 (latest version) with the specific analytical methods accredited as a field of testing. Where a laboratory is performing analysis using an analysis method that is not accredited it *shall* be clearly identified that it is not accredited.

Most wildfire investigations are multi-parameter trace material evaluations with the expectation that both the potential source(s) are identified, and the level of impact is estimated. As described in *Section 2: Composition of Wildfire Smoke*, the composition of wildfire smoke contains a wide range of vegetative and non-vegetative materials that may become combusted or "burned". Combusted materials produce a wide assemblage of recognizable particles with characteristic morphologies, in situ depositional patterns, and different chemical properties.

9.5.1 Microscopical Laboratory Evaluation Parameters

The competent professional and restorer *should* recognize there are two primary goals in the microscopical evaluation of wildfire samples:

1. Establishing the presence of particles indicative of a wildfire, and
2. Quantifying the level of impact.

The competent professional and restorer *should* understand that the impact on the structure and contents is determined by integrating the in-field site observations and testing, with the laboratory results of sampled locations. The competent professional and restorer *should* understand that surfaces determined to be impacted by the use of primary microscopical testing methods are not necessarily "damaged". The determination of "damage" is a multi-component evaluation of visual observations, in-field testing, and may require additional secondary laboratory testing. When required, the competent professional *should* consider the fire source, the structure's proximity to the burn zone, types of fuel sources, meteorological conditions, elapsed time since the fire event, and other factors that affect the resultant combustion particle level of impact and cleaning or restoration requirements. Wildfire particle infiltration and impact to structures (primarily in the burn zone) can continue to occur for a period of time following the extinction of the fire.

This extended infiltration time period is influenced by multiple factors with the most significant factor being the addition of moisture and rainfall.

The competent professional *should* understand that the rate of decrease of char and ash ratios in the exterior environment (and potential infiltration) will occur over several days to several weeks depending on meteorological conditions (e.g., wind speed and direction, humidity, and rainfall). The longer the outdoor char and ash particles associated with a wildfire remain entrained or become re-entrained in the air, the higher the potential for prolonged infiltration and accumulation inside the structure.

The competent professional *should* understand that although the infiltration of char and ash can continue for several weeks to even months after a fire event, the chemistry of those char and ash particles (particularly the ash) can change significantly before infiltrating a structure depending on exposure to sunlight and moisture.

The competent professional *should* understand that the chemistry and corrosion potential of re-entrained char and ash particles will significantly diminish with increasing distance from the burn zone, time since the fire event, and meteorological conditions following the fire event. These potential changes *should* be considered when selecting the type of cleaning or restoration required for sensitive surfaces and contents (e.g., artwork, electronics).

9.5.2 Quantitative Microscopical Measurement Criteria

It is presumed that the sample only provides a reliable representation of the exact location of the sample. Multiple and individually discrete samples may be required to characterize the level and variability of impact in the interior space of interest. The compositing or combining of samples for microscopical analysis *should* not be used.

The competent professional *should* understand there are several common quantitative microscopical analysis methods used to quantify the surface impact of settled combustion particles. There are also qualitative parameters within each of these methods that may be considered as part of the analysis. Examples of qualitative parameters include color, odor, texture, spatial depositional patterns, char, and ash size distribution. These parameters are used as a part of an in-depth forensic evaluation where provenance (i.e., source, origin, and type of fire) is part of the investigation.

Common quantitative optical and electron microscopical measurement methods used for the evaluation of particulate debris impact include particle count per unit area, Visual Area Estimation, and Assemblage / Indicator particles per Unit Area. These measurement methods are described below and in more detail in *Section 8: Analytical and Quantification Methods*. There is no demonstrated superiority of any of these three approaches in terms of assessing the level of wildfire impact. They are all equally reliable when performed by a trained analyst.

9.5.2.1 Particle Count Per Unit Area

The competent professional *should* understand that particle counts (on tape lift samples) are typically reported as counts per square millimeter (cts/mm^2) or square centimeter (cts/cm^2) based on the assumption that char and ash are the dominant members of the wildfire particle assemblage. Confirmation that most of the char and ash is from a wildfire is based on the confirmed presence of “indicator” or signature particles.

9.5.2.2 Visual Area Estimation (VAE)

The competent professional *should* understand that the VAE is a common tool used to determine the relative amounts (e.g., as determined by projected area) of different classes of particles present in a bulk sample. In settled dust samples containing wildfire particles, the VAE percent is a relative estimate of the projected area of wildfire combustion particles (primarily char, ash, and assemblage/indicator particles) divided by the total area of all particles.

The VAE estimate for tape lift samples only may be considered semi-quantitative when the sample loading as occupied area of particles in the microscopical field of view is taken into consideration.

9.5.2.3 Assemblage / Indicator Particles Per Unit Area

The competent professional *should* understand that this method identifies the source of particles and the assemblage of particles per unit area that can be considered as coming from a wildfire. The quantification includes char, ash, and indicator particles (in combination) rather than any one member of the assemblage. In this method, multiple square centimeters of the tape lift are examined. The competent professional *should* understand that the assemblage identified in this analysis are specific for a wildfire event.

9.6 Establishing Comparison Ranges of Impact

The competent professional *should* understand (as described in Section *9.6.1: Comparing Impact Metrics* that the primary microscopical testing methods *should* be used as an indicator of impact and are not a direct indicator of "damage" or potential health effects. This determination is a multi-component evaluation of visual observations, in-field testing, and may require additional secondary laboratory testing.

Statistical principles *should* be used in drawing inferences from even the smallest data sets, which serve as the foundation to both interpret the data and reach conclusions. Most investigations are primarily focused on the presence or absence of wildfire residues to provide useful information with regard to the degree of relative property impact. Accordingly, it is assumed that data is generated to test a hypothesis based on quantitative differences in combustion residues between two or more relevant comparative zones, sites, locations, or surfaces. Statistical principles specific to the evaluation of wildfire debris impact ranges are provided in *Appendix A9: Analysis, Use, and Interpretation of Data for Wildfire Impact (additional info).* The competent professional *should* consider the range of sample results and how representative any given sample location is to the entire site under investigation. In cases with wide variations in sample findings, the competent professional *should* consider the highs and lows of the sample results, and how these may be related to points of ingress of wildfire particles into the given space under investigation. Refer to *Section 7: Sampling Methods and Strategies* for additional information.

Comparison ranges *should* typically include the following classifications to differentiate background or baselines levels from differential levels of impact:

Background or low range - Several methods can be used to establish the baseline or background ranges found in non-impacted structures. These include site-specific data or compiled databases. Site-specific background ranges *should* be determined from surface sampling in the subject structure's interior surfaces, and contents as part of a sampling plan (refer to *Section 7: Sampling Methods and Strategies*). Baseline ranges developed, and maintained by individual laboratories, or obtained from publicly available sources, *should* be acceptable alternatives when site-specific background data are not available or obtainable. The laboratory *should* be able to provide detailed information on the analytical methods, analytical variability at baseline or background levels, sources, locations, and testing conditions of the structures in the database, and the statistical analysis of the data to establish the baseline range. The competent professional *should* understand that the laboratory Limit of Quantitation (LOQ) *should* not be assumed to be equivalent to the background. The competent professional *should* exercise professional judgment (refer to *Section 9.9.3: Professional Judgment*) in determining the applicability of the selected background ranges to the subject structure.

Elevated or high range - The elevated or high range is established by comparing the testing results to the baseline or background selected for the subject structure or contents. For results treated using classical statistics, samples greater than the 90^{th} percentile of the baseline data are commonly used to differentiate baseline, or a background range from data that may be classified as atypical, or elevated (see *Appendix A6: Integrated Decision Matrix*). In many cases, elevated levels (assuming normal distribution and classical statistics) *should* be considered to be at least a multiplicative factor of 10 (order of magnitude) or more above the selected baseline range and consider the analytical variability of the testing method. Elevated quantitative measurements *should* not be used as a sole indicator of impact from a specific event without establishing provenance (e.g., assemblage particles indicative of a wildfire) and additional information provided by the visual inspection.

Atypical range - Sampling results that are greater than the baseline or "Background or low range", but less than the "Elevated or high range" *should* be classified as "Atypical" and receive additional investigation. Several quantitative and qualitative approaches *should* be used in an attempt to categorize the results. Quantitative methods may involve further statistical treatment of the available data to reveal significant differences in the distribution of the data set. Additional sampling and analysis of the subject structure and contents may be required. Qualitative parameters include observations gathered in the visual inspection and in-field testing phase.
Examples for defining the quantitative microscopical ranges (numerical and VAE values) above the "Background or Low Range" are given below:

- Elevated Range - when the upper limit of the "Background or Low" range is determined to be a unit value of 1, an "Elevated Range" may be assumed to begin at a 10-times higher (one order of magnitude); and
- Atypical Rang - when the upper end of "Background or low range" has been determined, an atypical range would exceed this upper end, and be lower than the elevated range which would require additional investigation or re-evaluation.

9.6.1 Comparing Impact Metrics

The competent professional *should* understand that different laboratories have their own internal Standard Operating Procedures (SOPs) to analyze submitted samples and report different metrics to estimate the concentration of combustion particle surface deposition using optical microscopy. This can complicate the interpretation of the results if multiple laboratories are used for the same project. Each sampling and analysis method has inherent limitations. The competent professional *should* consult with their laboratory to obtain guidelines specific to understanding their own data. Suggested guidelines are provided in *Appendix A9: Analysis, Use, and Interpretation of Data for Wildfire Impact (additional info).*

9.7 Post-Restoration Verification

When Post Restoration Verification (PRV) testing of impacted surfaces is conducted, it *should* be performed by an independent party, and use the same comparable "primary" sampling and laboratory analysis methods as the initial impact evaluation. The interpretation of visual area estimates, numerical criteria, and assemblage particle concentrations for PRV may be different than used for the initial impact evaluation.

9.8 Supplemental Chemical Analysis

Supplementary chemical analysis is not mandatory. However, supplementary methods can be used to address site-specific project goals and impact conditions associated with potential damage to materials (e.g., electronics, staining, color changes, surface changes to materials). These procedures may be used to evaluate structures located in the burn zone or in close proximity, or where the structure was directly subjected to the plume of the wildfire. The laboratory *should* be consulted for specific interpretation guidelines unique to the analysis performed.

9.8.1 Inorganic Chemical Analysis

9.8.1.1 pH and Electrical Conductivity

The analysis of alkalinity or acidity (pH) and electrical conductivity of the water-soluble components may be performed by direct surface methods (pH paper and contact electrode), as well as by soil analysis methods, modified to accommodate the specific sampling media and the amount of sample (e.g., latest edition of *ASTM D4972 Standard Test Methods for pH of Soils*). The corrosion potential from wildfire residues is primarily associated with residual ash oxides, hydroxides, and carbonates (predominantly Potassium, Calcium, and Magnesium-based), which can generate elevated pH and conductivity. The pH of “fresh” wildfire ash from leaves, twigs, and bark infiltrating and depositing on interior surfaces can typically range in the burn zone from 9-13. Competent professionals *should* understand that the corrosion potential of these residues is a function of pH, electrical conductivity, and the nature of the cations and anions generating the high pH.

