



SFPE STANDARDS-MAKING COMMITTEE ON CALCULATING FIRE EXPOSURES

Local Fire Exposures Working Group

Meeting Report -- June 29, 2016

Present: Ulf Wickström (Working Group Leader), Jonathan Barnett, Sean Hunt, Venkatesh Kodur, Craig Beyler (Committee Chair) and Chris Jelenewicz (Staff).

The following was discussed:

1. **Overview of mission** – The Local Fire Exposure Working group will review and consider expanding local fire exposure to include a wider range of conditions. Review available data in consideration of developing a database of results for method comparison. Review the current incident heat flux representation of the potential for heating the structure and seek to bring into line with the SFPE Standard 2 representation of the heat transfer boundary condition.
2. **Sub-Task 1, expressing boundary conditions** – The working group will look at how radiation temperature, gas temperature, adiabatic surface temperature, heat flux are defined in regards expressing boundary conditions to local fire exposures to ensure accuracy of the methodology.

It was noted that when compared to compartment fires, the difference between gas temperature & radiation temperature can make a difference in the accuracy of calculation.

The Eurocode methodology underestimates heat emitted from the surface. It was noted that heat transfer should be expressed by three independent terms:

Absorbed energy -- $\alpha_s \dot{q}_{inc} = \alpha_s \sigma T_r^4$
(where T_r is the radiation temperature)

Energy emitted by radiation -- $\varepsilon_s \sigma T_s^4$

Convection (difference between gas and surface temperature) -- $\dot{q}_{con} = h (T_g - T_s)$

That is -- $q = \varepsilon_s \dot{q}_{inc} - \varepsilon_s \sigma T_s^4 + h(T_g - T_s) = \varepsilon_s \sigma (T_r^4 - T_s^4) + h(T_g - T_s)$

as $\alpha_s = \varepsilon_s$

In a local fire the incident radiation may depend on flame temperature and flame emissivity and flame-surface view-factor as

$$\dot{q}_{inc} = \varepsilon_{fl} F \sigma T_{fl}^4$$

Then

$$q = \varepsilon_s \dot{q}_{inc} - \varepsilon_s \sigma T_s^4 + h(T_g - T_s) = \varepsilon_s \varepsilon_{fl} F \sigma T_{fl}^4 - \varepsilon_s \sigma T_s^4 + h(T_g - T_s)$$

Notice here that the emitted heat (second term) is independent on reduction coefficients ε_{fl} and F . In for example the Eurocode 1993-1-2 this not the case which reduces the emitted heat and thereby increases calculated temperature sometimes considerably.

It was also noted that thermocouples will not accurately estimate temperature as they will measure something in between gas temperature and radiation temperature, near the gas temperature. Plate thermometers are more accurate on measuring adiabatic surface temperature (also in between gas temperature and radiation temperature but closer to the radiation temperature) and better suited as input for calculating heat transfer by radiation and convection to fire-exposed surfaces.

Ulf will develop a first draft on how to express boundary conditions and send to the rest of working group to review.

- 3. Sub-Task 2, Local fires, Available formulas** – It was agreed that the working group will look at available data and calculation models, including the models in the existing standard and the methodology used in the Eurocode. The working group will also review Chapter 25 in the 5th edition of the SFPE Handbook (Heat Transfer to Fire from Surfaces) by Brian Lattimer. Venkatesh will work with Sean on this effort.
- 4. Sub-Task 3, Façade fires, Available formulas** – The working group will investigate if any data and methods are available for estimating façade fires. This may be too big a task for the working group as there are numerous construction configurations related to facades and there may be a lack of relevant data. The working group will also look at the methodology developed by Margaret Law and the Eurocode. Jonathan will investigate.
- 5. General discussions** – There was a discussion on including information about CFD models and if additional data is needed for the existing database in regards to local fire exposures. It was agreed that at this time the working group will focus on completing Sub-Tasks 1, 2 and 3. These other issues will be discussed at a later date.

6. **Timeline/Next meeting** – The next working group meeting will be held in mid-September. CJ will schedule the next meeting via a Doodle Poll and will not forget that Jonathon lives in Australia.

End of Report