

HSIPR Best Practices: Operating Costs Estimation

June 2011

Prepared for:
Office of Inspector General
US Department of Transportation

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ACKNOWLEDGEMENTS

This report was prepared for the USDOT Office of Inspector General by Steer Davies Gleave Inc., working under a subcontract to Charles River Associates Inc. for order number DTOS59-10-F-10085.

The Steer Davies Gleave personnel who participated in this work include Jon Bottom, Leo Eyles, Masroor Hasan, Felicity Hulme, Lucile Kellis, Scott Prentice, Lars Rognlien and Tessa Wordsworth. Mark Kiefer, an independent consultant, also contributed to the writing. Masroor Hasan was the project manager and Jon Bottom was the project director.

Martin Baynham-Knight of Steer Davies Gleave and Dan Brand, a senior advisor at Charles River Associates, reviewed the report and contributed useful suggestions.

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Glossary

Definitions of commonly used terms in the report are provided below.

- **Significant.** A change is defined as significant if it alters the quantity or cost by 25% or more. Where the term is used, it only refers to the element under discussion in the particular context and not the total operating cost. For example, a “significant” change in the electricity consumed by a train will increase the total energy cost estimate by a proportional amount because energy costs are directly derived from consumption and unit cost. However, the impact on total operating cost is less because energy is a second order cost driver. Conversely, a “significant” change in the salaries of maintenance staff will not increase rolling stock maintenance costs by the same proportion because material costs and fixed depot costs also influence this and are unaffected by the change.
- **Critical.** If an activity is defined as critical then it must be undertaken in order for the estimated costs to be viewed with confidence. In numerical terms omission of a critical element will mean that element of the estimate is an order of magnitude out.
- **Robust.** If an output is classified as robust, it has been calculated in a methodological manner with assumptions and sources of data recorded and the outputs sense checked or benchmarked. The reviewer is therefore provided with assurance that the output is of appropriate quality and accuracy.
- **Resource.** The principal resources required to provide an HSIPR service are:
 - Rolling stock (trains) to convey passengers between stations;
 - Labor (to operate and maintain the trains, railroad and station);
 - Materials (components requiring regular replacement such as train brake pads and discs, components which require replacement when they fail such as motors, consumables such as oil and cleaning equipment); and
 - Plant & equipment (road vehicles for maintenance staff, rail maintenance vehicles, maintenance machinery, personal tools, computers and software).
- **Diagrams.** A schedule or plan which allocates rolling stock (trains) and traincrew to particular services in a timetable. A diagram is usually produced for each train and member of traincrew showing the timetabled services to be worked that day. The process of “diagramming” is the allocation of trains and traincrew to provide the desired service.
- **Plant/equipment.** The tools and machinery to permit maintenance and repair of the HSIPR system. For example, at train maintenance depots, plant/equipment will range from personal tools for skilled staff to lifting equipment to remove equipment such as bodies from under trains and lathes for reprofiling wheels. In railroad maintenance depots, the larger plant/equipment will include mobile platforms for accessing undersides of bridges or overhead power lines, machinery for removing, cleaning and replacing ballast and machinery for maintaining the geometry of the way while insitu.
- **Assumptions register.** A record of the elements which are assumed to be true but where there is insufficient knowledge to prove this at the time. The register will state the source of the assumption, the other elements which are dependent the assumption and how and when the assumption will be validated and verified. Validation is the process of demonstrating the assumption is realistic, for example, through design. Verification is the process of proving the assumption to be true. For example, in the early stage of a project, train acceleration characteristics will be assumed, usually based on comparable rolling stock. Trip times and timetables will be developed using the assumption and are therefore dependencies of the assumption. The number of trains and

traincrew required to operate the timetable will be second order dependencies as they are driven by the timetable. The acceleration assumption will be validated when a manufacturer has been appointed to supply the rolling stock and design completed. The assumption will only be verified when the train has been manufactured and tested. An example of an entry in an assumptions register is presented in Table 4-8.

- **Risk register.** A record of threats to the success of the project where the cause and effect is defined. The impact of the risk is usually defined in \$, referring to the sum it will add to costs or remove from revenue. The probability of the risk is the likelihood of occurrence. Each register will define thresholds to measure degrees of probability and impact so that all risks are measured in a consistent manner. A good risk register will assign an owner to each risk, who will then document and deliver actions to manage that risk. The severity of each risk is the product of probability and impact and this is typically used as the measure by which risks are ranked. Management attention should be focused on the most severe risks. A risk register should be updated regularly (monthly) throughout an HSIPR project in order to provide an evidence trail of risks being managed and their impacts reduced or avoided altogether. An example of an entry in a risk register is presented in Table 5-8.
- **Quantitative Risk Assessment (QSR).** This is a methodological process using measurable data to understand the probability of loss and the value associated with it. Typically a range of values are given for the probability and impact of each risk and a Monte-Carlo statistical analysis undertaken to estimate the total loss likely. This value is then used to inform the estimate of contingency which should be set aside for managing those risks.
- **HSIPR operator:** This is the entity who is either promoting or will be responsible for providing the HSIPR train service. The HSIPR operator is responsible for developing the estimates of operating costs and submitting the proposals for review.
- **Day-to-day “plan”.** This is timetable and service offer which is offered to passengers and management structure and processes which organizes delivery of it. A key element of the plan is the contingency actions which bring it back to the normal state following unplanned disruption arising from equipment failure or external factors such as the weather.
- **Railroad manager:** This is the entity who owns and is responsible for safely operating and maintaining the railroad which consists of way, ties, ballast, bridges, switches, signals, telecommunications, stations and power supplies. In many cases, the HSIPR train service will operate on newly constructed railroad, designed to provide the fastest and most reliable trips for the HSIPR trains. The HSIPR operator will therefore own and be responsible for the new railroad and is classified as the railroad manager (also referred to as the landlord). However, the most efficient solution may be for the HSIPR train service to operate on an existing railroad, even if it needs to be improved to allow high-speed passenger trains to operate. In this case, the railroad manager is likely to be a different entity from the HSIPR operator, who is then classified as a tenant and will pay fees to the railroad manager to operate trains on their railroad. A railroad manager may have several tenants who pay fees to run trains on their network at set times.

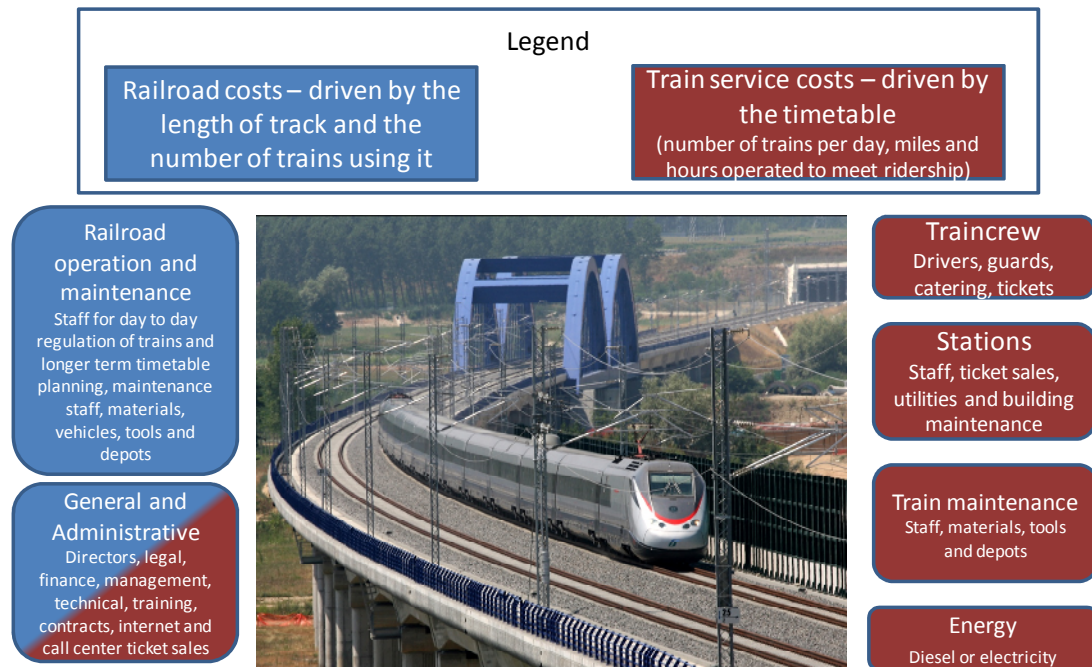
1 Overview of operating costs

Introduction

This section provides an overview of the costs which will be incurred by an HSIPR operator to provide a train service between two or more stations. It describes the key categories of cost, identifies the factors that affect the resource inputs (for example, numbers of staff and trains) and comments on the unit cost rates associated with each type of cost.

At the highest level, operating costs for an HSIPR service comprise two distinct components - those required to provide the railroad upon which the trains run and those associated with providing the train service which passengers pay to use. The key elements of each are illustrated in Figure 1-1 below.

FIGURE 1-1. HSIPR OPERATING COST COMPONENTS



Costs will be incurred in all of these areas either directly by the HSIPR operator or by a third party who is being paid to provide the service. Costs are generally proportional to the number of services running each day; the total distance operated by trains; and the time taken to make each trip. Trip time is driven by a combination of the speed and acceleration characteristics of the train and the number of stations it stops at.

Train service costs comprise:

- **Traincrew:** comprising the drivers, conductors or guards to operate the trains and staff providing on-board customer services;
- **Energy:** the cost of powering the train, usually diesel or electricity;
- **Stations:** comprising staff to provide ticket sales, customer information and train dispatching services. The station buildings will incur utility and maintenance costs;
- **Train (“rolling stock”) costs:** HSIPR trains are generally purchased and therefore treated as a capital rather than an operating cost. However, there are instances where the trains are owned by a

3rd party (for example, a financier) and the HSIPR operator pays an annual lease charge for their use. In this instance, the annual charge for leasing the trains is considered as an operating cost;

- **Train maintenance:** comprising of the routine planned maintenance of trains as well as reactive maintenance as a result of use, or incidents. This will cover the cost of staff, materials and depot facilities, including utility costs and their maintenance. HSIPR trains require inspection and minor component changes every 1 to 3 days depending upon the mileages operated, major component change every few years and a full train refurbishment every 15 years or so; and
- **General and administrative:** including management, marketing, telephone or internet ticket sales, staff travel and subsistence expenses, staff bonuses, uniforms and office overheads.

Railroad costs comprise the costs of providing and operating the infrastructure so that the train service can operate:

- **Maintenance:** including planned and reactive maintenance of way (track and structures) and systems (electrical distribution, signals and communications). Maintenance costs comprise staff, materials, plant/equipment and sub contract elements;
- **Operations:** including regulating train services through signaling and electrical control room staff and station staff where they are operated by the railroad manager. Operations costs are almost wholly staff based; and
- **General and administrative:** including management, technical (to set standards), accommodation and if the railroad manager has tenant HSIPR operators, contract/commercial staff to manage access agreements.

The company which owns and manages the railroad (the railroad manager) can be the same or a different corporate organization from the operator of the HSIPR service. Where the railroad manager and the HSIPR operator are separate organizations, the HSIPR operator will pay a fee to the railroad manager to use their railroad. In this case, the HSIPR operator is the tenant and the railroad manager the landlord. This access charge must cover the fundamental cost elements described above but where several train service and freight operators are tenants of the same railroad manager, they will share the overall burden of railroad operating and maintenance costs between them.

Operating cost estimates can be prepared in a bottom-up or top down manner. To illustrate the difference, consider the process of estimating the cost of building an office block:

- The top down approach obtains the total floor space from the specification or design and multiplies it by standard cost per square feet, obtained from analyzing the costs of recently completed office buildings in a similar neighborhood; and
- The bottom up approach identifies all the discrete activities which combine together to produce the completed building. The cost of each activity is estimated by assessing the labor, material and equipment required to complete a defined piece of work. For example, in the case of laying the building foundations, design drawings will confirm the volume of soil to be excavated and concrete to be poured. The contractor will apply the known cost of labor and hired equipment to estimate their productivity given any particular constraints of the worksite. For example, the time in days required to excavate the foundations is multiplied by the hire rate of labor and an excavator. The total cost of the building is the sum of the sub estimates with a view taken on efficiencies which will be obtained from running numerous tasks in parallel.

The basic end product of an HSIPR service are trains which run between specific destinations to an advertised timetable. Bottom up estimates are complex and time consuming to prepare but usually more accurate. Typically a bottom up estimate will present detailed rosters of staff to operate individual train services and to undertake inspections at maintenance depots. Top down estimates will use a generic cost per

train mile or hour operated. If used properly, top down estimates can provide an acceptable degree of accuracy quickly. However, top down estimating carries the risk of presenting a total which does not properly account for all costs as every HSIPR service is different.

Proportion of costs

Approximately 50% of the total cost of an HSIPR train service is accounted for by staff costs. The other significant cost elements are financing costs (particularly if trains are leased rather than purchased outright), energy (mainly for traction power but also utilities for stations and depots), materials and equipment (for the repair of trains, stations and the railroad). In order to sensibly present staff costs without overshadowing all other cost elements, it is helpful to disaggregate them into the general categories presented in Figure 1-1. This also better reflects the wide variety of staff grades and competencies (and therefore range in salaries) required to operate a safe and successful HSIPR service.

