

ADDENDUM TO REVENUE AND DEMAND MODELLING AUDIT



SYSTRA

EAST COAST MAIN LINE TRACK ACCESS APPLICATIONS

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1. INTRODUCTION

- 1.1.1 ORR must decide on the competing applications for access rights on the East Coast Main Line (ECML). The decisions will directly impact the commercial aspirations of the holder of the East Coast franchise (VTEC) as well as those of existing (Hull Trains and Grand Central) and potential open access operators (GNER and FirstGroup). The decisions, as well as affecting passengers, may also impact DfT finances and other stakeholders such as rolling stock supply companies and Network Rail.
- 1.1.2 In making its decisions ORR is following its published criteria and procedures. To support this process it has commissioned CH2M to fulfil three areas of this work related to estimating:
- the demand and revenue implications of the various applications, with particular reference to levels of “abstracted revenue” from other train operators. This helps the ORR to understand the impact of the application on overall industry revenues.
 - review the estimates established with input from the applicant(s), potentially affected incumbent operators, funders and any other interested parties; this enables an understanding to be gained by all parties of the forecasts and processes used and provides an opportunity for detailed explanations, and error correction; and
 - a “WebTAG-based” economic appraisal of the proposed services, this enables an understanding of the implications of the proposals on the wider UK economy.
- 1.1.3 Given both the commercial and policy implications of the decisions, the work can be expected to be subject to high profile and detailed legal and technical scrutiny.
- 1.1.4 CH2M issued a draft report on their modelling work on 29th May 2015, followed by second report on the 5th June, with correction of an error. Further feedback, from stakeholders prior to and during an ORR-organised “hearing” on the 12th June 2015, was also gained where a wide number of further issues were raised, covering data, modelling, and appraisal issues. CH2M have undertaken further analysis in response to these issues raised, and have produced a final round of modelling to assess the access bids, documented in the Phase 2 Final Report dated 7 January 2016 and associated appendices¹, which Systra were commissioned by the ORR to independently audit. This audit is documented within the report ‘audit-report-of-east-coast-access-analysis’ which was circulated to bidders along with the CH2M analysis.
- 1.1.5 Responses from bidders were collated and reviewed, and the bidders were invited to attend a further hearing on the 4th March 2016 at which any outstanding issues were discussed. Following this hearing we have been asked by ORR to provide further support to the ongoing analysis of the East Coast Mainline open access applications. This report documents the further audit work that we have been undertaking.

¹ This report subsequently became the published version titled ‘Assessment of Applications for Track Access on the East Coast Main Line: Phase 2 Final Report’ following minor drafting updates [7th Jan 2016]

2. AUDIT PROCESS

2.1.1 Following the hearing on the 4th March 2016 we have been asked by ORR to provide further support to the ongoing analysis of the East Coast Mainline open access applications. In particular we have been asked to:

- Carry out a further review of the air abstraction model with respect to the calculations used to ascertain the abstraction from the air mode due to competition on the basis of fares, to ensure that the logit model is functioning correctly.
- Audit a further option which updates the journey times for the FirstGroup application so that they are more comparable with VTEC journey times. Within this option the fares methodology has also been updated to better represent the competition in terms of fares between FirstGroup and VTEC. This is referred to as option 16 and is documented by CH2M within Appendix H.
- Review of VTEC's submitted response to CH2M's analysis which included calculations to derive implied fares elasticity values. The corrected values, together with a complete set of results, is documented by CH2M within Appendix J, which we have audited.

2.1.2 The work carried out on these tasks and our findings from these are summarised in the following subsections.

2.2 Air Abstraction Model Review

2.2.1 A number of comments were made about the Air Fares Model during the hearing. We have therefore undertaken further checking of its internal consistency and with the PDFH air/rail journey time model.

2.2.2 Because it is a logit model the inclusion (or omission) of elements that do not change between scenarios such as access costs and times is not relevant. However, we note that air parking costs are included.

2.2.3 The values of time in the model are approximately consistent with PDFH as follows. We have used PDFH values for 200 miles and also extrapolated from the 100 miles and 200 miles quoted in PDFH to 400 miles (as 200 miles is longest distance given). All PDFH values have been increased in line with the change in GDP per capita (+18.4%) from their given date of 2004.

