A Wind Shielded Fire Test Facility[1]

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INTRODUCTION

Sandia National Laboratories[1] has utilized pool fires to subject military components and radioactive material shipping containers to postulated transportation accident environments for over thirty years. Because these are usually very high value items, there is typically a single fire test. Because wind produces the biggest, uncontrollable effect on the thermal environment of open pool fires, there is a risk of an invalid test if winds develop during the test. For example, IAEA regulations specify the average speed must be less than 2 m/s.

To reduce weather related risks during small fire tests, several wind shielded test facilities have been developed. In developing these facilities, it was necessary to demonstrate that they closely simulated the environment in a large open pool fire.

Recently, a project was undertaken to develop a new facility that could reproduce the thermal environment of an open pool fire and comply with air quality regulations. The design of the facility is based on a scale-up of an existing facility that was used to develop methods for reducing emissions while maintaining the appropriate thermal conditions.

THERMAL CONDITIONS AND EMISSIONS REDUCTION

A number of tests have been run using a 1.8 m circular pool in a wind shielded facility (10th Scale Facility) to define the thermal environment for comparison with extensive data from tests conducted at Sandia in a 9 m x 18 m open pool. The walls of the 10th Scale Facility are water spray cooled to provide an appropriate boundary condition for radiative heat loss from the flames to the surroundings. Air flow into the chamber is controlled by variable speed fans. The air flow is set at a level that provides the proper test conditions while reducing the visible emissions from the facility.

Figure 1 shows average values of temperature measurements made in fires in the 10th Scale Facility and the 9m x 18m open pool. The temperature measurements were made with 1.6 mm OD, Inconel sheathed thermocouples mounted on towers in the fires. Figure 2 shows a typical

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[1] Sandia National Laboratories is operated by AT&T Technologies for the United States Department of Energy under Contract No. DE-AC04-76DP00789.

temperature measurement in the 10th Scale Facility. Figure 3 shows a typical measurement in an open pool fire; note the large standard deviation which is a result of wind induced fluctuations.

Figure 4 shows average values of heat flux measurements made in fires in the 10th Scale Facility and the 9m x 18m open pool. The heat flux measurements were made with 10 cm OD, thick walled steel calorimeters. By eliminating wind effects, the heat flux levels in the 10th Scale Facility are achieved with a flame thickness of less than one meter.

Overall, comparisons of a large number of temperature and heat flux measurements made in the two facilities show that the thermal conditions are similar. Additional detail on the open pool measurements is given in Bainbridge and Keltner 1988, Gregory et al. 1987, Gregory et al. 1989, Schneider et al. 1989, and Schneider and Kent 1989.

Emissions from the facility were reduced by improving the 3-T's; that is the time, temperature, and turbulence. The residence time was increased by adding a 4.3 m stack to the existing structure. The temperature was raised by reducing the air supply to the fire and insulating the stack. The turbulence was increased by installing baffles in the stack.

Smoke readings were made in order to qualify the 10th Scale Facility in accordance with local air quality regulations. Initial readings showed that the opacity at the stack exit was 100% prior to the facility modifications. Readings taken during the final qualification test showed opacity levels as low as 5% with an average value of 15%.

FACILITY DESIGN

The new facility has a 3 m x 3 m pool centered in the floor of a "cubical" test chamber that is approximately 6 m on a side. A sketch of the facility is shown in Figure 5. The walls of the chamber are water cooled to provide an appropriate boundary condition for radiative heat loss from the flames and control the temperature in the flames. Air flow into the chamber is controlled by four variable speed fans.

Control of the facility and data acquisition will be handled by a minicomputer based system with a total capacity of 140 channels of thermocouples and high level signals. Instrumentation or visual access to the test unit can be provided from a tunnel under the pool floor. There are observation ports in the walls of the facility to provide for viewing of the test unit, for real time or flash radiography, or for optical instrumentation.

SUMMARY

Construction of a new enclosed pool fire test facility is nearly complete. It is designed to provide the thermal environment of a large open pool fire and to meet air quality requirements. After startup, qualification, and calibration it will provide a unique capability for testing shipping containers with a very low risk of weather invalidating the test.