With staff costs distributed in this manner, energy, railroad operations and maintenance and train maintenance become the first order drivers of cost while traincrew, stations, general and administrative the second order. If trains are leased or accessed through external financing then this is a significant cost and generally large enough to be classified as first order.

Types of HSIPR operation will vary considerably. For example, many HSIPR operators will purchase trains outright, some may out-source train maintenance and others may share stations or stabling facilities with other operators. There is, therefore, no “rule of thumb” which can be used to guide where one should focus effort when forecasting costs.

Very approximately, for an HSIPR service which is landlord of the railroad on which its service operates and has purchased its trains, one might expect the proportionality of costs to be as shown in Figure 1-2. For reference this figure also summarizes the key drivers for each cost area.

It can be seen that energy, railroad operations & maintenance and train maintenance account for around 66% of the total annual operating cost, with the later two elements forming around half of the total.

FIGURE 1-2. PROPORTIONS AND KEY DRIVERS OF OPERATING COST

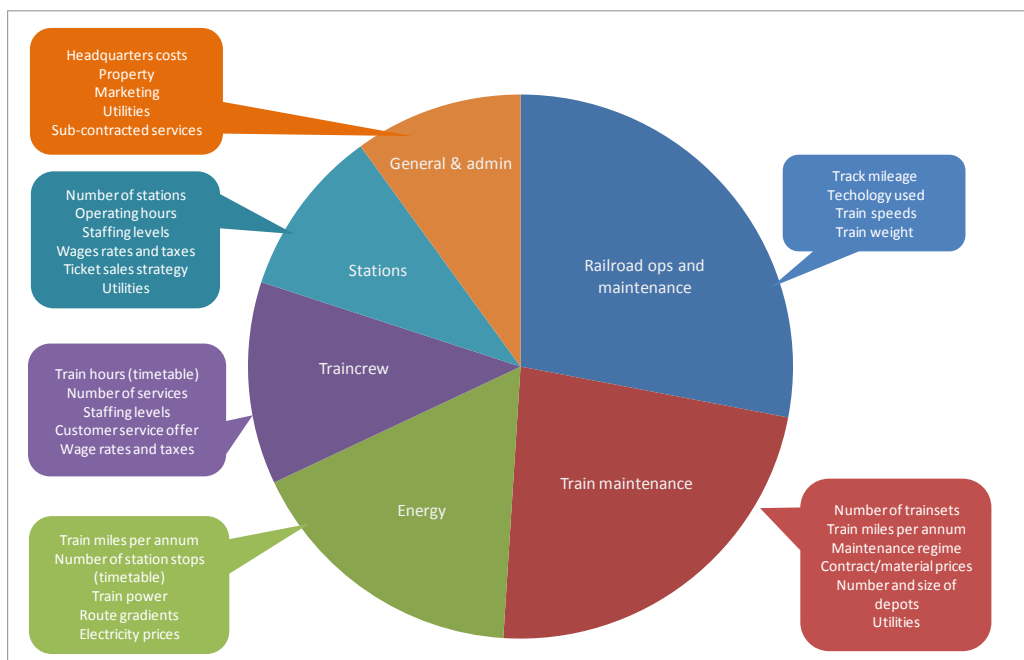


Table 1-1 summarizes the key elements of cost in each category and attempts to rank them in order of significance. This is illustrative as there is no “typical” HSIPR operation.

Energy is the only category in which staff does not constitute the first or second most significant element of cost. There will be differing grades of staff in all categories with salaries proportional to their skills and responsibilities. For clarity, only traincrew has been broken down into sub elements in Table 1-1.

TABLE 1-1. HSIPR OPERATING COST ELEMENTS

Cost category	Rank	Cost element
Traincrew	1	Drivers
	2	Conductors/guards
	3	Customer service staff
	4	Management/supervision
Railroad operations and maintenance	1	Staff
	2=	Materials
	2=	Plant and equipment lease, fuel and maintenance
	4	Depot costs (maintenance, utilities etc.)
Train maintenance	1=	Staff
	1=	Material
	3	Depot costs (maintenance, utilities etc.)
	4	Plant and equipment lease, fuel and maintenance
Stations	1	Staff
	2	Building costs (maintenance, utilities etc.)
Energy	1	Fuel consumed by trains
General and administrative	1	Staff
	2=	Internet/call centre ticket sales
	2=	Marketing and advertising
	2=	Building costs (maintenance, utilities etc.)
	2=	Specialist technical, commercial, legal support
	2=	General subcontract services
	3	Expenses, uniforms and misc staff costs

Train service operating costs

Prior to preparing forecasts of train operating costs, the HSIPR operator will have developed a train service specification that defines the outputs of the HSIPR service in terms of the frequency of service, the stations served and trip times. A good specification will also define the type of train which will be operated, times of start and close of service and differences in service level across the day (for example, longer trains on some peak services) and across the week (for example, lower numbers of trains at weekends).

The train service specification will be developed in conjunction with an assessment of ridership for HSIPR services, to ensure that it offers attractive trip times and frequencies between locations for which there is a market.

The first stage in estimating train service operating costs is to understand:

- What is to be delivered (the train service specification including quality);
- How it is to be delivered (will trains be purchased/leased, how will trains be maintained, how will tickets be sold and trains dispatched, who will be the railroad manager); and

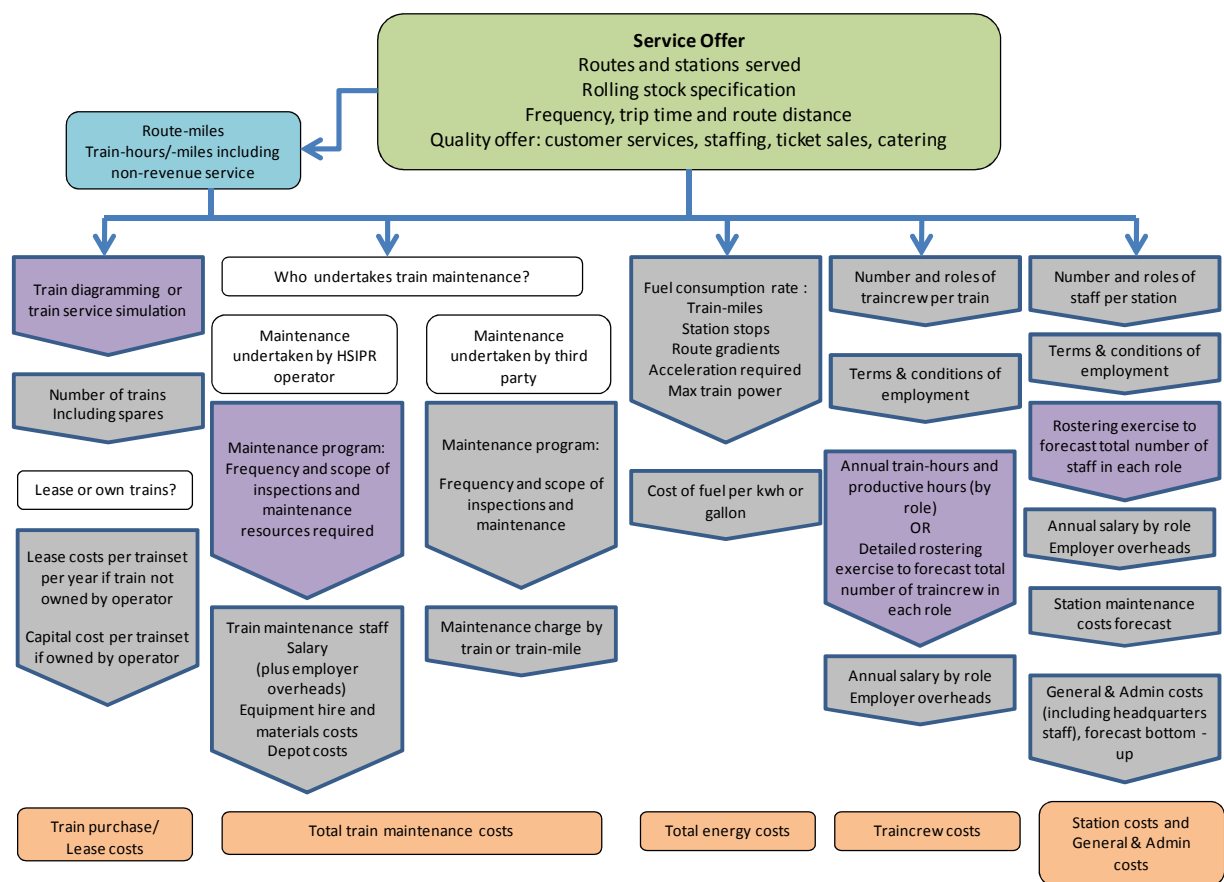
- What is necessary to meet safety and other national legislation (impacting on factors such as staff numbers and train design).

The metrics which have the largest influence over train service operating costs are the number of train miles and hours operated and the number and size of stations served. However, the level of customer service or quality offered can also have a significant impact.

Figure 1-3 summarizes the relationships between the key components driving train service operating costs.

The train service specification defines stations to be served along with the number of trains required to operate the service, the number of train miles and hours operated. The latter three elements have the largest impact on the accuracy of any operating cost estimate as most cost elements use these metrics as an input. They should be developed from the same assumptions as those used in the ridership forecasts.

FIGURE 1-3. TRAIN SERVICE OPERATING COST COMPONENTS



Train (“Rolling Stock”) purchase or lease costs

There are several types of trains which may be deployed - a traditional train formed of a locomotive and a number of carriages, or a fixed-formation multiple unit. Most worldwide high-speed lines use fixed-formation electric trains, which on the busier routes, operate in multiple (two trains coupled together). A multiple unit has benefits, in particular the ability to quickly turn round the train at a terminus station, whereas the traditional consist of a locomotive and carriages makes it easier for the operator to tailor train capacity to demand projections.

Acquiring trains to operate the HSIPR service is one of the largest areas of expenditure in the delivery of an HSIPR service. This cost will either be included as a capital (investment) cost prior to the commencement of the HSIPR service, or, if trains are to be leased from a third party, as an operating cost (a cost per train per year).

If the HSIPR operator purchases the trains directly from the manufacturer, they will often include a depreciation charge in operating costs, to spread the value derived from the asset over its useful life.

The cost of an HSIPR train, consisting of the driving, power and passenger coaches required to form an operational train, will depend on the technology used, legislative requirements (such as crash-worthiness) and the required capacity (the number of seats can range from 300 to 900 per train). The financial impact of these elements is illustrated by the fact that European HSIPR trains have ranged in cost from \$30m to \$70m (in 2009 prices) each.

Even during early stages of project development, the HSIPR operator should state the number of trains required and, most importantly, show the assumptions used to derive this from the number of timetabled services planned to operate each day.

The cost of purchasing or leasing each train will be subject to commercial negotiations between the HSIPR operator, the manufacturer(s) and possibly a financier. The price paid for a train (purchase price or lease price) will reflect trade-offs and the extent of innovation risk the HSIPR operator and train manufacturer are willing to take:

- The number of trains required (which itself is a function of the service frequency, trip time and confidence in the reliability of the trains themselves);
- The technical specification of the train (including maximum speed, acceleration and weight). Particular attention is paid to train weight as reducing weight will increase the build cost, but may lower the on-going operating costs of energy consumption costs and track damage costs;
- Safety and accessibility legislation (the costs associated with meeting standards including crash-worthiness standards and mobility impaired passenger access);
- The quality of passenger experience: high standards of comfort - comprising better quality interior fittings, ride quality and general ambience (noise and ventilation) - will increase the costs of building the trains;
- The availability of finance with which to build the trains;
- Where trains or components are built abroad, exchange rates;
- The risk associated with the HSIPR venture and the appetite for risk of the rolling stock manufacturer (in terms of the likelihood that HSIPR is a long term venture and manufacturers are willing to take the risks associated with HSIPR);
- The desire of rolling stock manufacturers to enter the North American HSIPR rolling stock market (which may drive down prices to gain entry to the market);
- If a customized train is required, the costs are likely to be significantly higher than if an existing design can be used; and
- The potential to expand the HSIPR network in North America (process may be shorter if manufacturers anticipate the order to be increased in the short or medium term).

Where new trains are procured, a key issue will be the delivery timescales of the trains; for example, in Europe it typically takes at least a year to select a preferred manufacturer and a further 3 years to deliver all required trains into passenger service. However, the manufacturer will require staged payments prior to introduction of revenue earning passenger service and this will need to be reflected in the commercial evaluation of the HSIPR service.

Where trains are leased from a third party, the train service operator will need to consider the length of the lease period, the terms and conditions, the price per train and the annual indexation of lease costs. Where trains are leased, it is also more likely that some element (or all) of the train maintenance will be undertaken by the lessor and the costs of this may be rolled-up in the lease costs, making train maintenance costs appear relatively cheap.

Traincrew

Traincrew includes drivers (including trainees), conductors and guards and for HSIPR services is also likely to include train managers and catering staff. It aids clarity if support staff such as managers and trainers are also presented separately in the estimation of traincrew costs.

Conductors and guards may undertake a range of functions including dispatching trains (for example, to open and close train doors and give the driver the “clearance to proceed” signal), selling tickets on-board, checking that passengers are traveling with valid tickets (revenue protection) and providing customer information and assistance. Depending on the scope of responsibilities of traincrew and the volumes of passengers on-board, it may be necessary to have more than one conductor or guard on-board.

Roles and responsibilities of traincrew will vary in different HSIPR proposals and therefore caution should be exercised when comparing staff numbers, costs and productivity between proposals.

