



Pool Fire Modeling Topics

2022 PHMSA R&D Public Meeting and Forum
Fire Protection Working Group

Pool fire modeling applications

- Facility siting studies
- Determine the need for equipment and structural mitigation measures
- Evaluate the effectiveness of pool fire mitigation measures

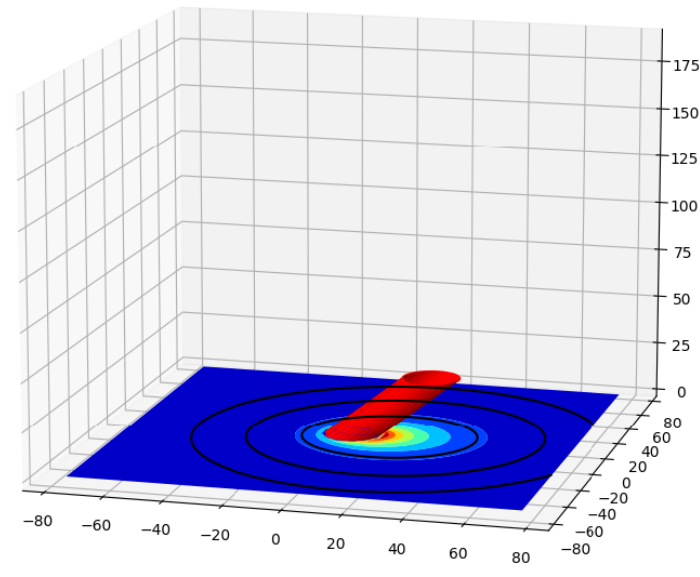
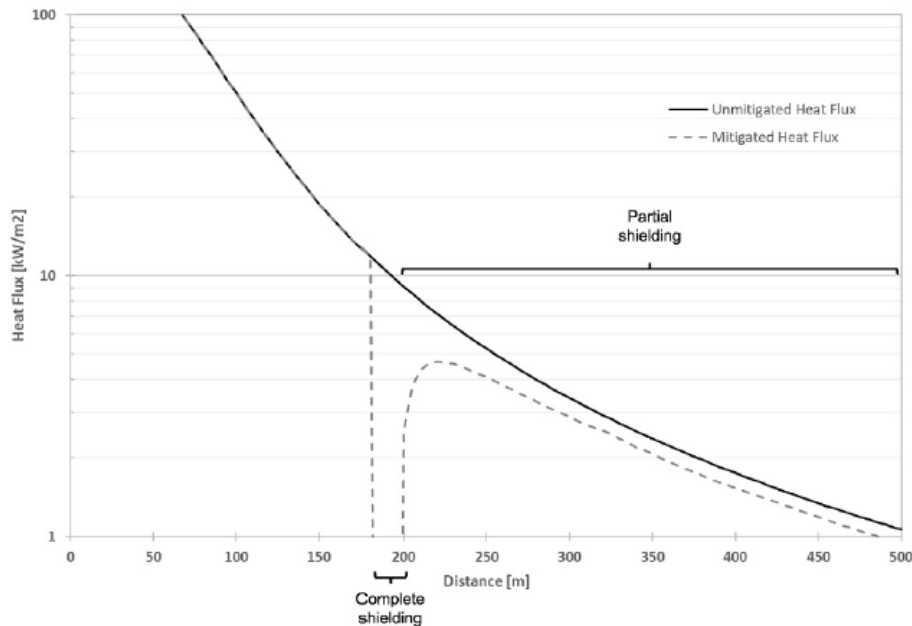


Modeling capabilities vs. limitations

- The only approved modeling tool is LNGFIRE3, which cannot account for:
 - Fuels other than LNG
 - Large obstructions
 - Mitigation measures
- CFD tools and LNGFIRE3 emulators can address these limitations, however:
 - No currently approved models
 - Lack of relevant model validation data

