RESTORATION INTEL • TECHNICAL FIELD PROTOCOL

Smoke Residue First-Look Card • Fire Restoration Chemistry & Residue ID

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Update history: https://restorationintel.com/smoke-odor-elimination-chemistry-science-fire-restoration/

GOVERNING STANDARD • ANSI/IICRC S700 (2025) SECTION 8 • ODOR ELIMINATION CORE AXIOM

Fire odor is not a surface phenomenon — it is a chemical presence embedded in porous materials off-gassing VOCs, PAHs, and acrolein. **A property that passes visual inspection and fails odor inspection has not reached S700 completion.** Completion standard: *client-verified undetectability of residues and odors*. Applying the wrong cleaning chemistry does not produce a partially clean surface — it produces a surface that is harder or impossible to restore.

1. Wildland Intrusion vs. Compartment Structure Fire — Field Triage at a Glance

DIFFERENT FUELS = DIFFERENT JOBS

Never conflate wildland smoke with a compartment fire even if the client uses the word "smoke" for both.

Triage Vector	Structure / Compartment Fire	Wildland / Forest-Fire Intrusion
Fuel Source	Building contents, polymers, synthetic foam, protein, electrical wiring.	Vegetation, forest biomass, fine particulate matter (PM), ash, soil minerals.
What You See	Soot patterns radiating from origin, thermal lines, HVAC distribution, possible char.	Fine ash on horizontal planes, loaded HVAC filters, minimal char unless structural flame.
Odor Character	Residue-class dependent: burnt wood (acrolein), pungent synthetic, or putrid burnt protein.	Lighter VOCs + biomass ash; persists heavily in textiles and HVAC ductwork after clean look.
First Operational Move	**Identify residue class first** (Dry vs Wet Synthetic vs Protein), then select pH chemistry.	**Source removal first:** Replace HVAC filters, HEPA horizontal ash, clean textiles. Do not skip HVAC.
Completion Standard	S700 Section 8: client-verified undetectable residue and odor.	Same S700 completion test. "It was only a forest fire" is not a lesser standard if odor remains.

2. Residue Type Identification: The Step That Determines Everything

MANDATORY PRE-ACTION GATE

Smoke composition depends on **what burned**, **combustion temperature**, and **oxygen availability**. The three primary residues require distinct, non-interchangeable chemical strategies:

DRY SMOKE RESIDUE

PH 9–11

Source: Fast-burning, high-oxygen combustion of natural materials (wood, paper, cotton textiles).
Appearance: Light, powdery, gray-to-black soot; loose adherence; sits on horizontals & airflow lines.
Chemistry: Carbon particles, moderate VOCs (formaldehyde, acrolein, benzene); neutral pH; less corrosive.

CRITICAL RULE: NEVER apply wet cleaning first. Wet chemistry smears and embeds dry particles into open surface pores.

Cleaning Sequence:

1. HEPA vacuum all dry surfaces thoroughly.
2. Dry cleaning sponge (vulcanized rubber).
3. Alkaline cleaner (pH 9 to 11) for residual soot.
4. Thermal fogging / hydroxyl for porous VOCs.

WET SYNTHETIC RESIDUE

PH 11–13

Source: Slow-burning, low-oxygen smoldering of synthetics (foam rubber, plastics, wiring, petroleum).
Appearance: Thick, sticky, dark brown/black; smears easily; heavy pungent chemical stench.
Chemistry: Polymer pyrolyzates, highly acidic (pH as low as 3–4); toxic halogenated VOCs (HCl, HCN, SO2).

24H / 48H URGENCY: Wet soot begins etching glass in 24h; causes permanent glass discoloration & metal tarnish in 48h.

Cleaning Sequence:

1. Light dry vac only for loose debris (no heavy vac).
2. pH 11–13 alkaline cleaner to neutralize acid.
3. Allow dwell time for chemistry before wiping.
4. Rinse with clean water + neutralizing agent.
5. Second chemical pass; ozone/thermal fog in vacant.

PROTEIN RESIDUE

ENZYME FIRST

Source: Kitchen grease, meat, cooking oils, organic biological matter combustion.
Appearance: Nearly invisible; thin yellowish/amber film; no black soot; identified by putrid odor.
Chemistry: Heat-polymerized protein molecules tightly bonded to painted substrates & drywall.