The number of each category of traincrew required will predominantly be determined by:

- Frequency of train service and end-to-end trip time;
- Turnaround times at terminating stations;
- Safety standards;
- Train design;
- Quality of passenger service offered; and
- Terms and conditions of staff.

The first two of these items are often summarized in terms of the number of train diagrams required, which is used at early stages of project development to indicate the number of teams of traincrew that will be required at any single period during peak hours of operation.

The number of drivers will also depend on the location of depots and stabling of trains, the time required to prepare trains for service and periodic training requirements. Some rail authorities require a second driver to be present in the cab for high-speed operations.

Traincrew salaries vary significantly according to the roles and responsibilities of staff. Drivers of HSIPR services generally receive very attractive salaries. Other traincrew whose responsibilities include train dispatch or are safety critical will also command higher salaries than those staff undertaking non-operational duties (such as selling or checking tickets). Catering staff are generally the lowest paid and this service may be contracted out (and in this case must be included in the “general and administrative costs” category of cost forecasts).

One of the critical components of forecasting costs is the assumption as to how unit costs grow over time. Salaries would be expected to increase in line with the cost of living, however, some categories of staff may be able to command higher salary increases, particularly when the resource base for people with their skills are limited or where staff are unionized.

The terms and conditions of staff are a critical element of the determination of operating costs, in particular in relation to the definition of the working week, employer’s contributions to health insurance and retirement funds and other elements of the salary package. Assumptions about payment for overtime working may also have a significant impact on total staff costs.

For long distance train services, traincrew account for a high proportion of staff travel and subsistence expenses and estimates of general and administrative costs should include these expenses.

Energy

The cost of fuel (generally diesel or electricity) required to power HSIPR trains is determined by the train service specification (miles operated, train speed and calling points) and the type of train operated (train weight and traction efficiency).

Diesel consumption rates are usually quoted as a number of US gallons per train mile, very approximately these are of the order of 2 US gallons per train mile (for a 650 ft train). Electricity consumption is usually quoted as kilowatt hours (kWh) per train mile, with a typical consumption rate being 25-50 kWh per train mile. Energy consumption rates are determined by the power rating of the train, the number of station stops, the maximum speed, required rate of acceleration, (loaded) train weight and gradients of the route.

HSIPR proposals should consider how they will procure energy and make an informed judgment on the unit price that they will pay. The US Energy Information Administration publishes average energy prices for each sector (including the transportation sector) and for each State and these may be used (during early stages of HSIPR proposal development) as a guide to the unit energy price that will be paid. HSIPR proposals will also make different assumptions about future energy prices which may have a significant impact on costs over time. Buyers of fuel may also hedge against future changes in prices resulting in a potentially lower price per unit.

Bulk buying of energy can result in discounts to market prices; this is particularly relevant where the HSIPR operator is a buyer of energy for other (not necessarily rail) operations.

There may also be a trade-off between energy costs and the design/build (and so lease/ownership) costs of trains. Some HSIPR proposals may take the view that it is commercially sensible to invest in energy efficient rolling stock - sometimes resulting in higher rolling stock costs but lower energy costs (and possibly lower railroad maintenance costs if the train is lighter in order to reduce energy costs).

Stations

Station staff will have a variety of responsibilities including selling and checking tickets, dispatching trains, providing information and assistance to passengers, providing security to passengers and ensuring that stations are kept in clean and attractive condition.

Station staff are typically divided into three categories:

- Train dispatch staff (who may also undertake light cleaning of stations and report where repairs are required);
- Ticket sales staff (located in ticket offices and/or providing assistance to passengers who are purchasing tickets from self-service ticket machines);
- Ticket checking staff (who either check tickets manually at the entrances to platforms or man ticket gates which automatically check tickets);

All station staff would be expected to provide customer information and support.

It is likely that the HSIPR operator will wish to have some influence on train service performance and standards of customer service at all stations and will employ at least a nominal number of station staff. These will be focused at key locations, for example, terminal stations, those with complex layouts or services or stations with high volumes of passengers. Sometimes more than one HSIPR operator may share a station. In such instances, the operator with the lower number of services may sub contract staff duties to the principal operator.

The number of station staff employed will depend on assumptions such as:

- The frequency of train service, length of trains, platform layout and volume of passengers at stations (which will all determine the number of staff required to dispatch a train);
- Start and end of service each day;
- The types of passengers who use the station (for example, if it is an airport station many passengers will be carrying luggage and may be unfamiliar with the HSIPR services and station, requiring a greater level of staff support to undertake their trip compared to other users of the HSIPR);
- How tickets are sold: does the retail plan rely heavily on at-station sales, either where tickets are sold by station staff in ticket offices or by self-service ticket machines. In the case of the latter, HSIPR operators should include staff resources to assist passengers who are using ticket machines;
- Use of technology for ticket sales: what assumptions are made about the proportion of tickets sold on-line, by ticket machines at stations or by telephone sales;
- The type of train operation (is the train designed to be dispatched by station staff or entirely by traincrew?);
- Quality of passenger offer;
- Terms and conditions of staff (working week and constraints on roles and responsibilities); and
- Who provides station staff (the HSIPR operator or a third party though subcontract).

If pricing (through the fares structure) is critical to managing demand and/or to delivering the business plan of the HSIPR, there will be a cost implication as sufficient staff will need to be employed to enforce compliance with the ticketing regime. The HSIPR operator will need to ensure that passengers are traveling according to the stipulations and restrictions of their ticket (e.g., traveling at the defined time where discounted tickets are offered for travel at particular times of day).

Similarly, if the demand forecasts indicate that at certain times there will be extremely high-levels of demand for HSIPR services, sufficient staff will need to be available to ensure that the station operates safely given the large volumes of passengers. This may also be the case when trains are heavily loaded on arrival at the station (for example, prior to the lengthening of trains to meet growth in demand).

Station staff are generally more productive than traincrew, since they require less preparation and handover time at the start and end of each shift and no travel time is incurred at the start or end of each day. HSIPR operators may also use part-time staff to provide additional cover at particularly busy times. A skeleton staffing level at the start and end of service when passenger demand is lower is also often provided. Station staff are generally paid less than traincrew.

Other costs incurred in operating and maintaining the station buildings include utilities such as electricity, gas and water. Such utilities will be consumed in proportion to the physical size of the station, primarily the number of platforms. Building maintenance costs are also proportional to the size of the station - day to day tasks will focus around keeping passenger areas in a safe and clean condition. IT equipment such as train arrival and departure display screens, public address equipment and ticket vending machines require regular inspection and maintenance - this equipment can be technically complex and the maintenance is often sub-contracted. Depending upon the region in which the HSIPR service is operating, property taxes may be payable on the stations; these are usually based on the physical size of the station or the revenue generated through ticket sales.

HSIPR passengers will often use other modes (or other train services) to access the HSIPR services or make onward trips to their final destination and it is important that HSIPR stations are integrated with other modes. Typical examples are bus stops and cycle parking. Short and long term car parking and taxi stands can generate revenue for the HSIPR operator but there is also a cost of maintaining these facilities and collecting and enforcing the parking payments and taxi permits. Generally however, the costs associated with these elements are less than the revenue generated.

Train maintenance costs

Modern HSIPR trains are technically complex and require regular maintenance inspections to ensure they operate reliably and safely. The cost of maintaining trains forms a large proportion of an HSIPR operator's cost base, with the cost per train mile being in the range \$4.00 - \$7.00 per train mile. For HSIPR operations with relatively low annual mileages, the effective per mile rate will be significantly higher than this as a proportion of maintenance costs are effectively "fixed", irrespective of mileage.

Factors affecting maintenance costs include:

- The number of trains operated (including spares) and the number of train miles operated (since maintenance will be required less frequently if each train operates a low mileage);
- Component life: the frequency with which components such as traction motors and brakes need to be replaced;
- Ability to undertake maintenance efficiently, for example, through technology that allows preventative maintenance (before components fail);
- The levels of work arising, for example, through vandalism to interior seats and tables (rather than normal wear and tear) or bodywork repairs from accidents;
- The contractual relationship with the railroad provider: it maybe more commercially sensible to maintain trains to a higher standard so that they inflict less damage to the track (through wear and tear). Increased maintenance costs from this could thus be partially balanced by reduced railroad maintenance costs or railroad access payments for track damage (depending on how access to the railroad is paid for);
- Different responsibilities for undertaking maintenance: the HSIPR operator may have a depot and employ staff to undertake day to day maintenance, but may outsource major maintenance tasks to the rolling stock manufacturer or a separate maintenance company (or train operator); and
- The commercial importance of train reliability - for example, if there is a performance regime whereby the HSIPR operator has to pay compensation to passengers when trains are delayed, then it may be commercially sensible to maintain trains to a higher standard in order to avoid train breakdowns. Similarly, if there is a performance compensation regime between train operators (whereby the HSIPR operator has to pay compensation to other operators if HSIPR trains delay other operator run trains), a similar approach to maintenance may be adopted.

The frequency with which trains are inspected and maintenance undertaken is usually defined by the manufacturer of the trains (in a similar manner to the way in which manufacturers of cars recommend servicing). Checks are therefore undertaken according to train mileage - basic inspections (e.g., brake discs and pads) are undertaken frequently; with more extensive checks (e.g., traction motors) being undertaken at greater mileage intervals. In the US, the frequency of checks and maintenance is enforced by the Federal Railroad Administration (FRA).

Maintenance costs can be charged on a different unit rate basis - for example, some maintenance may be charged as an annual cost for each train car (particularly relevant if the train manufacturer undertakes a significant proportion of the maintenance). This could be contractualized (in Europe this is referred to as a Train Service Agreement) on the basis of the annual train mileage being between a specified range. Other maintenance (often the day to day maintenance) may be charged as a cost per train car-mile.

There is an increasing trend (especially HSIPR) for trains to be provided under a "power by the hour" arrangement whereby maintenance costs are included in the capital cost of trains. This means that the train manufacturer is responsible for all maintenance and refurbishments (where these are defined prior to sign-off of the rolling stock contract). Under this type of contract, the HSR train manufacturer contracts to

provide a given number of trainsets each day, sufficient to operate the service. Penalty clauses for failure to deliver are included in the contracts.

Where train maintenance is undertaken by the HSIPR operator, the costs will be more complex, and comprise elements including the capital costs of building depot facilities; buildings maintenance costs; staff (labor) costs; materials costs; utility costs; property tax (if applicable) and plant and equipment costs (including, where applicable, lease and/or maintenance costs for specialist equipment such as the wash plant, lifting appliances and loadbanks to test motors).

Who undertakes the maintenance will also have an impact on how the costs of commercial risk are quantified and monetized. Where maintenance is undertaken by the provider of the train or a third party who also maintains the trains of other operators, there may also be efficiencies in terms of readily availability of parts and transferability of staff between tasks.

Comparison of train maintenance costs is challenging and any significant differences between the average maintenance costs (per train) of different proposals can usually be explained by costs being omitted from the analysis in error.

As the majority of the train cleaning effort takes place when trains are out of service and in sidings or depots, the costs of the staff and cleaning materials are generally included in the train maintenance category. The interiors of HSIPR trains will be given a basic cleaning at the end of every trip where litter bins are emptied and toilets cleaned. At the end of every day, they will be given an exterior wash and a more thorough internal cleaning involving vacuuming of carpets and seats, wiping of tables and surfaces. Every few months the interior of the train is given a thorough cleaning where upholstery is shampooed.

General and administrative costs

General and administrative costs are generally represented by four categories of costs:

- **Staff related costs:** comprising expenses, uniforms, bonuses and travel, where these are not already included in staff costs;
- **Administration:** including items such as office rent, IT equipment, internet and telephone ticket sales, marketing and advertising, stationary, legal and accountancy support. This category would also include costs paid to other parties for the sale of train tickets or provision of information about the HSIPR services;
- **Headquarters:** staff who are responsible for essential functions such as directors and senior managers, technical and safety standards, accounts and payroll, procurement and contract management, human resources and training, marketing and business planning (including train service planning and fares strategy). Some of these functions may be out-sourced, for example, payroll and technical support; however, the HSIPR operator requires its own staff to specify and manage subcontracted work; and
- **Operations:** staff who organize the day to day operation of the train service, usually managed through a control center. Here decisions are made on how to respond to service delay and plan for returning the service to normal operation as soon as possible, minimizing the impact on passengers. The operations control team will liaise with the staff of the railroad manager (and other train service operators where more than one exists on the HSIPR network). If not accounted for elsewhere, property taxes, utility and building maintenance costs for stations and depots (and the equipment in them) are likely to be included in this category along with sub contracts supporting the HSIPR operation such as replacement bus services and car park management.

