Measurement of train aerodynamic phenomena in operational conditions

There are a variety of aerodynamic effects associated with train design and operation - the determination of aerodynamic drag, the effect of cross winds on train stability, pressure transient loading on trackside structures, the physiological effect of tunnel pressure transients, the effect of train slipstreams and wakes on waiting passengers and trackside workers etc.

The magnitude of these effects broadly increases as the square of the vehicle speed and thus with the continued development of high speed train lines aerodynamic effects will become more significant in terms of design and operation. Now it can be hypothesised that the techniques that have been used to predict aerodynamic effects in the past (wind tunnel and CFD methods) are likely to determine magnitudes of pressures, velocities, forces etc. that are higher than those observed in practice, where other effects - such as track roughness, variability in meteorological conditions etc. are likely to usually obscure aerodynamic effects to some extent and, because of this, some of the current design methodologies are unnecessarily restrictive and/or conservative.

Thus the aim of the current project is to investigate and measure a range of aerodynamic phenomena observed in real train operation, both relative to the train and relative to a fixed point at the trackside, and to compare how such effects match model scale measurements and various types of CFD calculation, and thus to test the validity, or otherwise, of the above hypothesis. This will be achieved through the instrumentation of the Network Rail High Speed Measuring Train to measure aerodynamic effects, as the train carries out its normal duty cycle around the UK rail network.

Also trackside instrumentation will be installed at a suitable site that will allow off-train phenomena to be measured. Calibration wind tunnel, CFD and moving model tests will be carried out in the conventional way for comparison with data measured at full scale. The full scale, model scale and computational trials will be carried out by experienced RFs and will provide data for two doctoral studies, one of which will investigate how the train based measurements of cross wind forces, pressure transients etc compare with those predicted by conventional methodologies, and one of which will investigate how the track side measurements compare with conventional test results.

The investigators will synthesise the results and make recommendations for future aerodynamic test methods.