PRESERVATION MATTERS: DISASTERS

CULTURAL RESOURCES AND WILDLAND FIRE CHEMICALS

Topics covered in this brief:

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EFFECTS OF CHEMICALS

National Center for Preservation Technology and Training
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Cultural resources are one of many values that are considered in the objectives of wildland fire management. Fire can destroy or disfigure cultural resources, while fire management actions such as fireline construction can damage or displace resources. The use of fire chemicals is another management related hazard that wildland fire poses to cultural resources.

Immovable cultural resources, such as buildings, structures, monuments, and landscape features may be exposed to some type of fire chemical during suppression. These heritage properties are associated with past human use for purposes including habitation, travel, business, social, or industrial activities. Cultural resources provide visitors to public lands a chance to experience a time, place, and culture they may not see in their daily lives. Maintaining the unique characteristics of these special places and objects is essential to these experiences, and to providing a complete and accurate idea of our shared past.

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This document serves as an introduction to the ways in which chemicals used in wildland fire suppression can affect heritage properties. Much of the information provided here comes from the NCPTT study on fire chemicals and cultural resources. Included in this study were three building materials and four fire chemicals.

CULTURAL BUILDING MATERIALS

Precontact and historic structures can be constructed of one or many different materials:

Earth: Clay or mud fashioned into blocks, or used as mortar or a plaster

- Adobe is an unfired block of mud. It is also used as a mortar or plaster on some pueblos.
- Brick is the term for fired clay building blocks. Brick is a common material for constructing chimneys in historic structures.

Stone: Any type of stone that is cut or shaped, or ground for use as a plaster

- Non-porous stones include granite and quartzite. Many historic monuments are constructed of granite.
- Porous stone types include sandstone and limestone. These sedimentary rocks were widely used in the construction of pueblos.

Wood: Intact branches or logs or cut lumber

- Softwoods such as pine or fir are common building materials in cultural resources like a wikiup or log cabin.

Wildland fire chemicals are used to retard or suppress wildland fire. In this way, fire chemicals are understood as operational effects, because their impacts to cultural resources result from human action rather than the wildland fire (for more information, see the Preservation Matters Brief on Wildland Fire and Cultural Resources). Chemical concentrates are added to water to make it more effective at fighting fire.

FIRE CHEMICAL CLASSIFICATIONS

Fire chemicals are classified in three ways based on their properties and uses:

Long-Term Retardant

- Monoammonium and/or diammonium phosphate based
- Contains a corrosion inhibitor and a thickener
- May contain a colorant, such as a fugitive agent
- Medium to high viscosity
- Primary fire chemical effective at indirect attack (ahead of the fire), can also be used in direct attack (directly on flames)

Class A Foam

- Surfactant based
- Uncolored
- Can be mixed and applied in many ways to a desired bubble structure and viscosity
- Used in direct attack and mop-up (putting out hot spots in a burned area), commonly used in structure protection

Water Enhancer (Gel)

- Super absorbent polymer based
- Many are uncolored, some contain a fugitive color agent
- High viscosity
- Used in direct attack, can be used to pretreat fuels or structures (applied ahead of an approaching fire to make fuels less combustible)

Long-term retardants are the most widely used fire chemicals in the suppression of active wildland fires. These are often colored with a fugitive agent. Fugitive means the color is intended to fade with exposure to sunlight and precipitation. Long-term retardants are often dropped from aircraft, and the color shows pilots where to connect lines of retardant. The color also signals to fire personnel on the ground that an area is slippery.

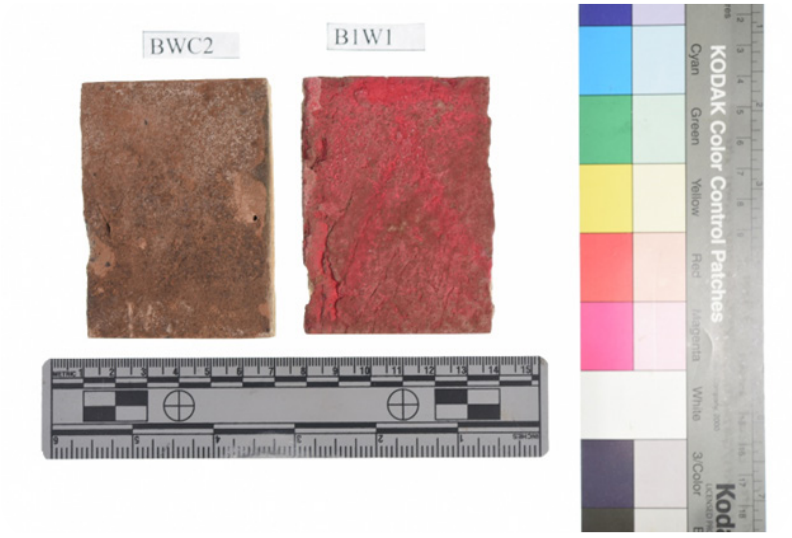
An airtanker drops more than 2,000 gallons of a red colored long-term retardant on the Bircher Fire in Mesa Verde. (NPS)

