Clean or Replace? Decontamination Framework for Firefighting Equipment and Hangars (ER20-5361)

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AFIT AIR FORCE INSTITUTE OF TECHNOLOGY

EPA United States Environmental Protection Agency

Bottom Line Up Front

- **Goal:** Provide data and information to refine existing guidance about how to flush per- and polyfluoroalkyl substances (PFAS) from firefighting systems, specifically hangar systems and Aircraft Rescue and Firefighting (ARFF) vehicles
- **DOD Relevance:** As many as 4,350 DOD aqueous film forming foam (AFFF) delivery systems in aircraft hangars and firefighting vehicles may require decontamination. Unless effective cleaning solutions are available, replacement will cost $2.1 billion, according to CBO.
- **Technical Gap:** No framework is available for evaluating cost and environmental impact of decontamination compared to costs of replacing components and systems

Technical Approach

Task 1. Establishing technical expert group of DOD and civilian experts from Airport Council International – North America

Task 2. Investigating decontamination protocols that take into account PFAS interaction with wetted surfaces

Task 3. Developing sample and analysis to avoid system recontamination

Task 4. Including small pipe hydraulics in predictive models

Schedule: Started summer 2020. Three year project.

ACTIVITY	Quarter after Start 1	2	3	4	5	6	7	8	9	10	11	12
Task 1. Technical Expert Workgroup	o	o	o	o	o	o	o	o	o	o	o	o
Task 2. Decontamination Framework			o				o				f	
Task 3. Sampling Protocols				o			o		f			
Task 4. Hydraulic modeling of small pipe			o			o			f			
Task 5. Technology Transition				o				o		o		f

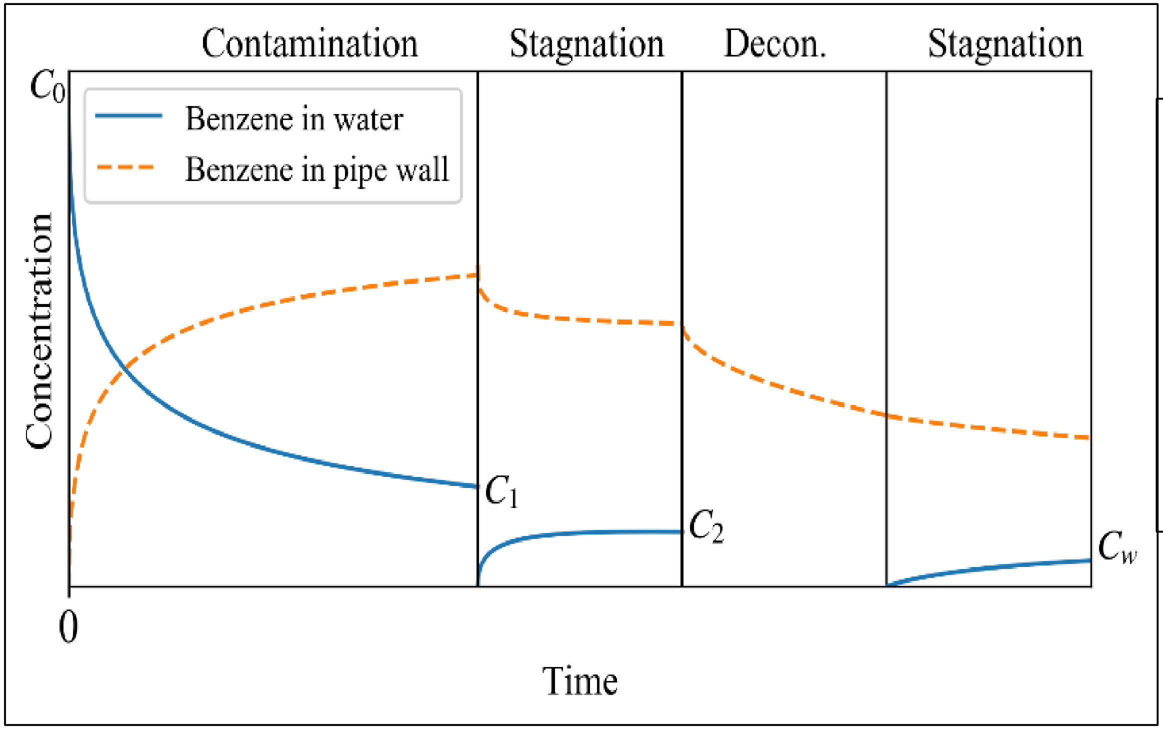
"o" indicates interim products/milestones
"f" indicates final products/milestones

Indicates other projects' data will be included, although actual timing depend on their schedules.

Technical Approach

Task 2. Investigating decontamination protocols that take into account PFAS interaction with wetted surfaces

1) PFAS stick to surfaces, so how to decon them?
2) What PFAS-surface interactions are important?
3) Of the many different surfaces in firefighting systems/equipment, which are important sinks/traps for PFAS?