Unlike other categories of costs, the components of general and administrative costs are unlikely to be calculated by estimating a level of resource required and a corresponding unit price. Instead they will be

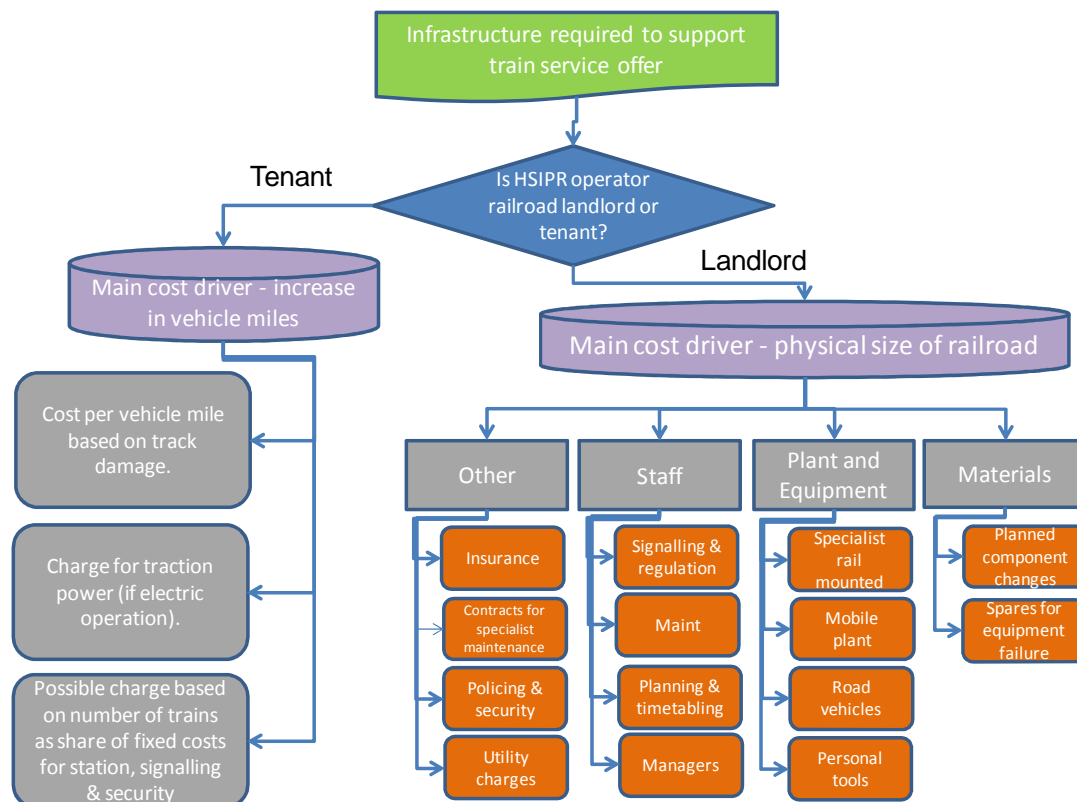
based upon a combination of general commercial experience of managing a service provider type organization and the specific technical and safety requirements of operating rail passengers services.

Railroad costs

Introduction

Figure 1-4 summarizes the key drivers of railroad costs and the following paragraphs discuss each of the main categories of such costs.

FIGURE 1-4. RAILROAD COST COMPONENTS



To provide some context prior to discussing the cost elements, it is useful to consider the magnitude of cost in operating and maintaining a railroad suitable for HSIPR services. A useful metric of railroad costs is the total operating and maintenance (excluding renewals) cost for railroad on a cost per mile basis. This allows comparison across different rail systems and geographical/administration regions on the same system.

The following estimates (in 2009 prices) have been derived from publicly available information as unit rates for railroad operations and maintenance:

- United Kingdom: \$177,000 per single track mile for intercity passenger lines;¹
- United Kingdom: \$233,000 per single track mile for the 68 mile High-speed 1 route between London and the Channel Tunnel. This is considered to be more expensive than the rest of the UK rail network, because of a very high-level of overhead (25%) as a result of the railroad manager being a

¹ Office of Rail Regulation Control Period 4 (2009-2014) determination.

(relatively) small stand alone organization who requires to support significant engineering and commercial support functions;

- UIC advises a mainland Europe average of \$90,000-102,000 per single track mile for high-speed lines. This includes France, Germany, Spain, Italy and Belgium.²

Operations

Control room staff such as signalers regulate the railway on a day to day basis in accordance with the agreed timetable. During periods of disruption, these staff will liaise with train service operators to control the impacts and revert back to the base plan as quickly as possible.

The principal cost is staff related and the quantum is driven by the number and size of signaling and electrical power control centers for the route. Fewer large control centers will require fewer staff to regulate the railroad than numerous small centers. The number of control centers required is a function of the physical size of the rail network being managed and the technology used as the interface between the signaling system and the operator. Some operations staff will be required to attend and manage incidents on site and liaise with maintenance staff as to how the railroad is performing.

This cost area covers staff and utility and building maintenance costs for the signaling centers as well as offices and vehicles for the out-based staff.

Preventative and reactive maintenance

This involves the inspection of the railroad and component changeover in accordance with the appropriate safety case. The safety case will be based upon guidance from equipment suppliers, actual (rather than forecast) use of the railroad and national standards. The preventative maintenance regime will be directly influenced by the frequency of train services, the actual type of trains used and permissible line speeds.

The railroad manager must retain some capability to undertake reactive maintenance - to react to unforeseen events such as component failure (for example, points failure), damage caused by the train operator (e.g., train derailment or poor wheel condition), third party (e.g., vandalism or road vehicle incursion) or weather events (e.g., flooding or landslides).

The key costs are staff, equipment and materials and the driver of costs is the quantity of assets requiring inspection and maintenance, specifically:

- Number of track miles where the “core” assets such as permanent way, track formation, drainage, overhead power equipment and lineside fencing are present;
- Number of switches and crossings (points);
- Number of structures such as bridges, cuttings, embankments and viaducts;
- Telecommunication and signaling systems;
- Number and size of stations to be provided along with facilities to be provided; and
- Electricity distribution equipment.

The specification of technologies used to run and regulate trains will influence the inspection and maintenance regime. For example, slab track requires less day to day maintenance than ballasted track as does in cab signaling compared with lineside equipment.

Specialist equipment is required to maintain the route, for example, ballast cleaners, rail grinders and overhead line access platforms. This equipment will either be leased or purchased outright and will have to

² Economic Analysis of High-speed Rail in Europe, Ignacio Baron, UIC Paris

be maintained itself. A sizable road vehicle fleet will also be required to transport staff and material from the depots to locations of work.

General and administrative costs

This will include integration of the above three cost areas and liaison with the train operating functions to agree timetables and manage commercial and performance agreements, liaison with national standards agencies and general management functions such as human resources, training, payroll, security/policing, safety and strategic planning. In the vertically integrated model, this cost area is “shared” with the train service functions.

The costs will include management, technical support, buildings, utility, procurement and if several operators are using the railroad, a sizable commercial and performance management team.

Renewals

After a period of time, the effective life of the railroad expires and it requires replacement. This affects asset types at different times, for example, the permanent way asset life will be around 20 to 25 years depending upon usage; signaling equipment asset life will be around 30 years and the life of civil engineering assets such as bridges, embankments and cuttings should be around 100 years. Some renewal functions are directly proportional to rolling stock usage, such as track; where others, such as signaling and telecommunications, are less so. Renewal of railroad is generally considered a capital cost and therefore is out of scope for this review. However, the head office function described above will have to be resourced to plan for renewals and these costs are part of operating costs and hence will be considered in the review.

Railroad ownership

In the majority of cases, the HSIPR operator will either already own an existing railroad and plan to run the new services on this or will construct a new railroad to support their service. In both cases, the HSIPR operator will be the landlord of the railroad and the same organization acts as the train service operator and railroad manager.

The railroad manager is responsible for the day to day operation of the railroad, preventative and reactive maintenance and renewals. If the HSIPR operator is the railroad manager then costs of operations, maintenance and renewals should be included in the HSIPR operating costs. The main component costs will be staff (labor) and materials (including equipment and plant).

Where the railroad manager is a separate organization to the HSIPR operator, they will charge a fee, usually a fixed \$ per train mile, in return for an agreed timetable path or slot. This access charge should cover the incremental cost to the railroad manager of additional maintenance and safety inspections of more passenger trains running on their railroad. The costs incurred by the railroad manager in planning timetables, regulating trains in accordance with the agreed timetable and maintaining the railroad are therefore shared between the various tenants who use the railroad.

If the HSIPR operator constructs a new railroad, they could act as a landlord and “sell” any spare capacity to other train operators in order to generate additional revenue. This alternate revenue stream has to be considered against potentially less reliable performance because the railroad is shared with slower trains. It is felt that opportunity for this in the US is likely to be small.

How a railroad manager will set charges for access to their railroad

A railroad manager will calculate access charges by dividing the total cost they incur for operating and maintaining the railroad proportionally amongst the operators who are tenants of the railroad.

The cost of operations and some elements of maintenance such as earthworks, bridges, tunnels, drainage and some system elements such as communication and electrification masts is dictated more by the physical

size of the railway being managed (number of track miles) and national standards (which specify employment conditions, technical, performance, safety and environmental requirements), rather than the number of train services operating on the network.

However, the frequency of maintenance checks and component renewal on the way and signaling systems as well as reaction to equipment failures increases in proportion to the number of train services using the railroad.

The landlord will set a charge whereby the tenant takes a proportion of the base cost of operating and maintaining the infrastructure and then full costs for any specific additional work which supporting HSIPR services require. For example, if the services are going to be shared with a railroad which is freight only, the landlord will have to increase the inspections of the way from monthly to at least weekly because of the increased safety requirements associated with HSIPR services. The fee charged to the HSIPR operators would cover the full cost of the additional inspections.

The fee will either be set as a fixed charge per year (to cover service operations up to a specified threshold) or a charge levied according to train miles (with the cost rate varying according to the length of train).

In some instances, there is a greater level of understanding of the impact (in terms of the wear and tear) of different types of train on railroad. In these cases, track access charges may also be proportional to the type of train operated (reflecting characteristics such as weight, maximum speed and wheel type).

2 HSIPR Project Development: Generic Issues

Introduction

HSIPR projects are major undertakings which can range in scale from adding new services to an existing operation, through to a completely new intercity service requiring construction of a new railroad and the purchase of new rolling stock. However, all these projects generally have at least three clear “stop/go” stages in their development lifecycle:

- **Preliminary:** approximate estimates are developed relatively quickly, with a low level of effort, and without requiring a detailed description of project characteristics. The study will be based on a series of generic assumptions and the purpose is generally to screen a large number of possible alternatives, or to quickly assess the likely feasibility of a candidate project. The output is the identification of a shortlist of two or three options and supporting evidence to make the case for more detailed consideration of these options;
- **Intermediate:** some appropriate balancing of accuracy, project data requirements and level of effort is attempted. Here the analysis would typically focus on investigating the feasibility of a limited number of alternatives defined in some detail. The analysis will be supported by concept design and the assumptions used will be less generic than at preliminary stage; and
- **Final:** accuracy of results is paramount. The analysis would typically be conducted to finalize a project’s documentation for submittal to approval and funding organizations. Only a single service option is being considered and it is underpinned by outline design to a level of detail which is suitable to form the technical work scope for a design and build tender. Timetable and performance modeling will have been undertaken and the assumptions of preliminary and intermediate stages validated through the design process.

A fourth stop/go point will arise immediately prior to awarding of a concession to operate an HSIPR service:

- **Commercial closeout:** in which the solution is based on detailed design and/or where sufficient development work has been undertaken to provide information such that parties can enter into firm contractual commitments to award an HSIPR concession. This is effectively the final due diligence before a concession is granted.

For large HSIPR projects, involving construction of a new railroad and purchase of new rolling stock it will take 3 to 5 years to progress from inception through to commercial close with a further 5 to 7 years required to construct the railroad, manufacture the rolling stock and start operation of a reliable HSIPR train service.

Estimates of operating costs will be developed with increasing detail and certainty through these project development stages. However, at all points in the project lifecycle, it is critical that the estimates of operating cost remain consistent with the factors which underpin the ridership forecasts, and these are reflected in the train service specification and method of delivery of the proposed service.

The manner of preparation and presentation of the operating costs should also be consistent throughout the project development lifecycle.

Throughout the development stages of a proposal, the HSIPR operator should provide a thorough description of how operating costs are estimated. This allows the reviewer to understand the proposal context, provides confidence in the proposition, highlights areas of risk, and facilitates an efficient process of reviewing and agreeing to fund for further stages of project development.

This chapter describes how the fundamental HSIPR proposition would be expected to evolve during the project development lifecycle and also the manner in which operating costs will be prepared at each stage.

Preliminary stage

The starting point of a preliminary stage proposal will be an explanation of the objectives which the new HSIPR service aims to achieve. For example, this could include stimulating economic regeneration of a region or city. It would also be expected that a large number of alternative route alignments and train service specifications have been considered to meet the objectives. The key requirement at preliminary stage is to sift out the best performing options from a long list. If they indicate that the objectives can be delivered in a manner which represents value for money, they can further be developed and examined in more detail at intermediate stage. It is therefore important to treat each option consistently and to facilitate this, a spreadsheet type model is usually developed which has limited number of inputs and uses high-level unit costs and resource assumptions.

Train service specification and interactions with existing services and railroad. An outline train service specification for each of the options presented should be prepared at the preliminary stage. This should describe the number of services on a typical day, the stations which the trains will stop and the expected trip times.

The train service specifications must reflect the initial market analysis and ridership and benefits forecasts.

Some high-level operations analysis should be undertaken to indicate that the train service specifications are deliverable, particularly if the railroad is shared with other train services. Evidence should be presented to provide confidence that the proposed trip times are achievable within the stated technology constraints.

Provision, ownership and charging of the railroad on which HSIPR services will operate. The preliminary proposal should confirm whether the HSIPR service will operate on existing or new railroad, who will own and operate the railroad and how the costs of providing or accessing the railroad have been included in the proposal.

Method of delivery of the proposed service. At the preliminary stage, the HSIPR operator will outline how the train service is to be managed for example, how tickets will be sold and information and assistance provided to passengers.

