UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
RESEARCH AND DEVELOPMENT

May 15, 2019

MEMORANDUM

SUBJECT: Research and Technical Support for Duct Work Studies at the Colorado Smelter Superfund Site

FROM: Stephen Dyment- EPA Office of Research and Development, Region 8 Superfund and Technology Liaison

TO: Sabrina Forrest- EPA Region 8 Superfund Remedial Project Manger

Ms. Forrest,

I am providing this technical memorandum to summarize findings and assist you with addressing comments or questions from stakeholders related to our Superfund and Technology Liaison Research (STLR) project "Effectiveness and Necessity of Cleaning Ductwork in Homes Impacted at the Colorado Smelter Superfund Site". Additional technical support activities related to a literature search, lead speciation work, and outreach to Regional Superfund risk assessors are also described.

Background

Initial concerns over metals exposures from Heating, Ventilation, and Air Conditioning (HVAC) system dust were expressed by some homeowners and Community Advisory Group (CAG) members following Superfund Technical Assessment and Response Team (START) indoor dust removal actions conducted at 27 homes in 2016 and 2017. Early remedial investigation (RI) site activities included soil sampling at more than 300 properties and dust at 102 homes at the Colorado Smelter Superfund Site. On, July 15, 2016 the EPA Region 8 Superfund Removal Program issued an Action Memorandum (EPA 2016b) approving an emergency removal action for dust in 19 homes, including homes with children under the age of 7 residing there. Initial sampling using x-ray fluorescence (XRF) at these properties included dust samples on wood floors with lead concentrations exceeding 33,000 mg/kg, carpets >7,900 mg/kg, and carpet pads >10,000 mg/kg (EPA 2016a). In 2017, seven more properties received emergency indoor cleanups (EPA 2017). After High Efficiency Particulate Air (HEPA) vacuum cleaning and dust removal conducted under START removal actions, several residents expressed concerns about metals contamination and recontamination of living spaces associated with dust in home HVAC duct work.

EPA ORD Duct Study Literature Search

As part of a literature search supporting this Colorado Smelter Duct Study, EPA identified limited research on impacts to residential dust exposures from cleaning HVAC ducts, noting a 1994 study conducted for the Canada Mortgage and Housing Corporation (CMHC) on "Efficiency of Residential Duct Cleaning" (CMHC 1994) and a 1997 EPA document entitled "Should You Have the Air Ducts in Your Home Cleaned" (EPA 1997). The CMHC 1994 study sampled 33 homes, measuring house airborne dust, dust volumes on duct surface and exits using wipe samples, biological measurements for yeast/mold/bacteria, system efficiency using fan current and voltage, pressure differential, and ventilation flow rates. Data were collected before, during, and after duct cleaning using 4 cleaning techniques from 16 different duct cleaning vendors including: cleaning with industrial vacuum and brushes, cleaning with industrial vacuum and air spray, vacuum truck, and vacuum truck/metal ball agitators. The study concluded that duct cleaning did not significantly reduce furnace fan energy use, supply or return air flow rates. Additionally, most duct wipes were not cleaner after the duct cleaning exercise, supply ducts were low in dust concentration and remained relatively unchanged from cleaning, while return ducts (typically with higher dust volumes) saw modest reductions in dust concentrations from cleaning. Indoor air measurements showed no significant reduction in dust concentrations from cleaning, instead a small increase in dust concentrations were noted after cleaning before returning to baseline levels within hours.

In the mid-1990s, EPA convened a panel of experts to explore the topic of duct cleaning resulting in a document by EPA's Office of Air and Radiation entitled "Should You Have the Air Ducts In Your Home Cleaned" (EPA 1997). Importantly the report notes that duct cleaning has not been shown to prevent health problems or conclusively demonstrate that dust levels in homes increase because of dirty air ducts. Further, dust found in the HVAC ducts cannot necessarily enter living spaces as much of it adheres to duct surfaces. EPA 1997; therefore, provides a series of recommendations for preventing water and dirt or dust from entering the HVAC system as the most effective way to prevent duct contamination.

EPA 1997 indicates that some research is suggestive of potential improvements to HVAC efficiency from duct cleaning that may result in maintenance or energy savings but noted little evidence that duct cleaning alone can improve HVAC system efficiency. The CMHC 1994 study had similar results, finding no measurable improvements to system efficiency following cleaning. Despite study limitations, EPA 1997 indicates that homeowners may consider duct cleaning in cases where substantial mold, rodent or insect infestation, or excessive dust may clog or release into living space from supply registers.