REFERENCES

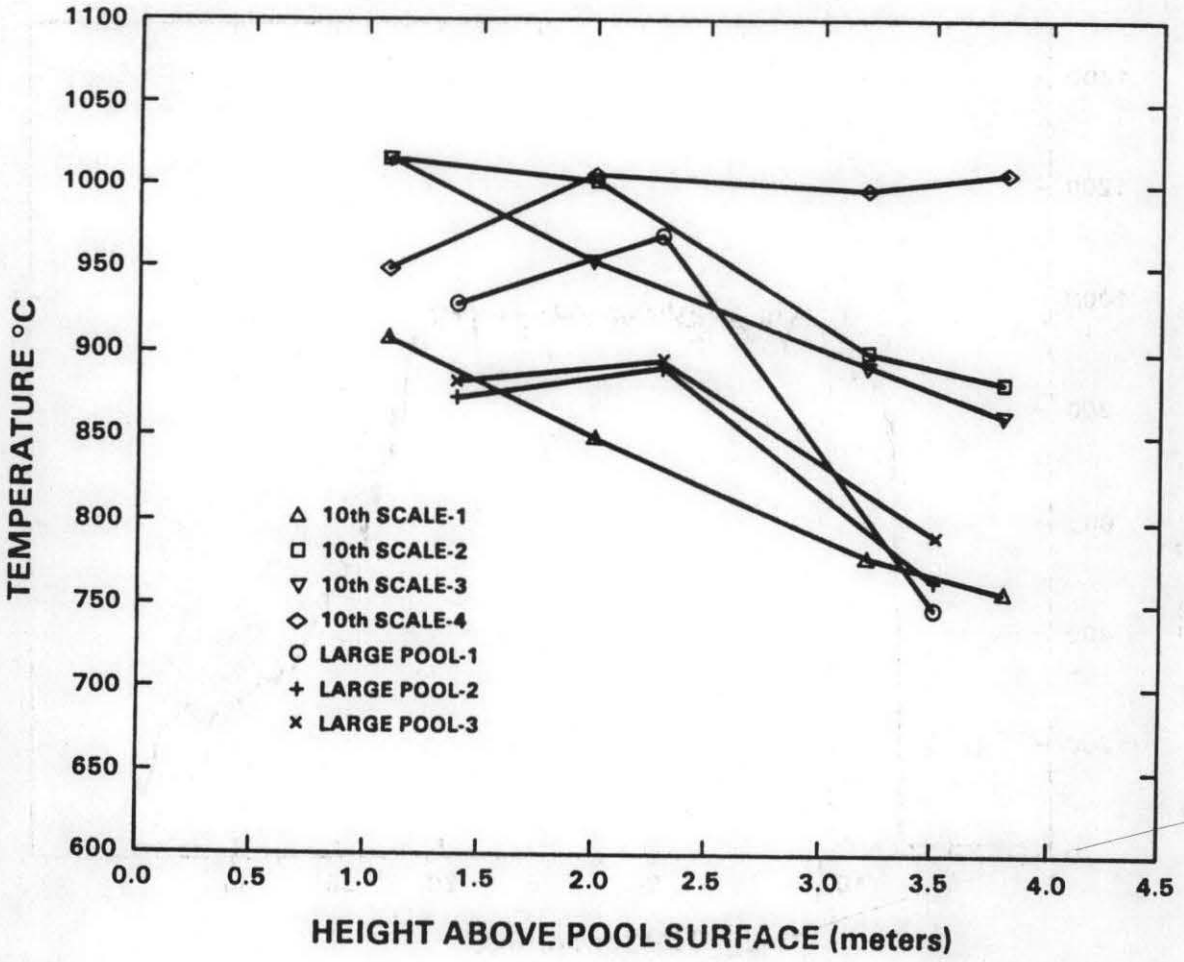
Bainbridge, B.L. and N.R. Keltner, "Heat Transfer to Large Objects in Large Pool Fires", Journal of Hazardous Materials, Vol. 20, 1988, pp. 21-40.