Quantification and monetization of key inputs. Forecasts of numbers of trains and staff required to operate the proposed service should be provided in the preliminary proposal; however, these will be estimated at a very high-level, using general assumptions.

Development of robust unit cost estimates. The unit cost rates used to calculate operating costs will be based on assumptions, probably taken from published data from other HSIPR operations.

Risks and uncertainties. HSIPR proposals at the preliminary stage should include a qualitative description of the key risks for each option being considered and how these may impact its deliverability and cost.

Interdependencies of elements of the proposal and consistency of assumptions. The HSIPR operator must demonstrate alignment between the estimates of ridership (passenger revenue), benefits and operating cost.

Intermediate stage

An intermediate stage submission should only consider a maximum of three HSIPR service options and some concept or feasibility design will have been undertaken since preliminary stage to demonstrate the options are deliverable.

At intermediate stage, the focus should move to develop operating cost estimates which are reasonably accurate in order to allow the project sponsor and/or funding authority to assess the viability of the proposal.

Train service specification and interactions with existing services and railroad. The intermediate stage train service specification will be fairly detailed with trip and turnaround times and the number of trains required more accurately assessed. It is not necessary to test the train service specification for deliverability using timetable modeling packages where the HSIPR service will operate on a newly constructed railroad with no interactions with other services. However, for more complex projects where there is interaction with other train services, verification of the train service specification through modeling generates greater confidence in the assumptions which underpin the proposal.

The train service specifications must reflect the evolving market analysis and ridership and benefits forecasts and it would be expected to see a number of iterations between the two. The train service specification presented for each option must be consistent with those used to prepare the demand and benefits forecasts.

Some high-level operations analysis (for example, by using train graphs) should be undertaken to indicate that the train service specifications are deliverable, particularly if the railroad is shared with other train services. Evidence should be presented to provide confidence that the proposed trip times are achievable within the stated technology constraints. Risks to the deliverability of the service must be highlighted, for example, locations of capacity bottlenecks at stations or junctions on an existing railroad.

Provision, ownership and charging of the railroad on which HSIPR services will operate. The intermediate proposal will confirm if who will own, manage and maintain the railroad and how access to the railroad will be managed and charged for. Where the railroad is shared with other operators, access rights and charges will reflect this.

Method of delivery of the proposed service. At the intermediate stage, the HSIPR operator will outline how the train service is to be managed, how tickets will be sold and information and assistance provided to passengers. These proposals should reflect and make reference to statutory requirements (for example, as specified by the FRA). It should be clear whether the HSIPR operator is assuming if resources required to deliver the HSIPR (e.g., staff and rolling stock) will be employed/owned by the operator itself or provided through a sub contract with a third party.

Quantification and monetization of key inputs. Forecasts of numbers of trains and staff required to operate the proposed service should be provided in the intermediate proposal; however, these will probably have been estimated at a fairly high-level, using a number of assumptions which will require verification at the final stage.

Development of robust unit cost estimates. The unit cost rates used to calculate operating costs will be based on assumptions until the point at which the HSIPR operator has obtained firm prices from the market place. This will not be until close to commercial closeout. The intermediate stage estimate will be underpinned by a large number of generic assumptions and it is important that the source of and rationale for these are documented, for example, through the HSIPR operator discussing with suppliers to understand the likely cost of trains and potential approaches to maintenance. They may also have discussed tenancing railroad access and sharing customer service facilities with other train service operators. Evidence of such communication such as letters or emails of support will assist build confidence in the proposal.

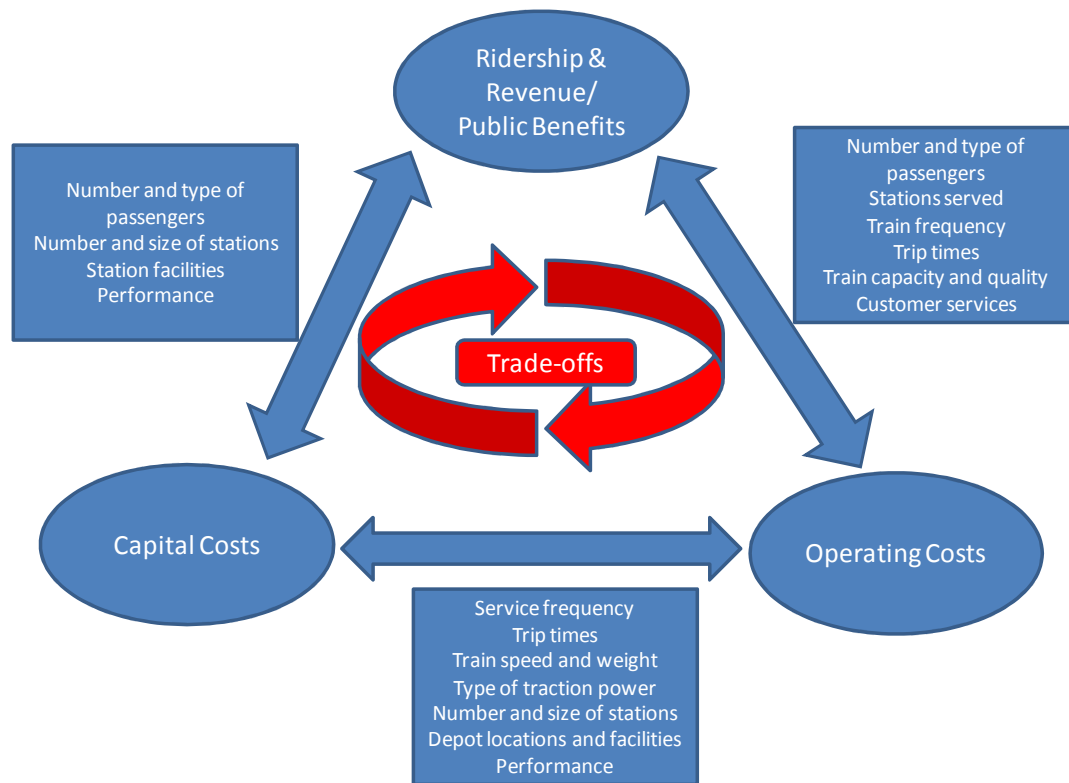
Risks and uncertainties. HSIPR proposals at intermediate stage should include a risk register which assesses the probability and impact of each risk identified along with the agreed treatment and owner. This information should be used to inform and justify the level of contingency applied to the cost forecasts.

Interdependencies of elements of the proposal and consistency of assumptions. The HSIPR operator must demonstrate alignment between the estimates of ridership (passenger revenue), benefits and operating cost. At intermediate stage, the proposal should now be very clear as to how the train service specifications have evolved through a process of iteration between:

- A high-level market assessment (usually the first stage of the ridership forecasts) and consequent ridership forecasts;
- Operating costs forecasts; and
- Capital cost forecasts.

The need to trade-off between the cost and revenue elements is illustrated in Figure 2-1 below.

FIGURE 2-1. RELATIONSHIP BETWEEN RIDERSHIP AND COST



The train service specification used preparing the capital and operating costs, ridership, revenue and public benefits forecasts must be consistent as should be the assumptions regarding the proposed quality of passenger experience. Often this is only reflected in estimates of ridership and omitted from the cost estimate. If the proposal does not confirm that sufficient seating capacity will be available to carry the forecast ridership in a reliable manner, then it should be flagged that either the forecast ridership, revenue and public benefits will not materialize or that the costs have been underestimated.

Final stage

An HSIPR proposal at final stage is expected to reflect the considerable development work undertaken on the project since intermediate stage. All forecasts are expected to be reliable and able to withstand challenge.

The evidence of the step-change in the level of detail to which the project has been developed and the associated improved confidence in the delivery of the project will be provided through a set of delivery plans setting out how the service will be delivered. These plans also form the basis of the quantification of costs.

Train service specification and interactions with existing services and railroad. The train service specification will reflect the detailed market research, and ridership and revenue modeling and forecasts undertaken for the final Stage.

A detailed timetable (referred to as a “working timetable”) will have been prepared which will have been modeled using a train simulation package to confirm that it (in particular, the trip times) is deliverable using the specified railroad and trains. The timetable supplied as part of the submission at final stage will include all services from start up to close of service, including timings at all stations and critical points on the network such as junctions.

The profile of ridership by day of week and time of day will have been prepared based on demand forecasts. This should be used to confirm the maximum capacity (seats provided between particular stations) which need to be provided, through a combination of number of train services and number of seats per service (a combination of train length and the seating configuration of each trains).

On shared railroads, the HSIPR operator must consult with other operators (such as freight) on the route to ensure that their future plans are not constrained or hindered by the train service specification. Documented evidence should be provided to confirm the position of other operators with respect to the proposed HSIPR service.

Provision, ownership and charging of the railroad on which HSIPR services will operate. At the final stage, the proposal must define the railroad characteristics (such as gradients, curves and line speeds) as these are key inputs to the modeling of the timetable and the entity who will be the railroad manager, responsible for operating and maintaining the railroad.

The proposal should explain how the costs of railroad operations, maintenance and renewals are included in the HSIPR proposal. Where the HSIPR operator will be a tenant to an existing railroad, also used by other operators, the proposal should explain, in detail, how the costs are shared between train service operators and the rationale behind the charging regime.

Method of delivery of the proposed service. While at intermediate stage it would have been sufficient for a HSIPR operator to identify an “example existing train” (for example, Germany’s ICE, Spain’s AVE or France’s TGV), at the final stage the HSIPR operator should have identified the exact specification of the train required and been in commercial discussions with likely manufacturers. This will require definition the train formation, car length, train weight, axle load, maximum power, maximum operating speed and number of seats.

At the final stage, the HSIPR operator will confirm whether trains will be purchased and owned by the HSIPR operator, or whether trains will be leased from a third party (usually a consortium of companies in the finance sector) and the likely terms under which the trains will be leased (e.g., the lease length).

The HSIPR operator will describe, in detail, how the train service will be operated and will confirm the staff and other resources required to operate the train service to meet the timetable and performance requirements, customer service offer and safety legislation. The proven working timetable (based upon the outputs of the train service simulation) will be used as the basis for a set of revised train diagrams, and a number of iterations may have been undertaken to investigate the trade-off between the timetable and the number of trains required (and then to optimize the allocation of trains). A detailed description of the responsibilities of each staff role will be provided and analysis will have been undertaken to ensure that the number of staff on each train or at stations or depots is sufficient to deliver the HSIPR services and customer offer.

Quantification of key inputs: The volume of resources required to operate the proposed service will be based upon the working timetable prepared and the detailed plans which are submitted as part of the final proposal. The number of trains required will be based on the working timetable, a detailed diagramming

exercise and the planned maintenance regime. Staff numbers in each role will be prepared by undertaking a detailed rostering exercise. A large number of assumptions will still underpin the cost forecasts but these will be specific rather than generic and the process by which each assumption will be validated clearly set out. Most assumptions will only be validated following commercial closeout through detailed design, award of supply contracts or through testing of delivered products. Confidence in the validity of unit rates and assumed quantities is always improved if benchmarked against other comparable HSIPR operations.

Development of robust unit cost estimates. Unit cost estimates will be based on negotiations with the suppliers of the resources and the management plans. For example, the cost of purchasing or leasing trains will reflect the technical specification of the train required and commercial negotiations with suppliers who have demonstrated capability to supply the train as specified.

Costs for maintaining the railroad and trains will be consistent with the asset management and train maintenance plans.

Risks and uncertainties. The process of developing a proposition from intermediate to final stage will be supported by a “live” risk register, a copy of which should be provided. It should be possible to cross-reference the risk register with the train service offer and associated costs to confirm that the proposed treatment of risks has been included (where relevant) in the forecasts of operating costs. Where risks have been closed out, the outcomes should be evident in the proposal.

Inter-dependencies of elements of the proposal and consistency of assumptions. The development of detailed ridership and revenue forecasts for the final submission will be reliant on a number of assumptions such as the availability of capacity to carry demand and a means to ensure that all passengers travel on valid tickets (revenue protection). Reference should be made to these inter-dependencies and how they have been accounted for in the cost forecasts.

Commercial closeout

The fundamental difference between a final stage proposal and commercial closeout is that the latter is of sufficient detail to form a commercial offer to operate a concession and reflects the risk position the HSIPR operator is willing to contract against. Relative to the final stage proposal, one would not expect significant change in timetable, how the train service is delivered, the customer offer or railroad access and charging plans. Any significant cost changes compared to the final stage proposal should reflect the HSIPR operator’s position on risk with respect to contractual and performance requirements which have been developed since the intermediate stage.

Extensive value engineering often takes place between final stage and commercial closeout to try and obtain the maximum amount of benefit (generally farebox revenue) for the lowest cost. It is important for any value engineering work to treat each element of the benefits, operating and capital cost triangle presented in Figure 2-1 in a consistent manner.

Train service specification and interactions with existing services and railroad. Unless there are major changes to the timetable driven by value engineering, commercial closeout is likely to see only a handful of minor adjustments to the working timetable, to reflect treatment of assumptions and risks identified at the final stage.

Provision, ownership and charging of the railroad on which HSIPR services will operate. Commercial closeout will include confirmation of agreement between parties on the contractual agreements between operators and railroad providers as to what will be provided in return for the charges to the HSIPR operator. It may be appropriate for the railroad owner and operator to provide evidence of their business plan in parallel with the proposal submitted by the HSIPR operator.