UNDERSCOPE TRAP: Most frequently missed fire loss. Scoping visually misses entire rooms where amber film migrated.

Cleaning Sequence:

1. Enzyme-based cleaner to chemically break bond.
2. Mandatory contact dwell time per enzyme specs.
3. Standard alkaline cleaner follow-up wash.
4. Hydroxyl generation for vapor & surface odor.
5. Encapsulate & repaint affected off-gassing walls.

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3. Deodorization Technology: Four Methods, Four Different Mechanisms

MECHANISM-SPECIFIC MATCHING

The technology that eliminates odor from one residue type amplifies it from another. Never choose equipment based on van availability.

Method	Physical / Chemical Mechanism	Best Application	Critical Limitations & Hazards	Hard Contraindication
Thermal Fogging	Heats deodorizing agent into dense fog (0.5 to 5 microns) that follows identical thermal penetration pathways as fire smoke.	Dry and wet smoke odor in wall cavities, subfloors, and structural framing.	Zero visibility; triggers respiratory distress; HVAC must be sealed. Complete evacuation mandatory.	**Occupied structures**; protein residue (leaves source bond intact); large commercial volumes.
Hydroxyl Generation	UV light generates hydroxyl radicals (OH•) that oxidize airborne and surface VOCs into harmless CO2 and H2O.	Occupied structures; protein residue after cleaning; ongoing restoration operations.	Slower process (requires 48 to 96 hours continuous run); surface and air treatment only.	**Deep structural cavities** (does not penetrate wall cavities like thermal fogging).
Ozone Treatment	Unstable oxygen allotrope (O3) aggressively oxidizes organic compounds and breaks chemical odor bonds rapidly.	Vacant, unoccupied structures with heavy, stubborn VOC odor loading.	Toxic to humans, pets, plants; degrades rubber, plastics, artwork, and electronics.	**Any occupied space** or spaces containing unprotected rubber, art, or sensitive electronics.
Encapsulation	Applies physical barrier coating (shellac, elastomeric, odor-lock) over cleaned substrates to seal residual off-gassing.	Cleaned framing, subfloor, and masonry with residual low-level off-gassing that cannot be replaced.	Supplemental final step only; traps moisture if applied prematurely; never replaces cleaning.	**Uncleaned heavy soot** or **unsound char** ("painting char is concealment, not S700").

4. HVAC: The Odor Distribution System You Must Address

MANDATORY S700 SCOPE

Every room in an HVAC-served structure receives smoke during a fire due to building pressure differentials. **An odor callback after comprehensive surface cleaning is almost certainly ductwork re-contamination.**

S700 (2025) Mandatory HVAC Scope:

- Video or visual access ductwork inspection at all accessible points.
- Evaporator coil and air handler blower inspection for soot.
- Mandatory replacement of all smoke-loaded filters immediately.
- Duct cleaning per **NADCA ACR standard** if residue is detected.
- Chemical coil cleaning if residue impinged on cooling fins.

Technician Deodorization Isolation Rules:

- **Thermal Fogging:** HVAC systems MUST be powered down and supply/return registers sealed to prevent deposition in air handlers.
- **Hydroxyl / Ozone:** HVAC blower may be run on recirculate ONLY during authorized whole-structure gas-phase runs after filters are removed.
- Never seal ducts with spray encapsulant while internal soot remains.

5. Encapsulant Class Decision Table & The S700 Char Rule

CONCEALMENT GATEKEEPER

Encapsulant Class	When It Legitimately Belongs	When It Is Unacceptable Concealment
Pigmented Sealing Primer (Shellac / stain-blocking)	Cleaned drywall or wood that still ghost-stains or exhibits minor low-level off-gassing.	Applied directly over heavy soot, uncleaned wet soot, or sticky protein film.
Elastomeric / High-Build (Flexible membrane)	Porous charred wood or masonry that will remain after char removal to sound material.	Applied over unsound, friable char, active corrosion, or damp/wet substrate.
Odor-Control Encapsulant (Penetrating lock-in)	After mechanical char removal and chemical wash, as final lock on framing fibers and VOCs.	Applied as the first or only "cleaning" step on raw contaminated framing.

THE CHAR RULE (ANSI/IICRC S700): Encapsulant is strictly for remaining sound material AFTER char is removed to a defensible boundary. Painting over carbonized char is NOT S700 completion. Trade names are not a methodology.