

Modeling Large Liquefied Natural Gas (LNG) Fires

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Model Evaluation Protocol for Fire Models Involving Fuels at Liquefied Natural Gas Facilities

Anay Luketa

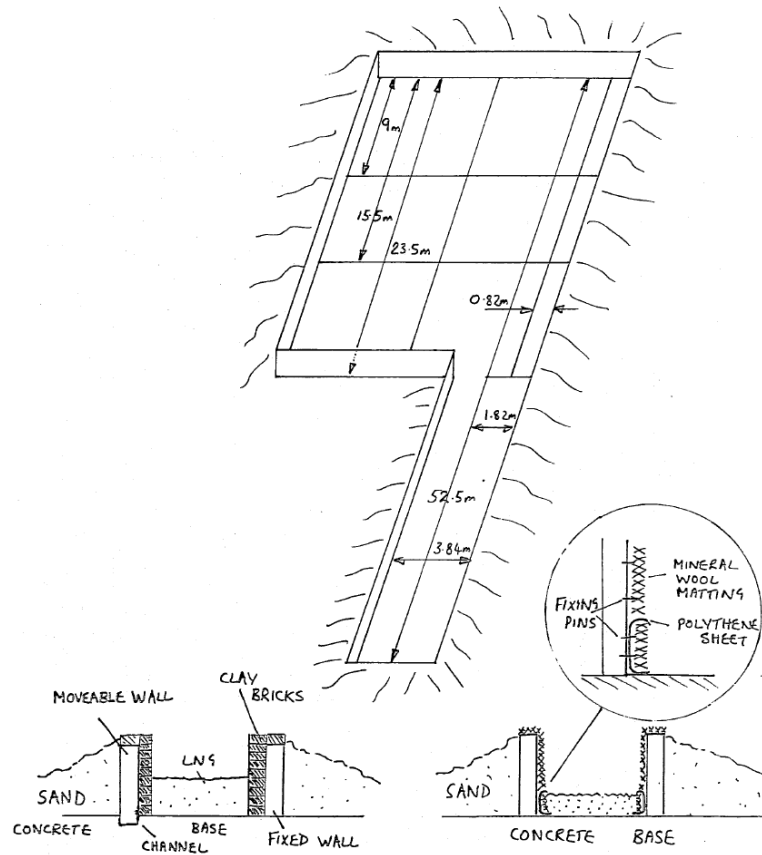
Prepared by
Sandia National Laboratories
Albuquerque, New Mexico
87185 and Livermore,
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The Pipeline and Hazardous Materials Safety Administration of the U.S. Department of Transportation has contracted Sandia National Labs in the USA to develop a model evaluation protocol (MEP) for liquefied natural gas (LNG) fires. The experimental data sets cited for validation include:

- BGC/GRI LNG Fires (1982) Thirteen LNG trench fires conducted by the British Gas Corporation (BGC) and the Gas Research Institute (GRI)
- Montoir LNG Fires (1987) Three 35 m LNG pool fires conducted by Gaz de France in Montoir de Bretagne, France
- Shell LNG Fireballs (2014) Four LNG fire ball experiments conducted by Shell Research Ltd, UK
- Sandia Methane Burner (2009) Twenty-eight 3 m diameter methane burner fires conducted by Sandia National Labs, USA
- Phoenix LNG Fires (2009) 21 m and 83 m diameter LNG pool fires conducted by Sandia National Labs, USA
- Loughborough Jet Fires (2012) LNG jet fire experiments conducted by GL Noble Denton in Cumbria, UK, in collaboration with Loughborough University, UK

BGC/GRI LNG Fires (1982)

Croce, Mudan and Moorhouse supervised 13 LNG trench fires conducted by the British Gas Corporation on behalf of the Gas Research Institute.



THERMAL RADIATION FROM
LNG TRENCH FIRES

VOLUME I - MAIN REPORT
FINAL REPORT

(September 1982 - September 1984)

Prepared by

P.A. Croce
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Arthur D. Little, Inc.
Acorn Park
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and

