Measurement of Combustor Can Flame Breakout Conditions

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In the event of a turbine fire resulting from, for example, a combustor can burn-through, there is a need for controlled engine shutdown before either involvement of the fuel supply system or the actual high velocity, high temperature flame issuing from the combustor causes major damage. To ensure adequate time is available for this, a flame breakout shield is interposed between the combustor unit and nearby structural and other sensitive components.

Paragraph 8 of Advisory Circular FAA 20-135 discusses conditions required of a test conditions to simulate engine case burn-through conditions specifying a jet from a 1" (25.4 mm) nozzle with a minimum temperature of 3000°F (1650°C) and a pressure corresponding to the maximum burner pressure of the installed engine (~ 350-650 psi). The requirement is that the test piece maintains its integrity under these conditions for a period of at least 3 minutes.

The rig required to conduct such testing is necessarily complex and expensive to build and the testing itself is difficult and involved. Hence there are clear advantages in being able to model such events and the response of materials to the burn-through environment using combination of fluid flow, solid phase heat transfer and structural response packages. Ultimately the range of testing needed to inform selection of materials, shield configuration design and even certification issues may be significantly reduced and even removed completely if well-validated models for this situation are available.

However before such a capability can be routinely applied there is a need to develop and validate suitable models. To do this high quality data for a range of representative burn-through scenarios must be generated. This paper considers the collection of such data considering the steps and the progress made at the Health and Safety Laboratory (HSL) towards this goal. The paper addresses:

1. The definition of the design fire: This defines conditions which any code and hence experimental rig must be required to simulate.

2. The design and construction of a suitable test rig to satisfactorily model these conditions in a controlled, repeatable and realistic way using a range of fuels and covering all pressures which might reasonably be encountered. A rig developed at HSL is described and some results obtained with the rig are outlined.

3. The measurement of conditions in the hot jet to provide high quality data for modellers. The jet provides a particularly hostile environment to which a test piece is exposed. In particular the measurement of temperatures ~2000°C with conventional probes is problematic. HSL have therefore sought to develop non-intrusive laser-based techniques for measuring conditions in the jet. A number of techniques have been explored and Rayleigh scattering identified as the most promising measurement methodology, having the potential to provide

information on the temperature, velocity and density throughout the jet with good signal levels and positioning information. Progress towards implementation of this technique and the collection of profiles across the jet is described.