Table 1. Values of Time Pence per minute (2015 prices)

JOURNEY PURPOSE	CH2M MODEL	PDFH 200 MILES	PDFH 400 MILES (ESTIMATED)
Business	90.2		
Business 1 st Class		107.3	132.8
Business Standard Class		50.6	62.9
Leisure	20.2	18.6	23.3

2.2.4 We have also checked the sensitivity of the model to changes in rail GJT and compared it with that implied by the PDFH curve. Ten minutes change in GJT in the model results in approximately two percentage points change in market share, whereas the PDFH curve implies about five percentage points. The business part of the model gives similar values to PDFH, but the leisure mode is much less sensitive. This indicates that the leisure time parameter is rather low. If we accept the value of time evidence then the leisure fares

parameter may also be too low. However, the relationship between fares and time elasticities and values of time only holds if all travellers have the same value of time (PDFHv5.1 Chapter B4); if the value of time is the average across a population, then the standard relationship does not hold.

- 2.2.5 The alternative way of considering the fares parameter is through the implied elasticity. This shows that the elasticity to rail fare is approximately -1.0 taking into account abstraction from air alone. When generation of new travel is taken into account it would be significantly higher, perhaps -1.5. It is unlikely that the actual elasticity is any higher than this or VTEC would be reducing fares significantly in this market, at least on trains that are not full. Furthermore, the nature of fares competition between air and rail, where the competition is mainly in the Advance sector of the market and some air passengers purchase considerably more time in advance than is possible with rail, means that fares elasticities may be somewhat lower than would be anticipated by a simple extrapolation of the air/rail journey time model. On balance, we believe that the evidence indicates that the fare parameter in the air fares model is approximately correct.

2.3 Option 16: FirstGroup Edinburgh with faster journey times

- 2.3.1 CH2M have developed a further option to model the FirstGroup application. This largely uses the established revenue model system used for the earlier options assessment, with the following exceptions:

- A proportion of the base level of revenue and journeys has been removed before being input to the modelling system. This proportion represents all First Class revenue and journeys, and standard class full fare walk up revenue and journeys as this subset is unlikely to switch to FirstGroup's services given the level of loading on these services and the limited availability of seats.
- The open access fares that have been used for FirstGroup's services have been adjusted from previous levels in options 7, 9 and 15. This is because CH2M estimate that 'train loads would be unsustainably high on a long term basis at First's proposed fare levels'. It is therefore reasonable to assume that FirstGroup would increase their fares, and CH2M estimate that train loads would be manageable if the discount offered by FirstGroup was reduced by 25%.
- The competitive response by VTEC included within option 16 has been calculated by a new methodology which adjusts the fare level offered by VTEC only for the number of seats equivalent to the passenger journeys that are lost to FirstGroup.
- The appraisal process for option 16 has been updated to include an effect of crowding.

- 2.3.2 In addition to these changes, option 16 – and the associated revised FirstGroup journey times - have been analysed within both the gravity and air abstraction models as per the previous methodology. The resulting journey and revenue uplifts have been input to the revenue model for this option.

- 2.3.3 The Systra audit of this option has been focused on the following tasks:

- We have reviewed the methodology statements held within Appendix H to ensure that the analysis carried out in this option is sound and in line with any corresponding industry guidance.
- We have reviewed the updated inputs to the model, and verified these where necessary.
- Where these inputs have been derived by other models, for example the gravity model, we have reviewed the models that have generated these inputs. In particular we have compared these versions of the model with the previous versions that generated the inputs for the earlier options to ensure that the inputs for option 16 have been generated in a consistent way.

- We have examined any updates to the formulas within the complete revenue model system to ensure that they align with any changes in the methodology approach.
- Using updated inputs and updated revenue model templates that have been audited as above we have run the complete revenue model system for option 16 to ensure that we can replicate the results produced by CH2M. Where inputs and functionality of the model have not been changed from previous we have used our existing audited version of the Revenue Model to ensure consistency with the previous approach.

