# ATEX for Explosive Atmospheres

By Mark Keating, Fluent Europe Ltd.

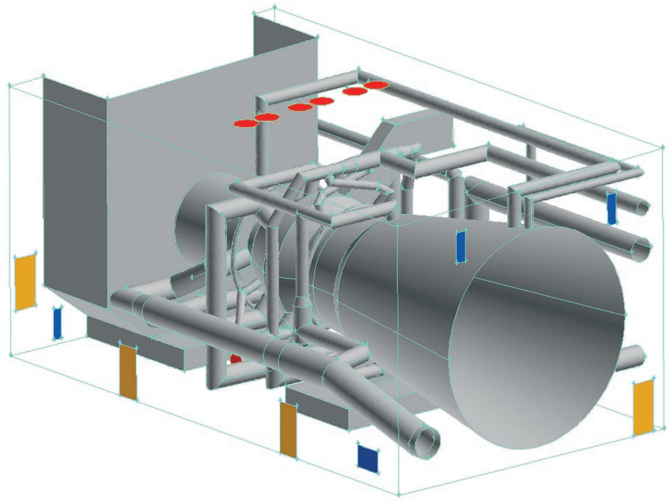
Gas turbine installations commonly involve housing the gas generator unit inside a confined acoustic enclosure, designed to attenuate noise levels and provide ventilation for controlled convective heat rejection and gas fuel leak dilution. Throughout the European Union, the potential for fuel leakage means that such enclosures must conform to the newly introduced ATEX Directives legislation (from the French *Atmospheres Explosibles*) as described in HSE (Health and Safety Executive) Guidance Note PM84.

In the detection of gas leaks it is important to balance the ventilation system so that leaks can be diluted and removed from the enclosure, preventing build-up to explosive levels. Dilution should not be so great, however, that the true leak magnitude is masked at the detection point. The philosophy is that leaks that cannot be detected are diluted and those that cannot be diluted are detected. PM84 declares limits on the size of the 50%LEL (lower explosive limit) gas cloud before detection as less than 0.1% of the net enclosure volume, where 100%LEL represents the fuel/air mixture just rich enough to be ignitable. Additionally, PM84 requires that the sensor alarm threshold be set at "ideally less than 5%LEL and no more than 10%LEL."

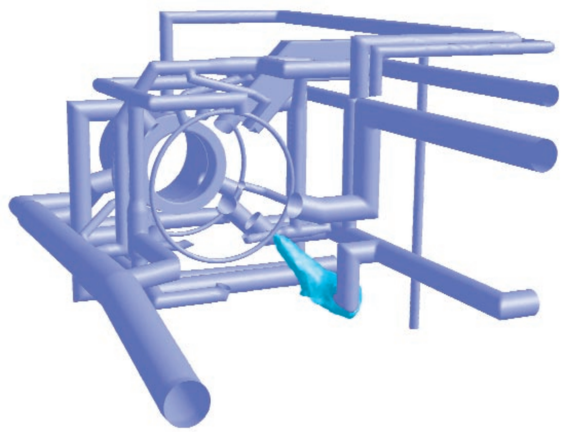
FLUENT was used in a recent case study to investigate the conformance to the PM84 guidelines at one particular power plant site in the UK. A representative model of the inside of the enclosure, including the gas generator, intake, diffuser, pipework, and enclosure walls, was built using GAMBIT. Roof extraction fans were used to establish a negative gauge pressure inside the enclosure, and side wall inlet vents were used for air supply. A tetrahedral mesh of approximately 3.1 million cells was used, with cells concentrated around the fuel manifolds. The level of heat rejected from the engine casing was calculated from a heat balance across the engine, and applied to the casing surface as the driving thermal boundary condition. In conjunction with site measurements of internal pressure and temperature, FLUENT was used to establish confidence in a baseline operating case prior to leak introduction.

For the safety analysis, a range of leak source flow rates, directions, and locations were modeled in an attempt to create the largest leak cloud possible. The leak flow rates used were based on the detector alarm threshold levels in the 3-10%LEL range. The leaks were introduced one at a time, as point sources in the worst possible locations – regions with relatively high ventilation air residence time and low local air velocity. A two-species mixture model (methane/air) was used to examine diffusion of the gases and a user-defined function (UDF) was used to calculate the sizes of the gas clouds.

The sizes of the steady state 50%LEL gas clouds for the worst leak considered were predicted at the 3, 5 and 10%LEL detection levels. These were determined to be 0.083% and 1.61% of the net enclosure volume for the first and last cases, respectively. The sizes that these gas clouds would reach before being detected depend on the exit detection levels. In this instance, it was decided to install detection capable of reaching the 3%LEL level rather than use a less sensitive limit coupled with localized dilution or ventilation system modifications. Detection at the 3%LEL level ensured compliance with the PM84 guidelines in that the cloud size was <0.1% of the net enclosure volume. ■



*Rendering of the gas turbine model created in GAMBIT, showing ventilation inlet (blue) and exit (red) ports; access doors (orange) are superimposed as a visual guide*



*An iso-surface of the 50%LEL cloud at (above) 3%LEL detection (corresponding to 0.083% of net enclosure volume), and (below) 10%LEL detection (corresponding to 1.61% of net enclosure volume); the turbine casing and enclosure walls have been removed for visualization*