9.8.1.2 Cation and Anion Analysis

Cation and anion analysis for the specific ionic species associated with wildfire residues may be performed by several methods such as SEM/EDX elemental analysis, ion selective electrode titration, or ion chromatography. Different methods may be used depending on the sampling location (proximity to the burn zone), the need to maintain the structural integrity of the analyte, or depending on the wildfire combustion phases (flaming vs. smoldering). Each method may address different aspects of corrosion or potential surface damage from wildfire residues. Applicable industry and government standards *should* be reviewed to establish acceptable impact thresholds.

Note: there is no established direct correlation between measurement for combustion particles and residues and the resultant potential surface impact from corrosion. The amount of settled wildfire residues by themselves may not directly correlate to surface impact.

9.8.1.3 Metals and metalloids analysis

The analysis of metals and metalloids in wildfire residues may be performed when impacted structures are in the vicinity of the burn zone, and especially when structures or manufactured materials have been consumed by the fire. The analytical methods may include but are not limited to SEM/EDX or Inductively Coupled Plasma (ICP/ICP-MS).

9.8.2 Organic Chemical Analysis

Thousands of organic compounds are known to be emitted during wildfires. The full characterization of these compounds remains a challenge as no single technique is best suited to measure such a large variety of chemicals. The diversity of the emitted compounds is dependent on the type of biomass, the fire temperature, the smoke age, and environmental conditions.

9.8.2.1 Volatile and Semi-Volatile Organic Compounds (VOCs and SVOCs)

The characteristic odors associated with wildfires are generated due to specific organic compounds classified as VOCs and SVOCs. These compounds are produced due to the complex chemical reactions and transition phases occurring inside the combustion plumes. Sampling and analyzing these types of compounds can supply important information, aiding the impact assessment process. Organic compounds in these categories may include pyrogenic arenes, alkenes, alkanes, alkynes, aldehydes, esters, organic acids, and polyaromatic hydrocarbons (PAHs).

The competent professional *should* understand that various methods are available to measure VOCs and SVOCs in post-wildfire investigations:

- direct-reading instruments that measure real-time emissions such as portable photoionization detectors (PID). This method may be used for initial screening;
- thermal desorption-gas chromatography-mass spectrometry (TD-GC-MS), using methods adapted from EPA method TO-17;
- vacuum canister sampling adapted from EPA method TO-15; and
- gas chromatography/mass spectrometry-based on EPA methods 625/846/8270 (SVOCs and PAHs).

The competent professional *should* understand many of the VOCs and SVOCs present in the wildfire smoke are found and have also been identified in homes as background chemicals, thus complicating the data interpretation procedures.

- the type and concentration of compounds emitted into the atmosphere from burning plants depend on the type of fuel, fire line intensity, fuel moisture, meteorology, geographical location; and
- the type and the concentration of compounds emitted into the atmosphere from burning plants depend on the type of fuel, fire line intensity, fuel moisture, meteorology, and geographical location.

9.8.2.2 Wildfire-specific Organics

The competent professional *should* understand that the major components of plant cells involved in wildfires are cellulose and lignin. The pyrolysis of these components produces levoglucosan, guaiacols, and syringols. These organic compounds may be used as indicators of biomass combustion.

9.8.3 Professional Judgment

The professional judgment offered by the competent professional *should* be based on a combination of information obtained from reliable sources, background information, results of sampling and analysis, direct on-site observations, and project objectives informed by education, training, and work experience.

The competent professional *should* consider the assumptions and limitations in the sampling and analytical methods.

The competent professional *should* objectively evaluate the available information and independently collected data on the site to develop a science-based judgment to inform the restorer and MIPs involved with the case.

10 Restoration of Wildfire Smoke Impacted Structures and Improvements

10.1 Restoration Purpose and Approach

The purpose of restoration of building structures and Improvements following a Wildfire event is to return the property back to Smoke Impact Level 0 (refer to *Section 11.3: Preliminary Assessment and Determination*). This standard deals with the visual, physical, or chemical impacts of wildfire-related soot, char, ash, and odor. For restoration of structures impacted by direct heat damage refer to the *IICRC S700 Standard for Professional Fire and Smoke Damage Restoration* (note: this is a draft Standard which is expected to be published around the same time as the S760) in addition to any relevant regulatory and building standards that may apply. The means and methods to restore wildfire-impacted structures may include light surface cleaning, heavy cleaning, resurfacing / repair, or material replacement. The restoration work *should* include a stepwise approach that progresses from least aggressive to more aggressive methods. Wildfire restoration work is a dynamic activity with a high potential for deviation from the original scope of work due to hidden conditions and varied effectiveness of restoration activities. Following the initial inspection of the project, the restorer *should* develop a Restoration Work Plan (RWP) (refer to *Section 12.9.2: Restoration Work Plan*) with anticipated outcomes provided to all Materially Interested Parties (MIPs) to the loss. Limitations and Complexities may also form a part of the RWP or scope.

10.2 Building Materials Science

Restorers *should* understand building systems and related physical laws in order to restore an impacted building and return it to its intended function. Building materials science addresses the materials and interrelated systems that compose structures in our built environment. It also addresses how buildings respond to different climatic environments. The restorer *should* be familiar with general building construction and associated materials.

Structural building elements are designed to resist ordinary climactic effects (e.g., wind, snow, earthquake) and the effects of gravity. Typical structural building materials include wood, steel, concrete, and masonry. The restorer *should* be able to visually recognize evidence of heat and fire impact that may have compromised the integrity of affected structural building components and may require additional expertise.

The restorer *should* be familiar with common non-structural building materials and associated means and methods of restoration. Non-structural building materials include a wide range of components and products with varying textures and finishes designed for practical as well as aesthetic purposes.

The restorer *should* have sufficient expertise to anticipate and recognize common pre-existing conditions that may affect the restoration scope of work or workplan (e.g., asbestos, lead, water damage, insect damage, and mold).

10.3 Equipment, Tools, and Materials (ETM)

The restorer *should* have training and experience in the use of wildfire restoration equipment, tools, and materials. Use of specific ETM will vary with restoration methods necessary for each unique project, however, for all equipment and products utilized, the restorer *shall* be compliant with applicable governmental regulations.

Equipment and tools that have been altered *shall* be taken out of service when they become a safety hazard. Equipment and tools that have missing or broken parts are a safety hazard and *shall* be taken out of service. Instructional, precautionary, and safety information for ETM is commonly provided within labels, manuals, technical bulletins, safety data sheets, and architectural specifications. From all sources, information for ETM involving transportation, storage, and proper disposal *shall* be read and thoroughly understood prior to use. When using cleaning chemicals and sealers/coatings, the restorer *shall* be aware of health, safety, and environmental considerations and make such information available to their clients, if requested.

10.4 Structural Integrity Issues

The restorer *shall* inspect the building exterior and interior for visible conditions that could pose a risk of causing collapse. A qualified professional such as a licensed engineer *shall* be consulted when evidence suggests that the structure may have been compromised.

10.5 General Recommendations for Restoration work

10.5.1 Inspection of Property

The restorer *shall* identify, plan, and implement measures to control workplace hazards.

Following a complete workplace hazard assessment, a visual inspection for damage *should* consider wind-blown embers that could have collected against the building or entered crawl spaces, HVAC systems, and attics that have potentially affected building cavities. The initial inspection of the property *should* include proximity to burn zone, review of anecdotal information presented by the occupants if present at the time of the wildfire (e.g., wind direction, smoke density, settled debris, proximity to burning structures). In addition, the inspection *should* include the construction method(s) involved, an analysis of opportunities for wildfire smoke to penetrate the structure and how open the structure was at the time of the impact of the event. Efforts to mitigate damage and time elapsed since the wildfire event *should* also be a consideration. Visual, test cleaning, olfactory and sampling evidence may also be considered as part of the inspection of the property.

Refer to *Section 9.3.3 Mixed Burn Zone Associated Sources*, *Section 11.3: Preliminary Assessment and Determination and Section 7: Sampling Methods and Strategies* for more information*.*

10.5.2 Establish a Controlled Work Area

Depending on the levels of smoke impact present within a structure the restorer *should* establish appropriate containment measures and environmental controls.

10.5.3 Monitor and Document the Restoration Progress

The restorer *should* monitor and document progress by a combination of visual observation, inspections and field testing as warranted and required by the scope of work. Documentation may include daily time sheets, equipment usage logs, diagrams, and photographs, and *should* be maintained.

Recommended changes to the scope of work *should* be documented (e.g., change order request). Refer to *Section 12.9.2: Restoration Work Plan* for more information.

10.6 Interior Structure

10.6.1 Containment of Work Areas

Cleaning of wildfire impacted areas and items *should* be conducted in a contained work area and in a systematic manner to prevent cross-contamination (e.g., ceiling to floor, and room by room). Cleaned items, rooms, and areas *should* be separated from uncleaned surfaces or contents by closed and sealed doors or plastic sheeting.

During cleaning activities HEPA rated and adsorbent media equipped portable air filtering devices operating in recirculation mode, exhausted to the outside, or other engineering controls *should* be used to reduce indoor airborne concentrations of particulates, odor-causing constituents, and to limit cross contamination. HVAC systems *should* be turned off and the duct openings sealed to prevent cross-contamination during cleaning activities. Refer to *Section 12: Restoration of Wildfire Impacted HVAC Systems* for additional information.

Because wind-driven and tracked-in wildfire particles may occur for weeks to months following a wildfire, repeat cleanings may be required for buildings located within or immediately adjacent to the burned area. Subsequent impacts of wildfire ash, soot, and char are beyond the scope of the initial restoration and the restorer's responsibility.

10.7 Interior Building Restoration

Interior portions of the building *should* be restored in accordance with and to the levels set forth in the restoration workplan. The restorer *should* evaluate the material composition, condition, and location of the material to determine the most appropriate restoration method(s). Restoration may require a progression of light, medium, and heavy cleaning methods. An impacted building may require one or more combination of methods. An impacted building may require repeat cleanings or one or more combinations of methods. The restorer can use professional judgment to adjust the workplan from light, medium to heavy cleaning. Adjustments to the workplan can be implemented either during the restorer's inspection, as well as when unforeseen surface conditions are discovered during work. When elevating to heavy cleaning methods for more than incidental areas, restorers *should* consult with appropriate MIPs regarding anticipated increases to cost, as well as time to completion.

Building components include a wide range of materials with varied surface finishes. The restorer *should* avoid methods that unnecessarily damage surfaces such that re-surfacing or replacement would be required.

It is recommended that odors be reduced by the elimination or topical treatment of odor sources. However, after demolition and cleaning, odors generated from sources difficult to address may persist. The restorer *should* avoid using measures that temporarily mask wildfire-related odors.

Where surfaces have not responded as anticipated the restorer *should* document these deviations and communicate these to appropriate materially interested parties.

Regarding the determination of light, medium, and heavy impact, refer to *Section 11.3: Preliminary Assessment and Determination.*

10.7.1 Light Cleaning

Restorers *should* initially clean surfaces using dry methods and tools such as cellulose sponges, tack-cloth (used for nonporous materials such as flooring and unfinished wood materials), woolen towel, or anti-static dusters and HEPA-filtered vacuums.

HEPA vacuuming *should* be considered a primary method used to remove loose wildfire particles from surfaces. Vacuum bristle brush heads can be used when cleaning materials with rough surfaces such as unfinished wood and other textured or porous finishes. Carpet cleaning *should* include HEPA vacuuming with appropriate powerhead attachment. Refer to: *ANSI/IICRC S100 Standard for Professional Cleaning of Textile Floor Coverings.*

Dry, or cellular sponge cleaning often removes loose wildfire particles from smooth non-porous materials such as metal, plastics, finished wood and painted surfaces. Since interior wall finishes and unfinished wood are not completely smooth, cellulose sponge cleaning may have limited effectiveness.

