Network Rail and the Office of Rail Regulation

Part A Independent Reporter Mandate

Mandate AO/008: Network Rail Materials Costs Benchmarking Study

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Contents

Executive Summary

Anonymised version

Please note: for reasons of commercial confidentiality, sections of this report have been anonymised and/or redacted.

Background and objectives

This report has been based on comparative price benchmarking and analysis of nine key material types, comparing "factory gate" prices paid by Network Rail with a number of other European rail infrastructure organisations. This is intended to help inform the ORR's understanding of the impact of materials procurement on the efficiency gap of 35-40% identified as part of the determination process for Control Period 4 (CP4) running from 2009 to 2013.

As well as analysing the key factors driving material price levels, this report provides an assessment of potential cost saving measures that we consider merit further investigation by NR for each material type.

Sourcing of materials cost data

The majority of NR's materials cost data were provided by the "National Delivery Service" (NDS) department, which oversees an annual procurement budget of over £280m.

Price data were obtained for comparison from the following organisations:

- Comparator 1: European rail infrastructure operator.
- Comparator 2: European rail infrastructure operator.
- Comparator 3: European rail infrastructure operator.
- Comparator 4: European rail infrastructure operator.
- Comparator 5: a contractor delivering rail infrastructure on behalf of a European national infrastructure provider.
- Comparator 6: project data from rail infrastructure projects in a (non-UK) European country.

Although both Arup and NR contacted on numerous occasions a number of other national rail infrastructure operators across Europe, it was not possible - at the time of writing - to obtain benchmarking data from them to support this study.

Harmonisation and summation of benchmark figures

It was necessary to apply a number of adjustments to input price data to enable meaningful price comparisons to be made on a consistent like-for-like basis. This included:

- discounting of transport costs, taxes, charges and other non-material price factors to ensure comparison, as far as possible, on a "factory gate" basis; and

- application of country-specific purchasing power parity values for incoming cost data provided in overseas currencies.

The results obtained have been presented on the basis of a single set of comparator benchmark figures, against which relative NR materials cost levels can be compared for each material category on an aggregated basis. Input prices are weighted according to estimated level of consumption for the respective variants within a given materials category[1].

Arup has also applied a sensitivity analysis, to test the impact of applying alternative purchasing power parity values, as well as testing the impact of other adjustments to comparator data. See Appendix C for further details.

Benchmarking results and key findings

The table overleaf sets out the key high-level benchmarking results, including:

- Average comparator price differential: this shows the percentage difference between the NR weighted average price levels versus comparator price levels for each material type. Material types where the NR price level is higher than the comparator price level are highlighted in red.
- NR cost efficiency potential: this summarises our assessment of the extent to which cost efficiencies relative to existing price levels may realised. For items showing a moderate or high efficiency potential, we have assigned an indicative efficiency potential figure that we consider may be achievable for the given material type.

Note: it is assumed that all material volume figures presented relate to one full year's worth of consumption for the given material variant, unless indicated otherwise.

[1] Average comparator price levels were based on amalgamation of the prices of several variants, with prices for individual variants weighted according to their consumption level (i.e. higher-volume items were given proportionately higher weighting in the combined figure). Where definitive consumption volumes were not provided for a given variant, proxy consumption levels were estimated according to the relative size and utilisation level of the rail network from which the source data originates (see Chapter 2).

Table 1 – summary of results and key findings

Material Type	NR comparator material expenditure[2] (2010 prices)	NR unit price (weighted average)[3]	Network Rail price differential (weighted average vs. comparators (%))[4]	NR cost efficiency potential
Rail	*£70.1m*	£574 / tonne	**-12.2%**	Low
Rail clips	*£2.9m*	£1.31 / item	**-0.8%**	Low
Sleepers	*£28.6m*	£29 / item	**-31.9%**	Low
Ballast	*£13.4m*	£6.70 / tonne	**-18.3%**	Low
Switches & Crossings	*£15.9m*	£48,186 / turnout £107,991 / crossover	**+16.3% (turnouts) +14.0% (crossover)**	Moderate[5]
Signal heads	*£2.0m*	£1,980 / item	*No data*	Low
Cabling	*£7.3m*	£1.14 - £8.10 / metre (signal cabling)	**-33.2% (signal cabling)**	Moderate[6]
Axle counter evaluators	*£0.2m*	£34,788 / item	**+124.9%**	Low[7]
Points machines	*£0.9m*	£22,612 / item	*No data*	Low

[2] These expenditure figures relate to the volumes and unit costs provided by Network Rail for materials variants benchmarked in this study. Whilst we consider these figures to be broadly representative of Network Rail's total 2010 expenditure for the given material categories, they are not intended to represent comprehensive or definitive total consumption levels for the given category. There may be other material types or variants that fall under the given categories which were not encompassed within the scope of this benchmarking study.

[3] Comparator price variants amalgamated and weighted according to the estimated relative consumption level (see Chapter 2)

[4] Negative value (-) indicates NR weighted average price below weighted average comparator price level ; positive value (+) indicates NR weighted average price above weighted average comparator price level.

[5] We estimate there is potential for Network Rail to achieve £0.3m annual cost savings in relation to procurement of Switches & Crossings (see Section 3.6).

[6] Although we consider there to be moderate efficiency potential for NR to achieve efficiencies in the procurement of cabling due to competitive market conditions (see Section 3.8), we do not consider it appropriate to provide a quantified estimation, due to the limited scope of comparator data for this material type, provided from only one comparator organisation.

[7] Although NR prices for axle counters were significantly higher than the comparator organisations, axle counter equipment needs to be integrated with other signalling equipment, which is likely to limit the scope for introducing an alternative supplier's equipment. We consider that single-supplier conditions and current low order volumes are likely to preclude any scope for volume efficiencies at present (see Section 3.9).

The results demonstrate significant levels of variation in comparator prices across different material types. NR price levels for the majority of materials types are below comparator price levels.[8]

In the context of the overall efficiency gap of 35-40% identified by the ORR as part of the PR08 process, we consider the cost efficiency potential for the materials reviewed to be limited. In only two out of the nine materials types studied have we identified what we consider to be moderate cost efficiency potential. On this basis, we have been able to estimate an annual cost efficiency impact of only £0.3m in total. On the basis of present benchmark price level and procurement conditions, we do not consider any of the material types reviewed, to have "high" cost efficiency potential.

The value of material procured by NR compared to other organisations is comparatively high. Economic theory suggests that the company should be able to take advantage of its purchasing power to obtain comparatively lower prices for a number of (the high-spend) items including rail and sleepers.

For rail, as the highest spend item, the NR price level is lower than the average comparator price level. The key price driver appears to be volume. NR and another (Comparator) organisation procure the highest rail volumes in the sample. Both enjoy lower price levels than other comparator organisations procuring lower volumes. Notwithstanding this, there was less variation across in the price paid for rail across the comparator organisations than for any of the other material types reviewed.

For switches and crossings, which also account for a comparatively high level of expenditure, the NR average price level for turnouts and crossovers was found to be higher than the price level for comparator organisations. The technical complexity and dependency of these items (driven by a multiplicity of site-specific factors) may restrict the potential to reduce cost to some degree. However, we consider that there remains a moderate level of efficiency potential arising from a greater degree of standardisation. In addition, increasing the number of items procured against individual variants in line with comparator organisations (rather than limiting orders per variant to just 1-2 items, as with the majority of NR S&C variants at present) may also generate efficiencies.[9] Based on the comparator data provided, we have estimated that up to £0.3m of savings in material procurement costs may be achieved by lowering the cost of 20% of NR turnouts and crossovers in line with comparator price levels.[10]

For the remaining material types (with the exception of axle counter evaluators), the results show an average comparator price level above the NR price level.

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[8] This finding is in contrast to a recent study undertaken by NR, which benchmarked materials costs from a UK contractor with costs from contractors in three other European countries. This study identified that UK civil engineering materials costs were significantly higher than overseas comparators. An extract from this report is provided in Appendix K.

[9] We recognise that Network Rail is well aware of the potential efficiencies in this area, and that it is presently developing a policy to increase the level of standardisation in its S&C procurement processes, as well planning as further increasing deployment of modular S&C components from current levels, in order to drive down costs.

[10] Although the focus of this study has been on material procurement prices, we also consider it to be appropriate that, the longer-term cost implications (i.e. from whole-life-costing perspective) are also taken into account when assessing the use of standardised materials / components – this is reflected in our recommendations below.

For concrete sleepers, another high-expenditure item, the NR price is 47% below the comparator price level. We consider that, although other sleeper types exist that have a lower procurement cost, such materials typically have lower performance characteristics or durability, and hence may be less suitable or economical for deployment on a widespread basis. One example is softwood sleeper variants, which although 26% cheaper than concrete variants, are presently procured by NR in far lower volumes due to their limited suitability for most track locations. We consider that Network Rail's current practice of material recycling / reusage through the cascading of higher specification concrete and steel sleepers to lower category routes represents a more economical alternative than the purchasing of new lower specification materials.

We consider cost efficiency potential for the majority of other materials types to be low for a number of reasons (discussed in the main part of this report). We consider a moderate level of cost efficiency potential for both signalling and telecommunications cabling may exist. This is due to competitive market conditions for such materials that could be more effectively exploited. However, due to very limited comparator data provided we do not considered it appropriate to include an estimation of cost efficiency potential for this material category.

Impact and recommendations

Based on the findings of this study, we have made the following recommendations (see Chapter 4 for further details):

- We recommend that - where it is not already happening - NR systematically monitors market prices for all major materials types procured by NDS, and continually assesses the prices of current suppliers compared to potential alternative suppliers of the same or similar material types.[11]
- We recommend that NR undertakes a cost-benefit analysis of implementation of materials manufactured to different specification levels in a number of categories, taking into account the impact of procurement cost savings levels compared to potential costs incurred due to differing material performance levels and compliance with required standards.
- We recommend that NR develops a robust methodology for appraising the relative costs of material variants in each of the major categories reviewed in this study on a whole-life-costing basis.
- We recommend that NR regularly reviews hedging and other measures taken by NDS to reduce exposure to supply market volatility and price escalation.
- We recommend that NR examines the potential for simplification of the Type Approval process, in order to facilitate greater competition and swifter introduction of alternative material variants and technologies.

[11] Network Rail already participates in forums such as the European Rail Procurement Council, which we consider an appropriate forum through which procurement knowledge and best practice can be shared. We do not consider there are likely to be significant potential benefits through procurement joint venture with other European rail organisations per se, given that Network Rail is of sufficient scale as an organisation to hold significant purchasing power in its own right; we also consider that differing material specifications and requirements could make a purchasing joint venture between the European rail organisations unworkable.

1 Introduction

Anonymised version

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1.1 Background and objectives

The purpose of this benchmarking report is to assess the cost of common rail materials procured by Network Rail (NR) against those procured by European rail organisations.

For the purposes of the study, the cost of the material is defined as the cost at the "factory gate"[12], prior to delivery to the client. The benchmarking data contained in this report are intended to inform the ORR's understanding of the relative influence of materials procurement in the efficiency gap of 35-40% identified within NR's cost base.

The overall objectives of this study are as follows:

- Provide a view of NR material costs and where relevant and practicable, its procurement practices.
- Provide a comparison of NR material costs with supplier costs from other UK and European sources in order to assess any efficiency gap.
- Inform the ORR's analysis of efficiency for PR13.

The background and objectives for this review are set out in full in the study mandate, attached as Appendix H to this report.

Due to the limitations of available data for certain material types, the materials list cited within the original mandate has been revised as follows. Further information on the materials selected is documented in Chapters 2 & 3 of this report:

- Rail
- Rail Clips
- Sleepers
- Ballast
- Switches and Crossings
- Signal Heads
- Cabling
- OLE Wire
- Axle counter evaluators
- Point Machines

[12] Factory gate price means the price paid to the manufacturer or supplier of the material at the point of purchase, discounting any transport, storage, handling or other service charges, and any VAT or other external charges.

1.2 Report structure

Our report is set out under the following sections:

- Chapter 2 - Approach and methodology: we explain our overall approach to the study, including the way in which appropriate comparator data were sourced and identified; we also set out the methodology by which costs are harmonised to enable meaningful comparisons from the various sources of data.

- Chapter 3 - Results and key findings: we set out in this section the results obtained together with our analysis of the key price differentials for each of the key materials categories; we also set out our assessment of potential cost saving measures that merit further investigation by NR.

- Chapter 4 - Impact and Recommendations: we provide an overall assessment of the impact of the findings of this report on the CP5 determination process, together with our recommendations to NR.

1.3 Limitations to our analysis

The findings set out within this report are to a large part informed by the provision of data from rail organisations which are not in the public domain, and often seen to be of a commercially sensitive nature. Whilst Arup has endeavoured to obtain as much detail as possible in relation to the background assumptions and methodology upon which the comparator data are based, there are certain areas of comparator data within the report for which full supporting information could not be obtained. As a result, we have applied - where appropriate - a number of assumptions to compensate for limitations in the data provided. These are noted in the main body of the report.

2 Approach and methodology

2.1 Sourcing of materials cost data

2.1.1 Network Rail data

The majority of NR's materials cost data were provided by the "National Delivery Service" (NDS), a centralised NR department with oversight of key elements of NR's materials and equipment supply chain. NDS has direct responsibility for the negotiation of supply contracts for the most significant materials items in terms of overall spend, overseeing an annual procurement budget of approximately over £280m[13]. This includes all of the materials types examined in this study.