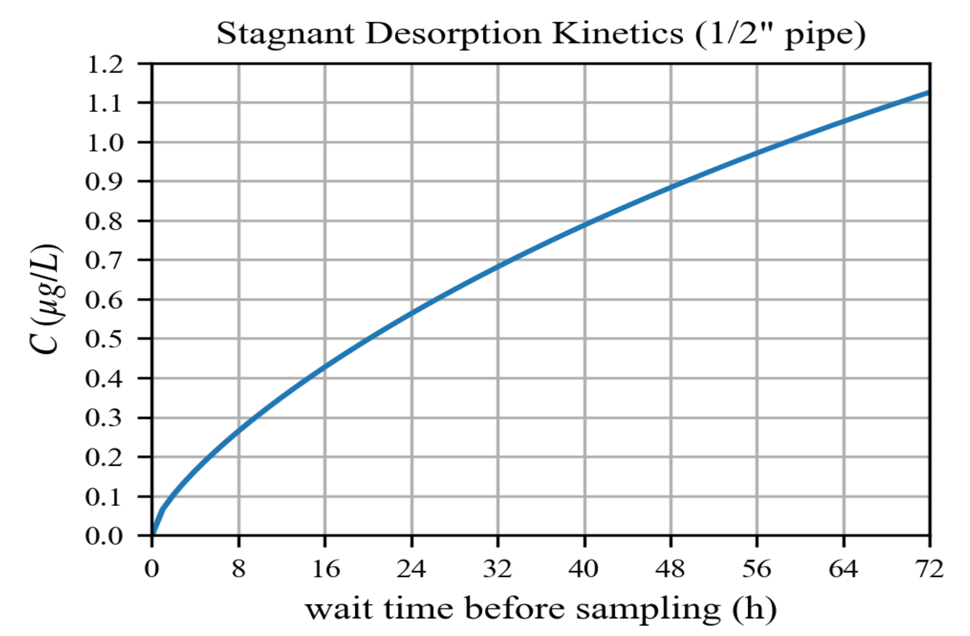


Following a single contamination event, concentration levels decrease after one or more intermittent, stagnation-decon cycles. Shown here for benzene (EPA, 2019). PFAS mechanisms will differ from benzene.

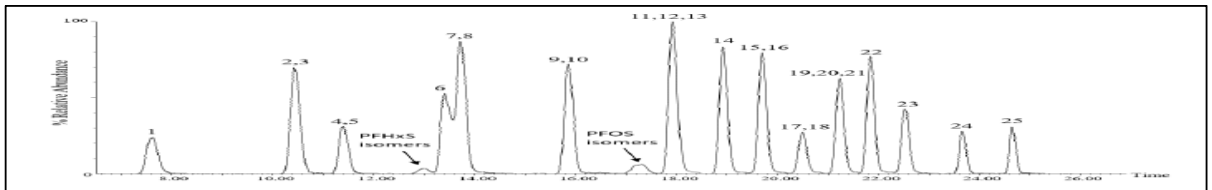
Technical Approach

Task 3. Developing sample and analysis to avoid system recontamination

1) How do you sample after decontamination?
2) Since PFAS are sticky, how long do you wait for them to desorb?
3) Rather than waiting a long time, can you wait a short time?



Desorption kinetics in mathematical models can inform sampling strategy, to avoid the pitfalls of not waiting long enough after cleaning before sampling. (EPA, 2019)

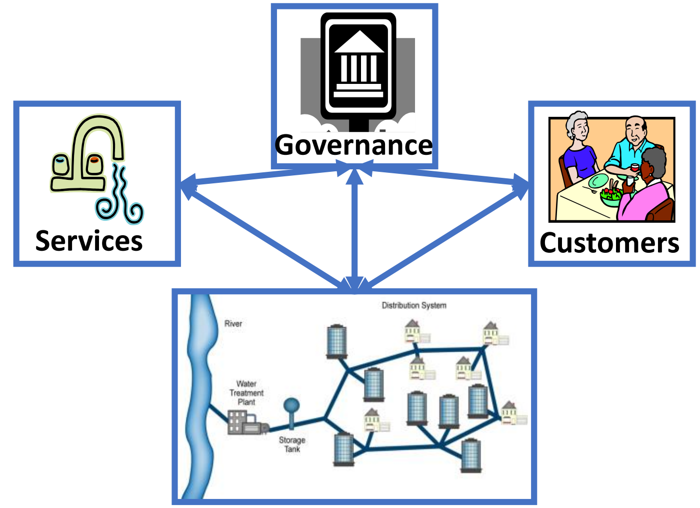


LC/MS/MS quantitation can be only as good as the sample.