2.3.4 The outcomes of this audit are discussed in the following sub-sections.

Methodology Review

- 2.3.5 We largely agreed with the approach for assessing option 16 as documented in Appendix H.
- 2.3.6 We did however have concerns associated with modelling crowding. We proposed a way of addressing this, in particular applying a GJT penalty in the appraisal process (but not demand and revenue calculation) to better reflect the dis-benefits felt by passengers of significantly loaded services. CH2M followed our recommendation in its analysis of option 16. We describe this issue below.
- 2.3.7 Initial attempts to model the faster timetable of option 16 resulted in high predicted loadings on the FirstGroup services. We were concerned that the crowding model was not appearing to handle train loads correctly, and CH2M agreed with this.
- 2.3.8 In option 16 CH2M refined its modelling approach so that it offered fares (higher than those set out in the FirstGroup application) that would result in manageable train loads. This meant that there was little overcrowding and hence the crowding model was less important.
- 2.3.9 The FirstGroup business model is based on reserving all passengers into seats so that standing is avoided. For the purpose of this note we have assumed that this model can be made to work, and that the average load factor of 71% that was an output of the modelling by CH2M is achieved.
- 2.3.10 In PDFH v5.1 crowding has an impact above 60% load factor for intercity services. Furthermore, this impact is linear up to 100% load factor (and we assume load factors do not exceed this). An average load factor of 71% means that some trains will be above this, others below. We have not sought to model the distribution but instead assume that 50% of trains are 60% loaded, 50% are 82% loaded. More people are on the heavier loaded trains than the lighter loaded ones. At a notional 500 seats per train we see that 60% loaded trains have 300 seats occupied whereas 82% loaded trains have 410 seats occupied. This means that 58% of passengers are in the more crowded trains ($410 / (300 + 410)$). The 58% remains the same whatever train capacity one assumes.
- 2.3.11 The PDFH crowding penalty for an 82% load factor is 3.4% of in-vehicle time. Hence the average crowding penalty is 2.0% ($58\% \times 3.4\%$). If we assume this applies for the London – Newcastle leg of the journey as there is insignificant crowding north of Newcastle, then this is a penalty of 2% of the journey time of 158 minutes, or 3.2 minutes.
- 2.3.12 Hence the economic dis-benefit of FirstGroup’s crowding is equivalent to 3.2 mins additional journey time to all FirstGroup passengers. This has been adopted within CH2M’s analysis.

Input & Calculation Audit

- 2.3.13 The MOIRA modelling has been updated for option 16 to model faster journey times for the FirstGroup services. The outputs from MOIRA are input to the revenue model, prior to their

input for this option they are adjusted to remove first and full (walk-up) ticket types as FirstGroup will not compete with the demand for these ticket types. The proportion of revenue and journeys to be removed has been identified by examining LENNON and NPS data. We have reviewed the calculations involved and they appear reasonable.

- 2.3.14 Consistent with our approach to auditing other options, we have not sought to replicate the data transfer process from MOIRA to the revenue model as this is time consuming, and previous sample checks on this part of the model gave no cause for concern that this has been handled incorrectly.
- 2.3.15 We have also not reviewed the timetable that has been used within MOIRA to generate the demand and revenue data to input to the model. This is in line with our previous audit approach in which we performed only a sample audit of the MOIRA modelling, we deem this to be a lower priority of the audit as all MOIRA SPG files have been shared with applicants as part of the engagement process.
- 2.3.16 The gravity model has been updated for this option with an updated GJT for Morpeth. This GJT is lower than for the other FirstGroup options and looks reasonable to us, however we haven't verified this value within MOIRA as we have not reviewed the MOIRA modelling for this particular option. The uplift factor that is input to the revenue model has been generated within the gravity model in the same way as for other options, however a dampening factor is then applied to this uplift such that the uplift factor only represents growth in demand associated with the ticket types that are being modelled within the revenue model. This dampening factor has been applied correctly.
- 2.3.17 The air abstraction model has been updated for option 16 with the revised open access fares from FirstGroup (see para 2.3.1 bullet 2). These have been calculated off-line and are input to the model as a percentage reduction in fares. These inputs look reasonable to us, however, in line with our previous audit approach, we have not sought to verify them further. The uplift factors that are input to the revenue model have been generated within the air abstraction model in the same way as for other options.
- 2.3.18 The FirstGroup yields used within the fares calculations in the revenue model have been updated for option 16. These have been calculated by analysing the difference between the stated FirstGroup fares and the VTEC in-scope fares and reducing the discount offered by FirstGroup by 25%. This approach and the resulting fares seem reasonable to us.
- 2.3.19 In addition to the input fares changes there was a small change to one of the formulas in the fares overlay. This is to remove the calculation of in-scope demand and revenue for open access as due to the pre-processing discussed in para 2.3.13 this is no longer required. The update to the calculation has been implemented correctly.
- 2.3.20 The calculations that set the competitive response for VTEC are calculated off-line from the standard revenue model, and are input to the model as a discount to be applied to VTEC fares. We have reviewed these calculations and confirm they have been carried out correctly, as per the updated methodology stated within CH2M's Appendix H.
- 2.3.21 After auditing the changes to the modelling system as described above we have collated all of the revenue model system updates and inputs changes and applied these to the version of the revenue model that we have previously audited. Using this updated system we have run option 16 and confirm that we can replicate the revenue results that CH2M present in Appendix H.