Gregory, J.J., R. Mata Jr., N.R. Keltner, "Thermal Measurements in a Series of Large Pool Fires", Sandia National Laboratories, SAND85-0196, Albuquerque, NM, August, 1987.

Gregory, J.J., N.R. Keltner, R. Mata Jr., "Thermal Measurements in Large Pool Fires", Heat and Mass Transfer in Fires, Journal of Heat Transfer, Vol. 111, No. 2, May, 1989, pp. 446-454.

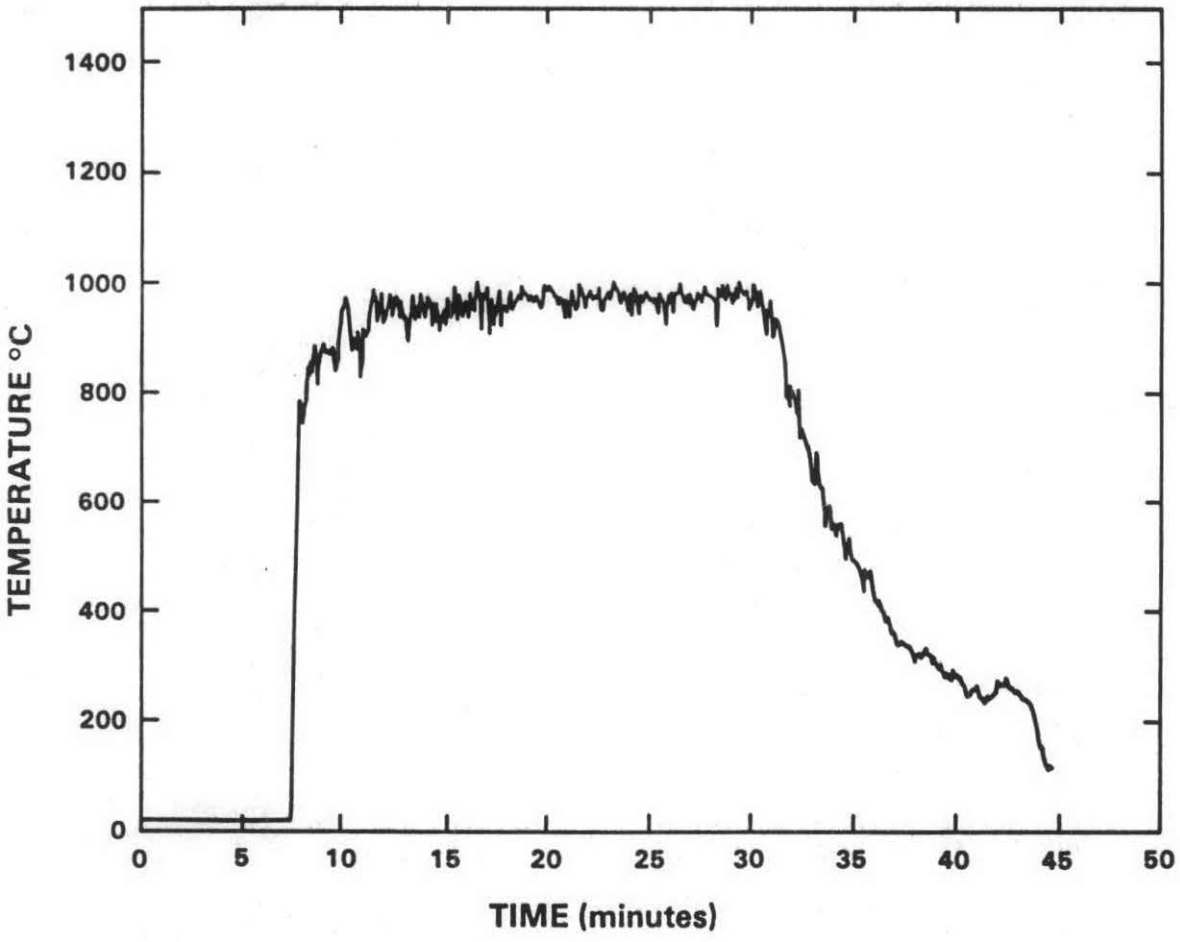
Schneider, M.E., N.R. Keltner, and L.A. Kent, "Thermal Measurements in the Nuclear Winter Fire Test", Sandia National Laboratories, SAND88-2839, Albuquerque, NM, January, 1989.