J. Moorhouse
British Gas Corporation
Research and Development Division
Midlands Research Station
Solihull, England

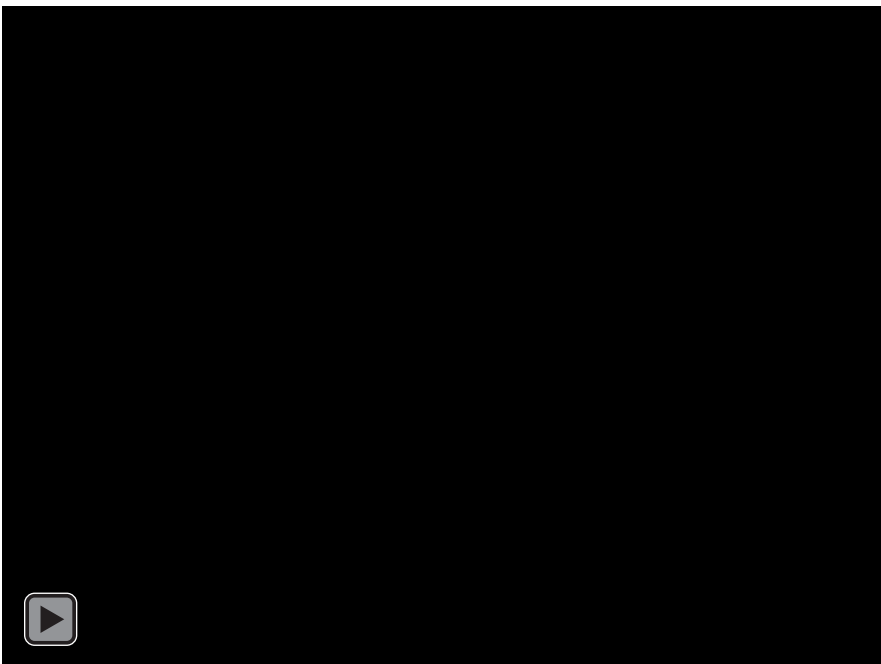
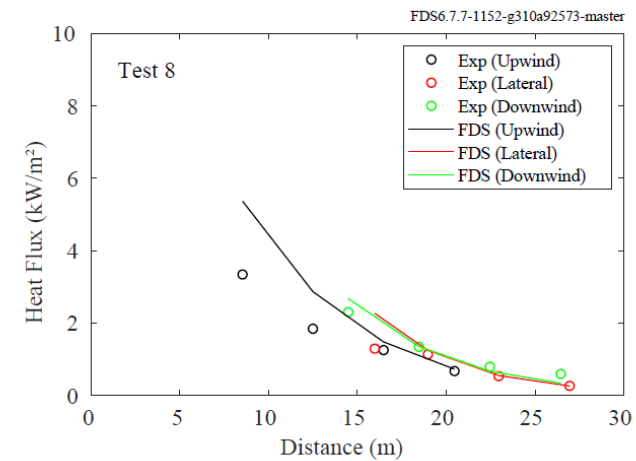
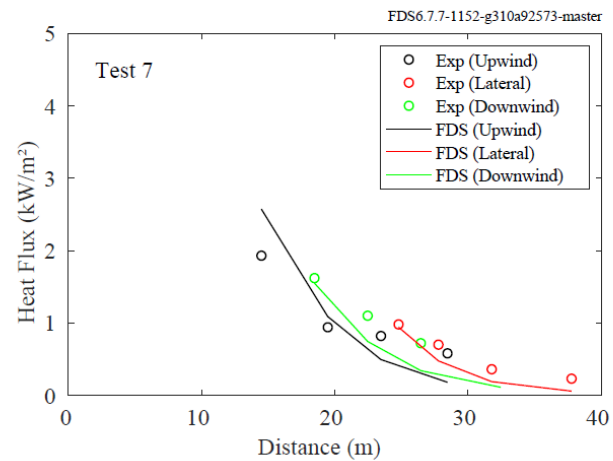
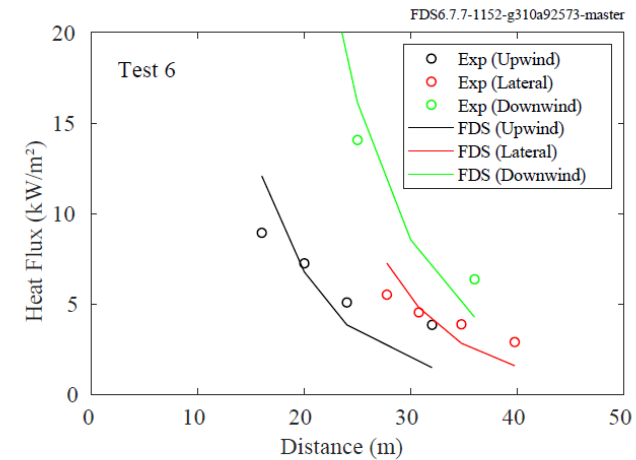
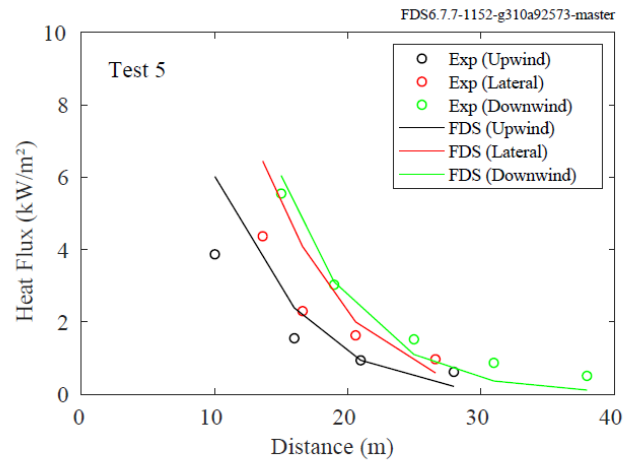
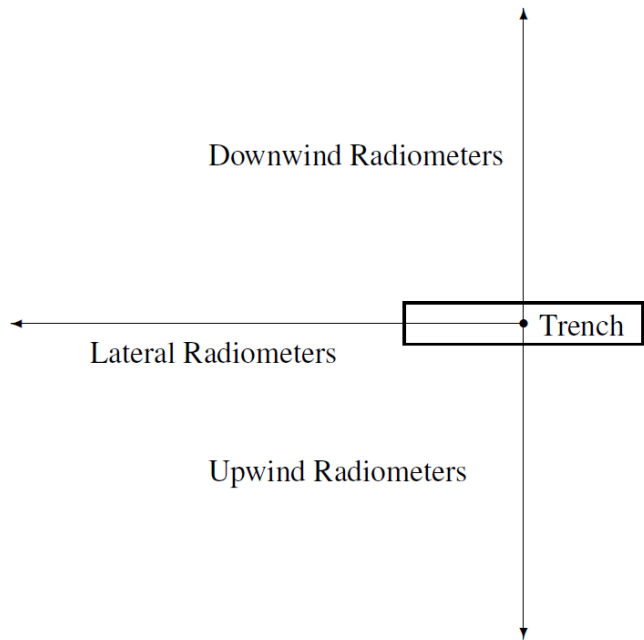
ADL Reference No. 88682

for

GAS RESEARCH INSTITUTE
Contract No. 5082-252-0719

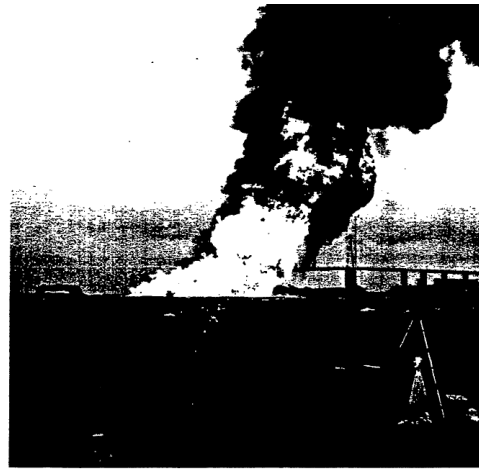
GRI Project Manager
Dr. Steve J. Wiersma
Manager, Safety Research

September 1984



Montoir LNG Fires (1987)

Three 35 m LNG pool fires conducted by British Gas, British Petroleum, Shell, Elf Aquitaine, Total CFP, and Gaz de France at the Montoir de Bretagne methane terminal.