EPA ORD/Region 8 Outreach to Other Regions

The EPA Colorado Smelter technical team also reached out to Superfund Risk Assessors and other EPA Regions to consider HVAC related findings at other Superfund smelter sites. One such study identified is the Bunker Hill House Dust Pilot Final Remedial Effectiveness Report completed in 2002 (US Army Corps of Engineers 2002). The study explored a variety of cleaning procedures and related impacts to dust found in living and non-living spaces at the Bunker Hill Superfund Site in Kellogg, Idaho. This study found that while HVAC system dust samples were collected in 7 homes only 5 of the homes provided sufficient dust volume to analyze. The geometric mean of lead in HVAC dust for the five homes was 1,207 mg/kg while the average mass collected from duct cleaning was 156 grams. The study found that most of the dust material was found in return vents prior to the HVAC system filter and was captured by the system filter, limiting the likelihood of recontamination of living space follow the 3 different clean procedures used. Indoor air sampling conducted further indicated the low probability and volume of material in HVAC systems that can re-contaminate living spaces. Instead the study focused on "soft reservoirs" like dust mats and carpets/carpet pads in home living spaces as a primary means of potential living space re-contamination from dust track in (Rasmussen et al 2018). The largest reductions in metals exposure at the Bunker Hill Site were related to outdoor remediation for reduction in metals concentration and subsequent dust track-in.

EPA ORD STLR/Region 8 START Duct Study

Despite findings from existing research indicating that duct cleaning is of limited value for potential health improvements, HVAC efficiency and maintenance, or dust control in home living spaces, in response to community concerns, EPA ORD initiated the study, "Effectiveness and Necessity of Cleaning Ductwork in Homes Impacted at the Colorado Smelter Superfund Site". In April and November 2017, EPA Region 8 START members and support contractors collected 148 samples at 7 homes including: 27 air samples, 7 vacuum filter dust samples, 20 living area wipe samples, 18 ductwork wipe samples and 76 deposition samples. The study focused on the following three questions:

- Is the existing furnace and ductwork contaminated with lead and arsenic dust?
- Is the operation of the furnace and ventilation system re-contaminating the living space of the homes that have been cleaned?
- Can a contaminated furnace and ventilation system be cleaned effectively without increasing contamination in a home?

Homes were chosen for sampling based on factors such as original contamination levels, presence of a forced-air heating system, and the willingness of the owner or tenants to be part of the study. Sampling at one home could not be completed because there was asbestos in the ductwork.

Results were shared with homeowners and CAG members via the "Sampling Activities Report for the Colorado Smelter Superfund Site Residential Duct Pilot Study" (EPA 2018a) and the Technical Assistance Services *for* Communities (TASC) Fact sheet (EPA TASC 2018b). Results of this study showed that while lead was detected in HVAC dust wipe samples, the material did not appear to leave the duct work in sufficient volume to contaminate living spaces before, during, and after duct cleaning as indicated by low lead concentrations in indoor air sampling, duct wipes and living space wipe sampling. Additional CAG comments noted the small sample size of the study and a conclusion that additional research on the topic may be warranted. It should be noted that while the presence of asbestos containing materials and the age of homes and HVAC materials limited some areas of the study, the 148 air, dust and wipe samples collected at 7 homes provide a robust data set for this study. Further, EPA authorities and risk management strategies may result in situations where lead that is not accessible or posing a risk to human health (for example: crawl spaces, attics or other confined areas) may be left in place. In these cases, disturbance of contaminants in non-living space may increase the potential for exposures in living spaces resulting from attempts to remove material. Results from EPA 2018 study show that while quantifying health improvements from HVAC cleaning remains an industry challenge, the potential for recontamination of living spaces from HVAC cleaning is limited.

2018 Synchrotron Advanced Photon Source Analysis of Colorado Smelter Samples

To consider potential lead sources of material found in duct wipes, the Colorado Smelter technical team also sent 2 dust wipe samples collected in the ducts of 2 homes to ORD researchers in Cincinnati, OH, for lead speciation at the Advanced Photon Source synchrotron facility at the Department of Energy (DOE) Argonne National Laboratory (https://www.aps.anl.gov/) in Lemont, Illinois. The samples were freeze dried, analysis pellets were prepped from unsieved, whole fraction and sieved to < 75 µm fraction, and analyzed for lead speciation at the Advanced Photon Source on 12/7 and 12/8/2018. Results provided in Table 1 below show that the lead speciation was dominated by lead adsorbed to the iron oxide goethite (~60%) (representative of Pb adsorbed to the surface of oxides and clay particles) and lead bound to fulvic acid (35%) (representative of Pb sorbed to organic matter phases) with minor contributions coming from plumbojarosite (Table 1). Previous analysis of outdoor soil samples at the site show plumbojarosite as the primary Pb phase, accounting for over 96% of lead present.