Schneider, M.E. and L.A. Kent, "Measurements of Gas Velocities and Temperatures in a Large Open Pool Fire", Fire Technology, Vol. 25, No. 1, February, 1989, pp. 51-80.



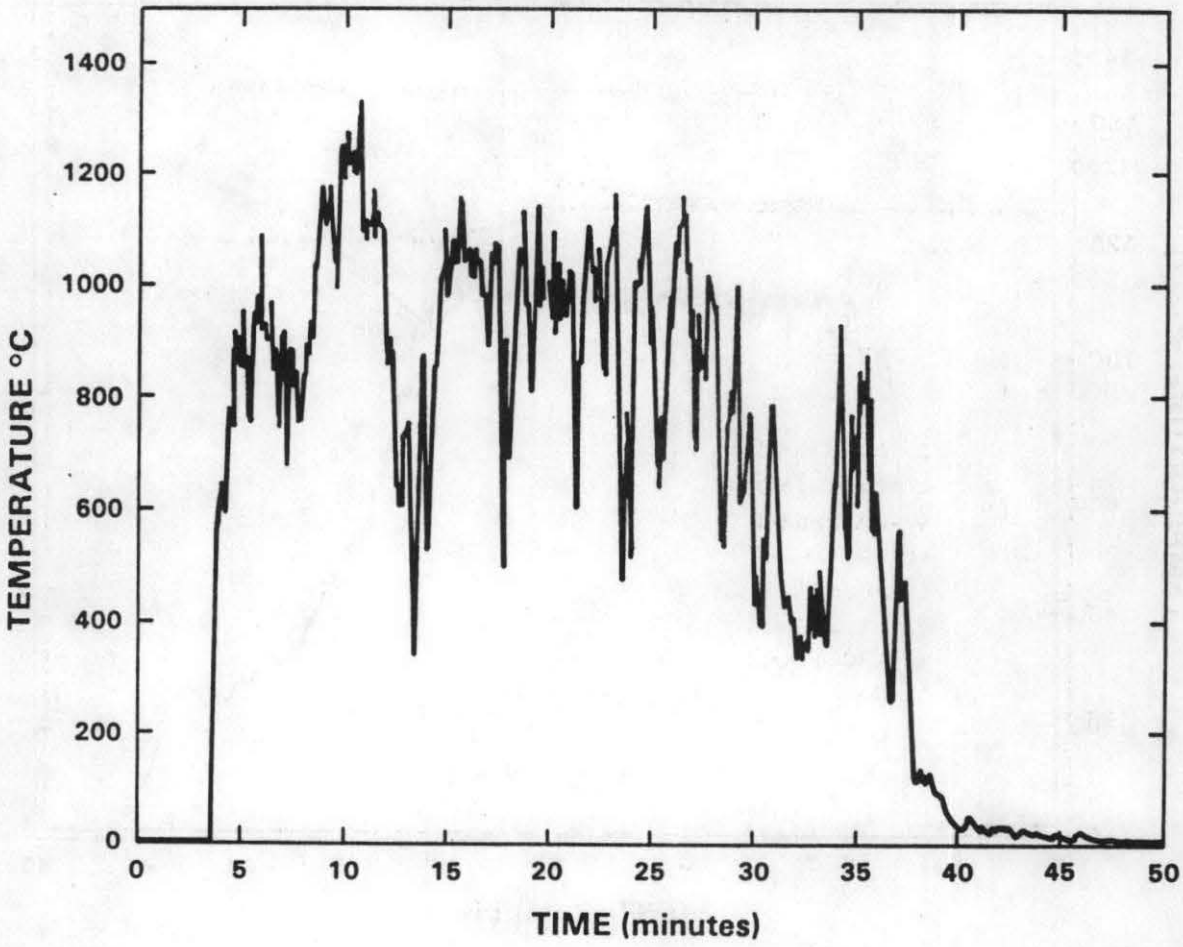
Average Temperatures in the 10th Scale Facility and the 9 meter x 18 meter Open Pool Facility

