Electrification: delivering the transformation

Very once in a while, when all the sums come together, the railway electrification engineers have a few moments of media exposure. Theirs is a mysterious world – maybe more of a black art even than the signal engineers. They work on a grand scale of electricity. Their electronic components are the size of transit vans and their circuit boards the size of tennis courts. They deal with unimaginably large voltages and, generally, their medium is invisible – although it may fizz and crackle occasionally.

And so it is again that electrification has hit the media. The sums have added up and work has started in earnest on the Great Western Main Line (GWML) as well as on schemes in the north-west.

In an exclusive and wide-ranging interview, our editor Grahame Taylor has been talking with Peter Dearman, Network Rail’s Head of Network Electrification. We will be covering the topics raised over the next two issues. Next month, in the run up to Railtex, Peter shares his ideas on the rapidly changing world of electrification with the rail engineer and we will look at the recently authorised GWML scheme.

Reaching out

The headline is that electrification will extend to Cardiff. Are there any other routes involved – diversionary routes perhaps?

The issue here, of course, is that all of these schemes have been developed in association with our stakeholders and funders. A rigorous business case review has got us to where we are. Others in the industry and the Department for Transport particularly have taken a lead in the business evaluation.

What we have is a project which is the summation of all that work. I would be more than delighted to plough through many other routes – electrifying the lot – but we all have to cut our coat according to our cloth. So the only diversionary facility on the GW is that we’re going to Cardiff on both routes to Bristol. We turn left or right at Wootton Bassett but that’s it! Sadly we’re not off to Gloucester.

What about the Newport freight lines?

Freight doesn’t benefit except as a by-product of the scheme which is intended to deal with passenger transport between London and Wales. Freight I’m sure will evolve but, at the moment, the effect will be marginal. So, no freight lines.

Technical talk

Is the system for the GWML intended to be an auto-transformer system – 2 x 25kV such as that on Thameslink and elements of the West Coast?

We’ll be using auto-transformers - 25kV x 2 because of the traction load we predict on the GW and the voltage profile along the line we wish to maintain to feed power to the trains. It will be fed from the 400kV grid around the country which has a very strong capacity.

How much of a challenge is it for the national power supplier to cater for this additional, probably grid-unfriendly, load?

The point you raise about single-phase electric traction load being fairly unfriendly on a three-phase system is valid but on the 400kV network it is less of a problem and won’t confront us with any technical difficulties.

Where will the incoming supply be provided?

How many traction power supply sites will there be along the route and where will they be sited?

We’re just at the point when we’ve designed the grid system. We’ll take a feed at the London end at Kensal Green, which is actually being built by Crossrail, and that’s because of the additional load of Crossrail at the London end of GW. The next feeder out will be at Didcot; there is then one at Melksham and the final one will be at Cardiff. Those are all derived from the 400kV network. With a feeding system designed, we are already in advanced negotiations with the grid supply company.

Will this be on the critical path?

It’s a long-lead item of course, hence the fact that we’re in early discussions with them now. It’s not that the actual equipment is on a long-lead time to build. Some of it is quite long, but not really critical in terms of this project. What’s challenging is that the 400kV network doesn’t get turned off very often. London doesn’t go dark! We have to programme our construction within the grid’s outage programme and that’s really the reason why we have to get on with it now.

Creating headroom

Feeding electrification through tunnels and bridges is always a challenge and on the GWML there are a number of tight clearance structures. Are there any particular special products or processes that are intended for use at these locations?

There are 137 bridges and tunnels in case you’re interested, some of which are very long. Obviously it’s impossible to over-
emphasise the influence of civil engineering structures on the electrification network. When you look at the cost breakdown of the work to electrify a line, the alterations to the civils structures is normally approaching the same value of the overhead line system - and this is true of GW.

We have the usual problem of civil engineering clearances, although none of them is insoluble on GW; we have solutions to them all. The question is 'how cost effective is the solution you select?' With a bridge, we face three possible solutions once it's clear that clearances aren't available. The first is to lower the track. This is usually the least costly of the jobs - grading the track downwards and back up on the other side - possibly with a bit of work on foundations. That's the simple end of the scale. The second option, if it's a flat deck bridge, is to simply jack it up. There are some of those on the GW. And then there are the arch bridges which are usually a demolition and reconstruction. So the bridges we can solve.