The following table provides an overview of the volumes and cost of key materials provided for comparison in this study.

Table 2 – Summary of NR benchmarked materials

Item	Total benchmarked volume (2010)	Unit of volume	Cost of benchmarked materials (£m)
FB113 rail	102,682	tonnes	58.9
CEN60 rail	19,535	tonnes	11.3
Sleepers	840,000	items	28.6
Ballast	2,000,000	tonnes	13.4
Switches and crossings	208	items	15.9
Signal heads	1,025	items	2.0
Points motors	43	items	0.9
Axle counter evaluators	6	items	0.2
Cabling	3,869,156	metres	7.3
Rail fasteners	2,232,200	items	2.9
Total benchmarked materials spend 2010 (£m)			**141.4**

2.1.2 Comparator data

In order to obtain a suitable range of comparator materials data, a number of European rail infrastructure managers were contacted, as well as various contractors involved in materials procurement for significant projects.

[13] NDS' annual procurement budget (FY2010/11) of £281m consisted of:

- Ballast – £20m
- Rail – £66m
- Sleepers – £44m
- S&C - £58m
- Railway Spares – 93m

This figure does not include logistics, on-track machines, rail fleet or road fleet costs.

Supported by NR and the ORR, Arup was able to obtain comparator data from the following European rail infrastructure managers:

- Comparator 1 (European rail infrastructure operator).
- Comparator 2 (European rail infrastructure operator).
- Comparator 3 (European rail infrastructure operator).
- Comparator 4 (European infrastructure operator).

Arup was also able to obtain comparator data from the following contractors and consultants involved in procuring significant quantities of materials for major rail enhancement / renewals projects:

- Comparator 5: a contractor delivering rail infrastructure on behalf of a European national infrastructure provider.
- Comparator 6: project data from rail infrastructure projects in a (non-UK) European country.

2.2 Harmonisation of cost figures

2.2.1 Harmonisation approach

A number of adjustments have been applied to incoming comparator cost data, with the aim of comparing prices on a like-for-like basis. These have been applied on the following basis:

- Standard cost harmonisation factors: a standard set of assumptions has been applied for the results presented in the main part of this report. These are summarised below and explained in further detail in Appendix B.
- Sensitivity analysis: we have undertaken a sensitivity analysis for a selection of harmonisation factors, including:
    - application of an alternative purchasing power parity value;
    - application of a nominal volume discount to a selection of the comparator data; and
    - exclusion of comparator data from higher-cost / lower-volume comparators.
- An overview of the sensitivity testing undertaken and the results derived is set out in Appendix C.

2.2.2 Standard cost harmonisation factors

We summarise below the standard cost harmonisation factors and underlying assumptions upon which the main results presented in Chapter 3 are based. (These factors are explained in more detail in Appendix B).

- **Factory gate price:** in general, materials costs have been compared and analysed on the basis of factory gate prices. This means the price paid to the manufacturer or supplier of the material at the point of purchase, discounting any transport, storage, handling or other service fees, and any VAT or other external charges.[14]

- **Standardised unit of measure:** the unit of measure utilised by NR for UK materials adopted as the standard unit measure for each material category. For example, UIC rail costs are presented on a per tonne basis, rather than a per metre basis as utilised by European comparators.
- **Parity of overseas costs with GBP (£)**: incoming cost data provided in overseas currencies were converted to a £-sterling purchasing power parity (PPP) value on the basis of the country-specific purchasing power parity value for the given country provided by OECD, averaged out over the period 2008-2010.[15] PPPs are used as currency conversion rates to convert expenditures expressed in national currencies into an artificial common currency (the Purchasing Power Standard, PPS), in order to try and remove the effect of price level differences across countries.
- **Price inflation adjustments:** All benchmarking data have been compared on the basis of 2010 £ sterling prices. It was necessary to adjust a small proportion of comparator data from earlier projects (2009 onwards) to account for inflation. For these data, an adjustment formula has been applied which combines RPI, as an overall measure of general economic inflation, with the building tender price index, which is likely to account for specific inflationary factors associated with factor inputs including materials. This formula comprises the following, applied on a year-on-year basis:
    - RPI index (%) applicable to source country * 0.5
    - Building tender price index (%) applicable to source country * 0.5

2.2.3 Collation of summary benchmark figures

- The results obtained have been summarised on the basis of a single set of comparator benchmark figures, against which NR materials cost levels can be compared for each material category on an aggregated basis (see Chapter 3).
- For material types with a significant degree of homogeneity between comparators such as rail, rail clips (Pandrol variants), sleepers (concrete variants), and ballast we have collated a single weighted benchmark figure. This entails:
    - Amalgamation of prices from each comparator organisation, with inputs weighted on the basis of annual consumption level for each variant.
    - Where annual consumption level figures were not provided or incomplete, the input figures from the relevant source organisations were weighted using a proxy consumption level, which was then

[14] Although the general approach has been to compare materials on the basis of factory gate prices, for some of the more technically complex items such as Switches and Crossings, the material prices shown are likely to contain elements of preparation and handling associated with the procurement price. It is not always possible, on the basis of price information provided, to isolate and discount such factors for such material types.
[15] Note: for the purposes of our Sensitivity Analysis, we have tested the impact of using an alternative purchasing power parity value, based on the average parity value for the last 10 years (2001-2010). See Appendix C for details.

evenly subdivided across the range of comparator figures provided from the given organisation.

- The proxy consumption level was calculated on the basis of the proportionate size of the comparator organisation's rail network, via the application of the comparative parameters:
  - total track km (60% weighting);
  - annual passenger km (30% weighting); and
  - annual freight tonne km (10% weighting).[16]

- For material categories with a lower level of homogeneity (such as cabling), we have provided the levels of price differentiation between NR and its comparators by means of a range, illustrating the extent of price differences with comparators in absolute and percentage terms.
- We have combined the aggregated comparator benchmark figures and our assessment of the cost efficiency potential for each material category with NR's overall level of spend for the given material type. This is intended to support the ORR's understanding of the efficiency gap, by providing an illustration of the potential magnitude of cost efficiencies relative to the given material category that may be attainable.

2.3 Analysis of key price differentials

We have undertaken a qualitative analysis of the extent to which key characteristics of each material type are likely to influence their relative price level. This has entailed consideration of the following:

- **Technical characteristics and material properties:** this includes assessment of the level of commonality and standardisation of material specifications across the comparator organisations, and the scope for variability in technical characteristics, vis-a-vis the performance and functional requirements of the given material in its deployment.
- **Sourcing and supply conditions:** this includes assessment of current supply arrangements (e.g. manufacturing process, order volumes, supply chain), consideration of viability and practicality of potential alternative suppliers and potential restrictions / hindrances to alternatives (e.g. technical compatibility, transport / delivery).
- **Material volumes:** this includes the impact of order volumes and continuity of supply for the given material type.

Based on this analysis, we have then undertaken a subjective assessment of the potential scope for NR to identify cost savings for each material type. We make recommendations for NR to investigate such savings on this basis in a number of instances.

[16] By means of an example, if material variants from Comparators 1&2 were to be combined for a single summary benchmark price, the weighting would represent the relative size and utilisation of the respective rail networks (relative to the UK rail network), calculated in accordance with the formula set out above (combining total track km, passenger km and freight tonne km).

3 Benchmarking results and key findings

3.1 Introduction

We set out in this chapter the results of our benchmarking analysis. For each material category, we include the following:

- Benchmarking price comparison: this sets out the overall results of our comparative analysis of NR prices using a single set of benchmark figures to provide a high-level overview of the results obtained.
- Price drivers and key differentials: we provide our analysis of the key factors influencing materials costs, together with our assessment of the potential scope for NR to identify cost savings for the given material category.
- Recommendations: we set out our recommendations for each material category.

Full details of the input benchmarking data upon which our analysis is based is provided in the following Appendices:

- Appendix A – Full benchmarking cost results: this provides a graphical overview of the cost levels for the key variants compared for each materials category.
- Appendix D – Material key characteristics: this provides an overview of the key technical characteristics of each of the material types examined, together with a review of supply market conditions.
- Appendix E – Material key variants: we provide a brief overview of the key technical characteristics of a number of key material variants, comparing NR variants with those provided by comparator organisations. .
- Appendix F – Reuse and recycling: we discuss the potential for reuse and recycling of each material type, and how this may influence material cost.

3.2 Rail

3.2.1 Benchmark price comparison

Table 3 – Key comparator indices: rail

NR comparator volume	122,200t
NR comparator expenditure (total)	£58.9m
Weighted NR unit price	£574/t (4 variants)
Comparator organisations:	Comparator 1 Comparator 2 Comparator 3 Comparator 4 Comparator 5 Comparator 6
Comparator price range:	£582/t to £814/t (12 x variants)
Weighted average comparator price	£653/t
Weighted average NR price differential vs. comparators (%)	**12.2% below average comparator price level**

Benchmarking analysis

In overall terms, Network Rail's weighted price for UIC rail was 12.2% below the average comparator price level.

One Comparator organisation provided the lowest benchmarked price in relation to 60 E1 (UIC60) rail of £582/t based on the supply of 108m long manufactured sections, just 1% higher than the NR price of £580/tonne for similar 60 E2 (UIC60) rail. The closeness in price can be attributed to the similarity of the two material types in terms of weight per linear metre of track, profile and loading capacity. Given that the volumes procured by both NDS and another comparator organisation – of 80,300t and 108,000t respectively for these variants – are higher than other comparator organisations, we consider this is likely to contribute to lower comparative price levels.

Data provided from another comparator organisation relates to a number of CEN60 rail variants, for which an overall volume of 44,600t was procured – only around one third of the NR total volume. The average price level of £641/t is 12% higher than the NR average, which corresponds to the trend of lower volumes driving higher prices.

Price levels for the other comparator organisations range from 3% higher to as much as 42% higher than the NR weighted average. Predominantly this reflects the source of data. Another comparator organisation's rail data are based on two

individual projects rather than a national procurement programme. Data points obtained for
In summary, the benchmarking for UIC rail has identified NR's price to be 12.2% below the weighted average comparator cost, which we consider to be driven predominantly by the generally lower total volumes associated with the comparator data.

Material characteristics

Around 84% of rail material (59 million tonnes) provided for comparison by NR relates to the lighter UIC 56 (56.3 KG/metre) rail type, with the UIC 60 (60 KG/metre) type accounting for only 16% (11 million tonnes). We understand that UIC 56-equivalent rail was installed across the UK rail network as standard during the 1960s[17], which we consider accounts for the higher levels of consumption, given that like-for-like replacement represents a more economical option than the replacement with UIC 60 rail in the majority of cases.

In contrast, almost all of the rail material provided by European comparator organisations was in the "UIC 60" (60 KG/metre) category; this is generally considered to be the standard rail type for most other European rail networks.

When comparing the Network Rail 56.3 KG and 60 KG per metre variants on a per tonne basis, the prices provided are (perhaps unsurprisingly) identical; conversely, when measured on the basis of length, the 56.3 KG/m rail is 6.6% more economical, i.e. covers a 6.6% greater length compared to the UIC 60 rail purchased at the same per tonne rate.

With regard to material grade, whilst all four NR rail variants and the majority of comparator rail variants relate to standard R260 grade material, three of the comparator organisations also provided price data for higher-grade R350 material. The data provided indicated that R350 material is priced between 10% and 30% above the standard R260 grade material, although it appears that such material is procured by the respective comparator organisations in far lower volumes than the standard grade material.

We consider that it would be appropriate for NR to continually monitor technical innovations and improvements in rail material quality, in order to take into account the benefits in terms of durability and associated whole-life-cost that introducing higher-grade material types may have.[18]

[17] Rail that is presently classified as UIC 56 (56.3 KG per metre) relates to the original standard weight of rail installed by British Rail during the 1960s of 113lb per yard.
[18] Steel rail material has been subject of continual research by manufacturers, with considerable modifications applied to enable the introduction of higher-grade material types to facilitate greater performance and durability. (Ref. "Tata Steel's innovative rail steels combat degradation": article on http://www.rail.co/2011/03/29/tata-steels-innovative-rail-steels-combat-degradation/, 29 March 2011.

3.2.2 Price drivers and key differentials

Table 4 – price drivers: rail

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Not significant**	• High level of uniformity between comparators. • Material characteristics, design and performance requirements specified by European norms.
Sourcing and supply conditions	**Significant**	• Highly capital-intensive production requires specialised, large scale facilities. • Production price likely significantly influence by coal and iron ore commodity prices. • Material bulk and dimensions mean high transport costs. • NR presently supplied by one UK rail manufacturing facility in Scunthorpe, providing rail in lengths of up to 216m. No comparable facilities elsewhere in the UK, therefore very little direct competition.
Material volumes	**Significant**	• Data obtained indicated that order volume has a significant impact on unit price.

Table 5 –cost efficiency potential: rail

NR Cost Efficiency Potential	Observations
Low	• Competition from supply sources in overseas locations (e.g. Austria) likely to be restricted by transport costs and by logistical issues.[19] • NR's existing supply chain is mature and appears cost efficient. NR already sources comparatively high volumes of rail from the Scunthorpe manufacturing facility. Rail is procured in extended 108 m lengths to enable lower installation costs. • Logistics of manufacturing and distribution limit prospect of viable alternatives for present large-scale UK supply process. • As the key determinant of the unit price variance is volume there appears to be some potential for cost efficiency depending on planned volumes. Unit prices should be reviewed in the event that volumes increase in the course of the Control Period.