Technical Approach

Task 4. Including small pipe hydraulics in predictive models

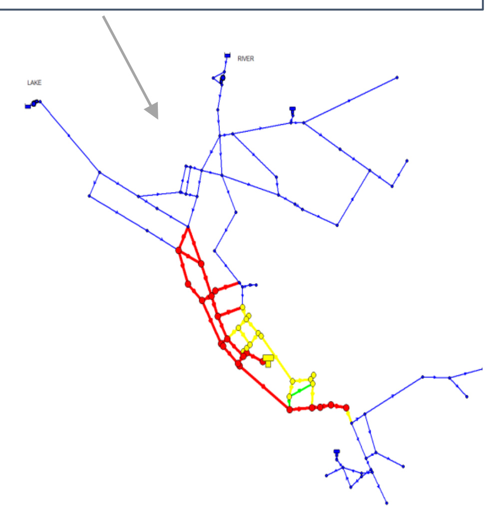
1) How to move contaminated water through a pipe system, given unique aspects of small pipe hydraulics? Hydraulic modeling software has been developed by EPA over the past 20 years, and EPANET is now routine in the industry.
2) Can models be applicable to many pipe designs, such that you verify performance for one design and apply it to others? Many piping systems exist, and it would be impractical to verify deconning of all.
3) Since piping diameters in firefighting systems are comparatively small, how does pipe size affect your ability to model water flow? Except for small diameter pipes, where comparatively more flow occurs next to pipe wall.



Physical Infrastructure

Hydraulic modeling is a systems-based approach to solving problems

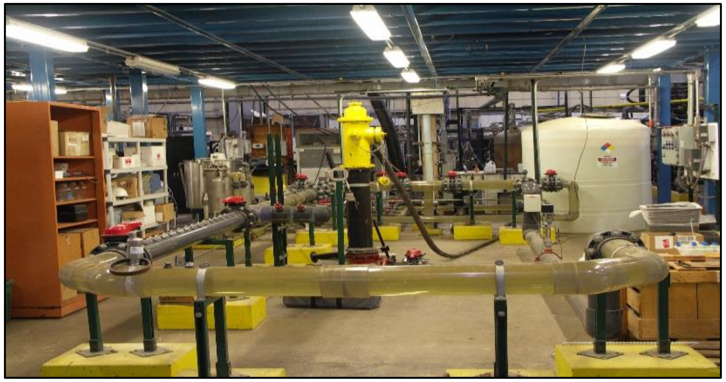
Modeling and simulation tools (e.g., EPANET) simulate flow, pressure and water quality in distribution system



Results to Date

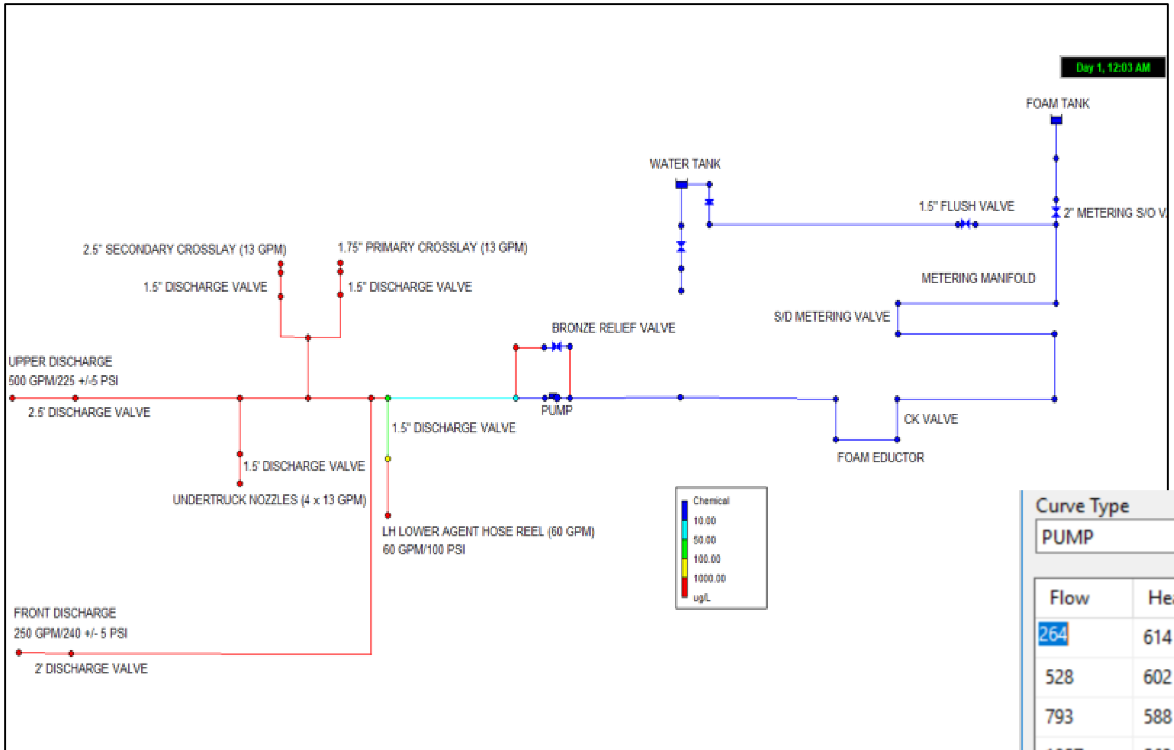
Tasks 1-3. Constructing test bed at EPA's Test & Evaluation facility in Cincinnati, OH and obtaining excessed USAF ARFF.

