High heat flux jet fire testing at SP Fire Research, Norway

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Jet fires represent a major safety risk both in offshore and onshore installations, as well as in other industries where ignitable gases are stored or transported at pressure. For sufficient fire safety in the oil and gas industry, the availability of robust and relevant methods for fire testing and evaluating new, as well as already installed and modified, products and materials are critical. SP Fire Research is, and aims to continue being, in the forefront when it comes to development of relevant test methods for the offshore industry.

Figure 1. High heat flux jet fire test according to ISO 22899-1 with modifications.

The current jet fire standard, ISO 22899

Today's standardized jet fire test, *ISO 22899,* aims to simulate thermal and mechanical impact by large scale jet fires resulting from pressurized releases of gas or fuel, at the most severe combination of erosive forces and heat transfer. The experimental setup described in ISO 22899-1 is sufficient to indicate the performance of many passive fire protection materials or unprotected objects at a certain range of jet fire exposure levels. However, there are limitations to the level of heat loads that can be achieved. The test standard is used for requirements of resistance towards jet fires at 250 kW/m^2, although it does not specify heat flux levels.

High heat flux jet fire tests

SP Fire Research experiences an increasing number of requests for *high heat flux* tests of 350 kW/m^2 and *sequential heat flux* jet fire tests. A sequential heat flux test means that, in one test, the heat flux is varied in steps according to requirements in a DAL specification. ISO 22899-1 does not fulfill requirements of high heat fluxes, and deviations from the test standard are necessary. In the absence of a sufficient test standard for jet fire tests of high heat fluxes, these tests are therefore project specific, and do not serve as a basis for type approval.

SP Fire Research has developed a test setup for *high heat flux* and *sequential heat flux* jet fire tests. This setup follows ISO 22899-1 as far as possible, but certain deviations are necessary in order to achieve sufficiently high temperatures. The main deviation from the test standard is the larger dimensions of the furnace (see Figure 1). In addition, we have developed strategies to control and optimize the air/fuel ratio throughout the test. These are challenging operations which requires skilled and experienced personnel.

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The temperature development in a jet fire test
At test start, the furnace and the test specimen are cold. During the first few minutes of the test, there is thus a significant convective contribution to the heat transfer. After this period, steady state is reached. The furnace temperature will then stabilize at the aimed temperature, which is based on the assumption of black body radiation (1176°C for 250 kW/m^2 and 1303°C for 350 kW/m^2 test, see Figure 2).

The importance of relevant test methods
Reported heat flux levels during a test may depend on the measurement technique or calculation method, which are not defined in the jet fire test standard. It is important to be aware of this. When there is a lack of harmonized guidelines for sufficient experimental setups, and for measuring and controlling the heat flux level, different experimental setups at different test facilities could yield different test results.

SP Fire Research's goal is to provide sufficient jet fire test methods that aim to fulfill the requirements with robustness, validity, and reliability. We have over many years gained knowledge and experience from jet fire testing and planning of ad hoc test setups. We use this knowledge to decrease the sensitivity of test methods to environmental conditions and geometry of the test specimens, and provide a better basis for heat load control, interpolations of test results, fire simulations, and risk analysis.

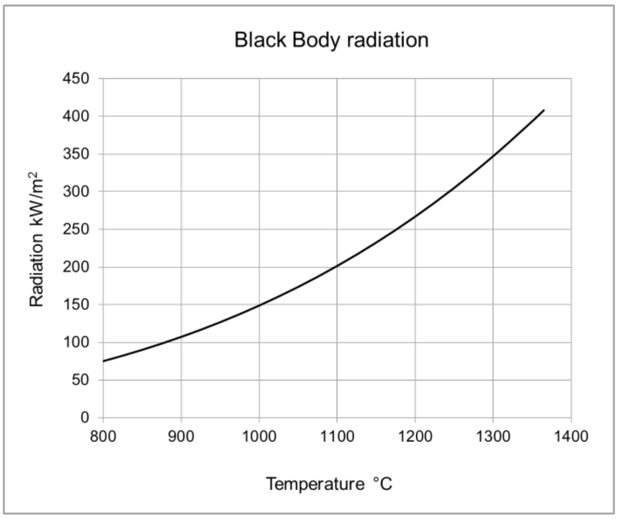

Figure 2. Black body radiation (kW/m^2) versus temperature (°C).

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