3.2.3 Recommendations

Based on the data provided, the price level for NR's rail variants appears competitive. Given the impact of commodity price volatility on the price level for steel products, we recommend that NR continues to monitor steel price levels closely and establish target rates for improvements in price efficiency.

[19] We note that Network Rail has previously procured rail from northern France; we consider the procurement of rail from European locations in reasonable proximity to the UK may represent a realistic potential alternative supply source.

3.3 Rail Clips

3.3.1 Benchmark price analysis

Table 6 – Key comparator indices: Pandrol clips

NR comparator volume	2.2 million items
NR comparator total expenditure	£2.9m
Weighted NR unit price	£1.31/item (6 variants)
Comparator organisations:	• Comparator 1 • Comparator 2 • Comparator 5
Comparator price range:	£1.05 to £1.72/item (7 x variants)
Weighted average comparator price	£1.32/item
Weighted average NR price differential vs. comparators (%)	**0.8% below average comparator price level**

Pandrol clips

Variations in the cost of rail clips across all comparators tended to depend on the fixing system utilised and the material type.

NR is supplied almost exclusively by Pandrol, whose clip variants include both lower cost clip types such as E1809 and larger, more expensive clip types such as PR427A. “Sheradised” (hardened) clips or those with a specific RAL colour coding were also found to be more expensive.

In overall terms, Network Rail’sweighted comparator price was 0.8% below the average comparator price level, with Comparator 5 showing the lowest comparator price of £1.05/item, and Comparator 2 showing the highest price of £1.72 per item.

Other clip types

When comparing Pandrol clip types with other manufacturers, the relative price level appears to be driven by the relative level of complexity of the given clip type.

More simple variants show lower cost levels. For example, the clips that one comparator organisation uses have an average price of £0.77, which is 41% lower than the benchmark NR price. Similarly, another Comparator clip type shows a benchmark price 15% below the NR average. The lower prices evident among such variants may be attributed to the large number of suppliers available in the market, many of them based in China, supplying large varieties of lower cost railway clips worldwide.

In contrast, the more complex clip type, procured by one Comparator costs around 33% more.

3.3.2 Price drivers and key differentials

Table 7 – price drivers: rail clips

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Significant**	• Material performance and functional requirements specified by European norms. • Significant variability of design between manufacturers.
Sourcing and supply conditions	**Significant**	• Pandrol is virtually monopoly supplier to NR. • Vossloh is the largest alternative supplier, but is not currently supplying to NR.
Material volumes	**Significant**	• All variants used are standardised products ordered from the manufacturer rather than bespoke designs. High volumes naturally result in lower prices for mass produced items.

Table 8 –cost efficiency potential: rail clips

NR Cost Efficiency Potential	Observations
Low	• Although rail clip supply to the UK market is dominated by Pandrol, the cost impact - even if savings in excess of 10% were achievable – is low. • Clip design requires compatibility of rail shoe and sleeper design, therefore clip type is dictated by asset management policy on sleeper assemblies and would be a high cost item to initiate change. NR already procures rail clips in comparatively large volumes, therefore there we consider there is little scope for further volume efficiencies

3.3.3 Recommendations

Whilst a useful indicator of cost efficiency in procurement, the impact of material changes in the purchase price of rail clips would have only a small impact on cost reduction. We consider that altering design standards for rail clips and associated fixing assemblies would produce only a small marginal gain, given their dependency on sleeper design, for which we consider there to be a greater potential efficiency impact (see below).

3.4 Sleepers

3.4.1 Benchmark price analysis

Table 9 – Key comparator indices: concrete sleepers

NR comparator volume	600,000 items
NR comparator expenditure (total)	£17.6m
Weighted NR unit price	£29.38 (5 variants)
Comparator organisations:	• Comparator 1 • Comparator 2 • Comparator 3 • Comparator 5 • Comparator 6
Comparator price range	£36/item to £50/item (12 x variants)
Weighted average comparator price	£43.12
Weighted average NR price differential vs. comparators (%)	**31.9% below average comparator price level**

Concrete sleepers

The weighted average Network Rail price for concrete sleepers was found to be significantly lower than the average comparator price, with a price differential of -31.9%.

A relatively wide spread of unit prices was identified amongst concrete sleeper variants, reflecting the differing specifications developed for the different sleeper types (in contrast to the comparative uniformity of rail variants).

NR’s G44 concrete sleeper was found to be the cheapest of all variants reviewed, with a unit cost of £27.88, indicative of the high procurement volume of 450,000 items for this variant. This compares to a cost of £47.00 for the more complex 5EF28 variant, designed for sections of track which accommodate an electrified third rail, with the far lower procurement volume of 25,000 items.

Amongst the comparators, the lowest priced variant was the a comparator variant costing £35.93/item, with the most expensive comparator variants costing around £50/item.

Other sleeper types

For other sleeper types, we found the following:

- **Steel sleepers:** the NR unit price of £55.33/item is almost 50% below the sole comparator price from one comparator organisation, of £100/item. NR's price data were based on a procurement volume of just one quarter the level of the concrete sleeper volume. We understand NR intends to limit procurement volumes of steel sleepers in future due to concerns about both purchase cost and potential price escalation.
- **Softwood sleepers:** the NR unit price of £21.67/item relates to a total procurement volume of 60,000 items (one tenth of the concrete sleeper volume).
  - NR's price is 10.3% below the benchmark price for one comparator organisation, but 9.9% more expensive than the benchmark price for another comparator organisation.
  - When compared to the purchase price paid by NR for concrete sleepers, softwood sleepers are 26% below the weighted average concrete sleeper price of £29.38.
- **Hardwood sleepers:** the NR unit price of £46.67/item relates to a total procurement volume of 30,000 items (5% of the concrete sleeper volume). NR's price is over 40% below the benchmark price for one comparator organisation, but 15.6% more expensive than the benchmark price for another comparator organisation. We understand that NR intends to minimise hardwood sleeper procurement in future due to concerns regarding cost and sustainable sourcing of such material.

3.4.2 Price drivers and key differentials

Table 10 – price drivers: sleepers

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Significant**	• Performance and functional requirements for main line load-bearing (25-tonne axle-bearing) sleepers specified by European norms. • Significant price variability between different variants.
Sourcing and supply conditions	**Significant**	• A limited number of major industrial groups operate various sleeper manufacturing facilities across Europe. • UK sleeper production dominated by around five manufacturers.
Material volumes	**Significant**	• Sleeper variants are generally manufactured to standard specifications rather than to bespoke designs.

Table 11 –cost efficiency potential: sleepers

NR Cost Efficiency Potential	Observations
Low	• NR procures concrete sleepers at a considerably lower price than the comparator organisations. • Although NR procures softwood sleepers at a price level more than 25% below the concrete sleeper price, such materials typically have lower performance characteristics or durability, and hence may be less suitable or economical for deployment on a widespread basis. Transport costs are likely to become significant for suppliers not within reasonable proximity (e.g. <200km), therefore scope for increasing the number of potential suppliers, e.g. from overseas, is likely to be limited.

3.4.3 Recommendations

Based on the data provided, the price level for NR's sleeper variants appears competitive.

However, we recommend that NR continues to monitor sleeper price levels closely, as well as continuing to make use of sleeper reusage and cascading of materials to maximise efficiency in the procurement and deployment of such materials..

3.5 Ballast

3.5.1 Benchmark price analysis

Table 12 – Key comparator indices: ballast

NR comparator volume	2 million tonnes
NR comparator expenditure (total)	£13.4m
Weighted NR unit price	£6.70 / tonne (1 x variant)
Comparator organisations:	• (Two Comparator Organisations) • UK civils price index
Comparator price range:	£6.96/t to £10.14/t (3 x variants)
Weighted average comparator price	£8.20
Weighted average NR price differential vs. comparators (%)	**18.3% below average comparator price level**

The cost of ballast was benchmarked against two European Comparator organisations, as well as the listed cost for UK crushed granite cost from a civil engineering construction index.

As indicated in the table above, the unit price at which NR procures ballast is lower than all three of the comparator organisations. This is considered to be the result of high volume and the availability of suitable material in the UK. One Comparator organisation showed a price level of £6.96 per tonne (4% higher than NR), relating to a slightly lower procurement volume of 1.94m tonnes. The other Comparator organisation showed a significantly higher price of £9.22 per tonne (38% above NR), although this related to a material volume only around half that of NR.

3.5.2 Price drivers and key differentials

Table 13 – price drivers: ballast

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Not significant**	• Required to conform with European norms for material characteristics, e.g. strength, hardness. • Constituted from hard impermeable stone such as granite. • Generally supplied by companies that also produce aggregate products from their quarries for a number of industries.

Sourcing and supply conditions	**Significant**	• Heavy bulk material leads to moderately high transport costs. • NR has consolidated its supply of ballast to two UK quarries.
Material volumes	**Significant/ Moderate**	• Low-value, high-bulk nature of ballast material means that higher order volumes will be likely to lead to economies of scale and lower procurement costs.

Table 14 –cost efficiency potential: ballast

NR Cost Efficiency Potential	Observations
Low	• Material already sourced from within the UK at comparatively low cost. • NR already procures ballast in comparatively large volumes from UK sources.

3.5.3 Recommendations

Based on the limited benchmarking obtained, the unit price at which NR procures ballast appears competitive. We recommend that alternative sources of cost data continue to be monitored.

3.6 Switches and Crossings

3.6.1 Benchmark price analysis

Table 15 – Key comparator indices: switches and crossings

	Turnouts (1 unit)	**Crossover (2 units)**
NR comparator volume	107 items	71 items
Weighted NR unit price	£48,186 (38 variants)	£107,991 (22 variants)
Comparator organisations:	• Comparator 3 • Comparator 5 • Comparator 6	• Comparator 3 • Comparator 5
Comparator price range	£23,993 to £65,010 per item (10 x variants)	£78,731 to £99,259 per item (5 x variants)
Weighted average comparator price	£41,427	£94,763
Weighted average NR price differential vs. comparators (%)	**16.3% above average comparator price level**	**14.0% above average comparator price level**

NR provided price data for over 200 Switches and Crossings (S&C) items, with a total value of over £16m. The data provided indicates that the price for any given switch / crossing type is likely to vary significantly, depending on its particular characteristics. The cost is governed by a wide range of design criteria including alignment, geometry, line speed and loading.

Due to the complexity associated with comparing specifications and design standards of various comparator organisations, and the limited amount of comparator data available, it was only possible to compare price levels on the basis of a simple average cost figure, calculated from the multiple variants provided by NR and the comparator organisations. Our analysis has been based on the following two comparatively simple S&C variants, which we consider are sufficiently homogenous in terms of overall technical characteristics to be suitable for comparison:

- turnouts; and
- crossovers.

For turnouts, the data provided from one comparator organisation was based on price data for 9 turnout variants (102 items in total), with an average price level 13% below the Network Rail average price level of £48,186. The data from another comparator organisation, based on 4 examples of the same variant procured for a specific project, showed a price level 11% below the NR average.

The single variant from one Comparator organisation was shown to have the lowest price level at £38,519, 20% below the NR average price; however, since this figure relates to only one variant, the price may not be representative of the average price of turnouts procured.

For crossovers, the average price paid by a comparator organisation, relating to a total of 17 items across 4 variants was found to be 16% lower than the average price for Network Rail's 22 variants. The single variant from another comparator organisation was also priced 8% lower than the Network Rail average.

For both turnouts and crossovers, the comparator organisations' data show that greater numbers of items are procured per individual variant, compared to NR which for the majority of variants procures a total of just 1 or 2 items per variant. This suggests a lower level of standardisation for NR switches and crossings compared to the comparator organisations. We consider that this is likely to contribute to higher cost levels due to the relatively bespoke nature of the majority of NR S&C variants provided.

3.6.2 Price drivers and key differentials

Table 16 – price drivers: switches & crossings

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Significant**	• Significant variations in design as a result of site-specific variations for any given switch installation (e.g. alignment and geometry, line and switch speed, site-related design parameters, bearer material, etc.). • European norms applicable to material strength and performance parameters.
Sourcing and supply conditions	**Significant**	• Consolidated European market now dominated by handful of large suppliers operating a wide range of production facilities for various switch applications. • NR procures the majority of S&C items through framework agreements presently in place with three major suppliers. • A small number of independent UK-based switch manufacturers supply switches for small-scale contracts and specialist industrial applications.
Material volumes	**Significant**	• Although order volumes for a given S&C variant are typically low due to the bespoke and individual nature of S&C applications, some degree of standardisation may facilitate the increase in order volume for a given variant. Increasing from just 1 or 2 items that are typically procured by NR at present to several items per variant is likely to lead to lower costs per item.

		• Comparator data indicates generally higher numbers of items procured per variant, suggesting a greater degree of standardisation.

Table 17 –cost efficiency potential: switches & crossings

NR Cost Efficiency Potential	Observations

Moderate
 	
Cost saving up to £0.33m (1.2% total expenditure)
	• Present NR framework agreements with three competing suppliers should ensure S&C items can be competitively procured.
	• Geometries and other design requirements are likely to be pre-determined to some degree limiting the scope for technical variation. Typical requirement for installation within a short possession timeframe is likely to further inhibit potential design flexibility
	• However, we consider that there is likely to be scope for a greater degree of standardisation by NR, to increase the order volumes for a given variant and thereby realise volume efficiencies in line with the comparator organisations.
	• An indication of cost efficiency potential may be given by taking the present price differentials for turnouts and crossovers between the NR weighted average price and the price paid by the comparators, and applying this to a proportion of present NR expenditure,
	• If the price differentials of 14.0% and 12.2% for turnouts and crossovers respectively were applied to around 20% of such items procured by NR, this would result in an overall cost saving of £0.33m, based on the following estimation:
	  ◦ for turnouts, a cost saving of £6,759 per item, applied to 20% of NR turnouts, would result in cost saving of £144.6k; and
	  ◦ for crossovers, a cost saving of £13,229 per item, applied to 20% of NR turnouts would result in cost saving of £322.5k.