In extreme cases, fire chemicals may cause changes to a cultural resource that leads to misinformed interpretations of their place in history. Appearance is one way visitors interact with cultural resources and form a deeper understanding of the past. For example, the color of a material informs us of its age, the technology available or valued when it was made, or the artistic preferences of the culture it belongs to. Fire chemicals color with fugitive agents, and even some uncolored chemicals, can discolor cultural resources. Fire chemicals can also harm the strength of cultural resources. Pieces of brick or stone walls might break off as a fire chemical weakens the exterior, making a building and the area around it unsafe for visitors.

EFFECTS OF WILDLAND FIRE CHEMICALS ON CULTURAL RESOURCES

Long-Term Retardant

- Discoloration, especially if the chemical is colored
- Efflorescence on porous materials
- Increased soiling
- Swelling and contracting of a material leading to desiccation
- Saturation and pressure changes as well as chemically altered bonds causing fracture in porous materials



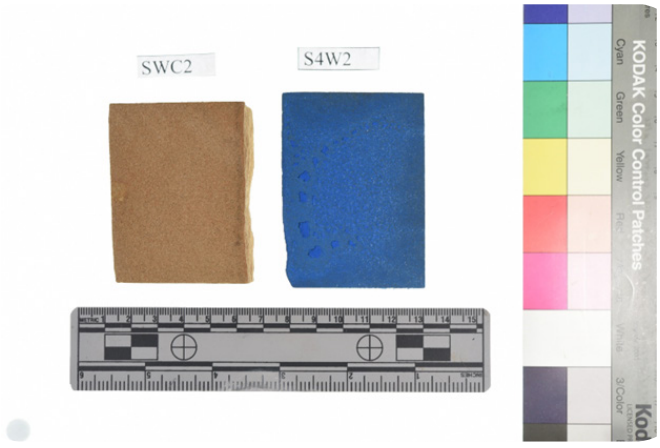
A brick sample, right, from the NCPTT study on fire chemicals was treated with Phos-Chek MVP-Fx, a long-term retardant. (Kaitlyn Eldredge, NPS)

Class A Foam

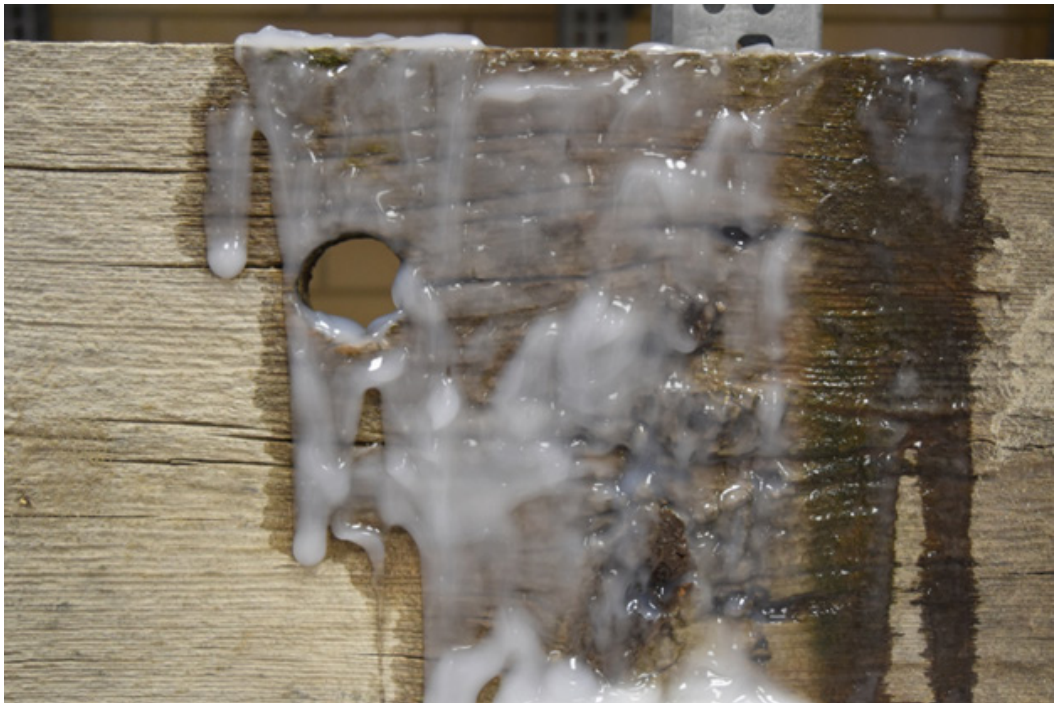
- Trapped moisture or salts
- Desiccation and flaking of surface material
- Causes wood to swell