- RCRA-permitted TSDF, located adjacent to Greater Cincinnati WWTP
- High-bay (33,000 sq. ft.) and 5 labs, including BSL-2 lab
- Analytical instrumentation and machine shop



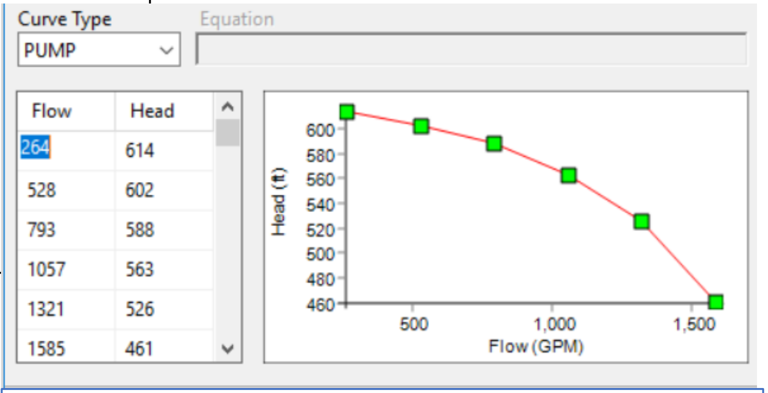
Results to Date

Task 4. Including small pipe hydraulics in predictive models -- ARFF



Input file for ARFF hydraulic system and contaminant concentrations for certain operation conditions. Since multiple ARFF designs exist, modifiable for specific systems.

Training with ARFF vehicle at USAF base

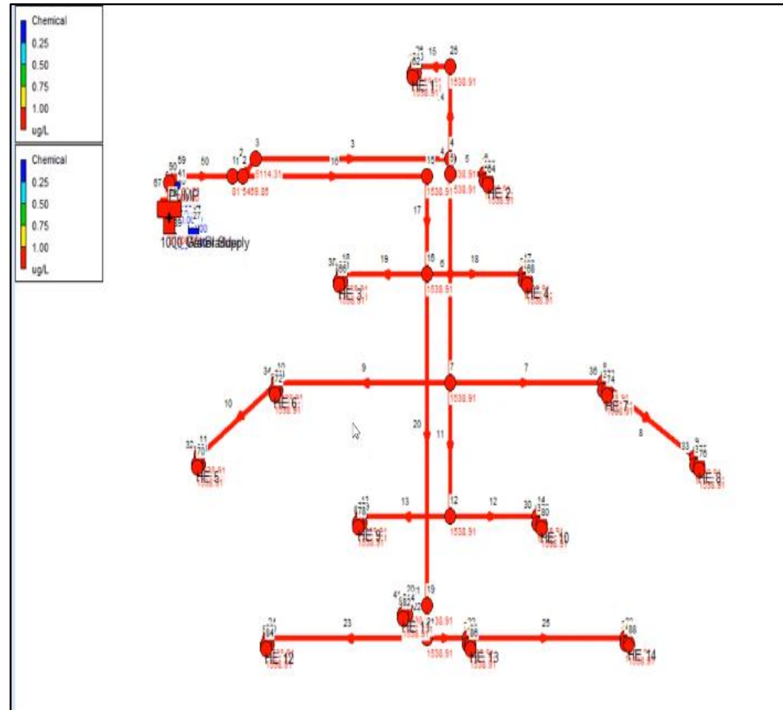


Different construction and operating conditions can be simulated, like flow rate and different pipe lengths.

Results to Date

Task 4. Including small pipe hydraulics in predictive models -- hangar

C-17 Hangar at USAF base.
AFFF piping and foam generators on ceiling.



Input file for a particular AFFF hangar.
Modifiable for specific hangars.

Lessons Learned and Next Steps

Next steps

- Perform tracer tests (i.e., with no contaminant-pipe interaction).
- Perform studies with contaminant interactions.
- Utilize data from other projects.
- Full scale studies as needed.

EPA's Water Security Testbed, located at Idaho National Laboratory. Includes full scale water system and premise plumbing.

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