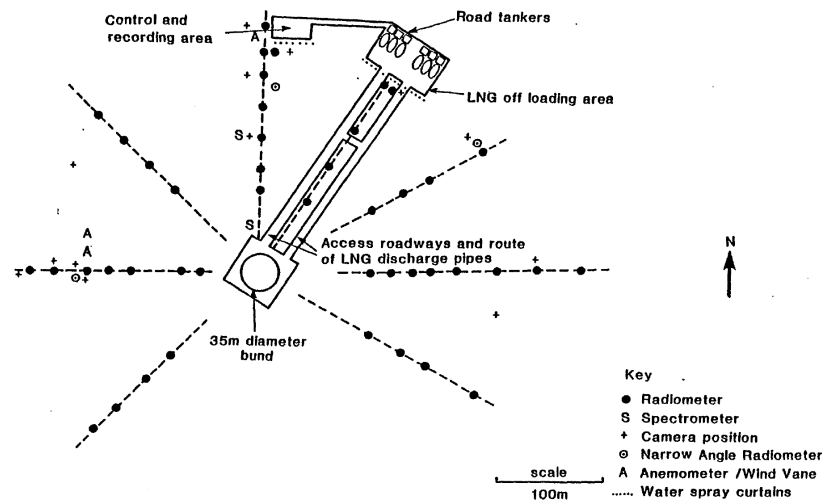


A. GENERAL CROSSWIND VIEW



Crosswind

Downwind



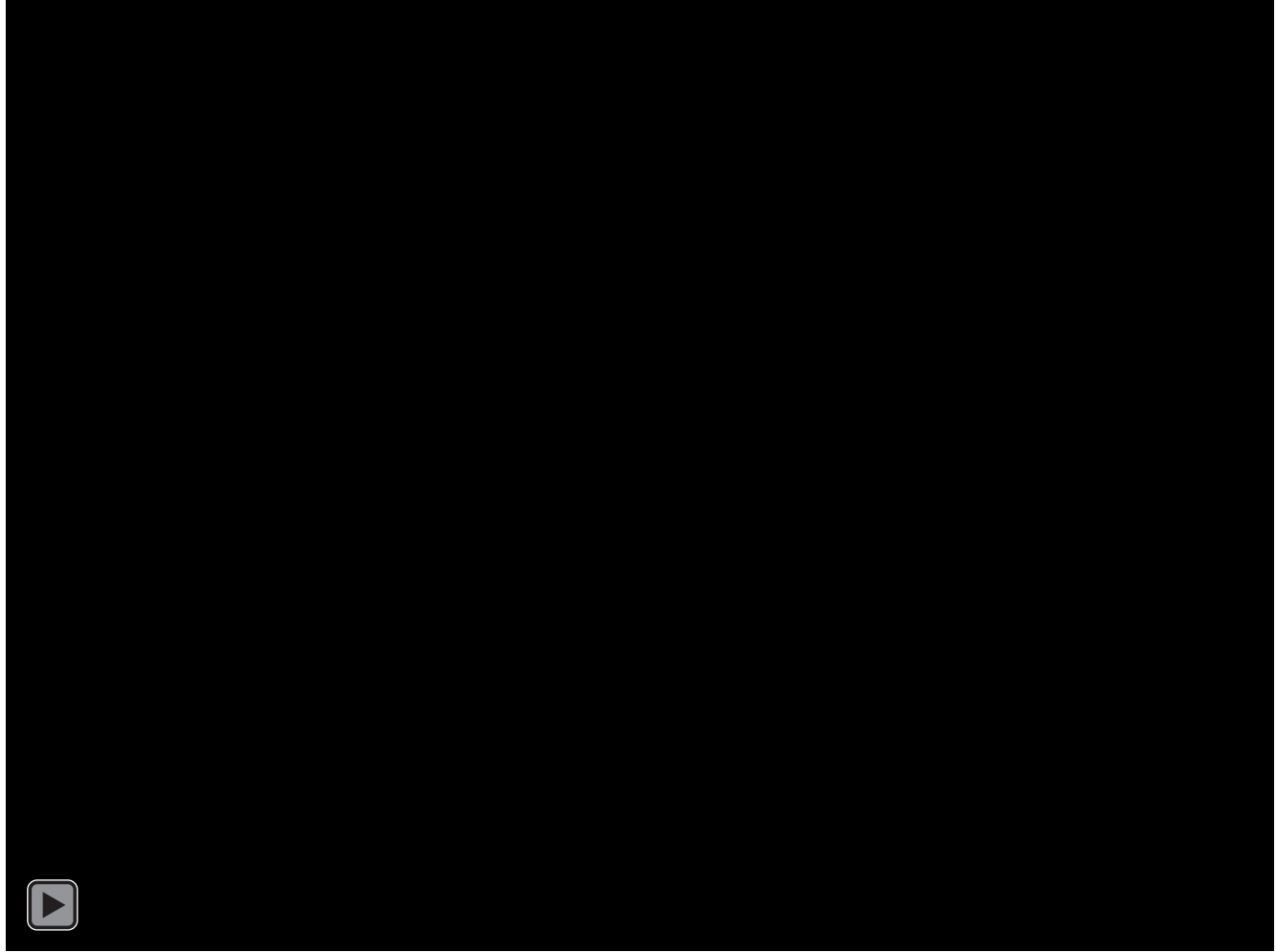
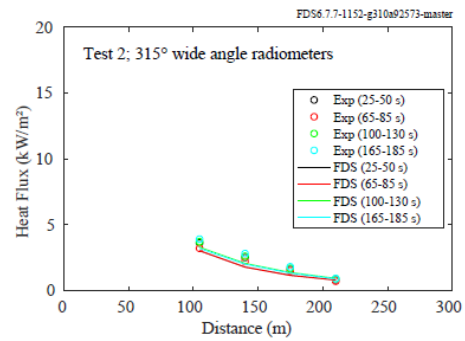
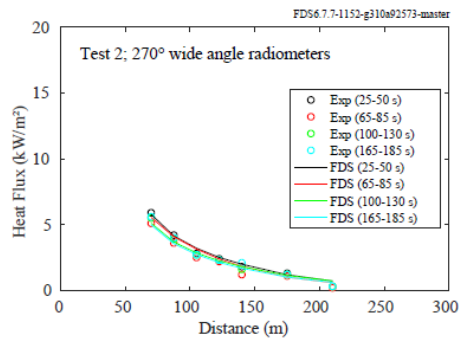
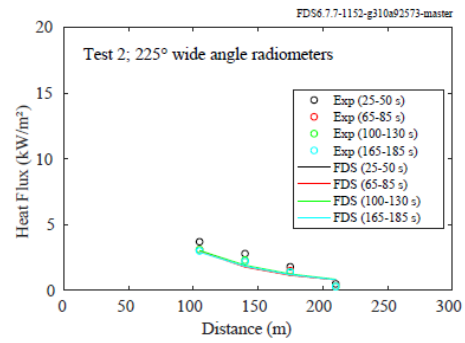
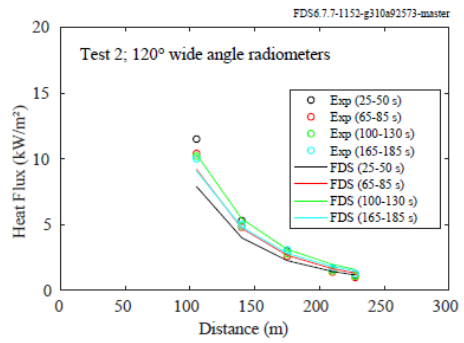
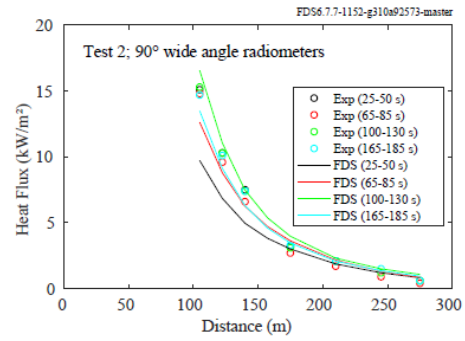
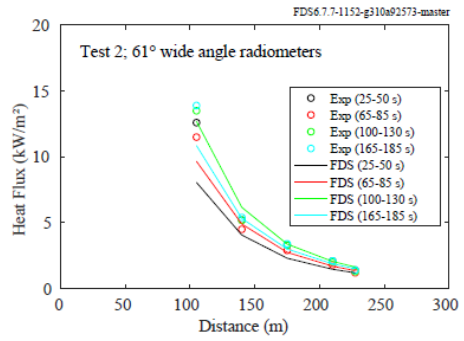
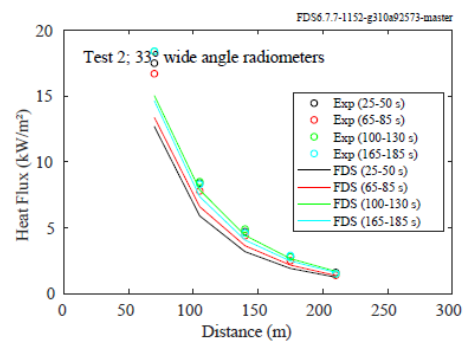
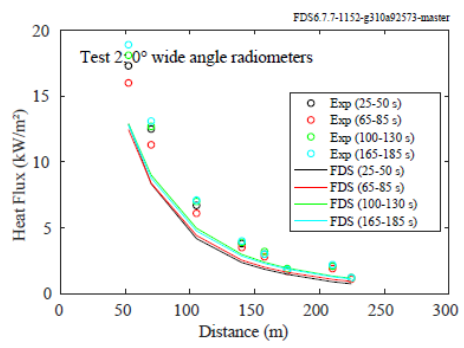
The Montoir 35m diameter LNG pool fire experiments

BY

Nedelka D.; Moorhouse J.; Tucker R.F.