When residues persist following the use of dry removal methods, damp detergent wiping *should* be performed and limited to smooth non-porous surfaces such as metals, glass, plastics, sealed wood and stone, semi-gloss or enamel painted walls/ceilings, and sealed flooring. Most light cleaning of surfaces *should* start and end with HEPA vacuuming as independent steps of the process.

Following cellulose sponge and/or damp detergent wiping a second round of HEPA vacuuming is recommended to remove any wildfire particulate that may have become dislodged by cellulose sponge and/or damp detergent wiping.

Repeat cleanings or progression to more aggressive methods may be warranted. When repeated or more aggressive methods are warranted the restorer *should* communicate changes to the scope of work and any increases in costs to appropriate MIPs. Refer to: *Sections 10.7.2 Medium Cleaning and 10.7.3 Heavy Cleaning.*

10.7.2 Medium Cleaning

Medium cleaning techniques can be most helpful when residues are indelible, tacky, or otherwise difficult to vacuum or wipe off surfaces. More aggressive cleaning methods can include scrubbing with nylon bristle brush or similar after foaming, pump-up or airless spray application of wet cleaning solutions. Wildfire residues are typically alkaline and can be tacky and resistant once adhered, so restorers may focus on cleansers with an acidic pH (pH lower than 7), and which offer detergency and degreasing with minimal solvents or VOCs.

Areas in closer proximity to wildfire can often experience a higher impact of wildfire smoke residues. Restorers *should* anticipate entrainment and impaction can require medium or more aggressive cleaning methods.

When medium cleaning methods are warranted, the restorer may consider the following cleaning procedures (this list is not intended to be sequential, exhaustive, or inclusive):

- insulation removal and cleaning within smoke impacted unoccupied spaces where air exchange could occur (e.g., attic, crawl space, roof space);
- washing of walls and ceilings (e.g., detergents, solvents, emulsifiers) to complete removal of combustion particulates;
- washing to a state of ready to prime or seal (often described as “cleaned for paint”);
- carpet cleaning may include HEPA vacuuming with a powerhead attachment, followed by a water rinse extraction system or restorative steam cleaning; or carpeting removal, if necessary;
- capture pressure cleaning of interior tiled surfaces;
- pressure cleaning of the exterior of structures or replacement of materials may also be required on areas closer to fire fronts; and
- cleaning and restoring of water supply equipment.

10.7.3 Heavy Cleaning

Heavy cleaning methods may include chemical treatment/etching, media blasting, and supplemental deodorization. The restorer *should* evaluate building components that have sustained wildfire related damage such as stains or odors which require specialized methods of restoration beyond light and medium cleaning methods. The restorer *should* advise the appropriate MIPs of the expected efficacy and cost of proposed heavy cleaning methods. Some of these methods have the potential to change surface characteristics such that restoration of the surfaces may be required (e.g., paint, refinishing).

In heavy cleaning environments, carpets are likely not restorable, and it would be expected that some degree of structural repair is also common. In addition, deodorization methods (e.g., odor counteractants, sealers) are often required in heavy cleaning environments.

10.7.4 Use of Smoke/Odor Sealers – Proper Use and Limitations

Sealers can be used as a final stage of deodorization and as primers before reconstruction. Sealers include a diverse group of formulations, functionality, and chemical technology.

Effective sealers typically provide three fundamental functions:

1. Block transmission of smoke odor.
2. Lockdown non-removable particulates, and
3. Promote adhesion, and block stains.

Sealers *shall* be compliant with local regulations governing VOC emissions and *shall* not reduce the fire resistance of structural surfaces in accordance with building codes, regulations, and laws.

Sealers *should* be:

- designed for fire and smoke restoration;
- confined to the uses specified on the product label and applied in a way to provide a continuous membrane;
- applied only after fire residues have been removed and neutralization of alkaline fire residues has been confirmed;
- capable of blocking odor but not inhibit normal water vapor transmission through structural assemblies and building envelopes; and
- permitted to fully cure before reconstruction commences.

Encapsulation or sealing of surfaces is not a substitute for remediation of structures as contaminants can continue to damage surfaces underneath encapsulants where surfaces are left untreated, and which will often cause both the substrate and encapsulant to fail.

10.7.5 Attic Areas

The restorer *should* evaluate attic spaces for evidence of wildfire smoke residues. Attic areas are generally separated, but not completely sealed from occupied spaces. The restorer *should* consider:

- attic openings to the outdoors;
- roof construction style;
- insulation; and
- openings between the attic and occupied spaces (e.g., ventilation components, stairways, ladderways, fire/smoke blocking between attic spaces, and mechanical, electrical, and plumbing penetrations.)

Based on inspection findings, the restorer *should* determine the most appropriate restoration approach that considers the materials involved, effectiveness of restoration method(s), and worker safety.

In some cases, wildfire smoke residue impact of loose attic insulation (e.g., rock wool mineral wool, fiberglass, cellulose) cannot be reliably cleaned and *should* be replaced.

In some cases, wildfire smoke residue impact on insulating closed cell spray foam and insulating sheet products may be cleanable although consideration *should* be given to the likelihood of such materials to retain odor particularly when inspections are conducted in the colder part of the day or on a cold day as odors commonly present more strongly with warmth.

Cleaning spray foam combined with the alkalinity of the wildfire smoke residue can result in erosion or delamination of the intumescent (fire resistant coating). Where the intumescent coating is no longer providing complete coverage of the foam, then the foam insulation *should* be evaluated as it likely does not meet fire safety code.

Cleaning or removing wildfire related particulate and odors from attic spaces *should* be performed using a combination of source removal, HEPA vacuuming and adsorbent media equipped air filtration units.

10.8 Deodorization

When cleaning methods are warranted and wildfire smoke odors are present, the restorer may consider the following supplemental deodorization procedures:

- thermal (solvent-based) or ambient (aka cold or water-based) fogging/misting of structural spaces and cavities with odor counteractants; and
- application of contact deodorization or odor-blocking sealers when despite cleaning, a restorer's professional judgment indicates that future smoke odor release is probable.

The restorer *should* consider the effect of residual odors when evaluating the restorability of materials. There are a number of technologies that may be employed in this area including but not limited to source matter removal, chemical deodorization agents, thermal and cold fogging of deodorization chemicals and gaseous phase deodorizers.

Use of gaseous phase deodorization *shall* comply with regulatory requirements.

The restorer *should* consider the effect of environmental site conditions and usage on odors being present within the structure.

10.9 Exterior Structures – Exterior Envelope and Finishes

Restorers *should* inspect exterior features and building components to identify wildfire related damages (heat, char, fire residues) and determine appropriate methods of restoration including cleaning, resurfacing or replacement.

Restorers *shall* notify appropriate MIPs of the results of any hazard or risk assessment or daily meetings that identify wildfire related damages and any hazards that have caused or could reasonably cause an unsafe condition (e.g., structure or tree collapse, natural gas odors, electrical hazards). Where there is visual evidence of damage that could lead to a loss of structural integrity or collapse, a qualified structural engineer or licensed contractor *should* be consulted.

Restorers *should* anticipate and recognize common pre-existing damages to exterior materials caused by age and exposure to weather (e.g., wood rot, cracks in concrete/masonry, deterioration of finishes, and localized stains unrelated to a wildfire event).

Accumulations of wildfire particulate on exterior surfaces may be HEPA vacuum cleaned or water washed using low-pressure methods (light or medium cleaning). Heavy cleaning requiring more aggressive methods such as brush cleaning using dilute mixtures of soap/detergents and water may also be warranted. Restorers *should* use care to prevent water washing methods from damaging exterior surfaces (e.g., high-pressure water or steam). Restorers *shall* comply with applicable governmental regulations and make reasonable efforts to prevent rinse or runoff from entering adjacent bodies of water, storm drains, or wetlands.

Heavy accumulations of wildfire particulate and stains on semi-porous or textured materials such as concrete, masonry, and rough stone may be difficult to completely remove without affecting the surface texture and color. The restorer *should* consult with the MIPs regarding use of aggressive cleaning and resurfacing methods (e.g., high-pressure water cleaning, abrasive blasting, grinding, chemical cleaning, absorptive poultice treatments). Where appropriate the restorer *should* test the efficacy of selected cleaning methods in a small discrete representative area. Restorers *should* take into consideration pre-existing conditions in the number of samples being tested. Restorers *should* not perform full exterior restoration without the client's written approval.

10.9.1 Fire suppression products

Restorers *should* be trained in the nature of fire suppressant residues, and how to remove them. Ground and aerial application of water-based Wildland Fire Chemical Suppressants can cause physical and chemical damage to materials and property that they impact. The damage to surfaces can range from physical deformation caused by large volumes of water/suppressants dropping from aircraft to surface staining. By design, suppression chemicals are intended to slow the spread of fire while causing no meaningful increase in health risk to potentially affected people and the environment.

In the United States, review, and approval to use commercial wildfire suppressant products has been conducted by the United States Department of Agriculture, Forest Service, U.S approved wildfire suppressants include long-term retardants, foams, and enhancers. A number of approved products have color additives. In other countries refer to the relevant authorities having jurisdiction (AHJ).

Suppressants may contain viscosity stabilizers, dyes, corrosion inhibitors, and a relatively high concentration of gum thickener to provide a high viscosity for improved drop characteristics from fixed wing airtankers. This thick consistency also improves surface retention that is beneficial during a fire but extends surface contact and discourages simple cleaning after the wildfire event. All of these factors are further aggravated by the time elapsed before the suppressant residues can be addressed. With evacuation situations for example, it is days or often weeks before even basic stabilization activity begins, and during this time the amount of uncleanable staining may increase.

These suppressant products are water-based and water-soluble but may not be free-rinsing especially after time on the surface and hot conditions that "bake" the surface and suppressant together. Best cleaning practices typically start with wetting the impacted surface, allowing 15-30 minutes to dwell, and then attempting to rinse clean with plain water. This may remove some or most of the suppressant. Suppressant residues can be very difficult to remove from rough or porous surfaces such as stucco, stone, wood, and certain types of roof tiles. High -pressure power washers *should* be avoided as poor operator skill and/or lapses in attention can be expected to cause damages to the substrate and/or drive the color pigment deeper into uneven surfaces.

Resistant residuals may be dissolved by a biodegradable degreaser applied via a foaming sprayer to improve contact time or "hang" on vertical surfaces. Active ingredients in cleansers suited to this cleaning include botanical degreasers and surfactants, as well as cleaners containing enzymes.

Cleanup water or rinsate, regardless of whether plain water or biodegradable degreaser, *should* be captured and not allowed to run off the property or into a storm drain as some suppressants are hazardous to aquatic life. Using Best Management Practices (BMP) such as straw waddles, absorbent dams, or other forms of run off containment measures *should* be employed. Extracted effluent *should* be placed into sealed drums and disposed of at designated chemical disposal facilities in compliance with local regulations.

Discoloration caused by suppressants may not be removable by light cleaning and require more aggressive cleaning, refinishing and/or replacement. A range of options may be applicable to the materials involved.

Vegetation covered with chemical fire suppressants *should* be rinsed with water as soon as possible. Some suppressants contain vegetative fertilizers such as nitrogen and phosphorus which can cause leaf burning or kill certain plants.

