

Preliminary Wildfire Inspection: Methods and Strategies

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1. Introduction

A preliminary wildfire inspection is defined as the initial inspection of a site that has been potentially impacted by a wildfire. The inspection is typically performed by a Restoration Contractor (RC) or Independent Environmental Professional (IEP) [*Both referred to as the “Inspector”*]. The inspection sites may be in rural, urban, or woodland/urban interface areas. Common examples of surfaces that may be inspected include exteriors, attics, crawl spaces, interior hard surfaces, interior soft surfaces, return air plenums, and supply air grills – generally accessible surfaces.

The primary objective of the preliminary wildfire inspection is to determine if the site, structures, systems, or contents were impacted by smoke residues from the subject wildfire. If an impact was determined to have occurred, then a more extensive follow-up inspection of hidden spaces and/or additional wildfire contaminants may be performed. The restoration work plan may be based solely on the preliminary inspection or a combination of the preliminary inspection and the results of the follow-up inspection/s. The assumption in this document is that the restoration work plan will be based solely on the preliminary wildfire inspection.

The goal of the preliminary wildfire inspection is to determine if the site was impacted by smoke residues from the subject wildfire. The objective of the Inspector is the detection of wildfire smoke residues on accessible surfaces. The evaluation methods that may be commonly used during the initial inspection include visual observation, visual wipe tests, odor detection, surface sampling, and on-site measurements.

The methods, strategies and practices that may be used for planning and conducting the preliminary wildfire inspection of sites and structures potentially impacted by wildfire smoke residues are described, including the preliminary inspection, evaluating the impact of wildfire smoke residues, and describing a strategy for evaluating their impact.

A preliminary wildfire inspection may have the following goals:

- Identify potential sources of wildfire smoke intrusion,
- Identify surfaces and systems potentially impacted by wildfire smoke residues,
- Determine potential impact of pre-existing smoke residues (if applicable),
- Determine potential impact from secondary sources (if applicable),
- Define Smoke Impact Areas (SIA),
- Define Smoke Restoration Areas (SRA),
- Determine Smoke Impact Levels (SIL).

An optional inspection and sampling strategy utilizing Smoke Impact Areas (SIA), Smoke Restoration Areas (SRA), and Smoke Impact Levels (SIL) as a method for associating the inspection results with the restoration work plan is described.

2. The Preliminary Inspection

The Inspector should identify the areas, structures, systems, and contents included in the scope of work, and clearly identify those areas and structures not included in the inspection. The contract and project documents may contain this guidance as well as comments on inspection methods and strategies. The information gathered during the initial preliminary inspection should be useful for making the preliminary determination [*Determination of potential impact*] and for the restoration work plan.

The Inspector should document any substantial deviations from the expected scope of work and the nature of the deviations. These deviations should be communicated to the Client [*Party paying for the Inspector's services*] in a timely manner.

The initial preliminary inspection includes, but is not limited to, the following elements: pre-planning, site characterization, occupant interview, visual inspection, odor detection, inspection strategy, and evaluation strategy.

2.1 Pre-Planning the Inspection

Relevant information should be obtained on the subject wildfire to the extent possible, including dates, location, area burned, fuel types, burn perimeters, distance from inspection site, prevailing winds, topography, and weather conditions. Any combination of these factors can affect the smoke plume and vary the impact a wildfire has on a particular site, even for sites that are relatively close.

Project personnel should be trained on the methods and strategies that may be used during the preliminary inspection, including:

- The areas, structures and assemblies that should be inspected,
- Preparation of standardized field sheets (electronic) for data collection so that the data can be entered into a database for assessment,
- The minimum information to be collected on the site and structures,
- The minimum information to be collected for each sample,
- Defining SIA and SRA (*if used*).

The status of the site to be inspected should be determined prior to the inspection. Are roads passable? Can electrical power be established, or will a generator be required? Will heat stress and hydration be an issue? Should respiratory protection be available based on the elapsed time since the wildfire and the potential impact? Will emergency communications (cell towers) be available?

2.2 Odor Detection

Wildfire smoke odors can vary from just detectable to strongly irritating. The presence of smoke odors indicates that airborne combustion products are present in the

immediate environment. However, the lack of smoke odors may not indicate the absence of wildfire smoke residues.

An odor survey should be performed as early in the preliminary inspection as possible. Olfactory fatigue is the loss of sensitivity to odors. Fatigue to wildfire smoke odors can occur rapidly (within minutes) when in an area where smoke-related odors may be present. This fatigue can reduce the ability to detect some odors and reduce the ability to distinguish between the intensity of odors.