Proceedings, 9th International Congress and Exposition of Liquefied Natural Gas, LNG9, Nice, 17-20 October 1989, Published, Institute of Gas Technology, Chicago, Volume 2, Pages III-3 1-23

1990



Shell LNG Fireballs

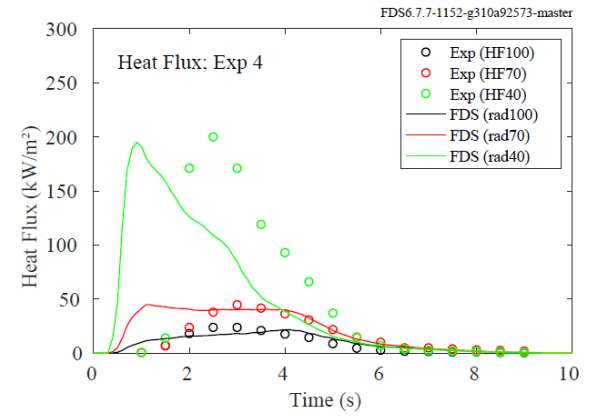
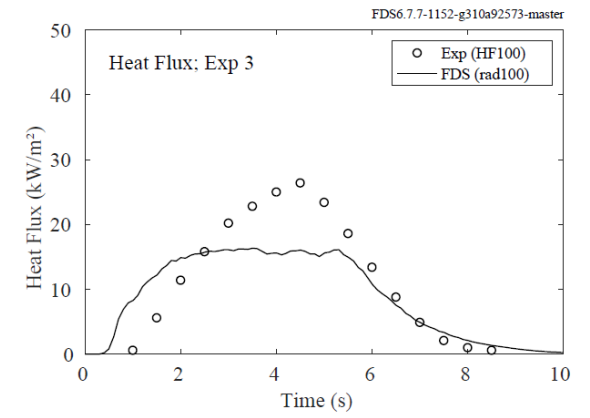
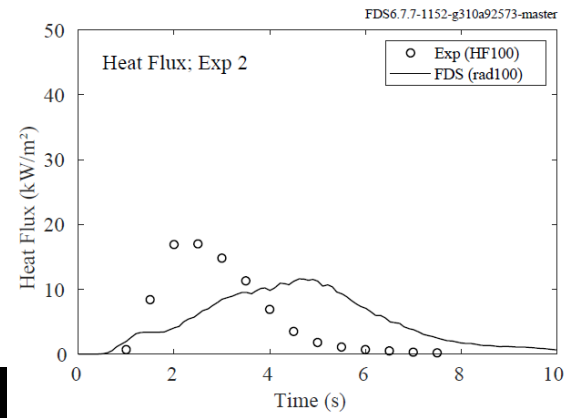
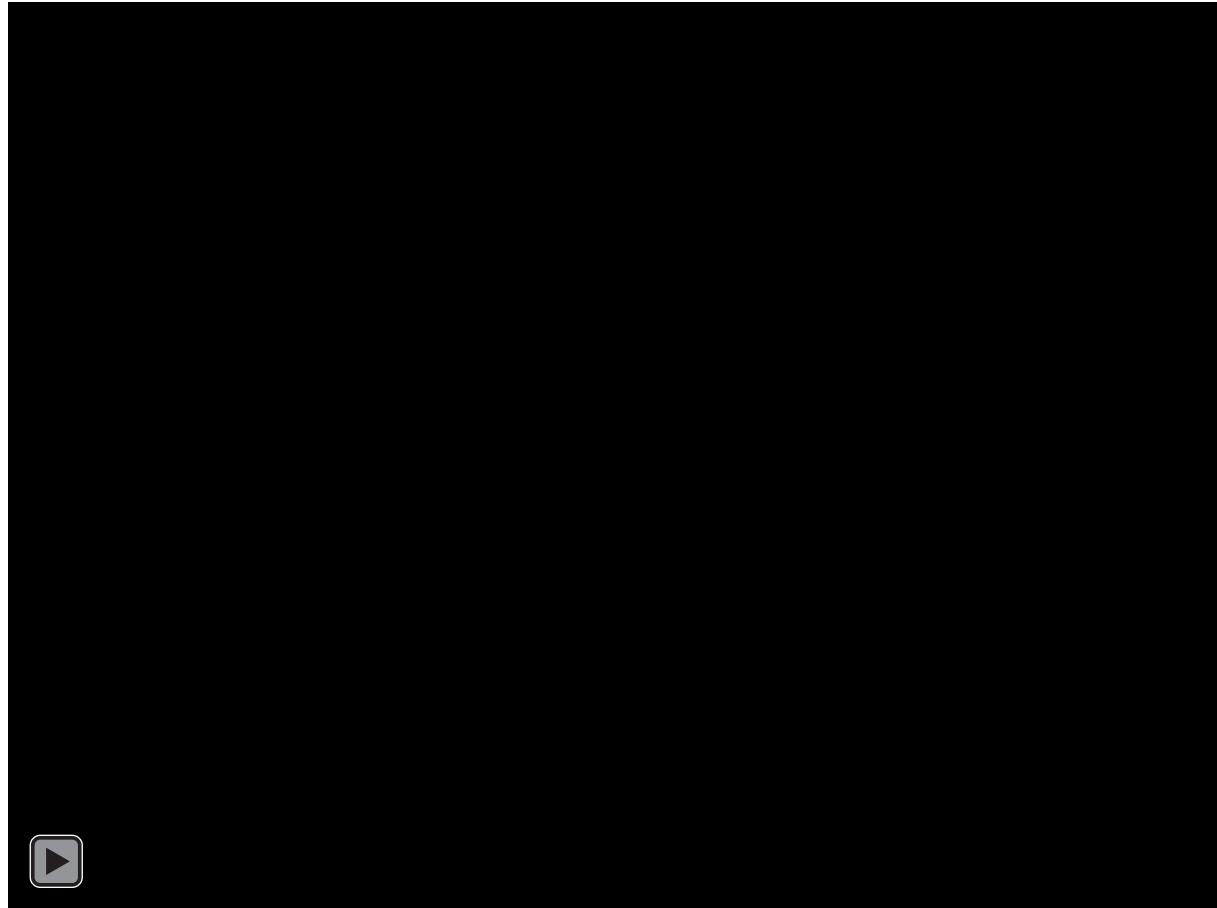
Source: S. Betteridge and L. Phillips. Large scale pressurized LNG BLEVE experiments. In *Proceedings of the 2015 AIChE Annual Meeting, Symposium Series No. 160*, New York, 2015. American Institute of Chemical Engineers.



Figure 4: Induced LNG BLEVEs three seconds after rupture of the 5 m³ vessels; Left - Experiment 2 (37% fill, 13 barg), Middle - experiment 3 (67% fill, 6 barg), Right - experiment 4 (69% fill, 13.6 barg).



Experiment #	Vessel Capacity (m ³)	Reservoir Pressure (barg)	Reservoir Temp (°C)	Final Fill Ratio	Calculated Release Mass (kg)
1	0.935	12.92	-120	66	247
2	5.055	13.01	-115	37	681
3	5.055	6.07	-131	67	1306
4	5.055	13.62	-115	69	1251



SANDIA REPORT

SAND2010-8676
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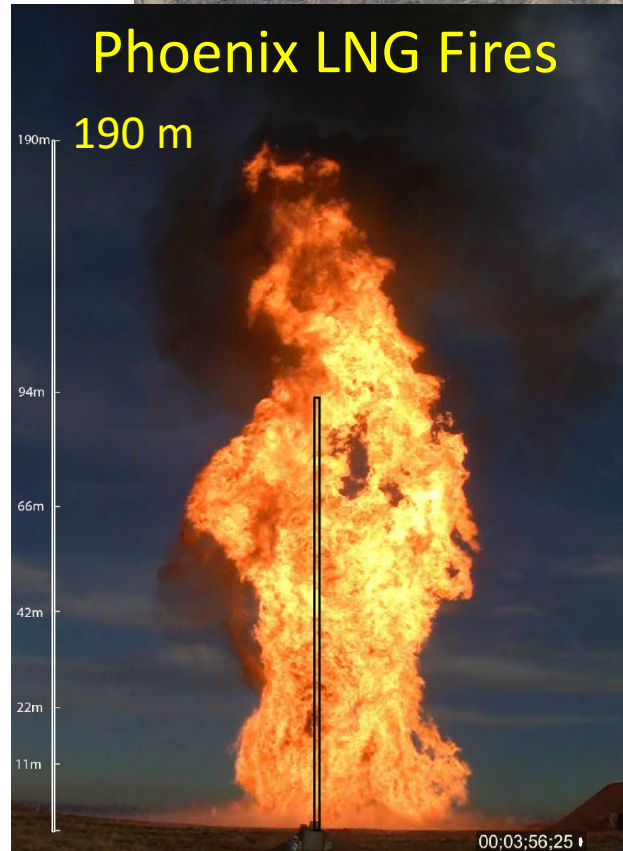
The Phoenix Series Large Scale LNG Pool Fire Experiments