Proper PPE *shall* be worn when cleaning up suppressants that are known skin irritants. Suppressant residues can be skin irritants.

10.9.2 Water Features

Water features include swimming pools, fountains, spas, and ponds. Post fire storm, it is not uncommon to find debris (e.g., plant, soil, structural, and vehicular) in water features. In the event animal carcasses are found in pools, ponds or water storage tanks, restorers *should* contact the local animal control agency or wildlife management to get instructions on removal and disposal. Restorers *should* not undertake restoration of filtration and related water feature equipment unless specifically trained to do so.

10.9.3 Water Supply and Storage Systems

In addition to the cleaning methods (e.g., light, medium, and heavy cleaning), water supply and storage systems may require additional treatments and testing from specialty contractors in relation to the water quality and filtration. Heating systems employed may also require specialized restoration. Testing of well water by a certified laboratory may be required before consumption.

10.9.4 Specialty Restoration

Other items such as specialty finishes to the exterior of buildings, external sculptures, and specialty equipment may require the services of additional specialty contractors. Manufacturers with technical expertise *should* be consulted to ensure appropriate rectification and remediation.

10.10 Landscape Features

Landscape restoration includes procedures for cleaning impacted surfaces of the exterior property. Landscape features include, but are not limited to:

- trees, shrubs, and foliage;
- irrigation systems;
- decks;
- hardscape;
- athletic surfaces;
- walls and fencing; and
- exterior lighting.

Consideration *should* be given by the restorer to exterior surfaces that can degenerate over time, and damage may be irreversible if left to when final landscaping is scheduled. Restorers *should* also understand that wildfires often cause spalling on concrete and asphalt surfaces, which may need repair, resurfacing or removal and replacement. Impacted landscape features *should* be addressed in the restoration scope of work.

Exterior systems and landscape features *should* be evaluated and remediated by appropriately qualified contractors. Restorers *should* consider the sequence of operations to prevent re-entrainment of fire related residues when scheduling restoration of landscape features. Restorers *should* give special attention to disturbed fire residue entering the intakes of the HVAC system. Remediation considerations are the same as for exterior finishes.

10.11 After Restoration

Acceptance of the restoration work *should* include the following criteria and be established at the commencement of work:

- visual evaluation of the work by the restorer, client, and other MIPs;
- if specified, additional Post Remediation Verification (PRV); and
- documented client's acceptance of the completed work.

11 Restoration of Wildfire Impacted Contents

11.1 Introduction

For this document, the term "contents" is generally defined as personal property that is not attached to a building.

An appropriate response is often the difference between successful restoration or repair, or costly replacement. When wildfire smoke intrusion occurs, many items that have become affected may not be damaged initially, however the condition of these items may degrade over time. Affected contents *should* be evaluated and, if restorable, appropriate mitigation or stabilization procedures may be taken to preserve them from further damage. This process begins with a visual inspection, including documentation, to determine the extent of the damage. Where practicable, contents may be inventoried and documented before being removed from the site. Various methods can be used to restore the affected contents. Certain types of content may require special handling and procedures.

11.2 Overview of the Contents Restoration Process

Effective restoration of wildfire impacted contents may include the following tasks:

- inspection, client liaison & evaluation for restorability;
- mitigation procedures and stabilization;
- inventory, packing, unpacking, transport, and storage;
- restorative cleaning;
- post-restoration evaluation (PRE); and
- post-restoration verification PRV.

11.3 Preliminary Assessment and Determination

To determine the restorability of contents, the restoration contractor *should* conduct a preliminary assessment. More than one type of restoration professional may be required (e.g., artwork, textiles, electronics). Determination for restorability *should* consider special and extenuating circumstances such as the probable presence of hazardous materials resulting from sources consumed by the wildfire.

The determination as to the restorability of contents *should* include the following factors:

- condition or level of severity of wildfire impact;
- the material composition; and
- financial value or cost of replacement; and other types of value (e.g., sentimental, legal, artistic, cultural, historical).

Contents restoration activities *should* be categorized as follows:

- restore - items that will likely be cleaned to Level 1 and returned to the customer;
- non-restorable - items unlikely to be returned to their pre-wildfire event or Level 1 condition. Such items *should* be documented and returned to the customer unrestored or disposed of as preferred;
- disposal - items that will not be cleaned/restored because either the customer does not want them or the restoration cost exceeds the item's value. (refer to "Disposal" section below); and
- preserve - items that are irreplaceable and unlikely to be fully restored to their pre-event or Level 1 condition. "Preserve" only applies to irreplaceable items which have sustained physical or visual damage related to wildfire smoke residues or odors. When preservation is required, the restoration Contractor *should* follow the additional precautions outlined in *Section 11.4: Non-Salvageable/Non-Restorable Contents*.

The restorer, customer, specialists, and MIPs *should* agree on the items to be restored, preserved, or disposed of.

11.4 Time of Exposure

Some materials may be further impacted by continuous exposure to accumulated wildfire contaminants. If in the opinion of the restorer or competent professional, restoration is required, then it *should* be performed in a timely manner. Refer to *Section 11.3: Preliminary Assessment and Determination* and *Section 13: Post-Restoration Evaluation and Verification* for additional information.

11.5 Contents Assessment and Triage

Restorers *should* understand that both wildfire contaminants and the mechanisms by which they deposit onto surfaces may vary. Restorers *should* know there is no single restoration treatment that addresses all of the smoke impact conditions restorers may encounter at sites. Restorers *should* apply the appropriate removal procedure based on the type and concentration of the residue and any associated odor. Some of the situations the restorer may encounter when evaluating types and concentrations of wildfire residues are as follows:

- items that require some form of pre-cleaning before being handled;
- the degree of wildfire impact adhesion to the surface material;
- surface material response to the application of restoration processes (e.g., vulnerable, resilient, durable, fragile);
- the need for neutralization of chemical residues (e.g., corrosion from alkaline or acidic residues); and
- items that the restorer is uncertain how to treat and may require a specialized expert.

Contents can be categorized by their intended purpose and use. Examples of these categories include but are not limited to:

- functional, purposeful, and necessary (e.g., furniture, clothing, appliances, electronics, tools);
- sentimental (e.g., family heirlooms, photographs, yearbooks);
- monetary value (e.g., jewelry, artwork, collectibles);
- durable (e.g., reusable);
- non-durable (consumable) - items intended to be used up and then replaced (e.g., cleaning products, paper products, disposable tableware);
- Ingestible - items intended for ingestion (e.g., food, drink, medicine, dietary supplements, lotions, and ointments);
- non-functional, obsolete, cost-prohibitive to restore (e.g., outdated electronics, outdated or ill-fitting and out-grown clothing, broken or worn-out tools or appliances); and
- commercial environments may require stock categorization to identify items for inventory control and insurance settlement purposes.

Restorers *should* understand the importance of these categories as it relates to the cost-effectiveness of restoration. It is not considered cost-effective for restorers to pack, move, store, clean, and deodorize non-durable goods when the restoration of contents cannot be performed on-site.

In some situations, when the restorative cleaning is performed on-site (e.g., light wildfire residues, low odor), it may be considered cost-effective, and therefore recommended, for restorers to remove wildfire residues from the exterior surfaces of unopened non-durable, consumable goods. When considering the different characteristics of wildfire residues and any associated odors, it is recommended that the restorer make decisions to clean non-durable, consumable goods on-site on an individual case-by-case basis. When presented with a pack out where high-value consumable or ingestible goods are present, it is recommended that the restoration contractor discuss these items with the client and reach a mutual agreement on the disposition of these items.

It is not recommended that restorers attempt to clean ingestible or absorptive items that are likely to be directly contaminated by wildfire residues or impacted by extreme heat (e.g., items that are not effectively sealed or packaged).

When encountering non-functional, cost-prohibitive, or obsolete contents, restorers *should* discuss restoration with the owner and other MIPs before performing restoration procedures. This is of particular importance when deciding to remove the contents for off-site restoration due to the added costs of packing, moving, and storage.

11.6 Inventory, packing, transport, and storage

After exposure to wildfire smoke residue, it may be necessary to remove contents from a damage site to perform building repairs, preserve the property, evaluate the damage, or perform the restoration.

Pack-outs may be performed in a variety of ways which are determined by cost, convenience, necessity, and other considerations. Full pack-outs include the inventory, packing, and removal of the complete contents of a residence or business. Contents items may be delivered directly to a facility for restoration or for storage, or to a secure temporary location for processing. Partial pack-outs may involve a portion of the contents, a particular class of item, or individual items. This work *should* be performed by restorers that have the plant facilities, licensing, insurance, equipment, and skills required for this work. It is recommended that the restorer also confirm, with their client, the level of pack back required at this stage so that precise records can be kept ensuring their correct placement on return. The decision to remove the contents *should* be agreed to by the client and appropriate MIPs.

A detailed inventory of contents *should* be completed before handling, packaging, cleaning, or storage and may include:

- description of items, including photo or video documentation;
- quantity of each item;
- condition, age,
- pre-existing damage;
- location of each item within the structure; and
- an inventory tracking method assigned for each item, box, or group of items.

Contents *should* be packed, transported, and stored using appropriate measures to minimize breakage, damage, or loss.

Appropriate MIPs *should*, where practicable, sign inventory forms acknowledging the inventory as representative of the existence and actual physical condition of the contents. Storage conditions *should* be controlled while contents are in the restorer's custody, care, and control. If stored in an external storage facility, appropriate MIPs *should* know the location and storage conditions.

11.7 Restorative cleaning of contents

Restorers who respond to the handling of contents that have been impacted by a wildfire *should* perform only those services they are proficient or qualified to perform. If there are situations that arise where there is a need to perform services beyond the restorer's expertise specialized experts *should* be retained or recommended promptly to the appropriate MIPs.

Contents items that may require the services of specialists include but are not limited to:

- documents and photographs;
- artwork (e.g., framed art, signed pieces, authentic paintings, sculpture);
- fine jewelry;
- weapons;
- sterling silver (e.g., flatware, serving pieces);

- electronics;
- antiques;
- musical instruments;
- textiles;
- clocks; and
- billiards tables and other gaming devices (e.g., pinball, slot machines).

Restoration of wildfire residues may require more than one approach, and options *should* be discussed and documented with the customer and MIPs. When the removal of wildfire residues is uncertain, spot testing of cleaning methods is an appropriate way to establish the most effective means of achieving a satisfactory outcome. Restorers *should* initiate spot testing starting with the least aggressive physical and chemical methods. By agreeing to perform restoration work in accordance with this Standard, the restorer *should* not incur undue responsibility for the damage they are attempting to remedy. In many situations, a procedure can only be evaluated by testing and observing the result.

The removal of wildfire residues is the first step in the restoration of contents. Freshly settled wildfire residues are often lightly adhered to the surface, which is sometimes protected by household dust not associated with the wildfire. HEPA vacuums *should* be used to ensure fine particles' capture and prevent their redistribution. Other dry methods such as electrostatic dusters, brushing, cellulose sponges, or adhesive rollers may also be effective in removing loose combustion particles. These processes *should* be used in conjunction with HEPA filtered AFDs to prevent combustion particles' redistribution and as a safety measure for technicians.