Method of delivery of the proposed service. The approach by which the proposed HSIPR service will be delivered should not have changed significantly from the final stage unless commercial negotiations with suppliers have identified significant issues which have had to be resolved through the re-specification of the delivery plan. Where significant changes have occurred, they should be flagged and detailed explanations provided as to how plans and costs have been updated to reflect the change.

Quantification of key inputs: Compared to the final stage proposal there should only be small changes in the forecast volumes of resources required to operate and deliver the HSIPR service. Changes should only reflect refinements in the quantification of costs or in response to trade-offs between the level of service offered and the costs of delivering this. Detailed design will identify all railroad maintenance requirements and step changes may occur if assumptions underpinning the single option design are found to be incorrect.

Development of robust unit cost estimates. The unit cost estimates included in commercial closeout will reflect the contractual negotiations which have occurred with the suppliers of the services. They should reflect the level of risk which the HSIPR operator is willing to accept. Some costs may change to reflect the phasing of payments, such as financing or lease costs for trains or specialist maintenance equipment.

Risks and uncertainties. The submission of the HSIPR proposal at this stage should be accompanied by a full risk register which provides an audit trail of the risks identified, their impact and treatment. This risk register should include all risks identified during the development of the HSIPR proposal. Risks which are still open should be highlighted and their potential impact, their proposed treatment and the risk owner identified. The costs associated with managing the remaining risks should be stated. At this point, there will still be unknown risks and retaining small levels of contingency would be prudent. However, all costs should now be categorized and accounted for with no lists of exceptions sitting alongside the proposal.

Inter-dependencies of elements of the proposal and consistency of assumptions. By commercial closeout, the roles and responsibilities of all contracting parties in managing interdependencies and owning any assumptions which remain to be verified (that is they will only be confirmed once the HSIPR system is operational) should be clearly documented. This is a time consuming process and the reviewer needs the inter-dependencies and assumptions to be thorough and clearly recorded. If caveats in the contractual documentation are being relied upon to manage inter-dependencies and the delivery responsibilities of each party, then the likelihood of successful implementation to time and budget is lower and it would be prudent to consider retaining higher levels of contingency.

3 Case Studies

Introduction

In this section, we assess published data from a number of different rail systems. Rather than provide a literary review of each study, we try to identify strengths and weaknesses in how each study has considered operating cost in the following areas:

- Operating the train service (train staff and energy costs but excluding train purchase or lease costs);
- Rolling stock costs (including maintenance and depot costs);
- Operating the stations (staff, utilities and ticket sales);
- General and administrative and head office costs (marketing & management); and
- Operating and maintaining the railroad (the cost of accessing the way).

Six case studies are considered covering the USA, Canada, Brazil, Mainland Europe and the UK. These highlight a range of practices in specifying the HSIPR train service and estimating costs associated with this. One is a preliminary level study, two are intermediate level, two are (theoretically) final stage and one is approaching commercial closeout.

The context for each of the case studies is summarized in the paragraphs below.

Van Horne Institute, Calgary to Edmonton HSR, 2004: This is an intermediate stage study with the purpose of exploring the cost and benefits of HSIPR services linking the two cities and stimulating political debate on next steps. Three alternative service and railroad options are presented.

SNCF, California High-speed Rail Corridor, 2009: This study is SNCF's proposal in response to the FRA's request for expressions of interest to provide services on the designated California High Speed Rail Corridor. The content would be expected to be pitched at final stage as previous preliminary and intermediate level feasibility studies have been undertaken on this corridor by the FRA. However, the required level of route design has not been undertaken to inform a full final stage report and the operating costs are not presented in sufficient detail to confirm that they have been prepared to the level expected at final stage.

Halcrow - Sinergia, Brazil TAV, 2009: This study is being used by the Brazilian Government to seek bids to construct and operate under concession a new HSR between Rio de Janeiro and Sao Paulo. The study assesses a single railroad and service option. It was selected for review on the assumption it would be of a final stage level of detail. However, operating costs forecast by the study do not reflect this and the level of detail to which they are prepared varies considerably, with some cost categories appearing to be at preliminary stage, others at intermediate and others at final stage. Compared to these, other aspects of the project such as ridership are more comparable to final stage.

European Mainland Case Study, 2010: This confidential study is being undertaken for a corporation who will provide new train services as a tenant on an existing high-speed line in competition with the incumbent national operator. This proposal is close to commercial closeout level of detail. The only documentation available for review was updates to the cost forecasts but we were able to ask clarification questions of the project manager. We did not have access to the supporting detail behind the costs such as calculation of traincrew numbers. The focus of the operating costs documentation is to describe changes since final stage, many of which have been driven by a decision to scale back the size of the operation.

High Speed 2 (HS2), London to West Midlands, 2010: This study was undertaken by the UK Government to investigate if there was demand for HSR and to present proposals which would best accommodate this demand which could then be consulted with parliament and the public. The study focuses on a core railroad

alignment and service specification, with a high-level assessment of options to extend the route to additional locations. This is an intermediate stage report.

Network Rail, New Lines Program, 2009: This study, published by the manager of the UK railroad network, identified the existing network was close to capacity and presented HSR options as a means of accommodating natural growth as well as generating new growth. A large number of route options were considered and a preferred option identified through cost-benefit Analysis. This study would be classed as a preliminary stage report and its purpose was to stimulate political debate on long term plans for the UK railroad. This was achieved with the government undertaking the High Speed 2 study, also discussed in this section.

Operating the train service

The case studies have not presented their data in a consistent manner and there is considerable variance in the level of detail between each. For this reason, we have aggregated our review of the train service specification, traincrew and energy costs into a single section as all elements are interdependent and it is easier to discuss the inconsistencies, gaps and good practice with each report in a single section.

Summary

The Calgary to Edmonton study presents the staff and energy costs associated with providing the train service in a clear, disaggregated manner. This was the only study reviewed with sufficient transparency to readily permit a reviewer to apply the *Reviewers Quality Check Questions* (presented in the Operating Costs Toolkit report). This ultimately provides confidence that the cost estimate is of the required accuracy. The report considers a variety of technologies and operating methods and considers the acceptability of each to regulatory bodies.

The California study is a formal commercial response from SNCF to the FRA and while it provides the most comprehensive train service specification of the five studies, there is almost no substantiation as to how estimates of cost are derived. This study assumes that European technologies and operating practices can be modified to be acceptable to the safety regulatory regime in the USA. The cost of modifications to achieve compliance with US standards is not discussed. This risk combined with the lack of general supporting detail results in the reviewer having a low level of confidence in the accuracy of the cost estimates.

The Rio de Janeiro to Sao Paulo study makes good use of modelling techniques to calculate trip times, energy consumption and verify timetables. However, the outputs are not used in conjunction with disaggregated unit cost information, such as salaries for different staff roles. Overall, the level of cost detail falls short of that presented in other intermediate studies such as Calgary to Edmonton. This study assumes that European technologies and operating practices are adopted and the cost impact of these being unacceptable to regulators in Brazil is not considered. A review of other documentation provided as part of this study gives an impression that considerably more effort has been expended presenting and verifying the capital cost for constructing the railroad, compared with the costs of operating the HSIPR service for 30 years.

The European Mainland HSR case study presents staff costs disaggregated by grade and salary. However, the documentation made available or the case study does not explain the role and responsibilities of the staff. Consistent with the charging mechanism in the country concerned, energy costs are included in railroad access costs. Insufficient documentation was made available (for reasons of commercial confidentiality) to ascertain if the supporting information to the cost forecasts were of the standard expected at commercial closeout.

The two UK studies considered do not present a total annual operating cost - the data is presented as a 60 year present value as used in the cost-benefit analysis (CBA). This makes it impossible to sense check and

have full confidence in the cost; however, these are the only studies which apply contingency (both stated at 41%) on the operating cost before the information is input to the CBA. Both studies demonstrate how their proposals will comply with UK and European safety requirements.

Both studies have a high-level of operational focus with significant effort expended in developing detailed train service specifications tailored to the ridership forecasts. Despite both studies being published within 12 months of each other and having similar route alignments and rolling stock, the energy costs per train mile varies by almost 100% between the two. The lack of detailed information regarding the source of the power consumption rates for the assumed trains is a significant issue.

The HS2 study calculated the cost of traincrew through estimating the number of staff required and multiplying this by an average salary. It then divides this total by the annual train miles to obtain a staff cost per train mile. This is a useful metric which allows the cost impact of changes to the service level to be tested. However, the underpinning assumptions of staff numbers and salary for each role are not presented, therefore it is not possible to have confidence that the cost per train mile ratio used is correct.

Van Horne Institute, Calgary to Edmonton HSR, 2004

This study considered a range of different train types in terms of their key characteristics (including maximum speed, fuel used and train formation) and the existing manufacturers of each train type. Their relative strengths and weaknesses are analyzed and preferred train types are selected having considered whether they will be able to meet national safety regulations. The areas where there is a risk of additional cost arising (e.g., requirement for a second driver) are clearly identified.

The train service specification is adequately defined for an intermediate level study. The number of seats on each train (business and economy) is detailed and these are correlated with ridership forecasts.

Details are provided of the simulation work undertaken to determine trip times, annual train miles and annual train hours. This has allowed the fleet size of four in service and one maintenance spare to be identified. The simulation work provides a forecast of energy consumption for the various options and a good level of substantiation provided permits the data to be sense checked by the reviewer.

This underpinning detail builds the reviewers confidence in the robustness of the output cost estimates, particularly as it is a relatively small project in operational terms (12 services per day) and errors in these fundamental areas of number of trains and distance traveled will have a disproportionately high impact on the cost.

This study does provide a very good example of estimating and presenting staff costs. The report initially considers the technology to be used, the safety standards which will need to be complied with and the quality of customer service to be provided. This establishes the minimum requirements and allows the appropriate categories of staff to be identified including traincrew (drivers, including second man, train manager and on board catering/customer services), train maintenance and servicing, station staff, and call center for ticket sales. The specific salaries for each staff function are not presented but the total cost for each category is given and it can be verified that different rates have been used for each and that they are proportional, i.e., drivers cost more per head than train maintenance staff who cost more than customer service staff. Staff rosters have not been developed but are clearly identified as being required during the next stage of project development. The level of detail even progresses to the identification and substantiation of a single traincrew depot to cover the entire route and overnight/subsistence costs are included for staff finishing shifts out in this location. Station and onboard catering/customer service staff numbers vary for each option proportionally to forecast ridership demand.

The one area where the estimating process could have been more robust was in the conversion of staff required per day to full time equivalent staff in order to cover rest days, training and annual leave. The calculation methodology use for this was not explained.

SNCF, California High-Speed Rail Corridor, 2009

The proposal assumes European technologies and operating practices will be adapted to permit compliance with existing FRA standards. The extent to which modifications are required and treatment of costs associated with achieving them are not discussed. The cost of achieving compliance is potentially very large as safety standards and operating practices in the USA, in some areas are very different from those in Europe. This is potentially a show stopping risk and the impacts and mitigations should be given more prominence.

This report provides a very good example of a train service specification for an HSIPR network. The description of the train service specification is thorough and well defines and present peak and off peak service levels, trip times, stopping patterns and dwell times for different types of station. There is a clear relationship between the presented ridership forecasts and the proposed train service for each route and market type. From the information provided it is possible to sense check the average speeds quoted, giving confidence that trip times are achievable.

However, the study is very poor in the manner in which it builds up the estimates of operating cost from this excellent foundation. Only total costs are presented for a number of categories and neither unit costs, quantities nor underpinning productivity assumptions are presented. This means it is not possible to verify the robustness of the costs presented.

The report quotes neither the number of staff required to operate the service nor the salaries assumed. It is not clear what staff functions are included in the cost estimates but there is confirmation that the number of on-board staff is related to the number of train miles and train hours operated. The report does not specify the unit costs assumed for each staff function, simply stating that they are based on “international practice”.

The report confirms that the operating costs include the costs of energy, but no indication is given of how this cost was calculated.

Despite the lack of documented information provided, the study text implies operating costs have been forecast in significantly greater detail than they have been presented. For example, a very precise number of trains required has been specified and the proposal considers how tickets will be sold while minimizing station staff costs through the use of virtual ticket sales and ticket machines.

Halcrow - Sinergia, Brazil TAV, 2009

The proposal assumes European technologies and operating practices will be acceptable to the safety regulators in Brazil and does not present the cost risks of this not being the case.

The train service specification is sound and closely aligned to meeting the ridership forecasts. Timetable planning was undertaken using commercial modeling software (Railsys and VoyagerPlan) and the modeling process is explained in some detail in the Halcrow report, together with the some input assumptions. The report provides information on train frequency and trip times but it is not apparent what data was input into the VoyagerPlan model. The results of this model are also not described. From a reviewers perspective, it is therefore not possible to fully understand if the annual train kilometers and hours, which underpin staff and energy costs, are robust.

Little information is provided in the report as to how trains and staff are allocated to efficiently work the timetabled services - some form of train diagramming and staff rostering is expected at this stage.

The simulation outputs are used to provide good information on how the electricity consumption costs of the HSR were estimated - the power consumed by each service has been calculated reflecting the actual gradients on the route and speed profile of the train. Electricity tariffs are varied throughout the day and a discount is applied to reflect the use of regenerative braking, however, there is no substantiation of the

assumption that power returned to the system can be used elsewhere, nor is the source of the assumed 16.5% cost saving documented. The report estimates an annual cost of electricity which is equivalent \$0.97 per train mile. The study assumes the cost of electricity as \$0.06 per kWh with an assumed power consumption rate for the trains of 15kWh per train mile. Both rates appear to be low and probably result in a large underestimate of the actual energy costs.