LNGFIRE3 emulators

- Replicate the solid flame model in LNGFIRE3 using common computing tools



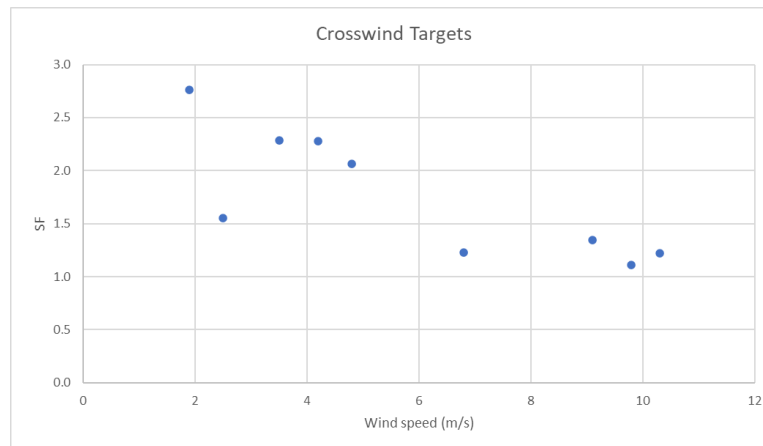
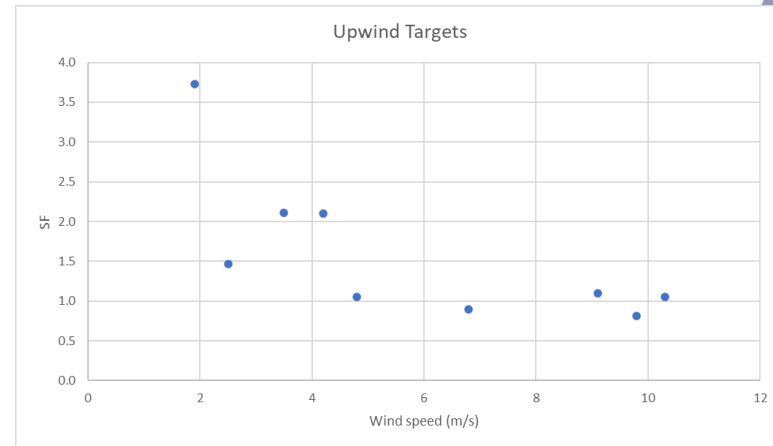
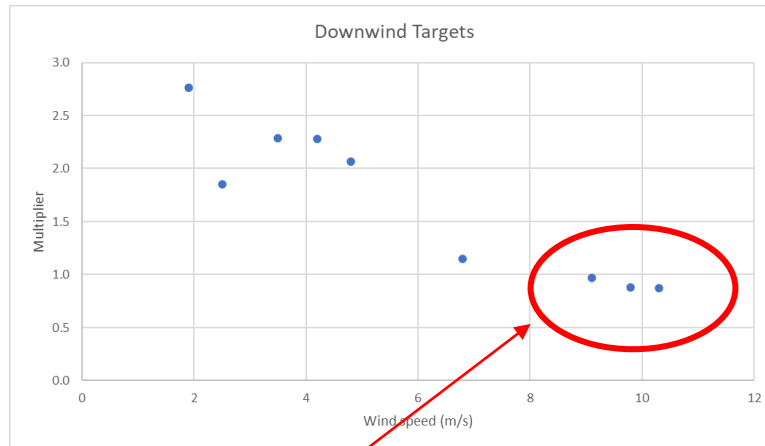
Gavelli, F., The effect of barriers on reducing thermal heat flux from a hydrocarbon pool fire, *Journal of Loss Prevention in the Process Industries*, May 2021, <https://doi.org/10.1016/j.jlp.2021.104554>

Unmitigated LNG pool fires

- “MVD for Fires at LNG Facilities” (SAND2022-6810)
 - Sandia methane burner tests
 - Montoir pool fire tests
 - Phoenix pool fire tests
- No tests at scale of pool fires typically evaluated