Preventative pre-cleaning (e.g., dry mechanical removal) *should* be performed on vulnerable items at the project site in order to reduce the degenerative effects of wildfire residues regardless of whether the item will be fully processed on-site or off-site. Wildfire smoke residues *should* be removed and treated before final finishes are applied, particularly on metal surfaces.

Restorers *should* understand that dry mechanical processes may not be effective in restoring appearance or removing odors. In the event of thermal damage, detergents and degreasers have a greater effect on adhered residues by loosening the residue from the underlying surface, dissolving the residue or suspending it until it can be removed. Liquids also function as lubricants reducing friction and reducing the aggressiveness of some abrasive processes (e.g., wetted scrubbing pads and 0000 steel wool). On some items, immersion by direct contact with a liquid cleaning solution for extended (dwell) time may increase the effectiveness of the process. Ultrasonic cleaning combines immersion in a cleaning solution with agitation from high-frequency sound waves. Restorers may utilize mechanical air drying and controlled drying following liquid cleaning processes (e.g., wet extraction cleaning, immersion) to avoid potential negative effects of over-wetting (e.g., dimensional. or textural change, color loss).

11.8 Odor Control of Contents

Restoration contractors *should* understand that the source removal of wildfire residues from contents by cleaning is a primary step in odor control. When practical and permissible, restorers may leave contents in place while deodorizing structural components (e.g., walls, ceilings, floors, fixtures) which can provide the added benefit of treating the contents while treating the structure. The following are examples of structural odor control processes that may apply to contents:

- contact (sprayed on) deodorization using aqueous odor counteractants;
- fogging (thermal or ULV);
- gaseous oxidation (in compliance with local AHJ);
- liquid oxidation;
  - Hydrogen peroxide;
  - Sodium Hypochlorite (Chlorine bleach); and
  - Chlorine Dioxide.
- absorbent media; and
- vapor release.

Malodorous contents that have been removed from the loss site (e.g., packed out) *should* be taken to a facility that has the capability to use the restorer's preferred odor control processes. Many restoration firms have a dedicated space in which items can be specially processed using heat, moisture, oxidizing gas, UV light, odor counteractants, chemicals, adsorbents, dehumidification, etc.

Restorers *should* understand that severe wildfires and other secondary damages may result in conditions impacting contents that cannot be remedied by cleaning alone. If the decision is made to attempt further repair (e.g., refinishing, reupholstering), an odor control process may still be required to remove fire-related odors.

11.9.1 Onsite vs In-plant

Firms specializing in content restoration handle contents within a structure that has been affected by smoke, water, construction dust, or other perils. This work is typically performed on-site, but many restorers maintain in-house facilities with deodorization chambers, drying rooms, ultrasonic cleaners, storage vaults, and other in-place equipment.

Cleaning considerations for onsite vs. in-plant or a combination of both *should* include:

- documentation, packing, transport, or storage expenses;
- risk of damage in transit, loss or theft;
- Bailee's and Inland Marine insurance;
- environmental controls;
- functional capabilities (e.g., ultrasonic, deodorization chambers);
- capacity; and
- high value and specialized contents.

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

11.10 Non-Transportable Items

To the extent possible, restorers *should* document non-transportable items that are being left on-site. Items of a private or confidential nature, jewelry, firearms, cash, and precious metals may be excluded from the restoration contractor's pack-out authorization by the owner of the items. In some cases, items may be left at the discretion of the restorer. These may include flammable or potentially explosive items that might create hazards in the storage facility (e.g., paint, gasoline, nail polish remover, ammunition).

11.11 Equipment, Tools, and Materials

When selecting a cleaning method, restorers *should* choose the most appropriate equipment, tools, and materials (ETM) for the project. Evaluating the material composition, the condition, value, and the location where contents are to be cleaned is instrumental in selecting the appropriate ETM.

Examples of the ETM restorers *should* be familiar with and have access to are listed below.

11.11.1 Equipment

Examples of mechanical, non-handheld, and specialty items include but are not limited to:

- air compressors;
- portable power generators;
- air filtration devices;
- powered machinery;
- gaseous oxidation generators (e.g., ozone, hydroxyl);

- ultrasonic systems;
- scaffolding;
- temporary containment systems;
- furniture moving pads;
- forklifts; and
- durable PPE.

11.11.2 Tools

Examples of mechanical or non-mechanical items, mostly small, handheld items include but are not limited to:

- HEPA vacuum cleaners;
- pump or trigger sprayers;
- foggers (e.g., ULV, thermal);
- general clean up tools (e.g., shovels, brooms, dustpan, mop handles, bucket, mop wringer);
- handheld non-powered tools (e.g., hammer, screwdrivers, wrenches, pliers, prybar, utility knife, tape measure);
- handheld power tools (e.g., circular saw, reciprocating saw, drill);
- extension cords; and
- ladders.

11.11.3 Materials

Materials are items consumed during a restoration process or procedure. Examples include but are not limited to:

- cellulose sponges;
- cleaning products;
- deodorization products;
- containment (e.g., zippers, poly film);
- cloths (e.g., terry, microfiber);
- floor protection;
- trash bags;
- equipment filters (e.g., pre-filters, HEPA);
- single-use PPE (e.g., protective suits, nitrile gloves); and
- adsorbent media (e.g., activated carbon.

11.11.4 Equipment, Tools, and Materials Usage

Restorers *should* have the required training and experience in the use of equipment, tools, and materials when performing wildfire restoration. Restorers *should* review ETM operating and use instructions prior to use. Restorers *should* exercise caution and rely upon professional judgment while working with ETM. ETM usage, maintenance, transport, and storage *shall* conform to safety and inspections set forth by the AHJ. Equipment and tools *should* be regularly inspected and maintained in good operating condition. Equipment and tools that have been altered, damaged, or have missing or broken parts *shall* be tagged and immediately taken out of service.

Product supplier labels, secondary labels, and SDS documents, including information on proper disposal, *should* be read thoroughly and understood prior to use. Restorers *shall* be aware of and follow regulations set forth by the AHJ governing disposal.

11.11.5. Equipment, Tools, and Materials Purpose and Application

Restorers *should* be trained in the appropriate use of ETM related to wildfire events. Restorers *should* understand which ETMs are commonly used on typical wildfire event projects (e.g., cellulose sponges, detergents, ladders, vacuum cleaners). In addition to the commonly used ETM, the RWP *should* include any specialty ETM that will be needed on a specific job. The list of possible ETM that could be used for contents restoration following a wildfire event is extensive but not static. Product improvements and advancements in the manufacturing of ETM continue to bring innovative technology to the restoration industry.

11.12 Contents Storage

Restorers *should* be capable of providing a secure, supervised facility with a stable environment in which to store the contents of their customers. It is recommended that restorers that have multiple pack outs stored in their facility keep each customer's property separated from other customers' property. Warehouse tracking systems *should* be used so that restorers can know exactly where the property of a particular customer is located within the storage facility at all times during the course of the restoration process and short-term storage.

Storage facilities *should* be well organized to allow items to be located and retrieved on reasonable advanced notice. Restorers *should* notify all appropriate MIPs when additional labor charges are to be incurred to facilitate locating and retrieving contents (e.g., partial delivery, staging items for in-plant inspection, order of delivery).

Restorers *should* provide documented evidence (i.e., inventory list) that all items in their care and custody have been loaded onto the truck for delivery.

11.13 Return of Contents (Delivery/Pack Back)

Restorers *should* provide documented evidence (i.e., inventory list) that all items in their care and custody have been loaded onto the truck for delivery. Providing this documentation to the client upon delivery allows the client to review the list to confirm that all the contents have been received. Restorers *should* obtain a signed acknowledgment of receipt for goods from the client at the time of delivery. It is recommended that this documentation be made available to appropriate MIPs and accompany invoicing to the party responsible for the payment.

Restorers *should* prepare buildings to accept the delivery of restored contents by installing protective materials on vulnerable flooring surfaces (e.g., carpeting, new or newly refinished wood flooring), stairs, and other high-traffic areas. It is recommended that doors, door casings, banisters, and railings be covered by protective pads (e.g., quilted moving pads) to prevent damage from furniture being manipulated within the building.

Restorers *should* use the documentation created during pack-out describing the location where contents were located within the building so that they can be returned to those locations upon delivery unless otherwise requested by the client. Furniture that was disassembled in order to be removed *should* be re-assembled upon delivery. It is recommended that unpacking and placement of boxed contents be offered to the client and documented when declined. If requested by the client, the restorer *should* provide any collateral (e.g., estimates, time, and materials rate sheets) for unpacking prior to providing that service.

11.14 Non-Salvageable/Non-Restorable Contents

Non-salvageable/non-restorable contents are those on which restoration is not attempted due to a lack of cost-effectiveness, the severity of the damage, or other factors, including those items for which restoration procedures have not been effective.

Restorers may be tasked (hired by the owner, insurance carrier, or other MIPs) with creating an inventory of items that have been determined through damage assessment to be non-salvageable. The level of inventory detail required *should* be agreed upon by appropriate MIPs prior to the work commencing. The restorer *should* also provide documentation for items where restoration efforts were attempted but failed and no additional form of repairs are able to correct in a cost-effective manner. These items *should* be photographed and described as accurately as possible and may include but not be limited to the following information:

- the name of the room or area within the building the item was found;
- a description of the item, or category of item, by name;
- description of damage;
- any manufacturers information (e.g., name of the manufacturer, model, serial number, capacity);
- quantity of the item(s) lost (e.g., single items *should* be individually listed. Numerous like-kind items *should* be counted and, if specified by the party paying for this service, categorized in some fashion (e.g., hardbound books, paperback books, spices, canned goods, dry goods, perishable goods, and plastic ware). Like-kind items may be grouped together and a per-piece-per-category of item assigned;
- approximate age of the item;
- any visible pricing information (e.g., attached price tag); and
- current value or replacement cost information, if applicable or requested by the MIPs.

In wildfires where the damage is severe (e.g., the damage to the item from the wildfire event may prevent complete identification and documentation of that item), restorers *should* interview the owner of the property to obtain as detailed a description as possible, including those listed above.

11.15 Disposal

Restorers *should* not dispose of damaged contents until the client provide written authorization to do so.

The disposal authorization *should* specifically address the designation for disposal items, the location to be discarded, the date and name of the authorizing individual, and the method of disposal. When feasible, the nature of the damaged materials *should* be documented with photographs. Refer to 17.14: *Non-Salvageable/Non-Restorable Contents* for additional information.

Items determined to be non-hazardous and non-restorable and that have been properly documented *should* be removed from the loss site as soon as practical so as not to impede other restoration work (e.g., demolition, structural cleaning).

Articles authorized for discarding *should* be disposed of in the manner specified.

Property designated for disposal *should* not be sold, donated, or diverted to other use unless so directed by written instruction by the client. Contents designated for disposal *shall* be disposed of in a manner in compliance with the AHJ. When the insurance carrier is compensating the property owner for the non-salvageable property, the damaged item becomes the property of the insurer, who may authorize disposal or retention.

11.16 Post-Restoration Evaluation

Post-restoration evaluation (PRE) may be conducted by the restorer to confirm the effectiveness of restoration in accordance with the RWP or to address a specific issue. The evaluation may be based on visual inspection and in-field evaluation methods.

Based on a visual and odor assessment, wildfire smoke residues may be considered remedied when returned to Level 0 (background).

For additional information refer to Section 13: Post-Restoration Evaluation and Verification.