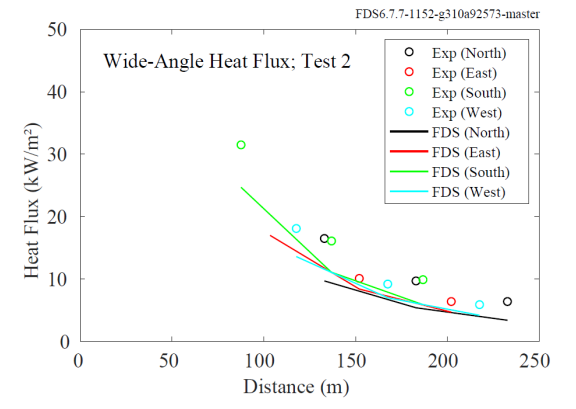
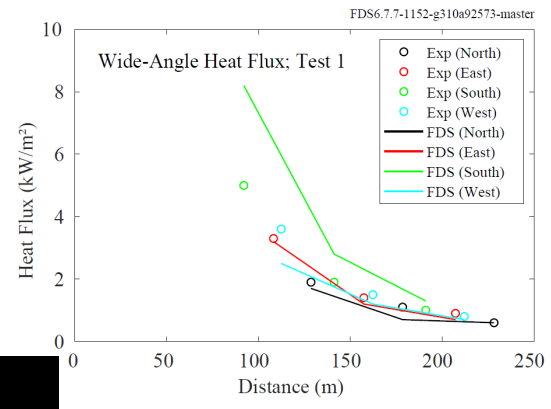
Thomas Blanchat, Paul Helmick, Richard Jensen, Anay Luketa, Regina Deola, Jill Suo-Anttila, Jeffery Mercier, Timothy Miller, Allen Ricks, Richard Simpson, Byron Demosthenous, Sheldon Tieszen, and Michael Hightower



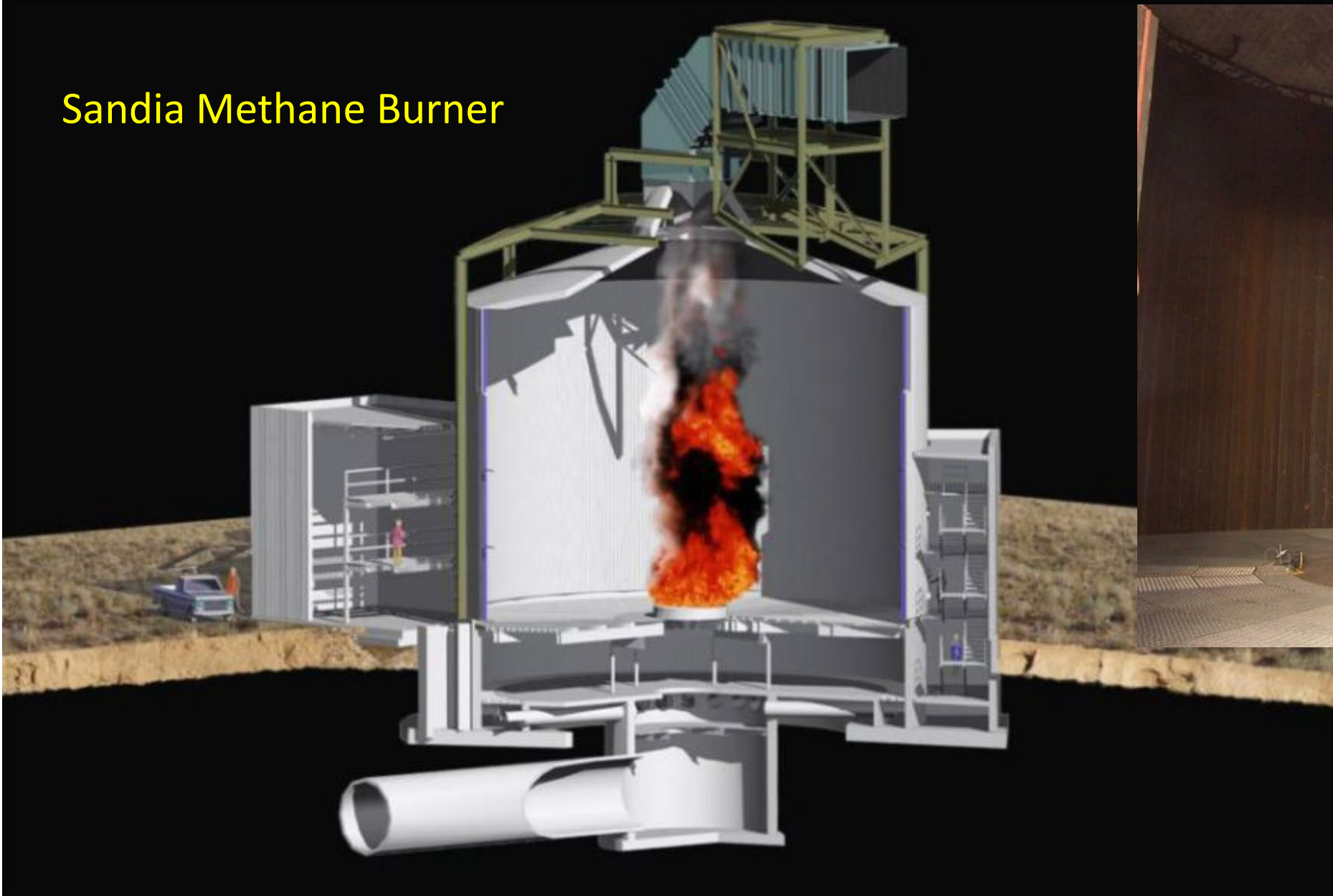
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Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.



