

## Derailment Investigation

On the 26<sup>th</sup> October 2005, a passenger train derailed underground on a sharp curve on the approach to Liverpool Central underground station. Thankfully, the incident occurred at low speed and there were no injuries sustained. Damage to both rolling stock and infrastructure was minor, but the 119 passengers on-board had to be evacuated by the emergency services.

The subsequent derailment investigation was undertaken by the UK Rail Accident Investigation Branch (RAIB) supported by DeltaRail, then operating as AEA Technology Rail. VAMPIRE® Pro was used to replicate the derailment mechanism and then provided a cost-effective tool to establish which remedial measure(s) would be most effective at preventing future derailments at this and other similar sites.

### The Evidence

The evidence on-site indicated that the initial derailment occurred when inner wheel of the derailed axle dropped between the rails. This then forced the outer wheel to flange climb up and over the outer rail. The outer rail showed a high degree of side wear consistent with high lateral contact forces and the general condition of the track suggested that gauge spread was the most likely cause.

DeltaRail therefore surveyed the track geometry in the vicinity of the derailment and measured the level of lateral restraint provided by the rails using a gauge spreading bar (shown below):



The profiles of both rails were recorded using MiniProf, as were the wheel profiles of the vehicle that derailed. The condition of the derailed vehicle was also investigated, but no significant issues were identified.

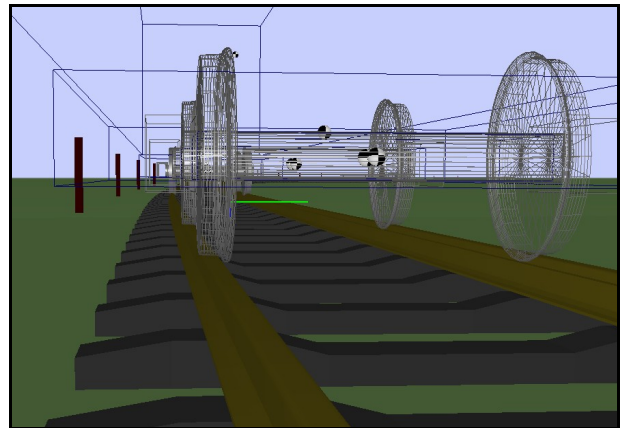
### Constructing the Model

The information collected on-site was used to construct a detailed VAMPIRE® track model. The track geometry data was processed to produce a VAMPIRE® track irregularity file and the results of the gauge spreading tests were incorporated using the variable track stiffness feature of VAMPIRE® Pro.

The measured MiniProf wheel and rail profiles were imported directly into VAMPIRE® to generate wheel/rail contact data. An appropriate vehicle model was already available from DeltaRail's extensive model library.

### Replicating the Derailment

The initial VAMPIRE® Pro analysis demonstrated that the lateral track forces generated by the passage of a single wheelset would not have been enough to enable it to drop between the rails:



However, the progressive widening effect of successive axles was predicted to cause the gauge to widen by 50mm. Given the already wide static gauge, this would have been sufficient to cause the derailment.

### The Effect of Vehicle & Track Parameters

Having successfully replicated the derailment mechanism, further simulations were undertaken to investigate what could be done to prevent future derailments at this and similar sites:

- modifications were made to the vehicle model to improve its curving performance, but it was concluded that only major changes to its design would prevent derailment
- an evaluation of vehicle speed showed that going round the curve more slowly actually increases derailment risk
- improved levels of lateral restraint (i.e. track condition) would greatly reduce derailment risk
- a check rail would be a highly effective means of preventing derailment in this situation



- although lower wheel / rail friction would reduce derailment risk, the reduction required to prevent derailment would adversely affect traction and braking performance
- replacing the heavily side-worn rails would not prevent a wheel dropping between the rails, although it would reduce the risk of subsequent flange climb
- operating the service with a more modern design of modern multiple unit would not prevent derailment under these conditions

The results of the investigation were subsequently published by the UK Rail Accident Investigation Branch on their web site, and a number of recommendations were made relating to the maintenance of this and other similar locations.

## References

Further information on the work of the UK Rail Accident Investigation Branch can be found at [www.raib.gov.uk](http://www.raib.gov.uk) and the full report into the incident (reference 14/2006) can be found on the “Publications” pages of their web site.

## Further Information

For further information, please contact the VAMPIRE® Helpdesk:

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