3.6.3 Recommendations

The limited findings of this part of our analysis suggest that there is a moderate level of potential cost efficiency in procurement of S&C materials under present arrangements. We consider that NR should explore the potential for a greater degree of standardisation, and increasing the number of items ordered against individual S&C variants, to enable volume efficiencies to be realised.

Furthermore, we consider that based on the nature of S&C materials, there is likely to be considerable potential in the longer term for further cost efficiencies, through the standardisation or modularisation of S&C, by either reducing the variants of S&C types or undertaking as much work as possible in an off-site factory controlled environment. We would recommend that NR continues to investigate the potential benefits of such measures.

3.7 Signal Heads

3.7.1 Benchmark price analysis

Table 18 – Key comparator indices: signal heads

NR total annual consumption volume	*Data requested*
NR comparator expenditure (total)	£2.0m
NR comparator volume	1,025 items
Weighted NR unit price	£1,980/item (33 variants)
Comparator organisations:	*No comparator data obtained.*

Unfortunately none of the comparator organisations was able to provide appropriate data to compare against the signal head price information provided by NR.

3.7.2 Price drivers and key differentials

Table 19 – price drivers: signal heads

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Not significant**	• The main technical and functional requirements of signal heads are pre-determined by overall signalling configuration requirements at a systemic level. • Detailed technical and functional requirements are specified within the standards of the given railway infrastructure provider. • Modern signal heads utilise LED clusters as standard.
Sourcing and supply conditions	**Not significant**	• NR procures signal heads through framework arrangements with three main suppliers including Ansaldo which supplies LED signal heads across Europe. • Although a considerable number of alternative signal head manufacturers exist in other European countries, these can generally be regarded as local suppliers, catering for the particular characteristics of local signalling infrastructure. • ETCS-Level 2 roll-out across a greater proportion of the European network in future years, may lead to a fall in demand

		for visual signals in the longer term.
Material volumes	**Significant**	• Given the requirements for signal heads to confirm with specific specifications for a given rail system, it is likely that larger order volumes to conform with NR standards and characteristics would lead to cost savings.

Table 20 –cost efficiency potential: signal heads

NR Cost Efficiency Potential	Observations
Low	• Design requirements are specified to a high level of detail by NR standards, hence little scope for flexibility. • NR already procures comparatively large volumes of signal heads from its framework suppliers – which in 2010 included over 250 items for the most popular two variants.

3.7.3 Recommendations

Although none of the comparator organisations was able to provide appropriate comparator data for this category, we consider there to be comparatively low efficiency potential with relation to signal heads material pricing for the reasons set out above. We would nevertheless recommend that NR continues to monitor the price levels of suppliers of signal head technology across the market, and to consider higher volume orders with as high a level of standardisation as possible. This would allow NR to take advantage of the company’s purchasing power and to enable material volume efficiencies to be realised on an ongoing basis.

3.8 Cabling

3.8.1 Benchmark price analysis

Table 21 – Key comparator indices: cabling (signalling & telecommunications)

	Signal cabling	**Telecommunications cabling**
NR comparator volume	445,600 metres	47,300 metres
NR comparator expenditure (total)	£4.2m (34 x variants in total)	£0.8m (6 x variants in total)
NR unit price range	£1.14 - £8.10/m (5 x variants selected for comparison)	£3.51/m (1 x variant selected for comparison)
Comparator organisations:	Comparator 6	Comparator 6
Comparator price range	£0.54 to £6.63/m (5 x variants)	£10.42/m (1 x variant)
% range comparator price differential vs. NR	-56.2% - +189.9%	+197.0%
Weighted average NR price differential vs. comparators (%)	33.2% below average comparator price level	66.3% below average comparator price level

Although our benchmarking comparison for signal cabling was based on only a single comparator organisation, the results showed significant variations in comparative price levels across the five variants reviewed, with two of the five Comparator 6 variants showing lower price levels than their NR equivalents, and three of the variants showing higher price levels. In average terms, the NR price level was around a third less than the comparator price level.

Telecommunications cabling prices were based on the comparison of a single NR variant with a single variant from Comparator 6. The Comparator 6 price level was almost three times more expensive than the NR price.

In general terms, the relatively low volume of material for the Comparator 6 cost data is likely to be a key factor in the cost differential as material prices are based on lower project based volumes versus national supply requirements.

Due to limitations in the comparator price data provided, it is not known whether differing nature or characteristics of the cabling material (e.g. fibre optic versus copper) may also have been a cost differentiator in this instance.[20] We would

[20] Due to the growing problem of cable theft, we understand that Network Rail is purchasing modified cabling materials which include anti-theft dyes, armoured casing, and other anti-theft features. We consider that the costs relating to such features will need to be factored into the analysis of cable procurement costs going forward.

recommend that Network Rail continues to source data from cabling suppliers (including both current suppliers to the rail industry, and suppliers to other industries), to ascertain the extent to which further savings cabling prices may be available.

3.8.2 Price drivers and key differentials

Table 22 – price drivers: cabling

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Not significant**	• A variety of different types of cables are used in railway infrastructure, made up from various core materials (aluminium, copper, fibre optic etc.) and various types of cover / sheathing. • Technical characteristics tend to be standardised according to the application that the cabling is being used for.
Sourcing and supply conditions	**Significant**	• Key cost drivers for supply of input materials for cabling such as the price of copper, are subject to considerable volatility. This requires careful planning and hedging of the material supply based on known volumes of materials. • The approach to risk management (e.g. speculative or risk averse) is a key driver in the cost of cabling materials. • NR has a number of framework contracts in place for different types of cabling. • There are a large number of cable suppliers in other European railway markets. They generally also supply cables for a number of other industries.
Material volumes	**Significant**	• Although the scope of cabling requirements may vary significantly across different cabling types and variants, there are likely to be large scale orders for significant volumes of cabling when renewals projects are involved. This would be likely to significantly influence price.

Table 23 –cost efficiency potential: cabling

NR Cost Efficiency Potential	Observations
Moderate **(Due to limitations in comparator data, we do not consider it to be appropriate to make an**	• Although NR already has framework supply contracts with a number of suppliers, the market is competitive and there is likely to be scope for investigating further widening from additional supply sources. • The data sample obtained indicates significant levels of price differentiation; the strategy for procurement of high volume, volatile materials (principally copper) will be pivotal in

estimation of cost efficiency potential for this material category)	ensuring potential efficiencies are realized. • Evidence of lower telecommunications cabling cost for some categories is worthy of further exploration on a project by project basis. • NR already procures comparatively high volumes of cabling from its framework suppliers; therefore, the scope for volume efficiencies is likely to be limited.

3.8.3 Recommendations

Although only limited comparator data have been obtained for this material category, we consider that the competitiveness of the cabling supply market warrants investigation by NR of further widening of their supply sources, and review of procurement terms to ensure cabling is being supplied on the most competitive terms possible.

Risk mitigation strategies such as hedging are a particularly important aspect of materials supply for areas of high price volatility such as copper. The approach taken by NR should be reviewed, to ensure NR minimises its exposure to price volatility in the market through its supply arrangements.

3.9 Axle counter evaluators

3.9.1 Benchmark price analysis

Table 24 – key comparator metrics: axle counter evaluators

NR comparator volume	6 items
NR comparator expenditure (total)	£0.234m
Weighted NR unit price	£34,788/item (1 x variant)
Comparator organisations:	• Comparator 1 • Comparator 6
Comparator price range:	£9,600 to £22,400/ item (3 x variants)
Weighted average comparator price	£15,467
Weighted average NR price differential vs. comparators (%)	**+124.9% above average comparator price level**

The NR price data for axle counter evaluators are based on a single variant, which was the most expensive of all four variants compared.

3.9.2 Price drivers and key differentials

Table 25 – price drivers: axle counter evaluators

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Significant**	• Axle counter equipment is comprised from highly specialised components. • Variations arise in terms of the information gathered by the axle counter evaluator (e.g. on site conditions and specific route and plant data), the technology or software utilised, quality and maintenance requirements. • Such equipment must be integrated with the rest of the signalling system.
Sourcing and supply conditions	**Significant**	• Axle counter equipment is supplied by a handful of specialised manufacturers across Europe including Siemens, Frauscher and GE transportation. • Alcatel is presently the sole supplier to NR of axle-counting equipment.
Material volumes	**Significant**	• Order volume likely to have limited effect on price due to the specialist nature of the components used, and limited number of components presently procured. • Order volume may play a more significant role in price levels in the future, given that the utilisation of axle counter evaluators, in favour of traditional track circuit technology, is expected to become more widespread.

Table 26 –cost efficiency potential: axle counter evaluators

NR Cost Efficiency Potential	Observations
Low	• Although a small number of potential alternative suppliers exist in the European market, axle counter equipment needs to be integrated with other signalling equipment, which is likely to limit the scope for introducing an alternative supplier's equipment. • Single-supplier conditions and current low order volumes are likely to preclude any scope for volume efficiencies at present.

3.9.3 Recommendations

Although we consider there to be comparatively low cost efficiency potential for this material category, we consider that further investigation should be initiated to identify why costs in Comparator 1 and Comparator 6 are significantly lower than the price obtained by NR, in order to inform the future procurement of axle counter evaluators on a larger scale.

3.10 Point Machines

3.10.1 Benchmark price analysis

Table 27 – Key comparator indices: points machines

NR comparator volume	38 items
NR comparator expenditure (total)	£0.869m
Weighted NR unit price	£22,612/item (2 variants)
Comparator organisations:	*No comparator data obtained.*

Unfortunately none of the comparator organisations was able to provide appropriate comparator data for the points machine prices provided by NR.

3.10.2 Price drivers and key differentials

Table 28 – price drivers: points machines

Factor	Price Impact for material type	Remarks
Technical characteristics and material properties	**Significant**	• Point machines are complex components supplied by specialist manufacturers. • "Tampability" is an important factor in the selection of point machine technology • The selection of point machine technology is limited by point layout types e.g. in-bearer clamp locks (IBCL) are generally used for concrete layouts only in new-build projects • Older models such as Style 63 and HW types cannot be used in some renewal projects in which the heavier UIC 60 rails are used, because their output drive force may not be adequate • Power supply constraints may restrict the use of high-power point machine variants such as Hy-drive in some cases.
Sourcing and supply conditions	**Significant**	• Each technology is owned by only one manufacturer.
Material volumes	**Significant**	• Higher volume purchases could support efficiencies, given the limited number of specialised variants, .

Table 29 –cost efficiency potential: points machines

NR Cost Efficiency Potential	Observations
Low	• Selection of point machines is limited by existing site constraints such as power supply • Installing additional points machines of the same type as those already installed in a given area, rather than alternative more cost-effective variants, is often justified by NR on the grounds that uniformity is likely to mean more efficient maintenance practices. • IBCL (In-bearer clamp locks) and Hy-Driv0065 are the preferred systems for renewal projects currently as they allow machine tamping. • Each technology is supplied by only one manufacturer therefore price competition for a given point machine type is non-existent • Introduction of new point machine types and manufacturers may be worth investigating

3.10.3 Recommendations

NR's emphasis on machine-"tampability" of ballast in the selection of point machine technologies has led to the preference of IBCLand Hy-drive in renewal projects due to the limited number of manufacturers and technologies currently available in the UK. Another cause for the limited range of point machine types used is likely to be NR's desire to minimise potential risks of disruption to services due to teething problems caused by the introduction of new variants.

We consider that more price competition may be possible by introducing more point machine variants and manufacturers into the UK market. However, the high costs and the lengthy process involved in gaining NR Type Approval for introduction of a new variant is likely to have deterred some manufacturers from introducing new technologies. We therefore recommend that NR examines the potential for simplification of the Type Approval process, in order to facilitate more competition in the UK point machine market.

Since the introduction of more point machine types to the infrastructure may have impacts on other aspects of the system such as maintenance costs, we recommend NR also undertakes cost benefit analysis to understand the cost efficiency that can be gained from using alternative suppliers relative to the potential risks in a whole-system context.

4 Impact and Recommendations

Table 30 –key recommendations

No.	Recommendation to NR	Location in text	NR data champion	Due date
M1	We recommend that where it is not doing so already, NR systematically monitors market prices for all major materials types procured by NDS and continually assesses the prices of current suppliers compared to potential alternative suppliers of the same or similar material types. This applies in particular for: • Steel prices and UIC rail suppliers (in particular if NR anticipates larger order volumes, given the significant influence of volume on price levels) • Cabling materials (for both signalling and telecommunications) • Point machines.	3.2, 3.8, 3.9, 3.11, 3.12		
M2	We recommend that NR undertakes a cost-benefit analysis of implementation of materials manufactured to lower specification levels in a number of categories, taking into account the impact of procurement cost savings levels compared to potential costs incurred due to differing material performance levels and compliance with required standards. This applies in particular for switches & crossings variants, for which a greater degree of standardisation or modularisation may be achievable.	3.6		
M6	We recommend that NR develops a robust methodology for appraising the relative costs of material variants in each of the major categories reviewed in this study on a whole-life-costing basis. This should combine the analysis of initial purchase price with an assessment of the relative cost impact in relation to maintenance and lifespan of the given variant, as well as any other cost impacts the given variant may have, e.g. systems integration, compatibility with maintenance of adjacent / related infrastructure elements, etc.	3		
M5	We recommend that NR examines the potential for simplification of the Type Approval process, in order to facilitate greater competition and swifter introduction of alternative material variants and technologies.	3.11		

Appendix A – Full benchmark results overview

** Redacted for reasons of commercial confidentiality **

Appendix B– Cost harmonisation methodology

Factory gate and unitised pricing adjustments

“Factory gate” refers to the price paid to the manufacturer or supplier of the material at the point of purchase, discounting any transport, storage, handling or other service fees, and any VAT or other external charges.