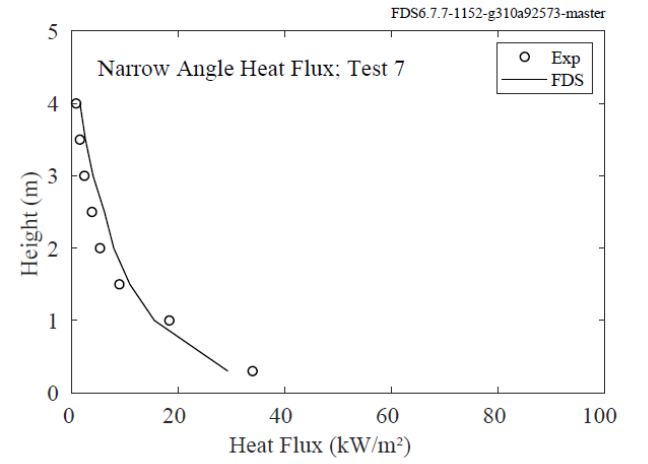
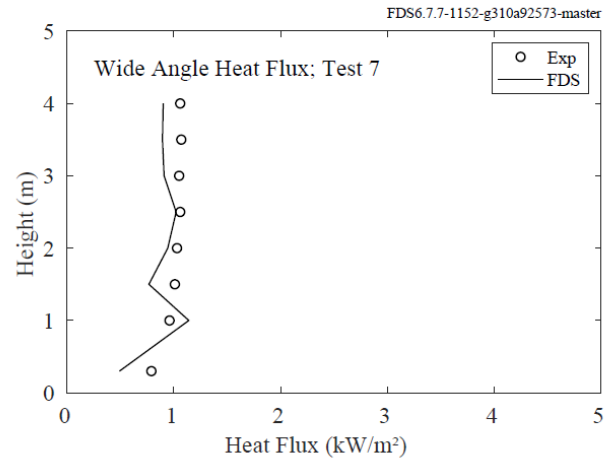
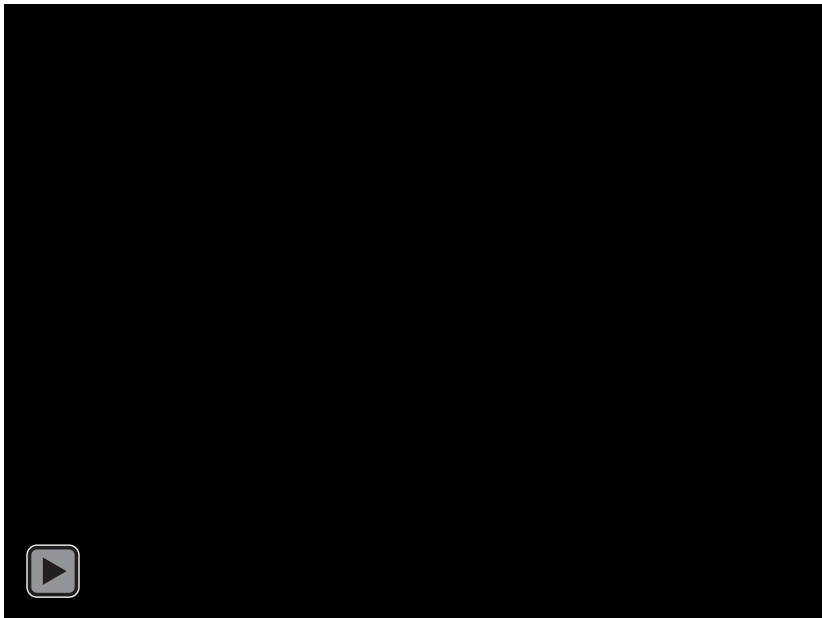
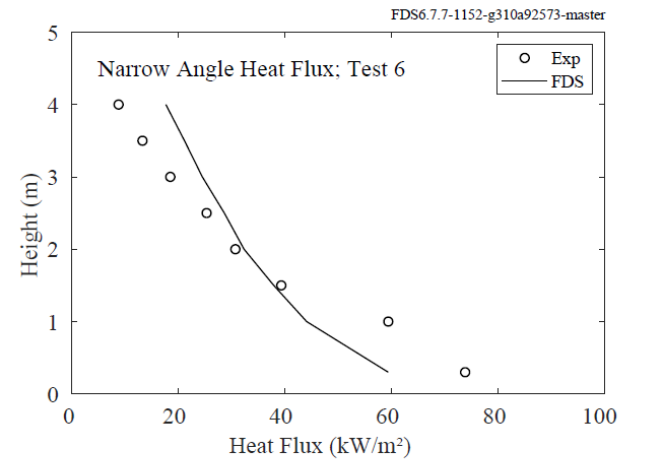
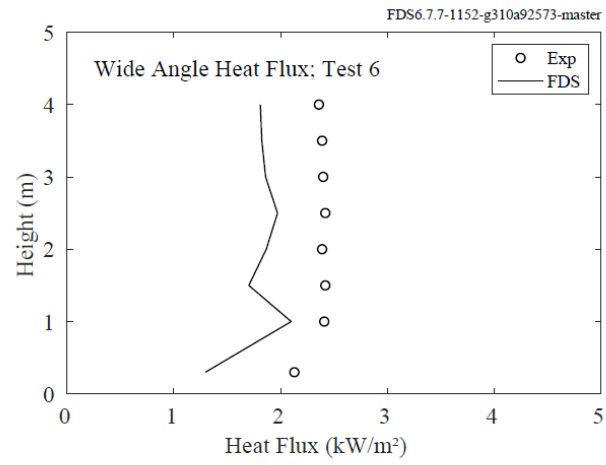
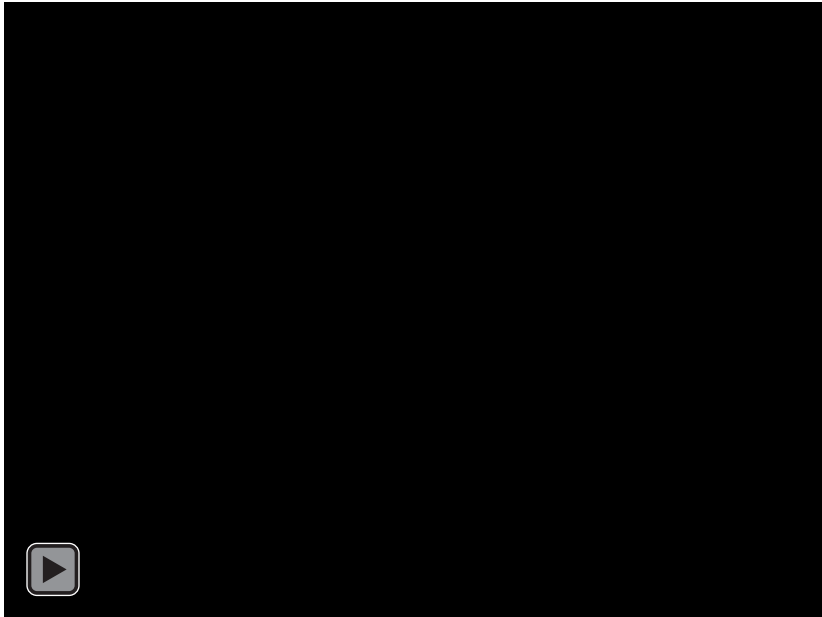