FIGURE 1



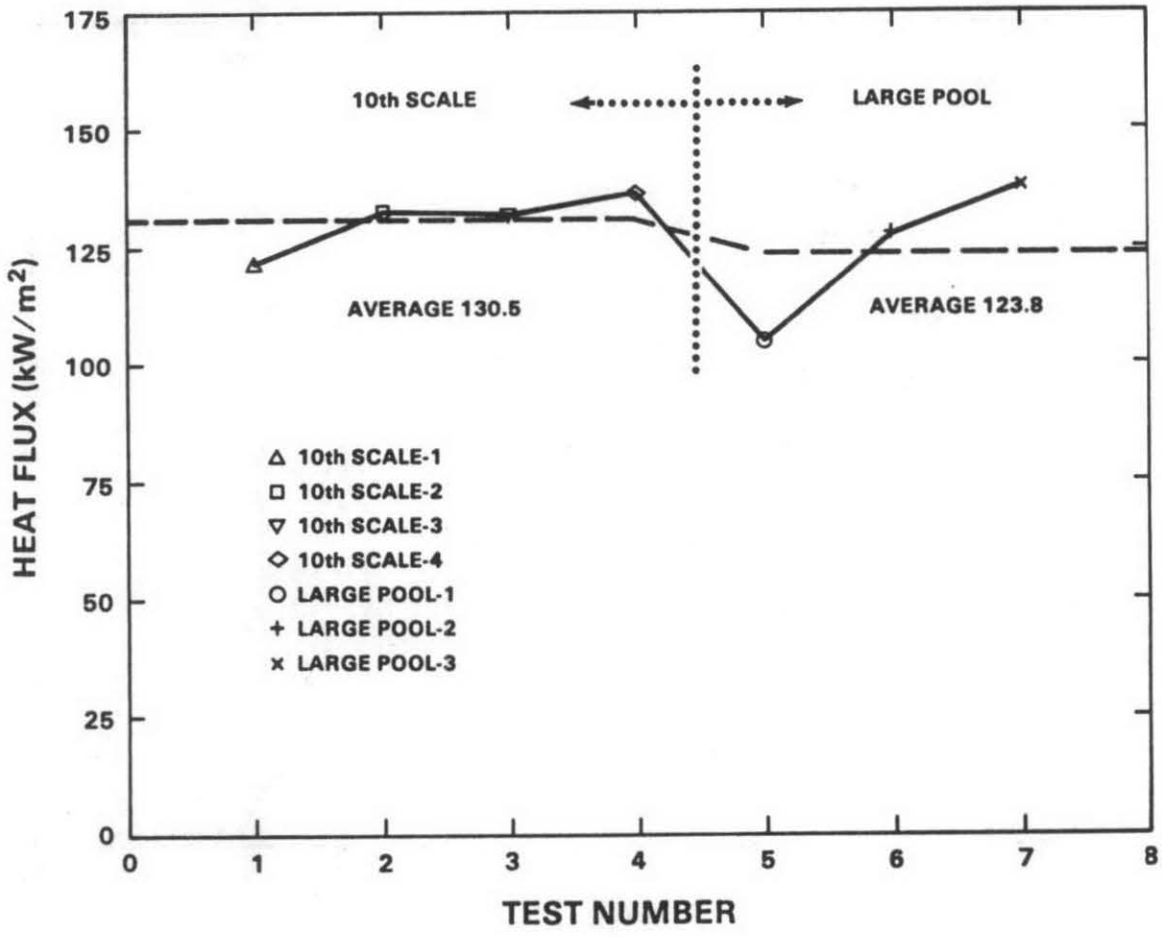
Temperature History at 3.2 meters During a Test in the 10th Scale (Wind Shielded Facility) Average: 954°C, Standard Deviation: 17°C