Adjustments were applied to input materials price data to ensure the comparison of prices on a factory gate basis including discounting of VAT and any other mark-ups, service fees, etc.

Parity of overseas costs with GBP (£)

Utilisation of PPP values

Incoming cost data provided in overseas currencies were converted to into a £-sterling figure for the benchmarking comparison by means of a country-specific purchasing power parity (PPP) value.

Purchasing power parities (PPPs) are indicators of price level differences across countries. PPPs tell us how many currency units a given quantity of goods and services costs in different countries. PPPs can thus be used as currency conversion rates to convert expenditures expressed in national currencies into an artificial common currency (the Purchasing Power Standard, PPS), eliminating the effect of price level differences across countries.

PPPs can be applied in analyses of relative price levels across countries. For this purpose, the PPPs are divided by the current nominal exchange rate to obtain a price level index (PLI) which expresses the price level of a given country relative to another.

Using PPPs has the advantage of providing a reflection of the real purchasing power of a given currency (in this case GBP) for a tangible pre-defined basket of goods and services in another country, without the distorting effect of exchange rate disparity or temporary fluctuations.

PPPs are not primarily designed to capture price changes within a limited time period, but rather to provide an overview of aggregated price differences across countries or other geographical units. Unlike the item sampling and price collection that underlie consumer price indices, PPP indices tend to show incremental changes over extended periods of months / years, unlike the fluctuations likely to be experienced in exchange rates over a given period.

OECD 2008-2010 PPP figures

For the purposes of this study, Arup used the PPP values provided by the OECD, applying the average parity value for the period 2008-10 to the comparator data. These indices are produced through the multilateral cooperation between the National Statistical Institutes of the participating countries, Eurostat and the OECD, and are published on a bi-annual basis.

For the main results in this report, Arup has utilised the average PPS / PLI value published for the years 2008-10.

Appendix C – Sensitivity testing of cost results

Sensitivity Testing Approach

Results from benchmarking analyses based on data obtained from multiple sources are sensitive to adjustments applied to raw data as well as data consistency. To understand the impact of purchasing power parity adjustments applied to comparator data and volume discount assumptions on the benchmarking comparison results, sensitivity tests were carried out.

Summary of results obtained

In general terms, we do not consider that the results obtained for any of the three sensitivity test scenarios would cause a change in the qualitative results or conclusions of this study.

In each of the three scenarios, application of the sensitivity test has affected the results as follows:

- For material categories for which the comparator benchmark price is above the NR benchmark price, application of the sensitivity results in the narrowing of the price differential, i.e. comparator prices become "less expensive" compared to NR. The exception to this pattern is the price differential for rail clips, which in all three scenarios reverts from a positive value (more expensive than NR) to a negative value (cheaper than NR) following application of the sensitivity.
- For material categories for which the comparator benchmark price is already below the NR benchmark price, application of the sensitivity results in the widening of the price differential, i.e. comparator prices show a greater cost saving compared to NR following application of the sensitivity.

This suggests that the benchmarking results set out in the main body of this report reflect a cost comparison methodology that results in lower relative price levels for NR materials relative to other organisations, compared to when the sensitivities set out in this Appendix are applied.

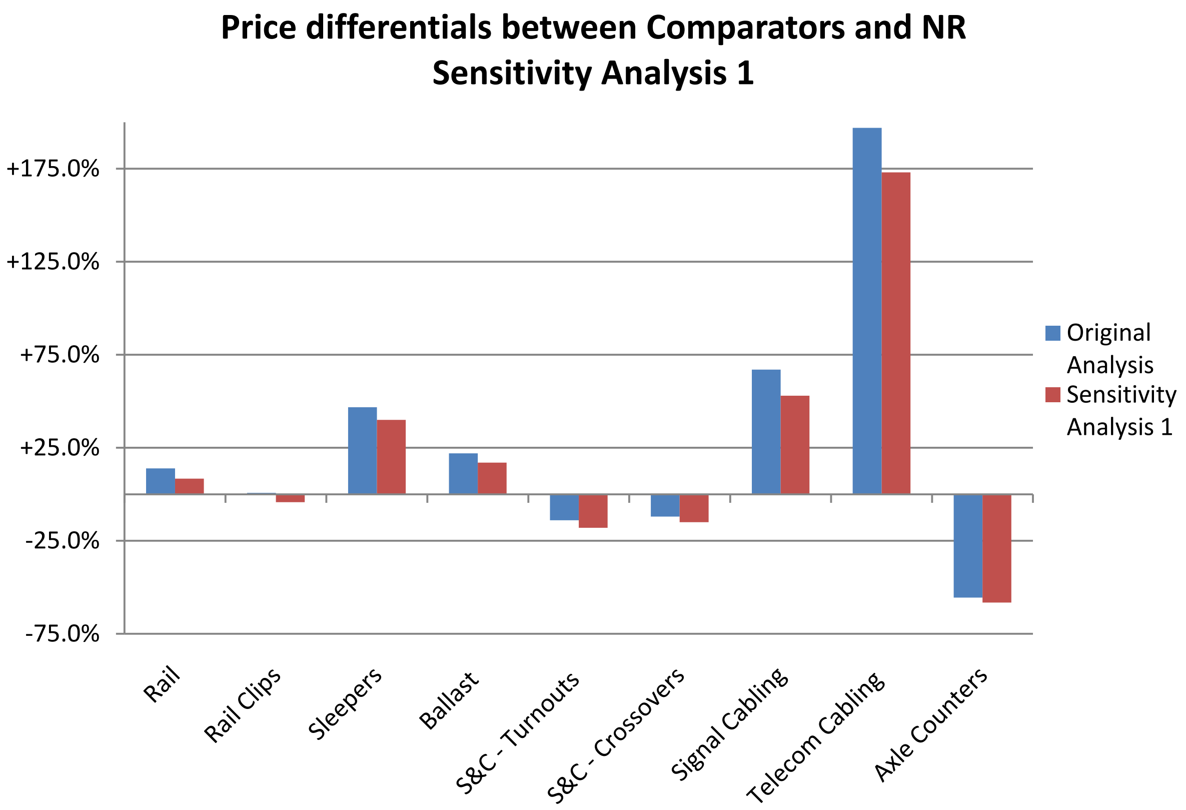
Sensitivity Analysis 1: Use of alternative Purchasing Power Parity (PPP) adjustment factors

The original benchmarking analysis was based on European comparator price data converted to pound sterling using average PPP values between 2008 and 2010. To understand the impact of using alternative PPP adjustment factors on the relative prices of railway materials between Network Rail and European comparators, the European comparator price data are re-adjusted using average PPP values during the 10 year period between 2001 and 2010 in this sensitivity analysis. Using 10-year average PPP values to adjust comparator price data also reflects the longer term price level differentials among between the UK and comparator countries.

A summary of the results of Sensitivity Analysis 1 is shown in the table below:

	Comparator price range		Weighted average comparator price		Weighted average comparator price vs. NR price	
	Original Analysis	**Sensitivity Analysis 1**	**Original Analysis**	**Sensitivity Analysis 1**	**Original Analysis**	**Sensitivity Analysis 1**
Rail	£582 to £814/t	£544 to £784/t	£653/t	£622/t	+13.9%	+8.4%
Rail Clips	£1.05 to £1.72/item	£1.00 to £1.65/item	£1.32/item	£1.25/item	+1.1%	-4.2%
Sleepers	£36 to £50/item	£35 to £47/item	£43/item	£41/item	+46.8%	+40.0%
Ballast	£6.96 to £10.14/t	£6.66 to £10.14/t	£8.20/t	£7.81/t	+22.4%	+16.6%
S&C - Turnouts	£23,993 to £65,010/item	£22,979 to £62,263/item	£41,427/item	£39,738/item	-14.0%	-17.5%
S&C - Crossovers	£78,731 to £99,259/item	£75,405 to £97,014/item	£94,763/item	£91,649/item	-12.2%	-15.1%
Signal Cabling	£0.54 to £6.63/m	£0.49 to £6.10/m	£3.45/m	£3.17/m	+67%	+53%
Telecom Cabling	£10.42/m	£9.58/m	n/a	n/a	+197%	+173%
Axle Counters	£9,600 to £22,400/item	£9,283 to £20,588/item	£15,467/item	£14,599/item	-55.5%	-58.2%

The following chart shows the effect of using alternative PPP adjustment factors on price differentials between the comparators and NR for key materials (a positive price differential indicates that the weighted average comparator price is higher than NR price):



Since the value of pound sterling relative to the Euro between 2008 and 2010 had been lower than the historical average in the period between 2001 and 2010, using the average PPP values during the ten-year period between 2001 and 2010 as adjustment factors for the comparator price data would lead to lower comparator prices for all materials.

The comparator-NR price differentials would be narrowed in materials for which weighted average comparator prices were found to be higher than NR prices in the original analysis; the comparator-NR price differentials would be widened in materials for which weighted average comparator prices were found to be lower than NR prices in the original analysis.

For rail clips there would be a sign reversal in the comparator-NR price differential – the weighted average comparator price would change from 0.8% higher than NR prices to 4.2% lower than NR prices.

Overall, we do not consider that the use of alternative PPP adjustment factors would not cause a change in the qualitative result of this study. .

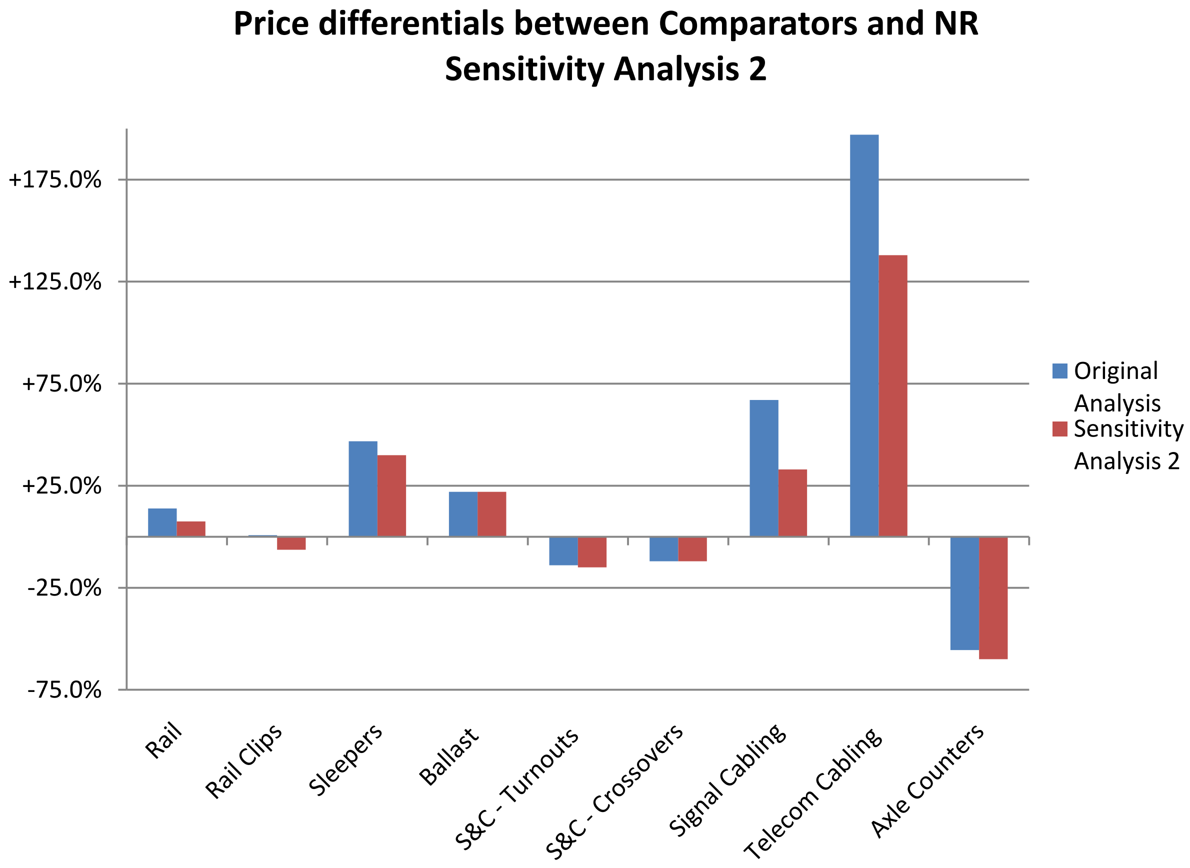
Sensitivity Analysis 2: Application of volume discounts on selected comparator cost data

The unit price data for NDS and some of the comparator organisations correspond to high volume orders procured centrally for multiple projects and include the effect of volume discounts. Since some comparator price data are based on catalogue prices and prices for materials procured for individual projects respectively, price reduction may be possible if materials were procured centrally in larger volumes. To test the impact of these potential volume discounts on the weighted average comparator prices, a 20% discount has been applied to the price levels for some of the comparator data through this sensitivity analysis.