The report identifies 4 staff as being required per train and acknowledges the potential need for a second driver - however, it does not state what the roles and responsibilities of each member of staff is. This is a major omission and brings into doubt both the traincrew cost forecasts and the station staff forecasts. It is not clear which of these staff teams is responsible for train dispatch, ticket sales or revenue protection. This also provides uncertainty as to the number of customer service staff allocated to each train - the quality of service offer provided should be directly linked to ridership and revenue forecasts.

With regard to salaries, there is no differentiation between drivers, conductors and other staff and this makes it difficult to comment on whether the level of staff costs is reasonable. The employment conditions of staff are also not specified: in particular in relation to working hours, overtime, holidays, sickness, retirement and other benefits and without this information there is a risk that costs may be omitted, for example, through lack of clarity on hours worked each week or the additional costs of overtime.

European Mainland Case Study, 2010

The business case review document specifies the number of trains per day on each section of route and quotes the annual train miles which will be operated by the HSR service. Train hours per year are not specified; however, this is not surprising as at this stage of development of the HSR proposal this metric is not key (items such as staff costs would be defined by a staff rostering exercise rather than according to an assumed number of productive hours per year).

The documentation states the number of each category of traincrew required to operate the service and the annual unit cost of each category of staff (where these are drivers, on-board staff, depot drivers and operations room staff). The assumed increase in unit cost rates (real wage growth) is also specified in the report. The report does not confirm the assumptions regarding the number of staff (by category) required to operate the service - the staff numbers imply that there is one driver and 4/5 on-board staff on each train.

Responses to clarification questions have confirmed that on-staff numbers were calculated through a detailed train diagramming and staff rostering exercise, which takes into account leave, sickness and productivity assumptions.

Consistent with the changes to the proposed HSR train service specification the document notes that there has been a reduction in on-board staff numbers as a result.

The energy costs of operating the service are included in the railroad access costs, which are estimated on the basis of a cost per train mile. This approach is consistent with the charging mechanism in this European country, where the costs for railroad access and electricity are charged as a single item. An attempt was made to identify the cost of traction energy by examining the published access charge for diesel trains on the railroad in question and subtracting it from the charge offered to the new HSIPR operator. However, the difference between this did not result in credible traction power cost estimates.

High Speed 2 (HS2), London to West Midlands, 2010

The proposal confirms that the proposed trains which will operate the HSR service comply with UK and European safety requirements, and there are unlikely to be any costs to modify the trains for UK operation.

A train service specification is presented giving details of the peak and off peak service frequency between different origin and destination stations, trip times, and dwell and turnaround times. The proposed service is

consistent with the forecast demand and outlines the number of passengers per train and the required length (to give the correct number of seats) of each train.

The study describes generically how the operating costs of HS2 services were forecast but does not always clearly present key underpinning data such as the annual train miles operated. For example, electricity consumption is presented as a variable cost of \$7.2/train mile and assumes a consumption rate of 45 kWh/train mile and a cost of electricity of \$0.16/kWh. To a knowledgeable reviewer, this may seem reasonable as it is benchmarked against other European rail operations; however, the source of these assumptions is not identified and the calculation by which the total energy cost is derived is not presented.

The identified rolling stock will regenerate electricity into the network when braking and assumes this will reduce overall power consumption by 20% in those sections where significant braking is expected. This is a more prudent assumption than in the Brazil example where the discount for electricity regeneration appears to have been applied to the total estimated power consumption. However, the report does not clarify how this element is factored into the calculation which derives the unit rate of \$7.2 per train mile.

Staff costs are described in detail with the staff being categorized into traincrew and station staff. Traincrew is further broken down into driver and conductor costs and assumes that operation of a train requires one driver and two conductors. These are then converted into a cost per train mile by dividing the total traincrew cost by annual train miles.

Presenting traincrew as a cost per train mile is very useful for quickly visualizing the proportion of costs of operating the HS2 service, for example, we see immediately that energy costs are around 50% higher than train staffing costs. A composite cost per train mile also lends itself to allowing sense checking of the train service specification, for example, the cost impact of adding or removing individual services can quickly be ascertained. However, it must be remembered that staff costs are proportional to the time they work rather than distance traveled and the use of costs data in this manner is only reliable within reasonably limited tolerances.

The estimate of total annual operating cost is only presented as a 60 year present value (PV) and not in tabular form in a recent price base. This makes it very difficult for a reviewer to sense check the robustness of data.

The study applied a very prudent risk uplift of 41% to all operating costs to compensate for the relatively low level of development detail.

Network Rail, New Lines Program, 2009

The train service specification is linked to the ridership forecasts and the key operational assumptions on headways (the minimum gap between trains), acceleration and braking characteristics of trains and services intervals and station stopping patterns clearly defined.

An outline timetable for a “standard hour” is then presented, giving the departure and arrival time at stations served for each train. Train hours, train miles and number of train sets required for each option are also specified. Some simulation was undertaken to verify trip times but the extent of work is not described in detail and neither are its outputs.

The report confirms that the train service specification is used to calculate the volume of rolling stock required and the number of platforms at stations.

Electricity consumption is derived from Network Rail analysis of traction costs on the UK’s only high-speed line. However, the underpinning assumptions are not presented and the rate quoted of \$8.95 per train mile is 25% higher than that assumed in the HS2 study.

Staff costs are categorized as train staff (drivers, trainee drivers and guards) costs and the station staff (general station staff and ticket sales staff) and cleaners. The report confirms that key elements in preparing bottom-up costs have been considered, using the calculation of driver costs as an example (defining items such as annual salary, allowance applied for sickness, leave and training, insurance and retirements and the “productive hours” per week). The cost of a driver is clearly calculated and then expressed as a cost per train hour. This takes into account the relatively low productivity to drivers - in this case estimated as 20 hours per working week. However, the other traincrew such as conductors and customer service staff are expressed as a total cost per train hour and no data is presented to permit verification of the actual constituent parts of this cost. This approach to calculating staff using train hours means that the total number of staff required to operate the train service is never actually presented.

The report does not provide an estimate of the annual costs of operation of the service. Total costs for the operation are only presented as a 60 year present value, for comparison of the preferred option with alternative options. This makes it very difficult to sense check the outputs. The operating costs used in the cost-benefit analysis were increased by 41% as contingency to reflect the large number of assumptions underpinning the estimates and the low level of development of the project.

Rolling Stock

Summary

All of the case studies assume rolling stock will be purchased outright rather than leased from the manufacturer or a financier. There is a very wide range of cost estimates, for what in effect, are almost identical rolling stock types. With the exception of the European Mainland example (which is at final stage of development and confirms the precise specification of the train which is being procured to operate the service), all the studies reference French TGV, German ICE or Spanish AVE type trains and these fleets are supplied by two manufacturers.

The Calgary to Edmonton study provides the greatest level of detail for maintenance costs, where assumptions are clearly laid out and costs allocated against them. Notably, this is the only study which does not use a simple assumed cost per train mile as the basis for estimating rolling stock maintenance costs. It also provides a good level of detail on the workload which is likely to be required at the maintenance depots.

The HS2 report uses an aggregate maintenance cost per train mile but does provide the best level of substantiation in terms of the actual cost areas this is expected to cover. However, it is very difficult to verify that the sum of the individual cost areas will be consistent with the total derived by multiplying the annual train mile by the unit cost.

The Brazil TAV study presents a unit cost for train maintenance but without any substantiation and the California and UK New Lines studies make no reference to train maintenance costs. It is suspected that the high rate noted in the UK New Lines study for energy costs actually contains a provision for rolling stock maintenance because this value is consistent with the sum of the energy and rolling stock maintenance unit rates used by the HS2 study.

Van Horne Institute, Calgary to Edmonton HSR, 2004

There is clear presentation of the calculation to determine the four trains required to deliver the timetabled service and the single maintenance spare. The low service frequency results in the proportion of spare trains to trains in service being 1:4 rather than the more usual 1:10 for larger fleets. Potential manufacturers are identified and the trains are assumed to be purchased outright and treated as a capital cost, rather than leased and treated as an operating cost. The estimated cost of each HSR train is \$68 million.

The servicing and maintenance regime for rolling stock is described in detail allowing the workload at the two maintenance locations to be visualized by a reviewer. It is assumed that wheel turning and major overhauls will be subcontracted because the capital cost of providing equipment to undertake these tasks for a fleet of 5 trains does not provide value for money. The costs for sub contracting this work are clearly presented. Staff numbers are estimated for the daily servicing depot and the main maintenance depot.

The cost of operating both train maintenance facilities is considered - this covers utilities, building maintenance and cleaning, property taxes and security.

This study identifies the areas of potential cost to maintain the rolling stock fleet in a manner which delivers the specified timetable. The estimates placed against each area can readily be sense checked and also updated should requirements change, which is likely given this is only an intermediate level study.

The total maintenance costs quoted in the report comprise approximately \$12.5m per year for labor and materials, \$3.5m for management costs and \$3m for depot costs. Given the fleet of 5 trains (10 locos and 40 or 50 carriages) and 1.4million train miles per year, this equates to \$4m per train per year or \$22.6 per train mile. While the cost per train is broadly consistent with other studies, the cost rate per train mile is very high mainly due to the relatively low number of mileage operated. This verifies train maintenance should not be considered to be only mileage based, a significant element of the maintenance inspections is “fixed”.

SNCF, California High-speed Rail Corridor, 2009

The study proposes use of European HSR rolling stock which will be modified for compliance with US standards. Estimates of the number of trains required during each phase of the project are provided but there is no information as to how these numbers are calculated. Procurement of the rolling stock is assumed as a capital purchase. The total cost of the fleet of 238 trains is \$9.2Bn which derives a unit cost of \$38.8 million per HSR train. It is not clear whether contingency is included in this value.

The fleet requirement assumes a 10% provision for maintenance and in addition to this a number of “hot spares” are diagrammed. These are trains stored at strategic locations and ready to enter service if an existing train fails.

Capital costs are included for the provision of maintenance facilities but no detail is provided as to what these consist of. Neither the costs for the maintenance of rolling stock nor any detail on examination frequency or staff and equipment required to undertaken them are presented.

Halcrow - Sinergia, Brazil TAV, 2009

The method and assumptions used to diagram the train service is not explained and it is therefore not possible to assess whether 42 trains deemed to be required is correct. Only three trains, or 7% of the fleet are planned as spares for maintenance and no strategy is presented as to how the service should be managed around this relatively low proportion. The rolling stock is assumed to be purchased and is treated as a capital cost. The average cost per train is \$25.6 million.

Two different rolling stock configurations are proposed to cater for long distance Express (Rio to Sao Paulo) and Regional trips. With only 3 spare trains, there is a risk that a low-density seating long distance Express train would need to operate a Regional service, resulting in significant passenger over-crowding.

A low number of spare trains will mean greater risks associated with regularly providing sufficient rolling stock to operate the full timetable. This places an increased burden on train maintenance. One would expect that there will be a trade-off between purchasing trains (for cover) and maintenance costs yet this trade-off is not mentioned in the report.

Train maintenance is quoted as a cost per train mile based on benchmarked international rates. While convenient, this approach gives no visibility to the costs of staff, material, equipment and plant that are

covered within this value and how this compares to the preventative and reactive maintenance workload which will be generated by a fleet of 42 trains operating the specified timetable. In this specific example, the cost of \$4.9 per train mile accounts for half of the total operating costs of the proposed HSR. This seems disproportionately high compared to the other costs presented but without information on the planned maintenance regime, staff numbers, assumptions on wheel turning and major overhauls and depot operating costs, there is little means of validating its accuracy. As a result, the reviewer has less confidence in the quality of the overall estimate.

This study does highlight the recent trend for an HSIPR operator to procure maintenance along with rolling stock. An annual availability fee is paid by the HSIPR operator to the manufacturer which covers the cost of financing, building and putting the trains into service as well as maintaining them. This usually means the manufacturer will construct and staff their own maintenance depot(s). The study does not use this mechanism but had it done so, the rolling stock costs would be treated as operating rather than capital cost because the maintained trains are being acquired through payment of an annual fee rather than through milestone capital payments in the early stages of operations.

European Mainland Case Study, 2010

It is understood that a detailed diagramming exercise was undertaken to define the number of trains required to operate the service. A total of 25 trains (formed of 11-car articulated electric multiple units with a total train length of 650ft) are being procured of which 2 or 3 are maintenance spares. The cost of procuring the trains is treated as a capital cost, with the total capital cost of the order being 570million Euros (equivalent to \$32million per train). It is noted that while the HSIPR proposal confirms that the proposed train service has changed between intermediate and final stage (the services will no longer serve all designations originally envisaged) the number of trains being procured has not changed. This is because the contract for procurement of the trains had already been signed.

Train maintenance will be undertaken by the train manufacturer and is similarly contracted. The contract assumes the trains will be operated in a specified manner and maintenance costs do not fall if train mileage falls, however, costs do increase if mileage increases.

The costs of train maintenance equates to \$1million per train per year. This appears very low but further data was not available to understand the reasons why.

The documentation notes that maintenance costs have increased in recent iterations of the HSIPR proposal as additional maintenance requirements have been identified for items which are not included in the core train maintenance contract (mainly in relation to on-board equipment and services). These additional costs are not insignificant.