Water Enhancer

- Discoloration from a colored or uncolored chemical
- Blocks the pores of brick and stone
- Increases soiling
- Swelling and contracting of a material leading to desiccation or fracture



The sandstone sample on the right was treated with FireIce-HVB-Fx, a water enhancer colored with a fugitive agent (Kaitlyn Eldredge, NPS)



A weathered piece of lumber is partially coated with an opaque white gel (Thermo-Gel 200L). (Kaitlyn Eldredge, NPS)

Faint white lines appear on this wood sample that was treated with Thermo-Gel 200L, an uncolored water enhancer
(Kaitlyn Eldredge, NPS)

CONCLUSION

Long-term retardants and some water enhancers are colored with fugitive agents, yet **discoloration might be permanent on some materials**. A colored long-term retardant, such as Phos-Chek MVP-Fx, can temporarily stain brick and sandstone. A colored water enhancer called FireIce HVB-Fx will permanently stain brick, sandstone, and wood. This water enhancer leaves a blue stain that clashes with the appearance of historic properties.

Efflorescence is the presence of salts on the surface of porous materials, and this process of **deterioration is enhanced by the presence of long-term retardants**. The salts are moved to the surface of the material as water within it evaporates. This movement weakens the material causing portions of its surface to detach. Soluble salts like the ammonium phosphates in Phos-Chek retardants can damage stone and other porous materials in this way. A new retardant that contains magnesium chloride could also damage stone by repetitive swelling and contracting of the salt when it mobilizes. Magnesium chloride is harmful to cultural resources because it absorbs water from the air even at low relative humidity.

If the pores of inorganic materials are blocked, the natural movement of moisture through the material is limited. **When moisture is trapped below the surface of materials like brick or stone, damage in the form of scaling, flaking, or crumbling can result.** This happens when saline water is trapped below the surface, and with fresh water during seasonal freeze/thaw cycles. Additionally, it has been found that the strength of porous stones decreases as they become wetted. If retardant blocks the pores of sandstone and it cannot dry it could be static in a weakened state.

Fire chemicals that increase the surface area of a material leave it more prone to soiling. This discolors materials and gives them a dirty appearance. Not only does this give the impression that a resource is uncared for, but soiling may hide interesting details. Unless removed through cleaning, soiling may lead to the formation of a crust on stone resources. In some cases, a crust could be strongly bonded to the material, and removing it would be harmful.

Repetitive swelling and contracting of the exterior of wood can exfoliate the surface. This changes the wood texture, which leaves the surface with a fuzzy appearance and increases the potential for future soiling and accelerated decay. Additionally, it has been observed that paint or varnish is stripped from wood as fire chemicals dry on the material. Soluble salts and swelling liquids found in fire chemicals have the potential to reduce the mechanical properties relating to the stability of wood.

The effects that fire chemicals have on heritage building materials are interconnected. Saline water and the deposition of salts within and on the materials cause much of the deterioration to cultural resources exposed to fire chemicals. Fugitive color agents can leave a resource looking unattractive or out of place. **Due to the many hazards of fire chemicals to cultural resources, it is necessary to clean them appropriately.** This entails identifying an effective yet gentle method for removing fire chemicals that does not compound or enhance the harmful effects of fire chemicals.

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ABOUT NCPTT

The National Center for Preservation Technology and Training (NCPTT) is the leading research, technology and training center within the National Park Service.

NCPTT helps preservationists find better tools, better materials, and better approaches to conserving historic buildings and landscapes, archaeological sites, and museum collections. It conducts research and testing in its laboratories, provides cutting edge training around the U.S., and supports research and training projects at universities and nonprofits. NCPTT pushes the envelope of current preservation practice by exploring advances in science and technology in other fields and applying them to issues in cultural resource management.

NCPTT publishes its Preservation Matters Series to provide easily accessible guidelines for preserving cultural materials. To download more in the series, visit https://www.nps.gov/subjects/ncptt/preservation-matters.htm.

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