A summary of the results of Sensitivity Analysis 2 is shown in the table below:

	Comparator price range		Weighted average comparator price		Weighted average comparator price vs. NR price	
	Original Analysis	**Sensitivity Analysis 2**	**Original Analysis**	**Sensitivity Analysis 2**	**Original Analysis**	**Sensitivity Analysis 2**
Rail	£582 to £814/t	£537 to £817/t	£653/t	£617/t	+13.9%	+7.5%
Rail Clips	£1.05 to £1.72/item	£1.02 to £1.35/item	£1.32/item	£1.22/item	+1.1%	-6.4%
Sleepers	£36 to £50/item	£35 to £47/item	£43/item	£41/item	+46.8%	+40.0%
Ballast	£6.96 to £10.14/t	£6.96 to £10.14/t	£8.20/t	£8.20/t	+22.4%	+22.4%
S&C - Turnouts	£23,993 to £65,010/item	£23,993 to £62,263/item	£41,427/item	£41,161/item	-14.0%	-14.6%
S&C - Crossovers	£78,731 to £99,259/item	£78,731 to £99,259/item	£94,763/item	£94,763/item	-12.2%	-12.2%
Signal Cabling	£0.54 to £6.63/m	£0.43 to £5.31/m	£3.45/m	£2.07m	+67%	+33%
Telecom Cabling	£10.42/m	£8.34/m	n/a	n/a	+197%	+138%
Axle Counters	£9,600 to £22,400/item	£9,600 to £17,920/item	£15,467/item	£13,973/item	-55.5%	-60.0%

The following chart shows the effect of the assumed 20% volume discounts on selected comparator data on price differentials between the comparators and NR for key materials (a positive price differential indicates that the weighted average comparator price is higher than NR price):



As can be expected, the 20% assumed volume discount applied on the selected comparator data would lower the weighted average comparator prices for all materials except ballast and crossovers, for which no data for the selected comparators were available. The comparator-NR price differentials would be narrowed in materials for which weighted average comparator prices were found to be higher than NR prices in the original analysis; the comparator-NR price differentials would be widened in materials for which weighted average comparator prices were found to be lower than NR prices in the original analysis.

For rail clips, there would be a sign reversal in the comparator-NR price differential – the weighted average comparator price would change from 0.8% higher than NR prices to 6.4% lower than NR prices.

Once again, we consider that the 20% assumed volume discount applied to the selected comparator price data does not change the qualitative result of this study.

Sensitivity Analysis 3:

** Redacted for reasons of commercial confidentiality **

Appendix D – Material Key Characteristics

D1 UIC Rail

Technical characteristics and material properties

UIC rail generally conforms to a standardised design, which is applicable across Europe. The two most common variants are 60KG/metre rail and 56 KG/metre rail. The heavier rail tends to be utilised most widely on heavily trafficked routes with a higher axle loading, whilst 56 KG/metre is utilised on lesser trafficked routes.

Some variability may be present with regard to the "grade" of steel, which in effect relates to hardness properties. "R260" is regarded as the standard grade, although more recently higher grade R350 material has been developed for usage in the most heavily trafficked routes, or on high speed lines.

Sourcing and supply conditions

The manufacture of rails in Europe is dominated by a relatively small number of major companies. The production of steel rails is typically performed by the established major steel manufacturers, often constituting a significant portion of their overall turnover. Steel production is a large scale and highly capital intensive process, which is performed at long established production facilities, although the corporate structure of the steel industry has been subject to significant change and consolidation over the years.

Currently, major steel rail manufacturers within the European rail market include the following:

- Tata UK (ownership of former Corus steel manufacturing sites): manufacturing sites across UK
- Arcelor Mittal: production sites in France, Belgium & Spain
- Thyssen Krupp: Germany
- TSTG Schienen Technik: Germany
- Voestalpine Schienen: Austria

As indicated above, rail is generally produced across Europe to standardised specifications for material grade, weight and hardness. However, manufacturers are seeking to bring higher-specification products to the market; this includes material properties specified to a higher level than present standards, e.g. grade, hardness; additional material properties, e.g. noise-reduction components, anti-corrosion coatings, as well as production of longer rail sections to raise efficiency of rail installation, e.g. production of 120m at Corus Scunthorpe plant for NR, TSTG Germany supplying 120m rails for DB network enhancements.

D2 Rail Clips

Technical factors affecting price

Rail clips are a highly specialised product, which in spite of being required in large volumes for any rail track enhancement or renewal project, must have particular physical properties. The clip must be manufactured with the right amount of tempering (or springiness) so that it exerts sufficient force on the rail foot to hold it in place, but not so much force that the clip cannot be inserted or withdrawn.

Although like other material types, rail clips are required to conform with European-wide norms relating to performance requirements, the design characteristics vary between different manufacturers. Rail clips design will necessarily relate to rail foot and sleeper design – indeed compatibility of these components is an essential pre-requisite for the design of any track solution, and therefore a new rail clip cannot be simply introduced on a “standalone” basis.

In practice, this is likely to mean the number of variant rail clip designs on a given European network is limited – given that Type Approval for a given clip type is inextricably linked to other track components that also require approval prior to implementation on a given rail network.

Nevertheless, in terms of clip design, changes have included the introduction of completely new clip designs – for example, the Pandrol “fast-clip” designed for faster installation – as well as improvements in material quality, durability.

Supply market conditions

The world rail clips market is dominated by two manufacturers Pandrol and Vossloh.

By far the largest manufacturer of rail clips in the world is UK-based company Pandrol - which is more than double the size of its nearest competitor, supplying rail clips across the world. Pandrol has a virtual monopoly in rail clip supply on the UK mainline network.

Vossloh (Germany) is a significant supplier of rail clips in Germany and elsewhere in Europe, with a particularly strong presence in the supply-chain for new high-speed rail tracks, in both Europe and Asia.

D3 Sleepers

Technical factors affecting price

Detailed design of railway sleepers tends to vary between countries; the vast majority of track renewals involve concrete sleepers. All sleeper designs are subject to European norms for performance requirements (e.g. material grading, strength parameters (shear force, deflections, etc.), serviceability). Sleepers are typically designed to accommodate maximum axle loads – which, once again, tend to be a standard value on most principal rail routes in Europe of 30 tonnes, although in UK a 25 tonne value is commonplace for secondary routes with lower traffic levels.

Supply market conditions

UK sleeper production is dominated by less than 5 manufacturers, who compete under open tender to produce sleepers according to detailed NR design specifications.

Major suppliers include Tarmac (UK), RailOne (Germany), Voestalpine Klöckner Bahntechnik, Consolis Group (France – owns DW Schwellen (Germany), Stanton Bonna (UK), Sateba / Bonna Sabla (France)), LIB group (France), Heidelberg group (Abetong (Sweden); note – GMT (Steel sleepers)

D4 Ballast

Technical factors affecting price

Rail ballast is most commonly constituted from granite, or other similar types of hard, impermeable stone. Other material types such as limestone may be utilised in some cases, although such materials are likely to degrade after a certain length of time, whereas granite ballast material may remain in deployment for an almost indefinite period.

According to European norms, ballast is required to have particular attributes such as grade / size, strength and hardness.

The key material characteristic affecting price will be the availability and ease of access sources of the given material, rather than the technical characteristics of the ballast itself.

Supply market conditions

Within the UK, granite material is widely available in a number of locations across the country. NR presently sources ballast from eight quarries across the UK, although it is proposed to further consolidate the supply chain to include just two quarries.

D5 Switches and Crossings

Technical factors affecting price

Switches and crossings used in the UK are manufactured in accordance to UIC and CEN standards as well as NR specifications. They are generally specified by the length of the switch and the angle of the crossing. In the UK, switches are specified from letter A to H indicating length with A being the shortest and H the longest. Higher train speed requires longer switches, which involve not only higher material costs but also higher engineering costs. Multiple point machines may also be required at longer switches.

Similar to standard fixed rails, crossings can be made of steel strength grades R260 or R350 depending on the application. The cross point between rails can be assembled out of several cut and bent pieces of rail or can be a single piece of cast manganese steel, which has the advantages of reduced level of maintenance required and better ride safety and comfort. Special welding technologies can also be employed to improve track continuity and fatigue performance.

Supply market conditions

Switches and crossing suppliers for the UK rail market include large international suppliers as well as smaller UK manufacturers. The key suppliers involved in the 3-year negotiated contract purchase agreement for switches and crossings with NR between 2009 and 2010 were all large international suppliers or their subsidiaries. They include –

- VAE: the world market leader in turnout technology headquartered in Austria. It has manufacturing facilities in Europe, America, Austria, Africa and Asia
- Corus Cogifer: a joint venture between Tata Steel and Vossloh Cogifer of France supplying switches and crossings to the UK market. In addition to the partnership with NR, it has also supplied switches and crossings for Manchester Metrolink, Nottingham tram, East London Line and Croydon Tramlink.
- Balfour Beatty Rail: part of the international engineering, construction and services group. It acquired the UK switches and crossings product manufacturer Edgar Allen in 2006

Some smaller UK switches and crossing suppliers include:

- Hall Rail: a UK-based independent manufacturer and supplier of switches and crossings. It was awarded a 2-year contract by NR in 2009 for the emergency supply for switches and crossings.
- ALA Rail: a family run business based in Wales specialising in the manufacture and installation of railway switches and crossings.

D6 Signal Heads

Technical factors affecting price

Signal heads can take the form of banner repeater signals or colour light signals. Banner repeater signals generally consist of a single lamp that indicates different signal aspects by varying the position of the banner displayed. Standard colour light signals are similar to road traffic lights that generally have one lamp for each aspect, while ‘searchlight’ colour light signals are capable of displaying all three colours (red, yellow and green) from one single lamp.

Modern light signals use clusters of LEDs in replacement of incandescent lamps. This results in more even colour output, reduced power consumption and longer working life. Signal heads can also have different viewing ranges, positions of mounting and shapes of housing.

Signal heads used in the UK comply to the Railway Group Standards and are approved by NR.

Supply market conditions

Signal heads used on NR infrastructure have been supplied under framework agreements with three manufacturers –

Dorman: UK leading railway signalling and infrastructure lighting manufacturer under Unipart Group. It had been involved in framework contract with NR to supply LED signals. It also manufactures warning lamps and LED signs for the road.

VMS Limited: UK market leader in LED messaging signs and road traffic management systems. By securing a 3-year Framework Supply Contract with NR to supply LED signals, the manufacturer has begun its expansion into the rail sector recently.

Ansaldo STS: a global supplier of traffic management, planning, train control and signalling systems headquartered in Italy. It has been involved in UK rail projects such as High Speed 1, West Cost Main Line and Cambrian Line.

Signal head markets in other European countries also seem to be dominated by local suppliers.

D7 Cabling

Technical factors affecting price

A variety of different types of cables are used in railway infrastructure. Some of the different types used are:

- Signalling Cables
- Power Cables
- Earthing Cables
- Telecoms Cables
- Points Heating Cables

Depending on their applications, cables can be of different materials (aluminium, copper, fibre optic etc.). Their prices can vary depending on the number of strands in each cable and whether the cables are buried directly or within ducts. Cables can also be ‘armoured’, gel-filled, in water-swellable tape or in various sheath materials depending on the requirements on protection against moisture, rodent, fire etc.

Supply market conditions

Due to the variety of cables used in railway infrastructure and the relatively generic nature of cabling technologies, cables are generally sourced from a number of manufacturers through local distributors or from a manufacturer/service provider collaboration. The following suppliers have been in framework agreements with NR to supply cables.

Anixter: global distributor of fasteners, communications and security products, electrical and electronic wire and cable. It is headquartered in the US and operates in 52 countries. It supplies cables made by a number of manufacturers worldwide.

Cleveland Cable Company: UK electrical cable distributor based in Middleborough. It stocks a wide range of cables for various applications and has regional depots at Bristol, Glasgow, London, Milton Keynes, Newcastle and Warrington.

Eland Cables/Unipart Rail: A collaboration between Eland Cables, a UK manufacturer of electrical cables and cable accessories aiming at both UK and export markets, and Unipart Rail, a UK railway parts logistics company. The two companies have worked together previously on the West Coast Route Modernisation project.

There are typically a large number of cable suppliers in other European railway markets. They generally also supply cables for a number of other industries.

D8 Axle counter evaluators

Technical factors affecting price

An axle counter system consists of 'outdoor' equipments, such as the counting head, and 'indoor' equipments, such as the computer system that evaluates the axle data. The price of a system depends on the level sophistication of the technologies used.

While some low-cost systems are design for monitoring two track sections, more sophisticated systems are capable of monitoring up to 32 track sections. More sophisticated systems are also capable of accommodating complex station layouts.

Axle counter evaluation systems may have different microprocessor architectures that provide fail-safe mechanisms. They can employ two-out-of-two or two-out-of-three logics, by which track activities recorded on multiple processors are compared against each other to guarantee train circulation safety.

Different systems may also be capable of different control distance, which is the maximum distance allowed between the counting head and the evaluation computer. While some systems have a typical control distance of 6.5 km, some others have control distance of up to 40 km.