We're looking at some novel solutions in parts of the country where we might adopt what we call discontinuous electrification. Effectively this is creating a dead section under the structure with a dead wire to restrain the pantograph. This means you don’t need the electrical clearance on top of the mechanical clearance. It has some advantages in some places but whether it’s applicable to GW we'll be able to tell when we do the detail design phase. We will consider both options when we move into the detail design phase.

What speeds are feasible for solid beam these days?

You can get solid beam to run up to 125mph. The Swiss have just achieved that and the Germans are not far off getting something similar. With the speed through the Severn Tunnel being well below that, we don’t have a problem. Either of the technologies will suit. What we need to do now is the detailed design so that we can see which has the better cost profile and, importantly, what will fit into the construction programme of the job.

Coming together

On the subject of programming, what about interfacing with other things going on along the route - like Reading for example?

There is a massive amount of work being done on integration of programmes. At every level from Reading inwards on the GW scheme, there is a lot of interaction between Crossrail works, Reading remodelling, the electrification works and work associated with signalling as well. We're actually at an advanced stage sorting the integration issues with these projects so that we can implement appropriate parts of our scheme as they proceed.

For example, at Reading we will be putting in the foundations as part of the new arrangements. So we will at least have the foundations and steelwork in place in this sensitive area so the Reading project can get on with it.

Left A conductor beam installation in a tunnel on the German network.
At Reading, the OLE foundations and steelwork will be installed alongside the remodelling work.

its work. The good citizens of Reading won't have to suffer us coming along later to put the overhead line up! What has yet to be decided are the contracting arrangements for erecting the wiring to those structures. What will be the contracting strategy? We will come to a conclusion on this once we get to the latter stages of the GRIP process but the technical developments that we've made and the way that we're pulling the system design together will enable us to hold that choice open. What we need to look at carefully are the market offerings and the question that remains to be resolved is what will be the best cost profile for achieving the system and equipment specifications that we've put out to the trade. The jury's out on that question at the moment, but we must remember that we're still only at GRIP3. What engineering work has been done over the years? The fact that we've got to an established traction system design is evidence enough that we've done quite a bit of advance work. We understand the traction system needs for the system we're about to build. Much investigatory work has been done already. I can sit here and comfortably state that we can get through Severn Tunnel because we've done the survey work right through the route.

Early design considerations have gone through the mill in order to get us to where we are. We've developed a business case against a real scheme and what we now need to do, consistent with GRIP, is take the detailed options through to more detailed design. And of course, over the years, many structures have been rebuilt to electrification standards as the norm. A sensitive approach Will there be any p-way or signalling changes? As we move through the GW we're meeting up with a number of resignalling schemes that are already in place. If we go back far enough in history when we did the likes of the ECML we were experienced at doing route rationalisation, resignalling and electrification - it was a sort of mantra in BR. We're not quite in that same boat these days. But where the major junctions have signalling schemes approved then the remodelling that goes on alongside those schemes will be integrated with our programme. We'll be wiring over the top of those, but there are parts of GW where there is no such activity. The only trackwork that is likely to be undertaken will be that associated with any track lowerings to get electrical clearance. What heritage issues are likely to crop up? We've opened up the listed structures debates with English Heritage and all the interested parties already. Our aim is to deal with the necessary works in as sensitive a way as possible. The sorts of things we will be looking at will depend obviously on the actual structure but, in principle, what we'll be aiming to achieve first of all is minimal disruption to the existing structural lines. If it's a listed bridge for instance, it means looking at what's the best way to minimise the number of structures that need to be installed. Having done that, we'll do what we've done in the past which is to engage architects to help us to make the overhead line structure form more sympathetic to the existing civil engineering structure. For example, I would point at the Royal Border Bridge and Durham Viaduct where Arup helped us to come up with something that was more aesthetically pleasing than lumps of H section! We've done it many times before, but you must remember that each structure is different. You have to think very carefully and make sure that your solution is in sympathy with the structure. Many we have done over the past 20 years have been very good and quite an achievement.

With ‘sensitive’ structures such as Box Tunnel (far right), the project team will take a sympathetic approach to the OLE installation, as was the case with Durham’s listed viaduct (right).

The cutting edge

Peter has seen many changes in the world of electrification and outlined how some of these will be incorporated into the GW scheme. But the subject of innovation is too large just to tack onto the back of an article about one scheme so the rail engineer will cover this aspect of the interview in next month’s issue.

You’ll have to wait to hear about supermarket logistics and see why something called ‘IPC sixty-one eight fifty’ defies its amazingly boring title to be key to the way that electrification will be carried out in the future!