



LUND
UNIVERSITY



The Use of a Water Mist Curtain as a Radiation Shield

DANIEL A. MARTIN

MASTER'S THESIS RESEARCH



LUND
UNIVERSITY

Contents



- Potential uses of a water mist curtain shield
- Objectives of the research
- Previous academic research
- Background work
- Experimental setup
- Predicted results



LUND
UNIVERSITY

Potential uses of a water mist curtain shield



- Protect operational control rooms
 - Oil rigs
 - Marine vessels, etc
- Protecting high value targets from radiation exposure
- Prevent fire spread; i.e. compartmentation



LUND
UNIVERSITY

Objectives of the research



- Measure the radiation attenuation through a single nozzle water mist curtain
- Find the different radiation attenuation levels based on:
 - The vertical position within the water mist column
 - Radiation source
 - Vertical plane angle of the heat flux gauge



LUND
UNIVERSITY

Previous Academic Research



- Nozzle sizes tested:
 - Firefighting nozzles, sprinkler heads, and water mist heads (full/hollow spray)
- Pressures and nozzle flow rate:
 - 0.076 - 10 bars
 - 0.12 – 4.7 L/min (mist), 95 – 360 gal/min (fire nozzle)
- Sources of radiation:
 - Gas radiant panel, liquid pool fire, wood crib fire, Fourier Spectrometer
- $D_v0.5$ sizes:
 - Varied by location in the spray column and the nozzle (24 – 550+ μm)

[Ref. 1-7]



LUND
UNIVERSITY

Background work



- Continuation of the PhD work conducted by Prof. Bjarne Husted
 - Experimental and CFD results on high pressure water mist systems comparing hollow and full cone nozzles:
 - Droplet sizes in various region of the mist column
 - Droplet velocities
 - Volumetric density

[Ref. 6]



LUND
UNIVERSITY

Experimental Setup



- Danfoss Water Mist System
 - Power Pack PPH 6.3 with a piston pump
 - Single nozzle: 1910 Hollow Cone Nozzle (0.42 L/min)
 - Operating pressure: 100 Bars
 - Single fluid spray
 - $D_{v0.5}$'s = 28-35, 40, 48 μm



[Ref. 6]