Supply market conditions

The UK axle counter system market is dominated by large international manufacturers. Manufacturers that have supplied axle counter system to NR include Alcatel, Thales and Siemens

Other manufacturers supplying the European market include Ducati and GE.

D9 Point Machines

Technical factors affecting price

A number of different point machine technologies are currently used on Network Rail assets. The most common types include Style 63, HW type, In-bearer Clamp Locks (IBCL), Hy-drive and High Performance Switch System (HPSS).

Network Rail places particular importance on the machine-“tampability” of the track ballast after point machines are installed. Point machine technologies that allow track ballast to be machine-tampered, such as Hy-drive, are currently favoured by Network Rail.

Since newer point machine variants such as Hy-drive and HPSS have greater driving force output and consumer more power, the replacement of existing older variants may involve significant costs in redesigning the power system. Therefore like-for-like replacement of existing older variants such as Style 63 and HW type are preferred in some renewal projects.

Supply market conditions

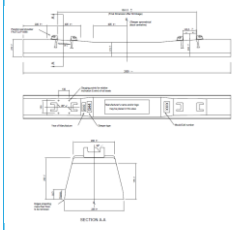
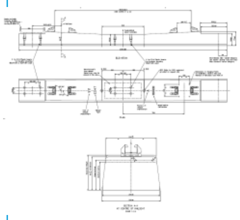
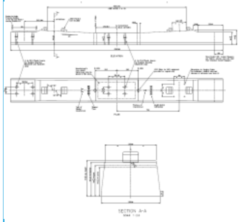
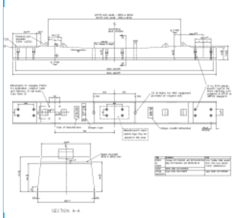
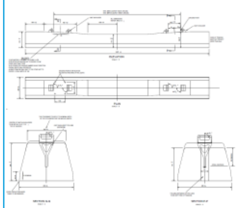
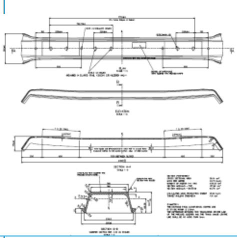
Each type of point machine technology is dominated by one manufacturer as each manufacturer owns each specific technology. Manufacturers that supply point machines to NR include:

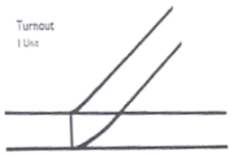
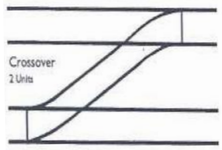
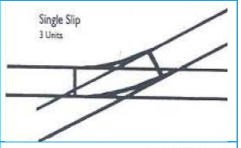
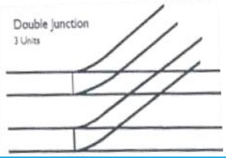
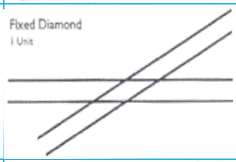
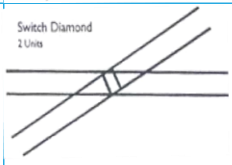
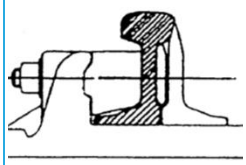
Style 63 – supplied by Invensys, formerly Westinghouse
HW type – supplied by Alstom, formerly GEC
IBCL – supplied by SPX

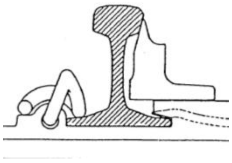
Other large international suppliers include Siemens and Thales, which do not supply point machines to NR currently.

Appendix E – Material key variants

Operator	Specification	Description	Cost driver	Image
Rail types				
NR	56 E1 (BS113A)	Grade R260/56.30kg/m/108m Grade R260/56.30kg/m/18.228m	• For 25t axles • Service life up to 1000 EMGT on straight track, heavy traffic and good maintenance	
NR	60 E2 (UIC60)	Grade R260/60.03kg/m/108m Grade R260/60.03kg/m/18.228m	• Used on heavier trafficed routes • Rail head profile slightly different from 60E1 • Better fatigue performance compared to 60 E1 ○ Cost similar to 60 E1	
	50 E5 (UNI50)	Grade R260/49.90kg/m	• Mainly used on lightly trafficked lines	
Rail Clip Types				
NR	PR401A	• For concrete sleepers and all PAN plates except PAN1 to PAN5 • For use in F23 to F27 series; EF28, EF29, EF33 Series; W402 steel sleepers • Brown powder coating to RAL 3009 • Nominal toe load 900 kgf • Clip weight 0.95 kg	• Installed mechanically or manually	
NR	PR401A S'DISED	• Corrosion protected version of PR401A • Sheradised, matt grey colour - natural	• Corrosion-protected • Mainly used in tunnels	
NR	PR427A	• Flat toe, purple powder coating to RAL 4005 • Clip weight 1.0 kg	• Used for maintenance replacement for the now obsolete PR303	
NR	E1809	• Powder coating to RAL 3009 • For use in F40 sleepers with a blue (GRN) insulator • For use in all other sleepers with an orange (Nylon Insulator) • Not to be used with grey cast iron 'PAN' type baseplates • Nominal toe load 1000 kgf • Clip weight 0.59 kg	• Traditional and low cost. • Installed mechanically or manually with standard track tools • Virtually maintenance free • Simple components	
NR	E1809 S'DISED	• Corrosion protected version of E1809 • CP Finish: Sheradised, matt grey colour – natural	• Corrosion-protected • Mainly used in tunnels	
NR	E2001	• Purple powder coating to RAL 4005 • For F27 sleepers • Must be used with a white (GRN) insulator • Nominal toe load 1400 kgf • Clip weight 0.75 kg	• High toe load • Standard finish • Used in difficult areas where insulator crushing or creep is occuring	
Sleeper Types				

NR	G44 (concrete)	• Designed for 30t axles • Housings for Pandrol Fastclips • For UIC60 rail • Can also be used for 113A rail by using thicker insulator fitments • For non third rail mainline • Length: 2500 mm • Base width: 285 mm • Height at rail centre: 200 mm • Height at sleep centre: 175 mm	• NR Standard sleeper (initial cost and service life) • Heavy sleeper • Slow track geometry deterioration rates	
NR	EG47 (concrete)	• For Fastclips • Positioning of housing for UIC60 rail, uses 10 mm rail pads • Length: 2580 mm • Base width: 290 mm • Height at rail centre: 165 mm • Height at sleep centre: 140 mm	• NR Standard sleeper on DC electrified routes (third rail)	
NR	EG49 (concrete)	• For e-clips • shape identical to EF28 but fitted with housings for Pandrol e-clips and 10mm rail pads • Length: 2580 mm • Base width: 290 mm • Height at rail centre: 165 mm • Height at sleep centre: 140 mm	• NR Standard sleeper on DC electrified routes (third rail)	
NR	5EF28 (concrete)	• For PR-clips or e-clips • Designed for third rail system • Length: 2580 mm • Base width: 290 mm • Height at rail centre: 165 mm • Height at sleep centre: 140 mm	• For use in low ballast depth • Increased width for load distribution	
NR	5F40 (concrete)	• For e-clips • Length: 2420 mm • Base width: 285 mm • Height at rail centre: 200 mm Height at sleep centre: 175 mm	• Reduced length for handling on single line relaying gantries • Standard sleeper in the 1980s	
NR	W560 (steel)	• Designed for 25t axles • For use up to 90mph where reballasting can be avoided by scarifying existing ballast and topping up with new ballast	• Whole life cost advantage over G44 under medium and light traffic • Deteriorates too rapidly on high speed high tonnage routes • Life shorter than concrete sleepers • cannot be used on DC electrified lines	
NR/	Softwood (timber)	• Suitable for 25t axles	• Max service life limited to 40 years (decay) • Life shorter than concrete and hard wood sleepers • Service life even shorter at rail joints or under heavy traffic • Economic for extending life of softwood sleeper jointed track under light traffic • Cheaper than hard wood sleeper	

NR	Hardwood (timber)	• Suitable for 25t axles	• High cost • Low weight • Life shorter than concrete sleepers • Sustainability issues • Limited to specific locations where concrete sleepers not suitable	
Switches & Crossing Types				
	Turnout	• Allows trains to be diverted to another route	• 1 switch unit	
	Crossover	• Allows trains to crossover to the other parallel track	• 2 switch units	
	Single slip	• Track switching possible for one of the crossing tracks only	• 3 switch units	
	Double junction	• Junction where a double track railway splits into two double track lines	• 3 switch units	
	Fixed diamond	• Where two tracks cross each other • Track switching not possible	• 1 switch unit	
	Switch diamond	• An active trackwork assembly used where crossing angle between two tracks is too shallow for fixed diamond to be used safely • Used for increasing safe crossing speed	• 2 switch units	
	Full depth vertical switch	• Switch blades made from full depth rail section • Stock rail clipped from one side only • Relatively cheap	• Increased wear and forces on switch • large stresses on bolt in service • Detection and replacement of broken bolts increases maintenance cost • Requires large amount of metal removed from planed areas • Reduced stiffness of the machined part • Debris can easily be trapped between stock and switch rails, causing failure	

	Shallow depth switch	• Switch blades made from shallow depth rail sections • Stock rail held by elastic fastening on both sides	• Designed for 25t axles • Service life up to 800 EMGT on straight track under heavy traffic with good maintenance • Stock rail bolt failure avoided • Forces reduced • Less metal removed required • Greater stiffness • Slide action of switch clears debris from baseplate – improved reliability • Default switch option used on NR	
	CV 10, EV 21, BV 8, C 11 etc.	• B, C, E etc. – indicates length of switch • V – ‘vertical’ switches formed of 113A rail profile • 8, 9.25, 10 etc. – indicates angle of the crossing (‘10’ indicates crossing angle of 1 in 10)	• The moving rail of the switch is designated with letters from A to H depending on its length • Switch rail designated A being the shortest and H the longest • Switch rail designated A has lowest speed limit while H has highest – it can carry train speeds up to 100 mph • B 8 generally used for low speed crossover on the main line • C 10 upwards are for general use • Longer switches have higher material costs as well as higher engineering costs • Longer switches may require more point machines	
Points Machine Types				
NR	Style 63	• ‘combined’ machines – incorporate both locking and detection mechanisms • Emergency hand operation possible • Supplied to British Railways 1968 onwards • Max force 5.4 kN • Weight 254 kg	• Limited routine maintenance • Supplied for left-hand mounting but can be easily converted on site to right hand mounting • Machine tamping possible only when operating mechanisms are disconnected • Can be swapped with HW type point machines with minor modifications	
NR	HW 2020	• ‘combined’ machines – incorporate both locking and detection mechanisms • AC immune • electromechanically driven • throw bar thrust 2.2 kN to 6.7 kN • weight 220 kg	• Suitable for left or right hand layouts • Most common in existing population • Machine tamping possible only when operating mechanisms are disconnected • Can be swapped with Style 63 point machines with minor modifications	
NR	IBCL	• In-Bearer Clamp Lock • Hydraulic driven • Symmetrical modular point actuation system • Incorporates a pair of lock and detection mechanisms • Max force per drive point 5.6 kN	• For vertical (113A) switches & crossings renewals • Allows for machine tamping	

NR	Hy-drive	• Variant of IBCL – with high power packs and additional hydraulic back drives • Max force per drive point 9 kN	• For NR60 switches & crossings renewals • Currently preferred by NR	
NR	HPSS	• High Performance Switch System • Fully integrated system including actuation, lock and detection of switch rails • Electro-mechanically driven • Torsional backdrive • Max force 9 kN	• Allows machine tamping • Minimal maintenance • Currently preferred by Network Rail for renewal projects	
Signal Head Types				
	Standard Multi-unit colour light signal	• Separate aperture for each colour	• Number of apertures depends on number of signal aspects required	
	Searchlight signal	• Red, Yellow and Green in one aperture		
	Banner repeater signal	• Signal aspects represented by varying position of the banner • Single aperture		

Appendix F – Reuse and Recycle of Materials

F1 Rail

There is currently a defined rail reuse regime at NR. The track asset management policy states that rails are to be recovered from renewal sites for reuse unless their conditions are deemed unsuitable. Rails may either be refurbished for use or directly cascaded to low category tracks, on which lower train speed and/or lower load and wear are expected. Cascaded or refurbished rails may only be specified for installation in renewals of routes with criticality classified as ‘low cost of incidents, high frequency’ and ‘low cost of incidents, low frequency’.

Rails that are not suitable for reuse track renewal are processed into the scrap metal market and used in steel manufacturing. NR opened its first purpose-built recycling plant in Westbury in July 2010. Rails, sleepers and ballast are currently processed in this plant.

F2 Rail Clips

Rail clips generally have longer service life than the rails that they are used on. Therefore rail clips are generally reused when rails are replaced. Rail clips are normally replaced in complete renewal of rail and sleepers. Once rail clips are replaced it is not possible to reuse them in other locations as they may have lost toe loads.

Due to their special geometries and usage there is little scope of the reuse of rail clips past their service life in other industries. Like rails replaced rail clips that can no longer be used on rail infrastructure can be sold as scrap metal.

F3 Sleepers

The reuse policy for sleepers at NR is similar to that for rails. Sleepers are to be recovered from renewal sites for reuse unless their conditions are deemed unsuitable. Cascaded sleepers may only be specified for installation in renewals of routes with criticality classified as ‘low cost of incidents, high frequency’ and ‘low cost of incidents, low frequency’.