Sandia Methane Burner



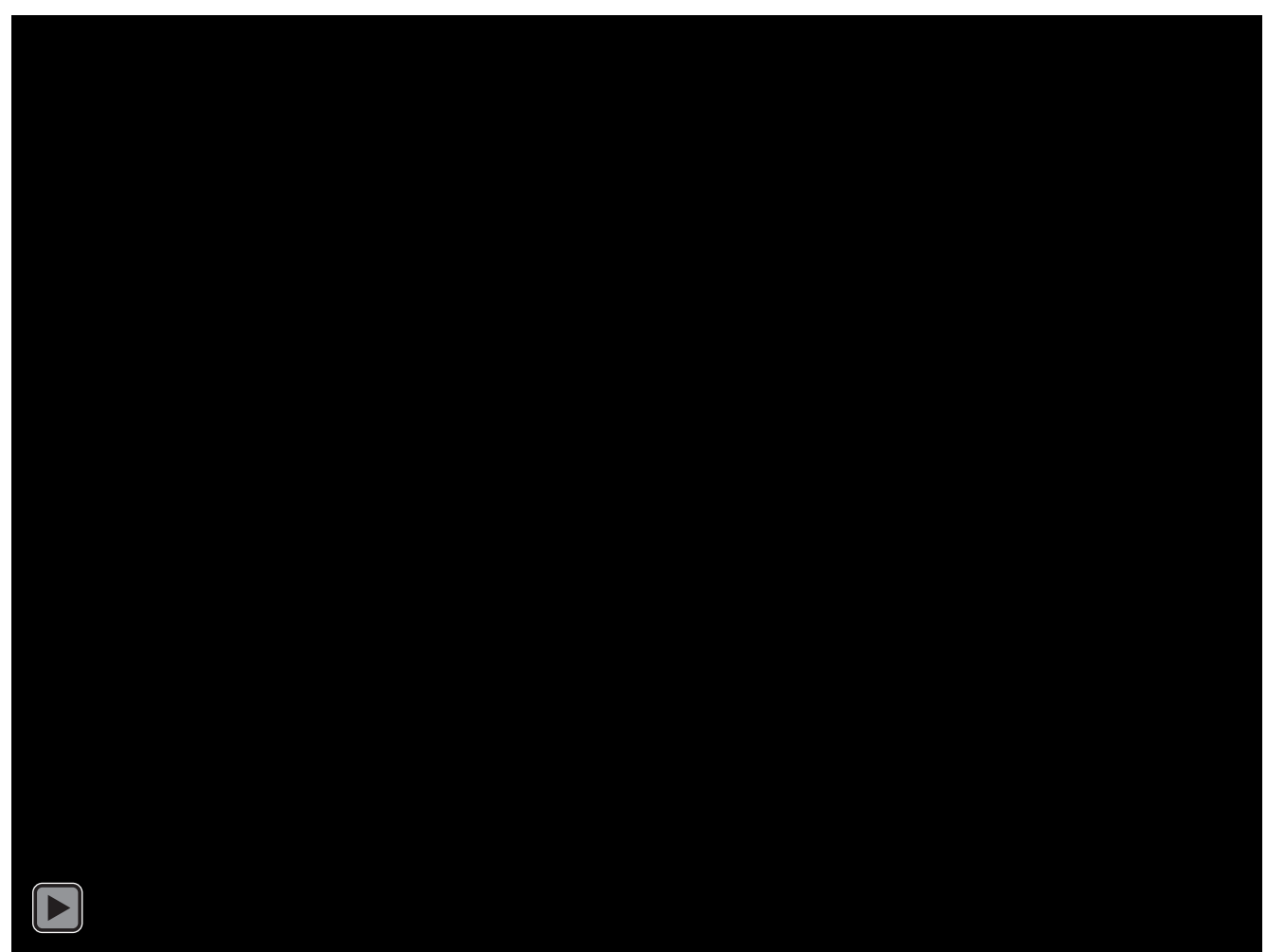
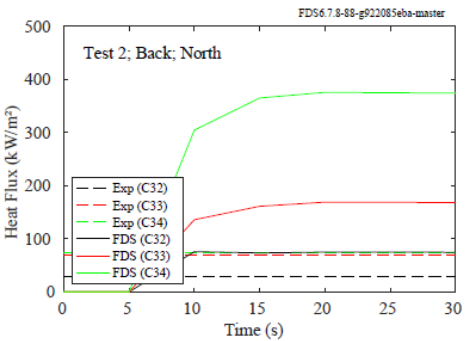
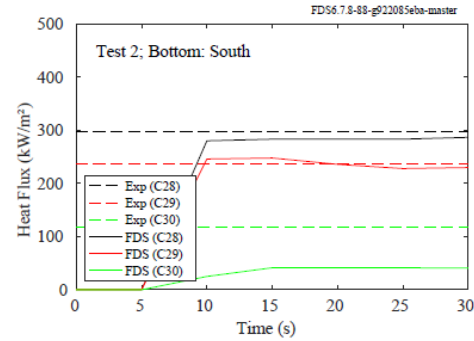
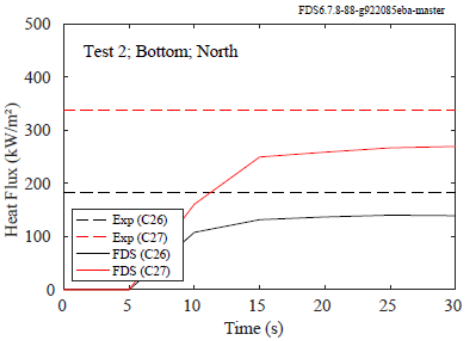
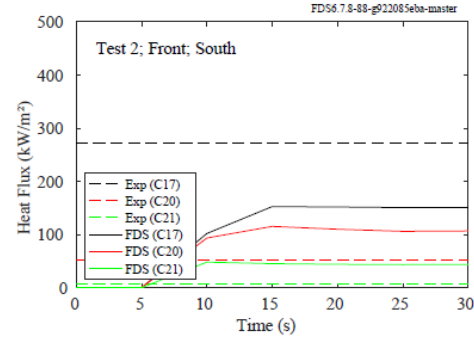
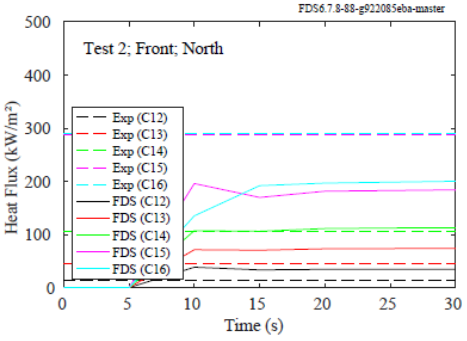
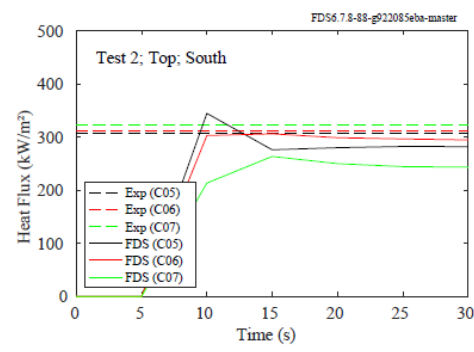
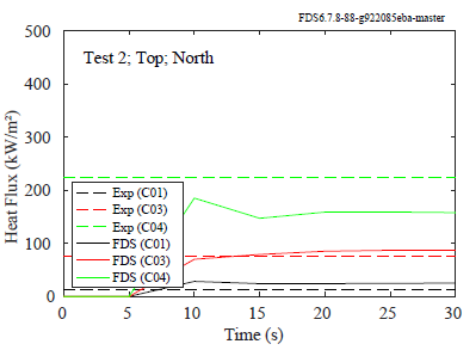
3 m diameter burner