In addition, the Inspector may be working in a community or general environment where wildfire smoke is present, and olfactory fatigue may begin upon entering that community. This factor should be recognized as a possibility, especially when multiple properties are inspected in series. Therefore, an odor detection survey should be one of the first tasks performed by the Inspector to minimize olfactory fatigue.

Several factors can reduce an individual's ability to detect weak smoke-related odors, including the time one is exposed to odor-causing combustion products (as little as five minutes), age, gender, smoking, a cold, sinus infection, etc. The characterization of smoke odors should begin (1) as soon as possible before adaptation (olfactory fatigue) occurs, (2) in locations with the faintest odors, working towards areas with the strongest odors, and (3) with breaks between odorous areas to refresh the olfactory nerves.

2.3 Site Characterization

An initial step in the preliminary inspection should be to review and characterize the site, including topography, structures, fixtures, landscaping, water features, and any fire-retardant residues that may be due to an incident response. Document structures and potential smoke entry points as to prevailing winds and the direction of the subject wildfire.

The topography of the site can affect the impact of wildfire smoke residues. Placement of the property in a valley can result in the prolonged exposure of structures due to nightly inversions and an increased impact. Locations on a slope can expose structures to wildfire-generated weather which can also affect the impact of a wildfire smoke plume.

The exterior surfaces of structures should be examined visually to evaluate the level of impact of wildfire smoke residues or other damage that may be due to the subject wildfire. The level of impact can provide guidance as to the need to evaluate elevated surfaces (vents, etc.).

Surfaces that are uncovered and exposed to the weather and those that are protected (covered porch, etc.), windward and leeward from the subject wildfire, penetrations (windowsills, doorsills, vents), and unoccupied spaces (attics, crawl spaces, garages) should be evaluated as separate Smoke Impact Areas. Examples of intrusion points

include, but are not limited to, vents, conduits, louvers, chimneys, windows, doors, attics, crawl spaces, and the building shell.

2.4 Occupant Interview

The Inspector should interview the occupants whenever possible to obtain Information on factors that can assist in the inspection and potentially influence how SIA are defined when evaluating the impact of wildfire smoke residues. The lack of relevant information can affect the quality of the inspection and ultimately the utility of the restoration work plan. These factors include, but are not limited to:

The history of the subject property while the smoke plume was impacting the property should be documented. Relevant information may include, but is not limited to:

- Direction of the smoke plume relative to the site,
- Weather during the plume impact such as the occurrence of inversions or other weather patterns affecting impact,
- Duration of the plume's impact,
- Proximity and severity of the impact of the wildfire plume for each structure,
- The status of perimeter penetrations during the wildfire (windows, fans, vents),
- Status of air handlers during the incident or before initial cleaning,
- Occupant activities during and since the subject wildfire (cleaning interior, washing exterior, restoration of systems),
- Smoke odors and residue deposits that may have been removed prior to inspection,
- The application of fire retardants to the site,
- Use of on-site combustion sources (candles, grills, hobbies, etc.),
- The history of the structure (previous house fires, neighboring house fires, remodeling since last wildfire if relevant - obtain information about the impact on the subject property and the restoration response).

Occupant activities such as the cleaning of interior spaces can affect visual observations, the evaluation plan, and the evaluation of the sample results. Since it can be presumed interior surfaces are cleaned periodically, it may be helpful in evaluating the impact of wildfire smoke residues to document typical cleaning schedules and methods (vacuum or HEPA-vacuum, for example).

The presence of combustion sources that may affect the evaluation of sample results should also be documented. Although a fireplace or wood stove may be obvious, evidence that the occupants use candles may not always be in plain sight. In addition, the potential impact from personal habits (smoking) and hobbies (wood burning) may not always be evident during an inspection.

2.5 Visual Inspection

The visual inspection and incident history is used to establish one or more hypotheses, or assumptions, about the potential distribution of wildfire smoke residues and their

impact on the site and each structure, system, and contents. These assumptions can then be developed into the elements of the inspection and evaluation strategy.

The visual inspection should include, but not be limited to, the following tasks:

- Initial review of the structure, systems, and contents to become familiar with the work site and scope of work,
- Characterize smoke-related odors,
- Prepare a floor plan of each structure,
- Document locations of soft surfaces, carpeting, hardwood flooring, etc.,
- Document dust loads, the locations and severity of visible smoke residues, the locations of smoke residue clusters, and the types of wildfire smoke residue deposits such as loose and adhered,
- Review the information and define SIA.

A floor plan should be prepared for each level of multi-floor structures and included in the client report. The floor plan can assist in visualizing and identifying areas with a similar impact (*SIA, SRA, SIL, if used*).