Concrete sleepers that have ineffective fastening systems but are otherwise serviceable can be refurbished in situ by replacement of fastening systems. Although refurbishment of sleepers may be preferable from sustainability perspective, the significant labour involved means that it may be more economical to use new sleepers.

Sleepers that are not suitable for reuse on railway infrastructure are sold for use in agriculture, landscaping and road paving.

F4 Ballast

NR's track asset policy statement states that ballast may be cleaned where suitable and reused as bottom ballast in situ. Uncontaminated ballast that is not suitable for reuse on railway infrastructure are recycled and sold for use in other industries. Recycled ballast can be used in a number ways in the construction and civil engineering industry. They may be used for:

- Bitumen bound materials
- Concrete aggregates
- Pipe bedding
- Hydraulically bound mixtures for sub-base and base
- Unbound mixtures for sub-base
- Capping
- Embankments and Fill

F5 Switches and Crossings

NR standards specify that switches and crossings that are not life expired must find further use. Specific requirements relating to the appraisals of switches and crossings for reuse are set out in the standards. Individual components of switches and crossings may have their defects assessed, grinded or weld-repaired before being reused. Switches and crossing components that meet the specification are normally restricted to reuse in lower track categories, on which lower train speed and/or lower load and wear are expected. The reuse of certain designs of switches and crossings assemblies is also explicitly prohibited in the standards.

Our understanding is that switches and crossings layouts are rarely reused in their entirety due to their sizes and the associated difficulty in transporting them. However, spare parts and off-cuts from the manufacturing process of switches and crossings are generally reused as appropriate.

Similar to plain rails, certain components in switches and crossings can be sold to the scrap metal market and used in steel manufacturing.

F6 Signal Heads

The LED technology currently used in signal heads provides a relatively long service life compared to filament lamps that were used previously. In the event of LED lamp failure, individual LED colour light module can be replaced but the repair and reuse of failed LED lights are generally not possible. Other components such as module lens, internal wires and the frame assembly can also be replaced separately. However, as the causes for the replacement are generally physical damage due to corrosion and ageing, the reuse of replaced components are not possible.

F7 Cabling

Due to their non-mechanical nature, cables are generally only replaced due to accidental damage, theft and vandalism or end of service life, which can be up to 60 years. We consider that there is limited economic benefit in the reuse of cables due to the relatively short life-cycle of signalling and telecoms technologies that can render specific types of cables obsolete by the end of their long service life.

However, cables that are damaged or past service life can be sold as scrap metal. This can potentially yield significant cost benefits particularly during periods of high metal prices.

F8 Axle counter evaluators

Axle counter systems are installed independent of the track infrastructure. In the event of track renewal, counting heads and evaluators can generally be retained and reinstalled on renewed tracks. Axle counting systems are also relatively reliable compared to other train detection systems such as track circuits. Faults on the axle counting systems can generally be resolved by resetting the system.

However, due to the complex specialist electronic components of axle counting systems, the refurbishment and reuse of systems that have failed to the point that replacement is required may not be easy without substantial inputs from manufacturers. Therefore limited economic benefits may be gained from the reuse of axle counting systems that are taken out of service.

F9 Point Machines

Mechanical wear due to number of operating cycles, flexing of the trackbed and environmental issues such as floods are the most common causes for degradation of point machines. As point machines are high-cost items, there is significant economic benefit in recovering parts from scrap point machines for reuse. The large number of different mechanical components in point machines also makes it likely that useful parts can be recovered from failed machines for reuse

NR currently works with Unipart Rail to identify and return scrap point machines for stripping and refurbishment. Useful parts recovered from scrap point machines are re-assembled with new parts to original specifications. According to Unipart Rail, the refurbishment and reuse of existing parts can yield 70% cost savings against completely new point machines.

Parts from Style 63 and HW types are currently refurbished and reused. To maximise cost benefits from the reuse of point machine components, NR can consider extending this practice to other point machine types by working with manufacturers and contractors.

Appendix G – Comparator network key characteristics

** Redacted for reasons of commercial confidentiality **

Appendix H – Original study mandate (ORR – 4th August 2010)

Mandate for International Materials Costs Benchmarking

Audit Title:	Review of Materials Costs
Mandate Ref:	
Document version:	Final
Date:	4 August 2010
Draft prepared by:	Marius Sultan
Remit prepared by:	
Network Rail reviewer:	

Authorisation to proceed

ORR	Marius Sultan	4th August, 2010
Network Rail	Ian Smith	4th August, 2010

1. Background

As part of the Periodic Review work carried out by the ORR during 2007-2008, a series of studies showed that there was an efficiency gap in the order of 35-40% in comparison to other similar operators across Europe. In order to better understand the reasons for this difference the ORR and Network Rail have conducted additional studies using mainly top down economic and engineering analysis to identify areas where efficiencies could be achieved.

Given that the cost of materials contributes to a significant proportion of overall maintenance and renewals expenditure, it is proposed to analyse the cost of typical materials used by Network Rail. The inherent challenges in making like-with -like comparisons and the need for this review to be a straightforward, lower cost undertaking mean the focus of the study needs to be on “factory gate” prices. Other “generic” factors likely to drive costs (such as exchange rate differentials and government charges and taxes) will be identified and accounted for to enable costs to be normalised.

Given that there will be a number of factors that influence the price of materials the ORR would like to understand the controllability of materials costs on a quantified basis.

2. Objectives

1. Provide a view of Network Rail’s materials costs and where relevant and practicable, its procurement practices
2. Provide a comparison of Network Rail’s materials costs with supplier costs from other UK and European sources in order to assess the efficiency gap
3. Inform the ORR’s analysis of efficiency for PR13

4. A version of the report shall be prepared for loading onto the ORR website.

3. Scope

The study shall consider the costs of the typical materials used by Network Rail in its day to day operations and is likely to cover the following.

- CEN60 Rail (consider the various comparable grades)
- FB113 Rail
- Sleepers (concrete, hard/soft wood)
- Ballast
- Typical switches and crossings
- Points motors
- OLE Wire (25kV)
- Axle counters
- Transformers
- Plant & Machinery (e.g. tamping machines)
- Civils work – concrete, coping stones, tactile strips

Once the consultant has made an initial assessment of the available information from the various sources then the ORR and Network Rail may agree to vary the schedule of items to be included in the study.

In order to understand the controllability and variance of materials costs, the study shall compare “ship-from” costs from other sources / suppliers most likely to be in the UK and Europe with a strong emphasis on other European rail organisations that have been agreed as suitable comparators for Network Rail.

In addition to looking at factory gate prices (the main part of the study), the consultant shall consider to the extent possible a quantitative assessment of the key factors that contribute to cost differentials. Where this is not practicable then the consultant shall provide a qualitative assessment. Factors to be considered that are likely to be relevant within this analysis include:

- Procurement strategy
- Supply market (sufficient competition, barriers to entry etc)
- Unit costs (buying power, negotiations etc)
- Economies of scale (bulk ordering)
- Inventory control (how well this is managed)
- Transport and storage arrangements
- Cascading of used materials (rails etc)

The consultant shall:

- Set out the assumptions which underpin comparisons including exchange rates used, methods of harmonising the costs etc in order that the ORR is able to make robust like-for-like comparison of the results sampled (as outlined above)
- Provide commentary on best practice and highlight areas of concern where Network Rail could achieve significant efficiencies in its operations

- Review what benchmarking Network Rail has already carried out and what its future plans are for keeping up to date with materials costs.
- Identify how Network Rail assures itself that the prices it obtains from the market are reasonable and that the processes within the organisation are "joined up" (e.g. that the policies are consistent with the strategic plans and that the plans then drive the materials volume requirements etc)

4. Methodology

1. The consultant shall undertake a literature review to explore existing sources of information and obtain sample cost information where available for the key infrastructure elements identified.
2. Set-up meetings with relevant Network Rail staff to understand the processes and procedures which are currently being used by the organisation.
3. Contact selected individuals within a number of European rail organisations in order to assess the unit costs of materials. The individuals shall be agreed with the ORR at the outset.
4. Contact at least five European rail organisations and where appropriate suppliers to assess the unit cost of materials at source. Where the consultant has not been able to gain access to relevant organisations then the ORR and Network Rail shall agree suitable alternatives or changes to scope.
5. Produce a set of recommendations and conclusions which identify areas for improvement and quantify at a high level, the scale of improvement in pricing that may be achievable in monetary terms.
6. Produce a draft and final report and present findings to the ORR and Network Rail.

5. Deliverables

1. Draft report for comment which details the findings, conclusions and recommendations. The consultant shall use best endeavours to obtain cost information from the various sources available.
2. Final report which incorporates the amendments from the ORR and Network Rail (on matters of factual accuracy). The report will be made available as a pdf file and a limited number of hard copies will be provided to both the ORR and Network Rail.
3. A presentation of the interim findings shall be made to the ORR and Network Rail.

6. Timescales

- Progress reports to be produced on a fortnightly basis
- Presentation of emerging findings 15thSeptember, 2010
- Draft Report shall be provided by 13th October, 2010
- ORR and Network Rail review draft report and return comments by the 22nd October, 2010
- Final Report to be produced by 29th October, 2010

7. Procurement

The ORR shall in the first instance approach the Part A reporter who has expertise in this area to submit a formal proposal for carrying out this study.

It is expected that that proposal will include a detailed methodology, timescales for deliverables, resources and costs on the basis of this remit.

Appendix I – Meetings

Date	Location	Attendees name & Division	Purpose of Meeting
17/08/2010	NR Kings Place office, London	Arup: Mark Morris, Tim Ashwin ORR: Marius Sultan, Amusin Falusho NR: Ian Smith	Kick off meeting: scope of study, study approach, next steps
19/08/2010	NR Milton Keynes office	Arup: Alexander Jan, Tim Ashwin NR: Ian Smith, Neil Roberts, James Heslop, Julia Terrett, Dave Ford, Steve Dady, Richard Wilson, Mark Dickinson, Andy T	Meeting with NR NDS staff, infrastructure materials supply chain and procurement
21/08/2010	NR Crewe Depot	Arup: Tim Ashwin NR: Howard Parker, Ian Smith	Meeting with NR team procuring OLE electrification materials
23/11/2010	One Kemble Street	Arup: Alexander Jan, Mark Morris, Tim Ashwin ORR: Marius Sultan NR: Ian Smith	Meeting with ORR and NR to discuss progress to date, update on comparator data gathering
21/12/2010	One Kemble Street	Arup: Mark Morris ORR: Marius Sultan, Richard Coates NR: Ian Smith	Meeting with ORR and NR to present progress to date
18/03/2011	NR Milton Keynes office	Arup: Tim Ashwin, Jian Li NR: Adam Todd, Stephen Dady, Katrina Law, Paul Jarvis, Kenneth Blackley, Mark Potter, Mike Black	Meeting with NR to discuss clarification questions
31/03/2011	One Kemble Street	Arup: Alexander Jan, Tim Ashwin NR: Ian Smith ORR: Marius Sultan	Discussion of emerging findings

Appendix J – Documents Reviewed

Document	Description
Network Rail Input Price Trends Summary Report, L.E.K. Consulting , 2007	A study into the future trends in input prices for Network Rail including main labour, plants & materials. Key drivers, impacts of supply constraints and change in constraints in each supply market are explained
International Construction Cost Survey, Gardiner & Theobald, 2010	International data for building cost information, labour rates, material costs and inflation statistics
Price Increases 2008 Supporting Information, Corus, 2008	An explanation of global demand growth drivers for steel, trends in input costs and developments in the steel industry that affect steel prices
The Rail Supply Industry – A Global Perspective, Arup, 2008	An analysis of the global railway supplier market conditions and trends
Rail Infrastructure Cost Benchmarking – Brief LICB-gap Analysis and Cost Driver Assessment, BSL Management Consultants, 2008	An analysis of gap between Network Rail infrastructure costs and European infrastructure costs using UIC Lasting Infrastructure Benchmarking data including an assessment of cost-drivers for Network Rail infrastructure expenditures
Annual Efficiency and Finance Assessment of Network Rail 2009-10, Office of Rail Regulation, 2010	An assessment of Network Rail's efficiency and financial performance including various spending figures and financial information
Network Rail Strategic Business Plan Control Period 4 Supporting Document – Asset Management, Network Rail, 2007	An outline of Network Rail's asset management strategies on tracks, signalling, structures, operational property, telecoms and electrification and plant
Track Asset Policy Part 4 Update, Network Rail, 2010	March 2010 update on Network Rail's policy statements for track assets with detailed descriptions of inspection, maintenance, refurbishment and renewal polices
Network Rail Standard: Serviceable Switches and Crossings, Railtrack/Network Rail, 1996	Specification setting out minimum standards to be observed for serviceable switches and crossing being considered for reinstallation in Network Rail infrastructure
"Benchmarking UK Rail Civil Engineering Projects to Europe", 27.01.2011	Benchmarking study undertaken by NR comparing NR civil engineering costs with other European rail organisations and contractors, including a comparison of materials costs from a UK contractor withcosts provided by overseas contractors.

Appendix K–Extract from NR benchmarking study on Civil Engineering Project costs

Network Rail recently undertook a benchmarking study of comparative costs for civil engineering projects, which included a comparison of materials costs from a UK contractor, with costs provided by contractors from three other European countries. Arup has been provided with a copy of this report.

The results of this comparison are provided on page 16 of the Network Rail report.