FIGURE 2



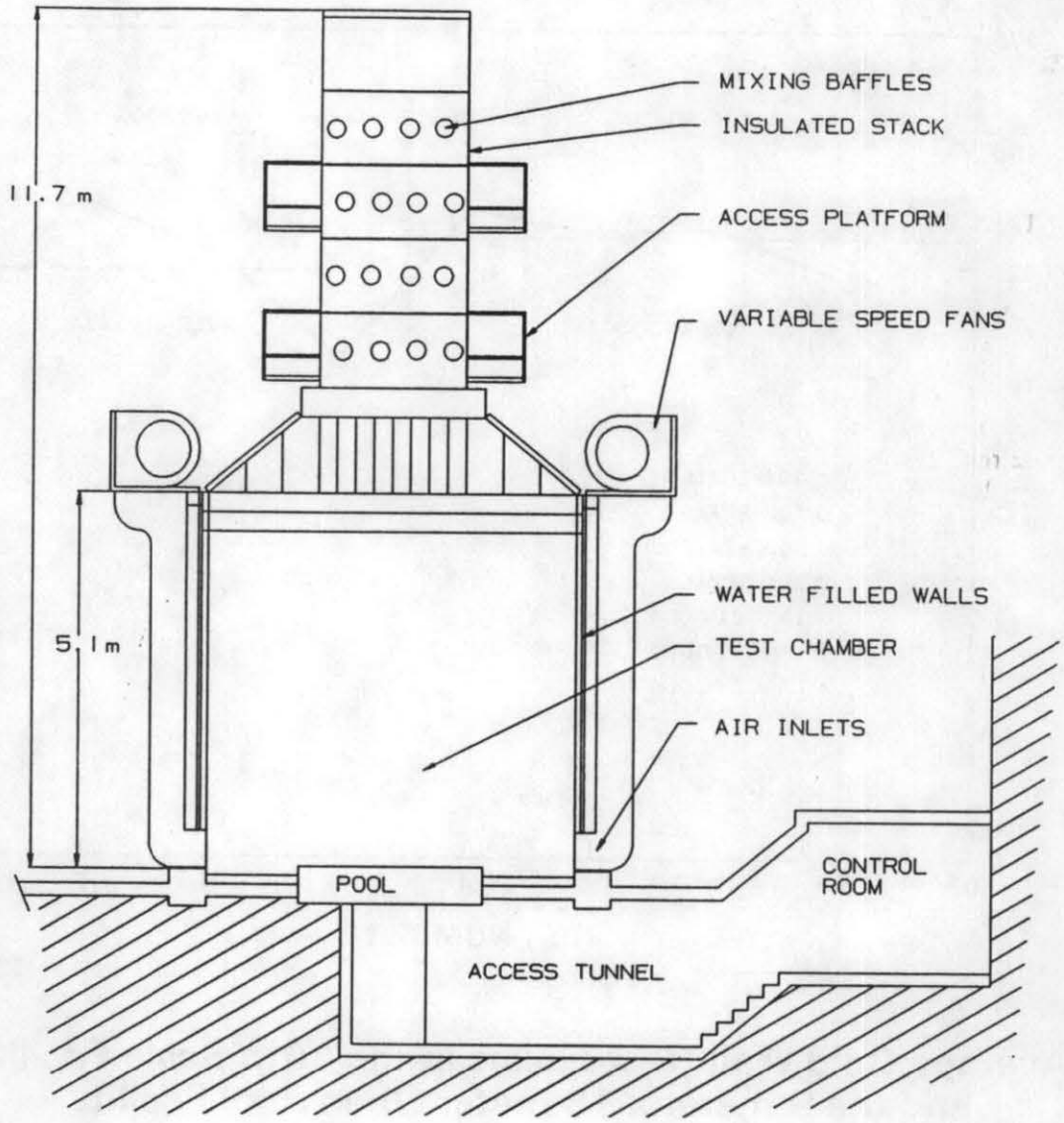
Temperature History at 3.4 meters During a Large Pool Fire (note wind induced fluctuations) Average: 873°C, Standard Deviation: 227°C

FIGURE 3



Average Cold Wall Heat Fluxes in the 10th Scale Facility and the 9 meter x 18 meter Open Pool Facility

FIGURE 4



Cross-Sectional View of the New Facility

FIGURE 5