11.17 Post-Restoration Verification

A Post Restoration Verification (PRV) inspection *should* be performed by a competent professional if the restorer cannot determine that a Level 0 (background) condition exists, if the restorer and appropriate MIPs are not in agreement as to the condition, or if it is necessary for insurance or legal purposes.

For additional information refer to *Section 13: Post-Restoration Evaluation and Verification.*

12 Restoration of Wildfire Impacted HVAC Systems

12.1 Introduction

Wildfires and structural fires are fundamentally different. In the case of a structural fire, the recirculation system is a potential conduit from the source of the fire to unaffected areas of the building. In the case of wildfire, the source is outside. In residential structures, wildfire contaminants enter the building through tracking and infiltration (e.g., doors, windows, and other penetrations). In addition to infiltration, wildfire contamination of the HVAC systems in commercial structures can occur through fresh air intake.

HVAC and ACS (hereafter both acronyms will be referred to solely as HVAC) include any mechanical systems that heat, cool, ventilate, clean, filter, treat, induce, or exhaust air.

The decision whether an assessment of the HVAC system is necessary is dependent on overall project conditions identified during the preliminary determination by the restorer and/or competent professional.

The HVAC section in IICRC S760, although similar to the *IICRC S700 Standard for Professional Fire and Smoke Damage Restoration* (*note for draft only:* this is a draft IICRC Standard which is expected to be published around the same time as the S760), contains specific considerations that apply only to wildfires. If there is evidence that the HVAC systems may have been severely impacted, then a qualified HVAC assessor may be retained to further assess the HVAC system. The HVAC assessment *should* be performed prior to restorative cleaning by a qualified HVAC assessor in accordance with this section. If restorative cleaning of the HVAC system is required, then the NADCA Standard *should* be used in establishing the approach to restoration. The NADCA approach includes wet and dry wipe testing methods. If wildfire residue confirmation is required, tape lift sampling and optical microscopy *should* be used as prescribed. Refer to *Section 7: Sampling Methods and Strategies of this Standard,* and *Section 8: Analytical and Quantification Methods*.

If a more detailed HVAC assessment is warranted the detailed assessment *should* follow the following guidelines.

12.2 Primary Purpose

This HVAC section has been written in conjunction with the current edition of ACR, The NADCA Standard by the National Air Duct Cleaners Associations for the Assessment, Cleaning, and Restoration of HVAC Systems. The primary purpose of this section is to define assessment and remediation procedures beyond those already established in the NADCA standard with a specialized focus on how wildfire residue has impacted HVAC systems. HVAC restoration is a specialized subset of property restoration.

This HVAC assessment uses visible and odor observations following a precise protocol. The S760 HVAC assessment standard provides specific guidance to the HVAC assessor based on the event type.

HVAC assessments provide a preliminary determination of visible and odor consequences to HVAC systems following a fire event. The assessment and scoped procedures are integrated with the current edition of ACR, Assessment, Cleaning and Restoration of HVAC Systems by NADCA, National Air Duct Cleaners Association.

12.3 HVAC System

HVAC and ACS (Air Conveyance Systems) hereafter, both acronyms will be referred to solely as HVAC) include any mechanical systems that heat, cool, ventilate, clean, filter, treat, induce, or exhaust air.

The HVAC system includes any interior airside surface of the air distribution system for conditioned spaces and/or occupied zones. This includes the airside surfaces of the entire heating, air-conditioning, and ventilation system from the points where the air enters the system to the points where the air is discharged from the system. The return air grilles, ducts (including make-up air) to the Air Handling Unit (AHU) the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers, and dehumidifiers, fans, fan housing, fan blades, supply air ducts, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils, and supply diffusers are all considered part of the HVAC system.

The HVAC system may also include other components such as dedicated exhaust and ventilation components and make-up air systems. For purposes of this standard, non-ducted ceiling plenums of all types and designs are not considered part of the HVAC system. *Citation ACR the NADCA Standard 2021*

12.3.1 Additional Mechanical Systems

Mechanical systems may include but are not limited to:

- exhaust and extraction systems (e.g., dryer vents, bathroom exhausts, laundry exhausts);
- outside air intakes;
- grease hood systems; and
- garbage chutes.

12.3.2 Exclusions

In addition to non-ducted open ceiling-type plenums, the following surfaces are also excluded:

- the non-airside surfaces of the system (e.g., exterior of a furnace and ductwork in a non-conditioned space); and
- insulating material on the outside of the ductwork.

12.4 Impact Mechanisms

Wildfire impact on HVAC systems ranges from very light to total destruction depending on the proximity to the fire. Airside surfaces within these systems are subject to various forms of impact following a wildfire event. For the purposes of this Standard, these forms of impact will be referred to as impact mechanisms. The principal impact mechanisms encountered when assessing the HVAC system to determine the course of restoration, or replacement may include, but are not limited to:

- physical impact on the system;
- the effects of exposure to high temperature;
- the characteristics, distribution, and deposit patterns of wildfire residues;
- the presence of moisture (condensation, fire suppression activity); and
- the types of materials used in the construction of the system.

12.5 Assessment

12.5.1 Introduction

HVAC systems may be impacted by combustion particulates regardless of whether the unit was operational during the wildfire event. Conversely, the presence of combustion particles in a building does not necessarily indicate the event impacted the system components. The initial assessment *should* be conducted by a restoration or competent professional to determine the impact of fire residues and odors and create the scope of restoration and repair.

12.5.2 The HVAC assessor

The HVAC assessor *should* be qualified through a combination of formal training and relevant experience in HVAC restoration. The HVAC assessor *should* be capable of recognizing smoke impact, have an understanding of damaged HVAC system components and capable of developing an appropriate restoration protocol. Industry designations such as the *NADCA Air Systems Cleaning Specialist (ASCS), NADCA Certified Ventilation Inspector (CVI) and RIA's Certified Mechanical Hygienist (CMH) have specialty focus on HVAC system assessment. The ACAC's Certified Indoor Environmentalist Consultant (CIEC), ACAC Council Certified Fire and Smoke Damage Consultant (CFSC),* and Certified Industrial Hygienist have a specialty focus on damage assessment in an indoor environment and limited HVAC system assessment. Each of these designations provides a body of knowledge useful in HVAC assessments.

12.5.3 HVAC Assessment

Findings during the HVAC assessment are compiled for consideration and recommendation for the development of the project restoration scope. These findings include but are not limited to:

- building usage type, and
  - residential;
  - light and heavy commercial;
  - industrial;
  - healthcare facilities, and
  - historically significant buildings.
- project considerations.
  - the mechanical system configuration and component types;
  - age and serviceability of the components;
  - project scheduling requirements;
  - engineering controls;
  - identifying areas where air turbulence will likely cause particles to accumulate; and
  - nonevent related systems deficiencies *should* be noted during the assessment.

12.5.4 Wildfire Damage Assessment

This assessment focuses on the visual and odor impact that a wildfire event had on the airside surfaces of an HVAC component. On any size project, an assessment *should* be made prior to restoration work being performed on that system. An HVAC assessment *should* integrate into the overall building restoration assessment. The professional specialists performing the assessment *should* be knowledgeable of and experienced with damage caused by direct fire, heat, combustion particulate, residue, and associated odors to determine if the components are restorable or damaged beyond repair.

To ensure effective scope considerations and recommendations for residue and odor removal, the assessor *should* identify and coordinate with the restoration contractor or third party regarding affected surfaces (e.g., airside and exterior including duct wrap and ceiling plenums). Parties *should* agree on who is responsible for servicing affected surfaces, and the final verification methods to determine cleanliness and odor removal.

12.5.5 Wildfire Residue Concentration Points

After a fire event, residues and odors can concentrate and may be absorbed in specific areas of the system where pre-existing particulate matter normally accumulates. The assessor *should* give priority to visually inspect these known areas of pre-existing particulate matter. The areas include but are not limited to:

- air filters;
- evaporator and heating coils;
- control boxes such as mixing boxes and VAV boxes;
- turning vanes;
- base of a vertical riser; and
- fibrous lined return and supply plenums.

12.6 Determining Restorable vs Non-Restorable Components

The composition and distribution of the wildfire particulate and residue combined with the airside surface characteristics are used to determine component restorability. For example, are the wildfire residues settled, adhered, or corrosive to the airside surfaces?

The HVAC system components *should* be accessed and assessed from multiple locations to determine the visual and odor impact to the components from the wildfire event. A complete assessment often requires some degree of disassembly of the HVAC components.

The mechanical operation and functionality of system components may need to be determined by mechanical contractors independent of the HVAC assessor. It is the responsibility of the restoration contractor to consider the assessment made by the HVAC assessor and the mechanical contractor.

Governmental regulations may require that a licensed HVAC contractor create any penetration or access into the HVAC system.

When determining the restorability of components, the following criteria *should* be considered:

- the HVAC components proximity to the wildfire event;
- the age, serviceability of the components;
- the type of materials used to manufacture the components;
- physical and material changes to the components as a result of the heat (e.g., deformation, melting, scorching, corrosion);
- the presence and effects of moisture (e.g., condensation, water from fire suppression efforts);
- the presence and effects of chemical deposits from fire suppression efforts (e.g., fire suppressant residues);
- the impact of wildfire residues on porous materials (e.g., duct liner, duct board, and fibrous insulation);
- the impact of wildfire residues on non-porous materials including but not limited to: corrosion, adhered residues and non-visible, odorous residues; and
- cost-benefit of the proposed restoration.

12.6.1 Test cleaning and Photo Documentation of Component Surfaces

Test cleaning of representative impacted surfaces *should* be conducted during the assessment to establish if the component is restorable, what condition it can be restored to and the recommended process(es) necessary for restoration. Test cleaning can also act as a quality control criterion for final cleanliness.

Note: A flow chart is included within this document to enable the reader to visualize pathways for testing and aid in decision-making for scope considerations. Test cleaning photos *should* be taken that indicate the existing and post-cleaning results in the same photo for dry-type and wet-type restoration methods. This includes but is not limited to sheet metal, duct liner, duct board, flexible duct, wooden pan joists, wall cavities, foamboard, and other airside surfaces. Refer to Appendix A12 *HVAC Assessment Flowchart 1.1.*

12.6.2 Restoration Considerations

By preparing samples and testing the viability of the methods in this section, all recommendations can be presented to the restoration contractor and materially interested parties (MIPs) at one time for cost evaluation and scope development. The HVAC assessor collects and prepares samples for the restoration contractor and the client for analysis and scope considerations. Duct liner, duct board, and fibrous insulation are evaluated for restorability from wildfire-related impact without causing erosion to the fiberglass airside surface. This is determined using the insulation erosion test. Refer to *12.6.7 Insulation Erosion Test* for additional information.

The duct liner adhesion test *should* be performed to determine if the duct liner is capable of supporting the additional weight of coating products. After performing dry cleaning, the duct liner and duct board with retained odors will require further testing and evaluation of proposed deodorization or coating products. Refer to *16.6.8 Duct Liner Adhesion Test* for additional information.

After performing dry cleaning metal duct surfaces that have retained residues and odors will require further evaluation of proposed deodorizers or wet cleaning options where applicable.