Audit of Appraisal Update

- 2.3.22 During the methodology review we suggested an adjustment to the appraisal process to include a crowding penalty for all passengers travelling on the heavily loaded trains (see the methodology review under sub-section 2.3 for more detail).

- 2.3.23 Whilst the inclusion of this method was our advice – and is certainly preferable to not considering the potential dis-benefit to passengers on these heavily loaded FirstGroup services – we note that this has been calculated as an approximation off-line from the revenue model; and does not consider the effect of applying this penalty to the actual in-vehicle times that are used within the revenue modelling system.
- 2.3.24 We have reviewed the adjustments made to the option 16 inputs to the appraisal model, and confirm the calculations have been carried out in an appropriate way. We have run these inputs through the audited version of the appraisal model and confirm that we replicate CH2M’s results in Appendix H.

2.4 Review of VTEC Response

- 2.4.1 We reviewed the technical note² submitted by VTEC in response to CH2M’s published analysis, and we provided comments to ORR on the issues raised within. In particular we reviewed the calculations VTEC supplied in which they had derived higher than usual implied fares elasticity values. VTEC was correct in identifying an issue with the calculation which, on correction, revised the outturn implied elasticity values to much more sensible levels.
- 2.4.2 When we first investigated the VTEC analysis we found that it included an error in that the change in revenue for all flows was divided by the base revenue for Leeds – London (rather than all flows). However, when this error was corrected, the implied fares elasticities were still high.
- 2.4.3 An issue was found by CH2M in their revenue model after we had reviewed VTEC’s calculations and shared our review with CH2M. CH2M found that the demand response of competitive response was correctly calculated however the revenue change is then calculated from the demand change by multiplying by the average yield. While we had audited these calculations at an aggregate level and found no issues, in examining the calculations at a detailed flow level it became apparent that an incorrect yield was being used in the model resulting in an incorrect revenue with respect to the competitive response.
- 2.4.4 In light of this error ORR requested that CH2M rerun the following options and these have been restated in Appendix J - an annex to CH2M’s original report³. We confirm that we have replicated these results and confirm that they have been stated correctly:
- Option 1: Alliance Yorkshire
 - Option 10: Option 1 + VTEC Full
 - Option 16: Revised FirstGroup option
- 2.4.5 Restating the results has had a small impact to the generation and abstraction ratio for these options and a small impact to the appraisal results.

² ‘Technical Appendix: VTEC Response to CH2M Report’ [8th Jan 2016]

³ Appendix J of ‘Assessment of Applications for Track Access on the East Coast Main Line: Phase 2 Final Report’ [11th May 2016]

3. CONCLUSIONS

3.1.1 SYSTRA has completed the audit of CH2M's Complete Revenue Model Suite as described in the previous chapters of this report. Following this audit we conclude the following:

- the CH2M Air Abstraction model adequately models the competition between air and rail mode on the basis of fares as well as GJT; furthermore it is consistent with PDFH.
- The updated methodology used to assess option 16 is appropriate for this test and follows industry guidance where applicable.
- CH2M has corrected the error in the modelling of competitive response that it identified in response to VTEC's technical note.
- The modelling processes applied are consistent with the methodology described within Appendix H and no errors or issues have been reported.
- The revenue and appraisal results are correctly presented in Appendix J, and we have been able to replicate these results ourselves.

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