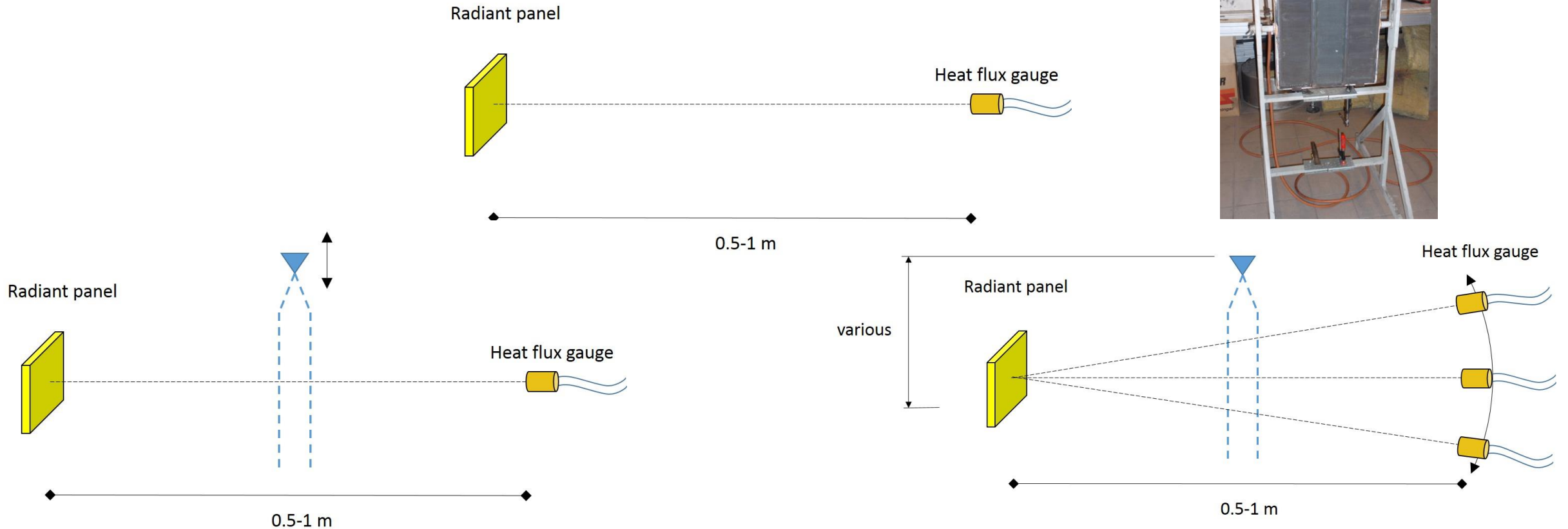


LUND
UNIVERSITY

Experimental Setup



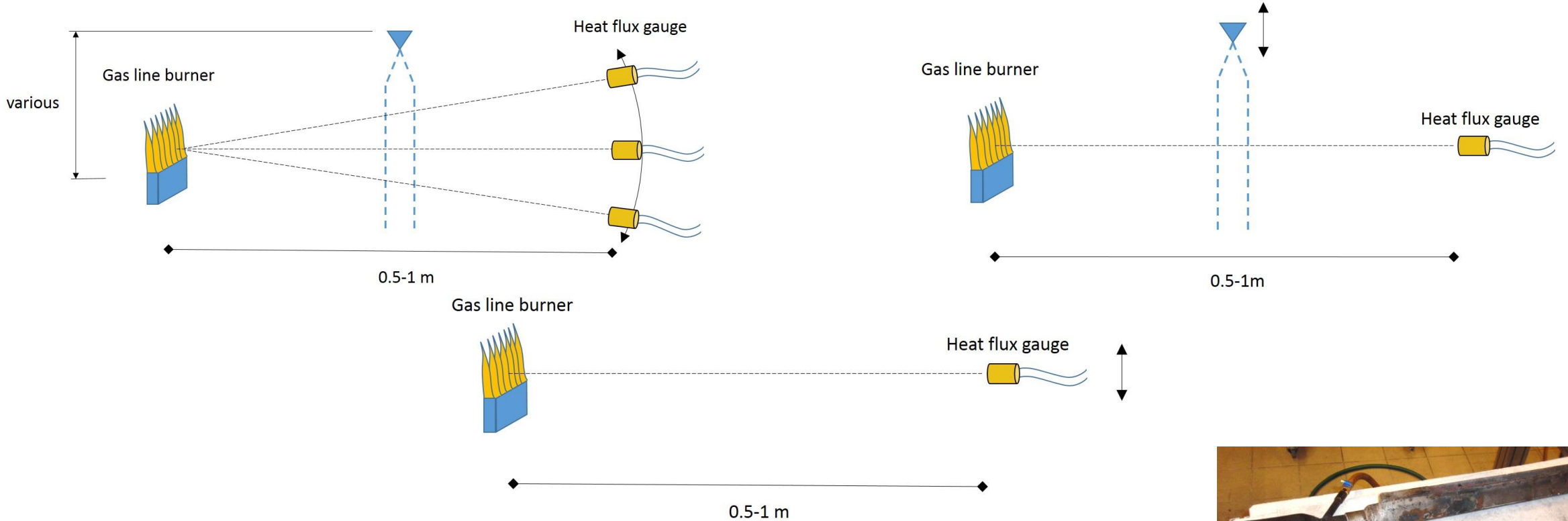
3 burner propane radiant panel: 39 x 47 cm





LUND
UNIVERSITY

Experimental Setup



Gas line burner (Methane and Propane): 2 x 39 cm



LUND
UNIVERSITY

Predicted Results



- From previous studies, attenuation ranges from 11 – 55%
- Predicted attenuation results from 35 – 60%
- Very difficult to predict attenuation; results based on the system and application:
 - Pressure, nozzle flow rate, nozzle type, number of nozzles, nozzle orientation, location within the mist column, environmental conditions, etc.



References

- [1] Sunahara, H., Ishihara, T., Matsuyama, K., Sugahara, S., Morita, M. "A study on relation between heat release rate and radiative heat flux of wood crib burning during water discharge" (2010) *Journal of Environmental Engineering*, 75 (658), pp. 1009-1017.
- [2] Reischl, U. "Water fog stream heat radiation attenuation" (1979) *Fire Technology*, 15 (4), pp. 262-270.
- [3] Dembele, S., Wen, J.X., Sacadura, J.-F. "Experimental study of water sprays for the attenuation of fire thermal radiation" (2001) *Journal of Heat Transfer*, 123 (3), pp. 534-543.
- [4] Heselden, A.J.M., A Hinkley, P.L. "Measurements of the transmission of radiation through water sprays" (1965), *Fire Technology*, 1 (2), pp. 130-137.
- [5] G. Parent, P. Boulet, S. Gauthier, J. Blaise, A. Collin, Experimental investigation of radiation transmission through a water spray, *Journal of Quantitative Spectroscopy and Radiative Transfer*, Volume 97, Issue 1, January 2006, Pages 126-141.
- [6] Husted, B P. "Experimental measurements of water mist systems and implications for modelling in CFD" (2007) PhD Thesis, Lund University, Sweden
- [7] Murrell, J V, Crowhurst, D, Rock, P. "Experimental study of the thermal radiation attenuation of sprays from selected hydraulic nozzles" *Halon Options Technical Working Conference 1995*, Albuquerque, NM USA.
www.nist.gov
- [8] *SFPE Handbook of Fire Protection Engineering. Chapter 14 Water mist fire suppression systems*. National Fire Protection Association, 3rd Edition, 2002.