12.6.3 Non-Adhered or Adhered Wildfire Residues and Odors

Non-adhered fire residues are removable using the NADCA Standard Surface Comparison Test Method 2 Protocol. Fire-related residues that remain after this process are considered “adhered residues”. Some fire-related adhered residues are permanent and not removable. Restorability of HVAC system components is primarily determined by the successful or unsuccessful removal of these residues and associated odors. The following methodologies will help resolve which surfaces can be restored and deodorized as well as those that cannot. Refer to *Appendix A12 HVAC Assessment Flowchart 1.1.*

12.6.4 Visual Testing Methodologies

Removal of wildfire residues from airside surfaces within the HVAC system can be assessed with two restoration methods. The methods are known as dry and wet-type methods. The HVAC assessor *should* identify representative areas impacted or not impacted by the event within HVAC systems for test cleaning and photo documentation. The photos *should* show the condition of the representative area upon the first encounter and then again after test cleaning. These photos will document the visual effectiveness of the various restoration methods. These results guide recommendations to restore, replace or take no action on a component. The final visual appearance of the components *should* be used by project decision-makers to create the site-specific scope for the HVAC systems. To perform test cleaning, small portions of the component’s airside surface may have to be removed from the HVAC for odor testing.

12.6.5 Dry Cleaning Test

Assessors *should* refer to the NADCA protocol known as ACR Standard 2021 Surface Comparison Test Method 2 Protocol which is known in this document as the “Dry Method”.

The following decisions on how to proceed with HVAC restoration following the NADCA dry method are described below and can be visualized on the HVAC assessment flowchart. The dry-cleaning method is always performed first before all other testing procedures. Perform dry-cleaning testing on the metal or insulated components. Based on the result of the dry cleaning, the next assessment step is outlined below. A testing flowchart is also included in this document following this procedure. Refer to *Appendix A12 HVAC Assessment Flowchart 1.1.*

12.6.5.1 Metal components

Restoration evaluation of metal components indicating visible event-related particulate that can be removed with dry cleaning methods *should* refer to Odor Retention Testing. Refer to *Appendix A12 HVAC Assessment Flowchart 1.7.*

12.6.5.2 Metal Components Visible Residue

Restoration evaluation of metal airside surfaces with visible residue after the dry method testing *should* refer to the Damp Wiping Method Testing. Refer to *Appendix A12 HVAC Assessment Flowchart 1.7.*

12.6.5.3 Fibrous Insulation Components

Restoration evaluation of fibrous insulation components suggesting event-related particulate that can be removed with the dry-cleaning method such as duct liner and duct board *should* refer to the Insulation Erosion Test. Refer to *Appendix A12 HVAC Assessment Flowchart 1.3.*

12.6.5.4 Fibrous Insulation Components Visible Residue

Restoration evaluation of fibrous airside insulation such as duct liner and duct board with visible residue after the dry-cleaning method test *should* refer to the insulation erosion test and the duct liner adhesion test before consideration of coating or replacement. Refer to *Appendix A12 HVAC Assessment Flowchart 1.2.*

12.6.6 Damp Wiping Method Test (non-porous surfaces)

The damp wiping method test *should* be used to determine the effectiveness of a proposed cleaning protocol for the removal of wildfire-related residues. Wet method tests are performed on metal airside and other non-porous surfaces. Wet test methods *should* be performed after the "Dry Test Method". These tests also determine if visible wildfire residues cannot be removed by damp wiping methods. Wildfire-related residues not removed with wet methods are considered adhered to the surface. The effectiveness of each method is tested on selected representative airside surfaces to establish scope considerations and recommendations. Refer to *Appendix A12 HVAC Assessment Flowchart 1.3.*

12.6.7 Insulation Erosion Test

Fiberglass insulation surface conditions vary from highly friable to highly stable. An insulation erosion test is used to determine if duct liner or duct board fiberglass surfaces can be restored using the dry-cleaning method without, abrading, fraying, or eroding the airside surface. This insulation erosion test is performed by evaluating results from the dry-cleaning method test. Several factors affect the condition of duct liners and duct boards (e.g., age, product type, moisture, insulation location, and thermal conditions). Insulated surfaces that cannot withstand the dry-cleaning method test without abrading, fraying, or eroding *should* be recommended for a repair coating or replacement. The HVAC assessor *should* report these conditions to the Restorer or MIPs as insulation erosion test findings. Refer to *Appendix A12 HVAC Assessment Flowchart 1.4.*

When the erosion tests indicate visual abrading or eroding surfaces, the duct liner adhesion test *should* be performed as part of the assessment. The adhesion test is required on duct liner but not typically applicable on duct board. Refer to *Appendix A12 HVAC Assessment Flowchart 1.5.*

12.6.8 Duct Liner Adhesion Test

The HVAC assessor *should* determine if metal ductwork with a fiberglass liner is properly fabricated, glued, and mechanically fastened to the metal duct. This two-part test determines if the fiberglass liner is capable of supporting any additional weight of a coating repair product.

When the erosion tests indicate visually abraded or eroded airside surfaces and a fiberglass repair coating will be recommended, a duct liner adhesion test *should* be performed to report the adhered condition of the duct liner to the metal surface. The adhesion test is required on duct liner but not typically applicable on duct board. Refer to *Appendix A12 HVAC Assessment Flowchart 1.5.*

Other common conditions that *should* be reported causing duct liners to delaminate, abrade, fray, or erode include but are not limited to:

- the proximity to the air handler;
- high-velocity airflow;
- increased weight from adsorbed moisture;
- close proximity to UV lights;
- high temperatures from a combustion furnace (higher temperatures dry out resins and binders in the fiberglass over time;

- added weight from existing coatings;
- unfinished butt joints (unfinished joints collect particulate and can emit fiberglass fibers into the airstream);
- age of the duct liner (older duct liners surfaces can become highly brittle and not capable of supporting coating repair products);
- size of the duct and the air velocity at the location of the liner; and
- deferred maintenance or neglect.

An indicator that the duct liner was improperly fabricated would be the discovery that the liner is missing mechanical fastener pins or has incomplete glue coverage. To perform the duct liner adhesion test, a section of duct liner approximately 20" x 20" or larger *should* be selected, cut, and removed from the metal surface. A visual assessment of the exposed metal surface reveals the amount of glue coverage on the metal applied by the original fabrication contractor securing the liner to the metal surface. *The North American Insulation Manufacturers Association (NAIMA)* states, "Fibrous Adhesive *shall* be applied to the sheet metal with a minimum coverage of 90%. Mechanical fasteners *shall* be used to secure the duct liner to the sheet metal and *shall* be spaced in accordance with NAIMA FGDLS or SMACNA HVAC DCS". Citation Fibrous Glass *Duct Liner Standard Design, Fabrication, and Installation Guidelines Third Edition, 2002.* Refer to *Appendix A12 HVAC Assessment Flowchart 1.5.*

A secondary part of the test of the exposed metal surface *should* be conducted to determine if fiberglass fibers from the duct liner are bound to the glue on the metal surface. This determines if the adhesive lost its bond over time to the duct liner. When the assessment indicates appropriate glue coverage with no bound fibers to the metal surface the duct liner may not be capable of being coated.

In some cases, fiberglass liners and duct boards may require replacement due to deterioration or a loss of structural integrity. Refer to *Appendix A12 HVAC Assessment Flowchart 1.5.*

12.6.9 Fiberglass Repair Coating

When fiberglass is initially eroding and friable, loose fibers may enter the airstream. The same condition can be present after performing the dry-cleaning method. Fiberglass repair coatings *should* be considered on duct liners or duct boards when the airside surface is eroding or friable or if the dry-cleaning method cannot remove the event-related particulate without causing erosion. In addition, fiberglass insulation may retain event-related odors after the cleaning process. Application of coating products often isolates remaining odors after restoration, but the coating's primary purpose is to repair the fiberglass airside surface. All coating products considered for use *should* be specifically formulated by the manufacturer for use on airside surfaces and comply with appropriate fire and smoke spread ratings according to applicable governmental regulations.

12.6.10 Coating Cost Considerations

When the duct liner fails the erosion test but passes the duct liner adhesion test, the restoration contractor *should* discuss the cost of coating versus replacement of the components with the MIPs and document the outcome with appropriate signoffs. Refer to *Appendix A12 HVAC Assessment Flowchart 1.6.*

12.6.11 Coating Application

Coating *should* be considered to duct liner or duct board if the existing airside surface is friable after dry cleaning. Under this friable condition, loose fibers and particulates may enter the airstream after cleaning. In addition, the insulation may retain wildfire-related odor after the cleaning process. The application of coating products may isolate these remaining odors. All coating products considered for use *should* be formulated by the manufacturer for use on airside surfaces and *shall* comply with appropriate fire and smoke spread rating according to the authority having jurisdiction.

12.6.12 Coating Compliance

HVAC coatings *should* be water-based, and meet or surpass:

- VOC content less than 100 g/l (as measured per the latest edition of *ASTM D6886 Standard Test Method for Determination of the Weight Percent Individual Volatile Organic Compounds in Waterborne Air-Dry Coatings by Gas Chromatography* [American Society for Testing and Materials]);
- Odor: 7 or greater (as measured per the latest edition of CRGI TM 78 Odor [Coatings Research Group International]);
- Application: 4 or better scores for Appearance, Sag, and Spatter (as measured per the latest edition of CRGI TM 64 Application/Touch-up); and
- Fire/Combustion & Superheated Air Testing (Compliance with building code and NFPA 101 Life Safety Code 90A/90B [National Fire Protection Association]).
    - Flame Spread: 0-25 (as measured per the latest edition of ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials);
    - Smoke Development:0-450 (as measured per the latest edition of ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials); and
    - Exposure to Superheated Air: No combustion or major deterioration (as measured per the latest edition of ASTM C 411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation).

12.7 Odor Retention Test for Evaluation of Porous and Non-Porous Materials (Semi-Invasive)

Metal and fibrous insulated components collect and retain odors differently. The purpose of the Odor Retention Test is to determine if detectable event-related odors are present on metal and fibrous insulated HVAC airside surfaces. These tests can be used to determine the effectiveness of proposed cleaning methods, deodorization, and coating procedures. Test results establish recommended options for the restoration contractor. When there is a dispute among the MIPs over the absence or presence of event-related odors, it is suggested that independent third-party evaluation be considered to develop the restoration scope. Refer to *Appendix A12 HVAC Assessment Flowchart 1.7.*

12.7.1 Fibrous insulation

The HVAC Assessor *should* select four samples of the potentially affected metal duct for odor and visual testing. It's recommended each sample be at least 10" x 10". The test sections *should* be removed from the same general area of the system and prepared for evaluation. To maintain the system's integrity, the HVAC assessor *should* replace the test sections with a piece of like, kind, and quality metal in accordance with applicable governmental regulations. Refer to *Appendix A12 HVAC Assessment Flowchart 3.1, 3.2.*

*Note: AHJ regulations may require that a licensed HVAC contractor create any penetration or access into the HVAC system for an assessment.

12.7.2 Metal components

Select four 10” x 10” sections of the metal duct for assessment. The test sections will be removed from the same general area of the system and prepared for a retained odor evaluation. To maintain the system's integrity, the HVAC assessor *shall* replace the test sections with a piece of like, kind, and quality consistent with applicable governmental regulations.

12.7.3 Sample Preparation for Odor and Visual Evaluation

Samples *should* be placed inside an airtight container (e.g., zip-closure plastic bag or a site-made enclosure fashioned from polyethylene sheeting or aluminum foil and tape) no larger than twice the dimensions of the sample. All project-specific sample enclosures *should* be similar. Samples are prepared as follows:

- **Baseline Untreated** - One sample *should* be retained as first encountered.