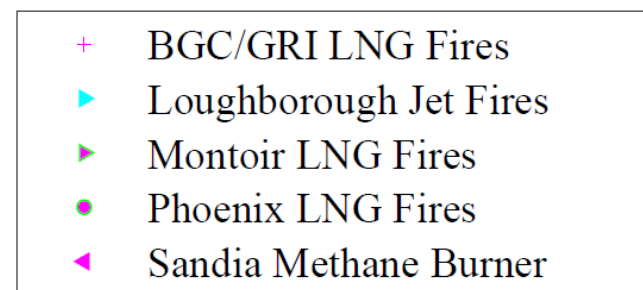
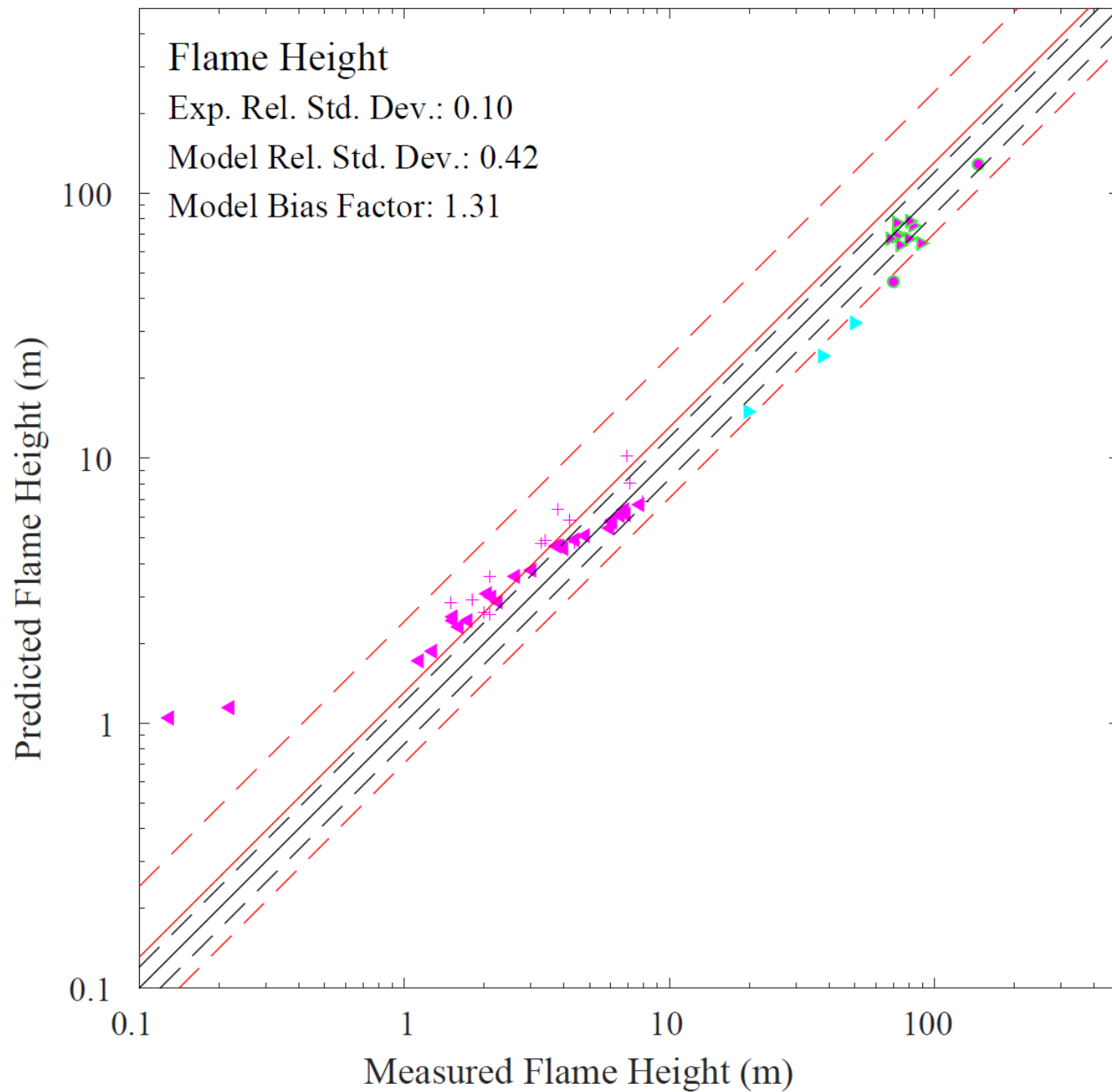
Sandia National Laboratories, Fire Laboratory for Accreditation of Models and Experiments (FLAME) / Radiant Heat

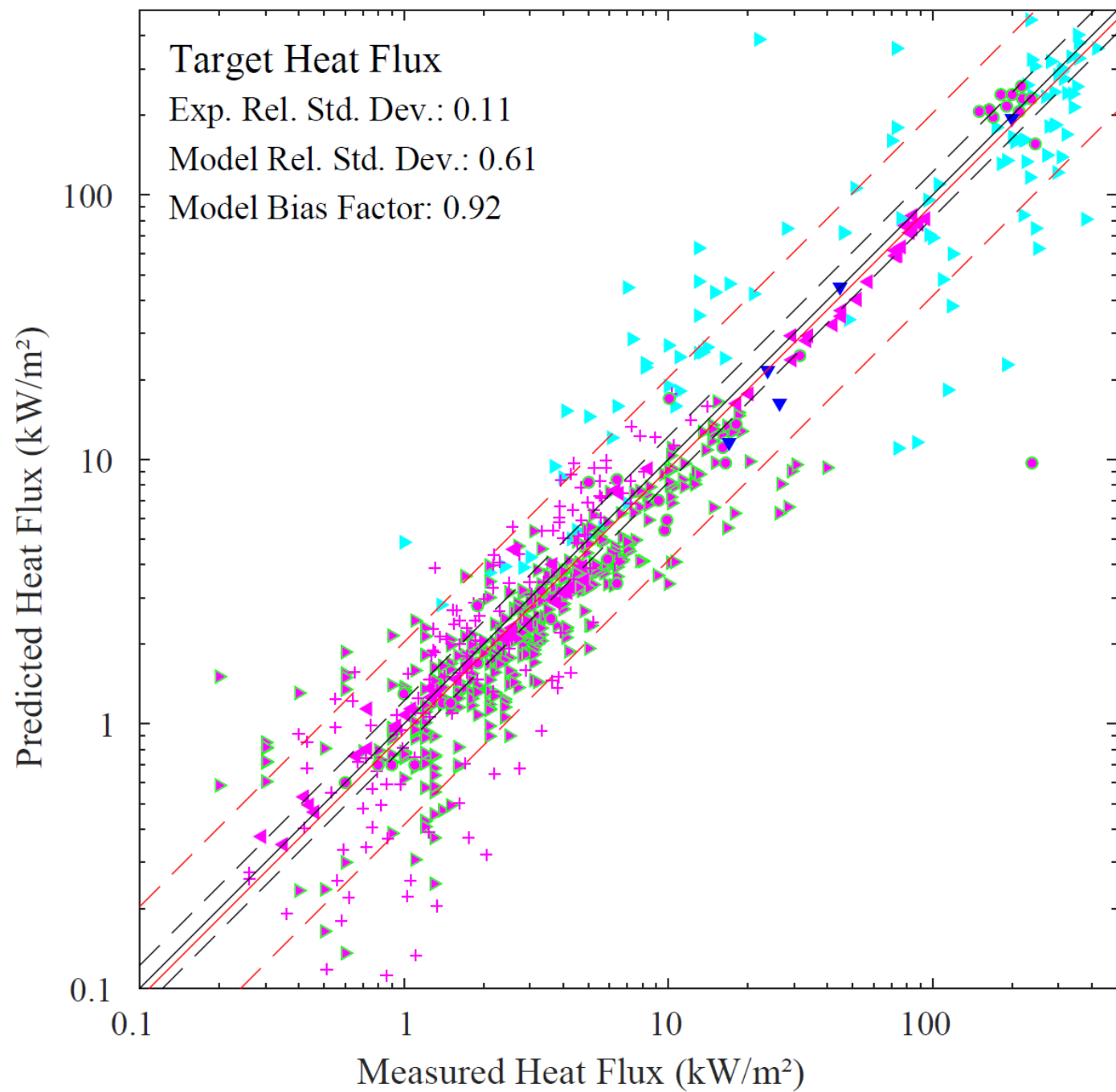


Loughborough Jet Fires









- + BGC/GRI LNG Fires
- ▶ Loughborough Jet Fires
- ▶ Montoir LNG Fires
- Phoenix LNG Fires
- ◀ Sandia Methane Burner
- ▼ Shell LNG Fireballs