FDS Validation Review (Montoir)

- Multiplier for FDS Prediction to match Experiment (<1.0 = over-predictive)



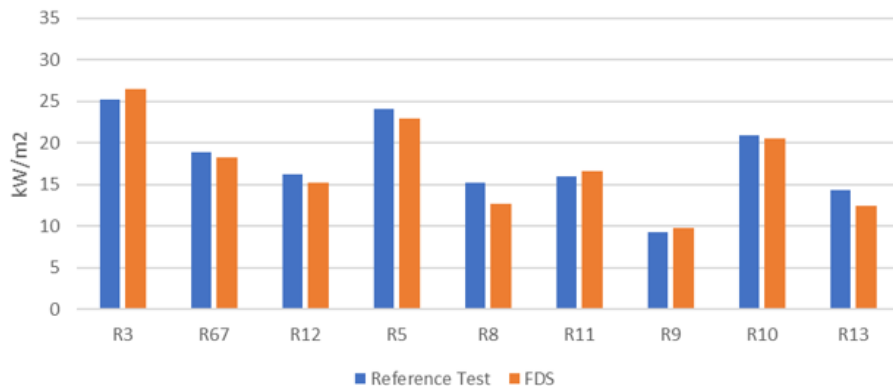
Focus of LNG
pool fire hazard
assessments

High expansion foam

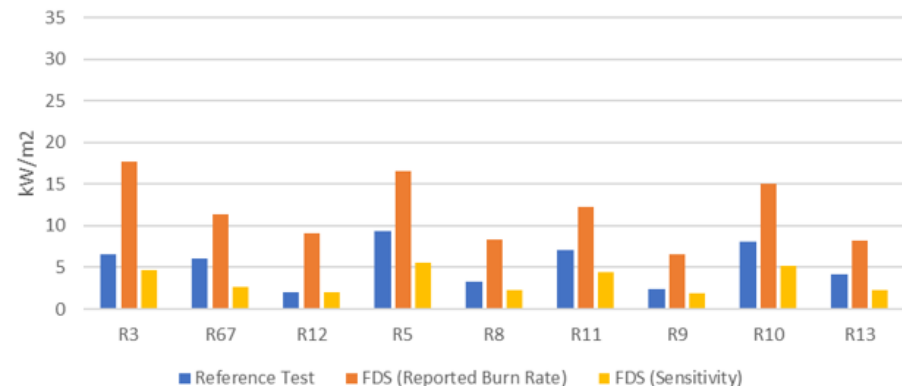
- Only one test (MKOPSC in 2009) was identified to provide burn rate and heat flux measurements before and after foam application (R&D Project #847)
- Reported heat flux reduced 60-80%, but the burn rate was reduced by less than 50%
- NFPA 11 calls for heat flux reduction of 90% at 1.5 pool diameters, which suggests a significant reduction in burn rate is required for compliance



Heat Flux Before Foam



Heat Flux After Foam



Insulating floating foam blocks

- Test conducted in 2008 at MKOPSC did not record burn rate or heat flux
- Test conducted in 2013 by Resource Protection International in Spain
 - 6.5 ft x 6.5 ft x 4 ft pit with 6 inches of LNG
 - Burn rate not measured



Knowledge Gaps

- 1) What are appropriate validation factors for advanced fire models?
- 2) No data to define burn rates for modeling that includes high expansion foam or insulating floating foam blocks

Note: Knowledge of burn rate also impacts sizing high expansion foam concentrate inventories

Potential R&D Project

- Conduct pool fire tests at scales typical to LNG installations to quantify burn rate and heat flux at distances up to several pool diameters from the source
 - With and without high expansion foam
 - With and without insulating floating foam blocks
- Industry benefits
 - Data set at appropriate scale for LNG facilities to support model validation
 - Justification for appropriate burn rates to model pool fire mitigation measures