Health & Safety

Portable Fire Extinguishers

Portable fire extinguishers are a critical first line of defense against collections damage and loss, but what are the impacts of their use on cultural heritage materials? This was the question that a project conducted between 2013-2017 set out to study. The project was undertaken by the Colonial Williamsburg Foundation, Jensen Hughes, and the Fire Protection Research Foundation with the generous support of a National Leadership Grant program from the Institute of Museum and Library Services. In addition to the primary question noted above, our secondary inquiry was to review the efficacy of cleaning methods after exposure. We also hoped to discover if damage occurred, when it occurred, and if the damage was immediate or worsened over time.

To answer these questions, five different extinguishing agents (ABC dry chemical, water mist, Halotron, FE-36, and ABC dry chemical followed by water mist – see Table 1 for active agents) were tested on 13 materials that represented common types of materials found in cultural heritage: iron, copper, aluminum, terracotta, porcelain, marble, travertine, fur, leather, varnished wood, unvarnished wood acrylic paint on canvas, and oil paint on canvas. The tests exposed the representative materials both directly and indirectly to the agents under non-fire (neat) conditions and in conditions approximating use in fighting fires. Samples were assessed immediately after exposure. The samples were then divided into two groups. One group was cleaned using four commonly-used cleaning techniques: brushing, swabbing with water, brushing with vacuuming, and cleaning with a soot sponge. A second group of materials was left with extinguishing agents intact for six months and then the same types of cleaning were undertaken. Both sample groups were assessed at six months, 12 months, and 18 months post cleaning.

Table 1: Portable Extinguishing Agents tested and their active ingredients:

Trade Name	Active Ingredient	Chemical Formula
ABC Dry Chemical	Monoammonium Phosphate	(NH_4) (H_2PO_4)
Halotron I (HCFC Blend B)	Dichlorotrifluoroethanol	$CHCl_2CF$
FE-36 (HFC-236fa)	Hexafluoropropane	CF_3CH_2CF

Damage noted was immediate and there was no indication that it worsened over time, suggesting that the cleaning of cultural heritage materials after an extinguisher is discharged can be delayed so that resources or expertise can be mustered as necessary; this may be a welcome finding for museums with smaller staffs or without conservation expertise. Apart from the ABC dry chemical, which dispersed throughout the test chamber, the extinguishing agents did not spread far although the introduction of a fire scenario does increase the extent of the extinguisher's impact. This suggests, unlike fixed fire suppression systems within buildings, if a portable fire extinguisher is deployed, the number of objects impacted is likely to be minimal (although in the case of ABC dry chemical it is likely that every object in the room would be impacted).

One of the expectations of the fire engineers working on the project was that we would see little damage with the so-called "clean agents" (Halotron and FE-36). However, tarnishing was noted on the metal samples and on organic samples the soot appeared to be driven into the surface, causing significant discoloration. Both the clean agents and the water mist also solubilized adhesives and dispersed inks suggesting that these effects and materials need some future study.

The project established an effective protocol for testing the impact of portable fire extinguishers and it identified areas of future research. The impact of extinguishing agents on textiles and archival materials was not tested and work should be done in this area. The cleaning methods tested were less successful than colleagues had reported, and it is unclear whether this is because of the agents themselves or the limitations we

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imposed on them to ensure consistency. However, it is clear that this is an area where the additional research could be focused. Approximately 80% of the ABC dry chemical powder was able to be removed, raising questions about whether this might be enough or might lead to future problems.

The full results and report are available at: www.nfpa.org/News-and-Research/Data-research-and-tools/Suppression/Impact-of-Fire-Extinguisher-Agents-on-Cultural-Resource-Materials.

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Further Reading

Benfer, M. and E. Williams. 2018. "Assessing the impact of fire extinguisher agents on cultural resource materials." *Fire Technology* 54 (1): 289-311. https://doi.org/10.1007/s10694-017-0684-9

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