A visual Inspection is often conducted in two phases. The first phase is a direct visual inspection of surfaces. If suspect wildfire smoke residues are detectable, then that may be sufficient for the intended objective. If residues are not visually observed, then the second phase is to test select surfaces with a white cloth and visually inspect it for brown or black discolorations as evidence of wildfire smoke residues. A black cloth can also be used to test surfaces for light-colored ash deposits. Notable depositions of visible wildfire smoke residues, as well as typical dust loads on horizontal surfaces, should be documented during the visual inspection. This information should be considered when defining SIA, SRA, and Smoke Impact Levels.

If surfaces are potentially restorable, the composition of affected materials and assemblies should be documented to the extent possible, which can assist in establishing and implementing an appropriate restoration work plan.

The potential for secondary effects from the chemical components of wildfire smoke residues on animal and vegetable fibers, synthetic fibers, metals, woods, and electronics are typically not evaluated during the preliminary wildfire inspection. The presence of wildfire smoke residues in hidden spaces is also not evaluated.

3. Issues with Preliminary Wildfire Inspections

3.1 Personnel Exposures

Even short-term exposures to the fine particles, secondary organic aerosols (SOA), semi-volatile organic compounds (SVOC) and other combustion products contained in wildfire smoke may be associated with adverse health effects.⁽¹⁾ Inspection personnel may repeatedly enter structures presumptively impacted by combustion products. Personnel subjected to repetitive exposures of short duration over many years of

employment can be subject to the same risks associated with long-term exposures, such as bronchitis, reduced lung function, heart disease, and stroke.⁽²⁾ A key finding of one five-year European Union study was that particles released from burning vegetation in forest fires became more toxic over time, with toxicity increasing to four-times the original levels after only five hours.⁽³⁾ The Inspector is encouraged to use the appropriate respiratory and personal protective equipment during wildfire inspections, especially when evidence of airborne combustion products, such as detectable smoke odors, are detected.

(1) (<https://www.cdc.gov/disasters/wildfires/smoke.html>)

(2) (<https://www.epa.gov/wildfire-smoke-course/health-effects-attributed-wildfire-smoke>)

(3) (<https://horizon-magazine.eu/article/four-times-more-toxic-how-wildfire-smoke-ages-over-time.html>)

HORIZON The EU Research and Innovation Magazine, 22 July 2020

‘Four times more toxic’: How wildfire smoke ages over time” by Richard Gray

These results showed wildfire smoke samples taken from the air more than five hours after they were released from a fire were twice as toxic than when they were first released and as they aged further in the laboratory the toxicity increased to four times the original levels.]

Inspection personnel working at sites without electrical power may be subject to heat stress, which can become an immediate danger to life and health. Such conditions may take precedence over other regulatory issues. Project personnel should be trained to recognize the signs of heat stress and heat exhaustion, and how to respond to them while on the job site. A heat stress safety plan should be included in the project documents (and provisions for hydration).

Occupants self-reporting adverse health symptoms commonly associated with exposure to wildfire smoke (eye irritation, respiratory distress, exacerbated asthma, for example) should also be considered in the evaluation of impact. Following an Occupant Interview with this result, an independent third-party inspection may be recommended to evaluate additional residues (SOA, SVOC) and hidden areas (ducts, wall cavities, interstitial spaces).

3.2 Hidden Spaces

The possible presence of wildfire smoke residues in hidden or interstitial spaces should be considered when evaluating their level of impact on a structure. It may be possible to evaluate the potential for hidden reservoirs during the preliminary inspection by detecting wildfire smoke residues around wall and floor joints, voids, and other openings. This can sometimes be accomplished using visual observation, odor detection, thermal imaging, and surface evaluation methods. However, the evaluation of the impact of wildfire smoke residues on hidden spaces using other methods is outside the scope of a preliminary inspection. Reservoirs of wildfire smoke residues

located within wall cavities and interstitial spaces are typically assessed during a follow-up inspection once the level of impact has been established.

Wildfire smoke can penetrate into below-grade substructures, confined spaces, or unfinished spaces such as basements, crawlspaces, mechanical chases, interstitial spaces, and attics. The inspection and evaluation of a restricted-entry space may be regulated by federal, state, local, or provincial laws and agencies. Whenever a space has the characteristics of a “permit-required” regulated confined space, seek guidance from a qualified professional concerning regulatory requirements that are to be followed.