- **Dry Cleaning Method Only** – The sample *should* be vacuumed using the NADCA protocol known as ACR Standard 2021 Surface Comparison Test Method 2 Protocol. *(See 5.6.3 description)*
- **Dry Cleaning Method and Deodorize** – The sample *should* be vacuumed using the NADCA protocol known as ACR Standard Surface Comparison Test Method 2 Protocol then a deodorizer will be applied in accordance with manufacturers' recommendations.
- **Dry Cleaning, Deodorize, and Coated** (**Duct Liner-Duct board Only**) – The sample *should* be treated the same as Item #3, with the addition of a coating applied in accordance with the manufacturer's recommendations Protocol then a coating will be applied in accordance with manufacturer's recommendations.
- **Dry Cleaning, Deodorize, and Damp Wiping Method – (Non-Porous Only)** Sample *should* be treated the same as item #3, with the addition of a damp wipe. vacuumed using the NADCA protocol known as ACR Standard Surface Comparison Test Method 2 Protocol then a secondary damp wipe was performed. Refer to *Appendix A12 HVAC Assessment Flowchart 3.1, 3.3.*

All products *should* be applied to the airside surface of the test sample and allowed to dry and cure in accordance with the manufacturer's directions.

12.7.4 Sample Documentation

Each sample test area *should* be photo documented. The sample location, test process(es), assessor ID, and date *should* be written on the sample container for the chain of custody.

12.7.5 Odor Evaluation

The sample *should* be prepared and cured in accordance with the manufacturer's instructions before being inserted into the airtight container. After a minimum of 24 hours but no later than 72 hours the sample collection *should* be opened in an odor-neutral area and odor evaluated by the appropriate MIPs. Refer to *Appendix A12 HVAC Assessment Flowchart 1.7.*

12.8 Test Results and Recommendations

The evaluation of samples for both porous and non-porous components *should* follow the same procedures performed in the same order. Odor evaluations by MIPs *should* be performed in a manner so as not to influence the decisions of others. Individual results *should* be documented. Any fire-related odor impact suspected beyond these test result evaluations *should* be determined by an independent third party.

12.8.1 Baseline Sample (Sample1) Evaluation

Baseline samples *should* be evaluated as follows:

- when no event-related odor is detected and no event-related residue is observed, the component *should* not be restored;
- when an event-related odor is detected, proceed to sample 2; and
- when an event-related residue is observed, proceed to sample 2.

12.8.2 Dry Cleaning Method Only (Sample 2) Evaluation

Dry method samples *should* be evaluated as follows:

- when no event-related odor is detected, follow the dry method restoration process;
- when an event-related odor is detected, proceed to the dry method and deodorizing (Sample 3); and
- when event-related residue is observed after the dry method vacuuming, proceed to Sample 4 or 5 method. Refer to 6.4 and 6.5 for information.

12.8.3 Dry Cleaning Method and Deodorized (Sample 3) Evaluation

Dry-cleaned and deodorized samples *should* be evaluated as follows:

- when the event-related odor is detected, follow the dry method process and the application of proposed deodorizer;
- when an event-related odor is detected (Duct Liner Duct board), proceed to sample 4 dry method and coated sample process; and
- when an event-related odor is detected (Metal), proceed to sample 5 dry method damp wipe sample process.

12.8.4 Dry Cleaning Method and Coated (Duct liner-Duct board) (Sample 4)

Dry-cleaned and coated samples *should* be evaluated as follows:

- when no event-related odor is detected – and cured coating-related odors are acceptable. Recommend coating of the component; and
- when the event-related odor is detected – Recommend replacement of the insulation or component

12.8.5 Dry Cleaning Method Damp Wiping (Metal components only) (Sample 5)

Dry Cleaned method and damp wiping samples *should* be evaluated as follows:

- when no event-related odor is detected, clean the system by the dry cleaning method followed by the damp method; and
- when an event-related odor is detected, replace metal components.

12.9 Additional Odor Stress Test

When warranted, the HVAC assessor may accelerate the odor off-gassing process of the samples. To perform this accelerated test, the sample is subjected to the range of normal heating and cooling cycles to simulate the environmental conditions of heat and moisture that the HVAC airside surfaces can encounter.

12.9.1 Additional Surface Assessment Method for Wildfire Particle Identification

If additional analytical or testing methods are required for wildfire particle and residue identification, refer to *Section 7: Sampling Methods and Strategies*.

12.9.2 Restoration Work Plan

The restoration contractor and materially interested parties create the restoration work plan after processing the HVAC assessment report. Additional considerations for the restoration work plan include but are not limited to:

- the event types;
- building usage;
- costs;
- schedule;
- standards;
- governmental requirements;
- native tribes;
- equipment;
- availability of HVAC restoration contractors; and
- other project requirements.

12.10 Regulatory Requirements

The restorer *shall* either be or use a licensed HVAC and duct cleaning contractor in accordance with the local jurisdiction.

13 Post-Restoration Evaluation and Verification

13.1 Introduction

This Section includes a discussion of methods and strategies that *should* be used to evaluate the condition of structures and contents following their restoration due to the impact of wildfire smoke. The assessment strategy *should* be based on a Post-Restoration Evaluation (PRE) performed by the restorer that may be followed by an optional Post-Restoration Verification (PRV) performed by a competent professional. The Standard does not cover structures directly impacted by the wildfire itself. Structures impacted by heat, fire, water, mold, or other related causes *should* be assessed and/or remediated by referring to the appropriate ANSI/IICRC standard (*ANSI/IICRC S500 Standard for Professional Water Damage Restoration, ANSI/IICRC S520 Standard for Professional Mold Remediation*, *ANSI/IICRC S590 Standard for Assessing HVAC Systems Following a Water, Fire, or Mold Damage Event,* and *IICRC S700 Standard for Professional Fire and Smoke Damage Restoration* (Note: *IICRC S700* is a draft Standard that is expected to be published around the same time as the S760)) for cleaning and remediation recommendations.

The purpose of the PRE is to determine that the areas of the structure and contents included in the scope of work have been returned to a Level 0 (Background) condition. If the restorer cannot make this determination, a PRV *should* be recommended and conducted by a competent professional. The PRE performed by the restorer *should* evaluate whether the restoration has been completed to current industry standards, or to a scope of work as agreed upon with the client. The evaluation process *should* include a review of the quality control procedures that *should* have been implemented according to the scope of work.

The objective of the PRE is to determine if residual wildfire residues are detected using visual inspection, in-field evaluation, and smoke odor detection (refer to *Section 6: Preliminary Determination and In-field Evaluation)*. Sampling and laboratory analysis are not included in the PRE. Typical tasks performed by the restorer during the PRE may include:

- selecting and using appropriate evaluation methods capable of providing a relatively rapid response;
- evaluating the workspace for residual post-restoration wildfire impact; and
- establishing criteria for assessing the acceptability of the surfaces included in the scope of work.

13.2 Limitations and Issues

It may be impractical to prescribe methods and procedures that apply to every PRE since each wildfire and each site may have unique characteristics. For example, some wildfire residues may be difficult to detect in hidden and inaccessible spaces. These hidden residues may also contain semi-volatile organic chemicals (SVOCs) that can off-gas and be associated with smoke odors. Consideration *should* also be given to seasonal conditions as odors may be more noticeable on warm and moist days. Whenever deviations from standard procedures occur, the restorer *should* document them and communicate their occurrence to MIPs in a timely manner. Refer to *Section 4: Limitations, Complexities, Complications, and Conflicts* for additional information.

13.3 Post-Restoration Evaluation Inspection

The PRE inspection *should* be conducted with the client in all exterior and interior areas, surfaces, and spaces which had been cleaned by the restorer including, but not limited to furniture, flooring, baseboards, structural ledges, artworks, window treatments, interior contents, knick-knacks, attic spaces, garages, and detached structures. Refer to *Section 6: Preliminary Determination and In-field Evaluation* for information on visual observation, in-field testing, and odor detection.

13.4 Post-Restoration Evaluation Documentation

The PRE inspection *should* document the current condition of the restored structure and/or contents and determine that the restoration acceptance criteria agreed to by the MIPs have been met. The PRE may also evaluate the quality of the work that was performed, that restoration specifications were followed, and that work practices met industry standards.

The restorer *should* confirm the RWP is implemented according to the restoration acceptance criteria. Refer to *Section 5: Restorer Qualifications, Administrative Procedures, and Project Documentation* for additional information.

13.4.1 General Comments

The restorer *should* describe, at a minimum, the portions of the site, structure, and contents included in the restoration scope of work. Inspection reports *should* be professionally generated using electronic media and not handwritten. Some commissioning parties require that reports be completed online using proprietary software. Field data sheets, preferably on electronic media, *should* be used to collect inspection information, visual observations, on-site measurements, and sample collection results.

The restorer *should* not include opinions, conclusions, or recommendations that are not supported by factual evidence collected at the site, associated with the site, or supportable by their education, training, or experience.

The following items *should* be documented, including but not limited to:

- the location of impacted areas in field notes;
- observations using photographs to support findings; and
- designate the locations of rooms or areas using compass headings or other universal methods (NW bedroom, 2nd floor rather than “Bedroom 3”).

13.5 The Post-Restoration Verification Inspection and Sampling

The objective of a PRV inspection is to determine if the concentrations of wildfire-associated residues have been reduced to Level 0 (Background), or if they are still elevated and further restoration *should* be recommended. If numerical data are reported by the laboratory, then the competent professional may interpret the results using:

- professional judgment;
- comparisons to a Level 0 (Background) sample; or
- comparisons to a numerical guideline derived from the assessment of previously collected samples.

The PRV may involve sample collection and analysis, which requires the interpretation of laboratory reports. The interpretation of the numerical data in those laboratory reports may involve the comparison of the sample results with guidelines that are based on numerical values.

Refer to *Section 8: Analytical and Quantification Methods and Section 9: Analysis, Use, and Interpretation of Data for Wildfire Impact* for additional information.

13.5.1 Methods

A PRV inspection may be performed when MIPs are not in agreement that a Level 0 (Background) condition exists or if it is necessary for insurance or legal purposes.

Methods applied during the PRV include those used during the PRE as well as more objective sampling and analytical methods used to characterize surface particulates. The PRV inspection may be similar to a PRE and include an inspection of the exterior and interior spaces of the structure included in the scope of work. In addition, the competent professional *should* conduct verification sampling using the quantitative methods presented in *Section 7: Sampling Methods and Strategies*, which describes the various types of test methods and their applications.

13.5.2 Sampling Plan

The competent professional *should* develop a sampling plan for the PRV inspection. PRV sampling can be less extensive than pre-restoration sampling if the primary intent is to verify compliance with the restoration acceptance criteria. The competent professional *should* collect representative samples in the restored areas, compare the results to the restoration acceptance criteria, Level 0 (Background) concentrations, or pre-loss condition. A more detailed sampling plan *should* be used when the PRV inspection may be the result of a dispute or when occupant exposure potential may be a concern.

The same limitations on sampling methods and the laboratory analysis of samples discussed in *Section 7: Sampling Methods and Strategies should* apply to the samples collected during PRV inspections.

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Portions of the following documents are referenced herein and thereby constitute provisions of this Standard. At the time of publication, the references as cited were current. All cited references are subject to revision, and those using this Standard are directed to investigate the necessity of applying the most recent editions or amendments of the references indicated below:

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