Table 1. Lead speciation as a percent for dust collected from interior ducts. Uncertainty given in parenthesis.

	Lead Adsorbed to Goethite	Lead Bound Fulvic Acid	Plumbojarosite
CSWPCO-312-01-All	64 (3)	29 (4)	7 (2)
CSWPCO-312-01-L75	58 (3)	36 (4)	5 (2)
CSWPCO-312-02-All	58 (2)	42 (2)	--
CSWPCO-312-02-L75	60 (2)	32 (3)	8 (1)

The low percentage of plumbojarosite and higher rates of sorbed lead species suggest that while some smelter related material is present as plumbojarosite species, other forms of sorbed lead dominate indicating potential contributions from other sources. Unfortunately, organic acids (i.e. fulvic acid) and minerals (i.e. goethite) scavenge lead when it is released into the environment from a variety of sources such as house paint or mine tailings. Given the age of lead release, the species expected, and pH driven adsorption transformations that can occur from a variety of sources, it is not possible to specify how much of the adsorbed and organic acid bound lead may be attributable to nearby smelters.

EPA Region 8 STL Outreach for Collaborative Research Opportunities

As part of outreach to other EPA Regions, STL Stephen Dyment contacted other ORD researchers and Regional Superfund risk assessors to explore interest in collaborating on potential future research in this area. Responding ORD staff and Regional risk assessors expressed no current interest in partnering on related research citing similar findings at their Superfund Smelter Sites. When considering potential exposure pathways for smelter related metals in indoor dust, respondents indicated that dust in HVAC systems was a low priority behind track-in of outdoor materials, soft reservoirs indoors, and best practices for limiting these sources.

Conclusions and Recommendations

Literature searches, other EPA Regional and ORD work, the Colorado Smelter STLR Study (EPA 2018a and 2018b), and technical support activities indicate that duct work is not a significant source of home contamination or recontamination following indoor cleanups at the Colorado Smelter Superfund Site. Existing studies and data indicate that outdoor soil cleanups, limiting dust track-in, use of cleaning best practices, and timely replacement (1-3 months) of HVAC system filters offer the best opportunities to limit metals exposure in indoor dust. EPA ORD currently does not plan to pursue additional research related to metals in HVAC duct work but will provide technical support as requested by the Colorado Smelter team and EPA Region 8 Superfund program.

References

CMHC 1994 "Efficiency of Residential Duct Cleaning". Canada Mortgage and Housing Corporation (CMHC) Research Report-. January 1994.

EPA 1997 "Should You Have the Air Ducts In Your Home Cleaned". EPA Office of Air and Radiation, Indoor Environments Division. October 1997. https://www.epa.gov/indoor-air-quality-iaq/should-you-have-air-ducts-your-home-cleaned

EPA 2016a POLREP #1 – Initial POLREP Colorado Smelter Superfund Site- Community Properties (OU1), Pueblo City, Pueblo County, Colorado. July 14, 2016.

EPA 2016b EPA Action Memorandum. Approval and Funding for an Emergency Removal Action Involving the Cleanup of Lead-Contaminated Indoor Dust in Residential Areas of Pueblo, CO., as a Result of Smelting Activities at the Colorado Smelter Site. July 15, 2016.

EPA 2017 POLREP #2 – POLREP Colorado Smelter Superfund Site- Community Properties (OU1), Pueblo City, Pueblo County, Colorado. June 5, 2017.

EPA 2018a Sampling Activities Report for the Colorado Smelter Superfund Site Residential Duct Study. EPA START January 2018.

EPA 2018b Technical Assistance for Communities (TASC) Fact Sheet. Summary of Duct Study Report. EPA TASC, July 2018.

Rasmussen et al 2018 Pat E. Rasmussen, Christine Levesque, Marc Chénier, H. David Gardner. 2018. Contribution of metals in resuspended dust to indoor and personal inhalation exposures: Relationships between PM10 and settled dust. Building and Environment, 143: 513-522.

USACE 2002 "Bunker Hill House Dust Pilot Final Remedial Effectiveness Report". US Army Corps of Engineers Seattle District, Terra Graphics Environmental Engineering, Inc. December 2002.