3.3 Visual Observation

Visual observation should be recognized as an important and necessary element of the preliminary inspection, but it may not be sufficient to detect all the wildfire smoke residues that may be present, even on accessible surfaces. The presence of microscopic particles or SVOC cannot be detected by visual observation alone. An initial inspection that includes a well-designed inspection and test strategy can provide a better characterization of the inspected space compared to visual observation alone. In addition, the use of appropriate sampling methods can reduce the uncertainty associated with the evaluation of the impact of wildfire smoke residues compared to relying solely on visual observation.

3.4 Products of Combustion

Smoke residues on surfaces, such as char, soot, and ash are only one type of wildfire contaminant. However, they are good indicators that a subject wildfire has impacted a site. Since a preliminary wildfire inspection is only intended to evaluate impact, the limited information these simple, cost-effective parameters provide are sufficient to achieve that objective.

4. Stratified Inspection Strategy

4.1 Objectives

The objective of using a stratified inspection strategy is to more closely associate the inspection results with the restoration work plan. A stratified inspection and sampling strategy is recommended by both the Institute of Inspection Cleaning and Restoration Certification (IICRC) in the S520 Standard [*Conditional Areas*] and by the American Industrial Hygiene Association (AIHA) [*Similar Exposure Groups*].

The stratified inspection strategy is a methodology for identifying those specific structures, systems, and contents that were impacted by wildfire smoke residues. It provides the basis for distinguishing between Smoke Restoration Areas (SRA) within structures. An initial objective of the inspection strategy is to define Smoke Impact Areas (SIA) during the preliminary inspection, and to evaluate the impact of wildfire smoke residues on structures, systems, and contents within each SIA. A second objective may be to define

SRA so that each SIA can be associated with an SRA in the restoration work plan. A final objective may be to assign wildfire Smoke Impact Levels (SIL) in each SRA as the basis for assessing the restoration of items, surfaces, and systems.

The goal of the inspection strategy is to associate the inspection results with the restoration work plan. There are two broad inspection and sampling strategies, or approaches, that can be used to evaluate the impact of wildfire smoke residues. The first inspection strategy considers the interior spaces in a structure to be essentially a single area for evaluation and restoration. This strategy can result in an evaluation of impact that may be applied to the entire interior space, or to all the contents, without regard to variations in the level of impact within the interior space.

For example, the Inspector may designate the first floor of a residential structure as a single space for the purposes of evaluation and restoration. Samples would probably be collected from surfaces without regard to the type of surface (windowsills, hard surfaces, soft surfaces, carpet) and averaged, and the individual samples in a composite sample would probably be collected from multiple surface types. Therefore, the reported laboratory results would be for the “first floor”, and the evaluation of the impact of wildfire smoke residue could not be considered in any finer detail for purposes of restoration.

The second inspection strategy is a stratified strategy that separates areas and spaces into Smoke Impact Areas (SIA), with the impact of wildfire smoke residue evaluated independently for each SIA. These areas are defined by the Inspector for the purposes of inspection and sampling.

4.2 Smoke Impact Area

The stratified strategy is based on separating the areas and spaces to be inspected and evaluated into Smoke Impact Areas, and each SIA is then evaluated independently. The inspection results for each SIA can then be independently evaluated to define Smoke Restoration Areas, which allows a different Smoke Impact Level (SIL) to be assigned to each SRA, potentially resulting in a more efficient and targeted restoration work plan. Smoke Impact Areas are defined by the Inspector. Examples of SIA include, but are not limited to:

- Exterior surfaces (unsheltered and sheltered)
- Exterior penetrations (windowsills, doors, vents, and grills)
- Unoccupied (attics, garages, crawl spaces)
- Structural surfaces (walls, ceilings, ceiling tiles)
- Interior penetrations (windowsills, blinds, perimeter door jambs)
- HVAC (return air plenums, air supply grills)
- Interior hard surfaces (floors, tables, door jambs, cabinets, dressers)
- Interior soft surfaces (fabrics, leather, carpets, clothing)
- Special-care items (electronics, works of art, antiques).

These are suggested as separate SIA because it may not be appropriate to use the sample results for one SIA to evaluate the impact of smoke residues for other SIA.⁽⁴⁾ Since it can be difficult to transfer the results from one SIA to another SIA, as many SIA as resources allow should be included in the inspection strategy.

(4) [Sampling and Characterizing Wildfire Smoke Residues. IAQ Radio Webinar, Dec. 10, 2021; Franco Seif, PE; Joe Spurgeon, Ph.D.; Eugenia Mirika, Ph.D. \[Inspections\]](#)

The use of SIA in an inspection strategy encourages the Inspector to (1) consider each area of a space in greater detail, (2) sample each area if resources permit rather than estimating impact by sampling a limited number of localized surfaces, and (3) limit the collection of composite samples to surfaces within the same SIA. Adopting this approach can result in a more efficient restoration, with a more targeted, cost-effective use of resources. The results for each SIA can be evaluated, Smoke Impact Levels can be assigned, and the SIA can be used to assess and define the SRA in the restoration work plan.

The SIA and SRA may be defined as being the same or different areas. For example, the SIA may be defined as the carpet in the living room, while the SRA may be defined as the carpet in the living room or the carpet on the first floor, depending on the results of the impact evaluation.

The SIA can also be defined to test a field assumption (hypothesis) once the incident history is known. For example, if prevailing winds were from the north during the wildfire, the northern areas of a structure may have been impacted more heavily than the southern areas. In this example, the Inspector may define the northern and southern areas of the structure as separate SIA.

4.3 Smoke Restoration Area

SIA are defined for the person performing the inspection, while the SRA are defined for the Restoration Contractor. For example, SIA such as interior windowsills and hard surfaces in the living room may be evaluated during the inspection, but typically SRA such as living rooms and dining rooms are restored. The objective of using SIA as part of the inspection strategy is to link the inspection results to the restoration work plan, using SRA to allocate resources by area rather than by structure.

The SRA are defined using the criteria collected in the preliminary inspection, including the visual inspection, incident history, odor survey, occupant interview, visual wipe tests, and sample results. The SRA may be defined by area, room, floor, system, etc., depending on the site, structure, and objectives.

SIA and SRA may be defined differently in the inspection and restoration phases. For example, an SIA of windowsills can be used to define an SRA as perimeter penetrations, interior hard surfaces, living room or first floor; an SIA of carpet as an SRA

of living room carpet, first floor carpet or house carpet. However, reference (4) should be reviewed for limitations on assigning SRA.

10.4.4 Smoke Impact Levels

Wildfire smoke impact levels can be defined based on the concentrations of wildfire smoke residues plus consideration of the other parameters determined during the preliminary inspection. Table 1 is simply an example of Smoke Impact Levels derived from one set of data.

Table 1. Example Smoke Impact Levels based on Percent-Char.

Percent Char	SIL	IMPACT	Restoration Work Plan
< 1%	1	None	Background; Control Area
1% - 2%	2	Low	Wiping, HEPA-Vac
3% - 10%	3	Moderate	Restoration
>10%	4	Heavy	Assessment, Systems, Occupants

5. The Evaluation of Impact

5.1 Scope

The preliminary evaluation of impact should be a written report that documents the inspection process; describes the SIA and SRA as appropriate; states the conclusions and recommendations derived from the preliminary inspection and evaluation; and assigns SIL to each Smoke Restoration Area.

Recommendations for additional inspections or assessments, including HVAC specialists or other professionals should be included in the written report; and the basis for the recommendations should be documented. Assistance should be provided to the client in understanding the pros and cons of these recommendations and their options.

5.2 Distance from The Wildfire

The types and amounts of combustion products in a wildfire plume can evolve and change over time as it is transported through the atmosphere. The distance of the inspection site from the subject wildfire can affect the amounts of char, ash, soot, and reactive chemicals contained in a wildfire plume, and therefore deposited as wildfire smoke residues (Reference 4).

A second factor is prevailing winds, which can have an important influence on the amounts of wildfire smoke residues that are deposited at an inspection site. Information on prevailing winds during the wildfire, and the direction of the inspection site from the wildfire, should be documented if available and considered in the evaluation of impact.

5.3 Elapsed Time

A wildfire inspection occurs at a specific point in time. The elapsed time between the time of the subject wildfire and the inspection can vary from days to years. It is expected that the concentrations of wildfire smoke residues will decrease with time due to physical degradation, weathering, occupant activities, etc. However, the results of the inspection can only reflect the impact of the residues that were detected at the time of the inspection. Therefore, elapsed time can be expected to affect the observed and measured impact of wildfire smoke residues (Reference 4).

5.4 Conclusions and Recommendations

The client report can be an opportunity to convert the inspection results into useful, understandable, and actionable information. The report should present the results of the preliminary inspection, discuss the significance of the findings, state any conclusions, and support the recommendations by referencing them to specific results whenever possible.

Many of the individuals who read the report may not understand the results, nor fully understand their significance. The significance of the important inspection results should be explained in as simple language as possible. Short sentences and bullet points can be more effective than long paragraphs when communicating technical information.

The conclusions and recommendations should be related to the purpose, objectives, and scope of work of the project whenever possible. If additional work is recommended, credibility and open communications can be maintained by documenting and explaining the need for that work.