Train cleaning costs are identified as one of the elements of rolling stock costs and are estimated on a bottom-up basis, with total train cleaning costs being equivalent to 15% of the costs of maintaining trains.

High-speed 2 (HS2), London to West Midlands, 2010

The calculation deriving the number of trains required is clearly laid out. The service frequency, trip and turnaround times identified in the train service specification for HSR only service requires a minimum of 7 trains. The intensive timetable proposed means these trains will each operate 1,250 miles per day. Consultation with rolling stock manufacturers identified that bogies and wheels need to be inspected every 2,500 miles. To provide the ability to operate additional and longer services in the peak, as well as providing maintenance spares, a total fleet of 16 trains is proposed. The cost per train is \$46 million which includes 18% contingency.

A similar calculation is undertaken to substantiate the additional fleet of 45 customized trains for operating through services to destinations beyond the proposed high-speed network. These trains will operate on the

conventional UK railroad as well as the high-speed network and therefore require duplicates of many systems. The cost per train rises to \$82 million due to the additional equipment required and the rate includes 40% contingency provision to reflect the increase in the complexity of these trains.

As with the Brazil study, rolling stock maintenance is specified as a per train mile charge which is equivalent to \$7.2 per mile. This is increased by 25% for the fleet of trains which will operate on the HSR and conventional railroads because of the additional complexity of these trains.

Depot locations and facilities required to maintain the rolling stock fleet are listed and confirmed as capital costs. Detailed maintenance schedules are provided showing the number of and type of examinations (both light and major overhaul) and time taken to undertake each. This detail allows the number of maintenance spares in the rolling stock fleet to be validated. However, the same issue as noted in the Brazil study arises where it is extremely difficult to validate the rolling stock maintenance cost as presented on a per train mile basis against all the components it is required to provide.

In accordance with UK Government guidelines for projects which are only at feasibility stage of development, a detailed risk assessment was not undertaken. However, a contingency of 41% (the recommended level for feasibility studies) was applied to operating costs before being input to the CBA. This contingency is intended to cover the cost risks which are likely to be present (although not quantified) at feasibility stage.

Network Rail, New Lines Program, 2009

The rolling stock type proposed for this HSR was assumed to have typical European HSE traction and performance characteristics. Unlike the HS2 report, this study assumes a single fleet will operate on HSR and conventional railroads. It is noted that the potential exists to reduce rolling stock capital costs if some trains are captive to the HSR network as trains operated on other European networks could be procured “off the shelf”. The assumed cost per train set is \$53 million including 41% contingency.

Fleet sizes are presented for all options considered. The base requirement can be verified by considering the service frequency, trip and turnaround times. No additional services are operated at peak times and no strengthening is specified - instead different lengths of trains are diagrammed to each service to best match the forecast demand. A minimum of 10% is assumed for maintenance spares; however, the basis behind this assumption is not documented.

While the report advises that rolling stock maintenance costs are included in the operating cost forecasts, information on the level of these costs and how they were estimated was unclear. Interpretation of information which was available indicates that train maintenance costs are likely to be underestimated.

The report does not present any detail on the maintenance regime assumed for the trains. Servicing and heavy maintenance depots are included in the capital cost estimate but no detail is provided on these.

Like the HS2 case study, the New Lines study follows UK Government guidelines for feasibility projects and includes 41% contingency on top of operating costs. Individual risks are not identified.

Stations

Summary

Less detail is generally presented for this cost area than those discussed above. The Calgary to Edmonton study continues with developing estimates for specific cost areas while the others, in general, apply generic rates to key quantities.

The HS2 report provides an excellent level of detail on the different roles and responsibilities of staff at stations and how this will vary with the size of station, service level and passenger footfall. Maintenance, utility and management costs are all discussed. However, the estimates are presented as a single sum per

station type and this slightly reduces the confidence in their accuracy because the component elements cannot be verified.

However, the other three studies present little, if any, substantiation for the costs assumed.

The two UK studies continue to apply 41% contingency to their cost estimates for use in the CBA (in accordance with UK Government guidance for feasibility studies).

Van Horne Institute, Calgary to Edmonton HSR, 2004

Facilities to be provided at the terminus and intermediate stations are clearly defined. Staff roles and responsibilities at each station are documented including ticket sales, train dispatch and customer assistance. Staff numbers are estimated to provide 7 days coverage at each station. An average salary is applied to provide a staff cost for each station.

Utilities, building maintenance and property taxes are included in a separate cost center which covers all property including offices, depots and stations.

Costs are provided to provide a central call center for ticket sales.

SNCF, California High-speed Rail Corridor, 2009

The report confirms that the operating costs for the platform, station and ticket sales staff are included although it emphasizes the benefits of virtual ticket sales and vending machines. This reduces the need for sales staff at the ticket sales area and can help manage demand on particular services through differential pricing between advanced and walk on tickets.

No disaggregated costs are presented for station costs.

Halcrow - Sinergia, Brazil TAV, 2009

There is no reference to the roles and responsibilities being undertaken by station staff and how this aligns with the HSR ticket sales policy. The total number of station staff is presented along with a cost; from this the average cost per staff member (which probably includes employers overheads) can be calculated.

The total estimate has provision for utility costs and while there is no substantiation to this, the sum is sufficiently large for it to be assumed that this covers stations as well as offices.

Station maintenance costs are taken as a percentage of the capital cost for construction.

European Mainland Case Study, 2010

The documentation does not name the 12 stations which will be served by the HSR, nor the level of staffing that will be provided at each. While the total number of station staff is estimated, it is not clear what their roles and responsibilities comprise. The costs of station staff are specified (both at a unit cost rate and as a total cost). The document confirms that as a result of the change in the train service specification (which slightly reduces the geographic coverage of the HSR) there is a reduction in the number of station staff required.

The case study includes an estimate of the costs of station facilities, where this is defined by the number of stations served and a lease cost for passenger lounges and an operating cost (where the latter is a percentage of station staff costs).

High-speed 2 (HS2), London to West Midlands, 2010

This provides a good level of detail on estimating these costs. A bottom up estimate has been prepared for station staff which include train dispatch, ticket office, passenger assistance, turnaround cleaning and station management.

- Train dispatch assumes five staff plus one supervisor per island platform per shift;
- Ticket office: an assumption is made regarding the number of ticket windows per shift in relation to station size plus supervision;
- Turnaround cleaning assumes one cleaning gang of seven can service two trains per hour; terminal stations only.

Costs are also included for passenger assistance staff and station management. The report confirms that the cost per staff member includes employer overheads (retirement contributions and insurance).

The costs depend on the type of the station, where four categories are defined: 10 platform terminus, 6 platform through, 4 platform through and 6 platform terminus. The costs are rolled up into an annual charge depending upon the category of the station and includes the appropriate staffing levels described above as well as provision for utilities and maintenance. The disaggregated costs for each element are not presented.

Network Rail, New Lines Program, 2009

Annual sums have been calculated for station staffing, maintenance, property tax and utilities based on the number of platforms at each station. Costs are presented only for a typical 4 platform station and for this, the utility, maintenance and property tax value is around 13% of the staff cost. The source information for this was quoted at the Association of Train Operating Companies, but no further information is provided about for example, staff salaries, assumed productivity or how trains will be dispatched.

General and administrative

Summary

The inclusion and estimation of costs which comprise this category vary considerably across case studies, with only the Calgary to Edmonton study providing disaggregated information on likely costs. The other studies either have no estimates for this area or have provision for staffing a head office function. No reasons are given for this in any of the reports which is of some concern as these are real costs which will be incurred in providing a successful HSIPR service.

Van Horne Institute, Calgary to Edmonton HSR, 2004

This section was thoroughly completed and covered staff equipment and uniforms as well as induction and regular competency/refresher training. Headquarters functions, insurance, marketing and advertising were considered along with a call center for ticket sales. These costs account for almost 18% of the total operating cost.

SNCF, California High-speed Rail Corridor, 2009

Marketing, information, security, insurance and clerk costs are included in total operating costs, however, details of what these cover and their individual cost breakdowns are not provided.

Halcrow - Sinergia, Brazil TAV, 2009

Costs are included for 20 Directors and management staff and 52 administration and finance staff; however, there is no information confirming how these numbers were derived.

A very precise mark-up (0.88%) on revenue has been included for sales and marketing costs, although it is not clear exactly what this cost covers.

An allowance has also been made for utilities for office buildings (but not stations).

In total, these costs represent 7% of total operating costs.

European Mainland Case Study, 2010

The general and administrative category accounts for a significant proportion of total operating costs on this project. The documentation identifies the key components, but little detail is provided as to how these were estimated. The key cost items within this category are:

- Ticket sales costs \$95m
- Head office costs \$40m
- Advertising \$30m
- Costs of first class passengers \$25m
- Contingency (quoted as a % of total operating costs) \$30m

To give context, the total annual cost of this HSIPR operation is estimated at \$625m per year, so general and admin costs account for 38% of total operating costs.

Insurance costs (1% of turnover), a cost for carrying first class passengers, a fixed cost for a call center and passenger compensation for delays are also included in this cost category.

Given the high cost of ticket sales, little information is provided on how this was estimated. The document proposes the proportion of tickets which will be sold via the internet and by automatic ticket machines and the number of automatic ticket machines that will be provided is also stated. The costs of selling tickets are estimated as a unit cost per ticket sold (irrespective of how they are sold). The source of this unit cost is not stated, nor is it confirmed how this relates to station staff costs.

The document notes that the latest operating costs forecasts have resulted in a very significant increase in head office costs (comprising both staff costs and overheads). The increase is accounted for by a bottom-up estimate of overheads (rather than a percentage increment on head office staff costs) and a revised view of head office staff salaries given market conditions and the proposed recruitment plan. It appears from the documentation that the bottom-up calculation of overheads includes estimates of costs for maintaining and updating IT equipment and hardware licenses and general IT assistance. Overhead costs account for nearly 50% of head office staff costs.

While the documentation provides a high-level comment on the media that will be used for advertising (and efficiencies of internet advertising), the estimate of advertising costs appears to be a high-level estimate.

The documentation also notes that costs have been included for access to safety vehicles, which is a requirement for access to the railroad. These safety vehicles are owned by the incumbent and it is assumed that the HSR operation incurs its share of rental costs for a diesel locomotive and five drivers.

High-speed 2 (HS2), London to West Midlands, 2010

Costs which would be included in the general and administrative costs category (such as headquarters function, insurance, advertising/marketing) are not mentioned in the report.

Network Rail, New Lines Program, 2009

Headquarters costs are presented as \$5.3M per year based on a bottom-up estimate of headquarters staff requirements for similar train companies. No further disaggregation is provided to clarify whether this includes sales and marketing, insurance and training costs. Contingency of 41% is added to this sum before it is input to the CBA.

Railroad

Summary

Four of the studies estimate these costs using a top down approach where a unit cost per route mile is multiplied by the route distance. This is reasonable for preliminary and intermediate stage studies providing the rate used is benchmarked against other rail systems. The Brazil TAV and HS2 studies have undertaken reasonable quantities of design and it was expected that a bottom up approach would be used where numbers of inspections and material requirements could have been forecast against the total quantities for the main assets such as way, overhead catenary, signaling and communications, stations and structures. The output of this calculation could have been sense checked against the top down ratios. However, this did not occur which is surprising as railroad costs form a significant proportion of total operating cost: 28% in the Brazil study, and 30% for HS2.

On Calgary to Edmonton, the HSIPR operator runs part of the service on new railroad and part as a tenant on an existing railroad owned by another organization.

Renewal of life expired railroad equipment is also treated differently between the studies. Calgary to Edmonton and HS2 are silent on this while Brazil TAV increased the annual railroad maintenance cost to make provision for this and New Lines treats it as a capital expenditure at set times during the CBA period.

Van Horne Institute, Calgary to Edmonton HSR, 2004

The HSIPR operator is a tenant either wholly or partially (depending upon the option) on a railroad owned by another organization. Involvement of the existing railroad manager (the landlord) allows more specific assumptions, than would normally be expected at this stage of the project lifecycle, to be defined - this included a 5 year access charge “holiday” if the upgrade existing route was selected. While this level of detail is informative and useful at this stage in the project lifecycle, it also carries risk as alternatives to compare against are less well developed. The report acknowledges the existing railroad managers workload will increase because of:

- Increased number of assets (predominantly twin rather than single track); and
- Increased maintenance regime to accommodate passenger rather than freight safety standards.

A charge per train mile is calculated for the new service on the existing railroad, which requires to be upgraded to accommodate HSIPR service. At \$0.78 per train mile for infrastructure operations and maintenance, it is not clear how this will cover the increase in operations and maintenance (O&M) costs which the landlord will experience. The landlord’s responsibilities will increase from providing a railroad for 21-25 freight trains per day to regulating a mixed passenger and freight service of approximately 45 trains per day. The additional trains will travel at close to twice the speed of the existing trains.

It is recognized that the landlord could have an extremely inefficient existing operation and the enhancement provides opportunity to improve efficiency, for example, through replacing numerous discrete signal boxes with a single central traffic control center.

For the option which relies on a mix of Greenfield (where the HSIPR operator will be the landlord) and existing railroad, only a total operations and maintenance cost is presented which is based on the experience of the landlord of the existing railroad. This equates to \$64k per track mile per year. This appears a little low and has perhaps been driven by the costs seen where the HSIPR operator is a tenant on another railroad, and therefore only pays a share of the total O&M cost. On the Greenfield section, the HSIPR operator will be responsible for all railroad O&M costs.

The report clearly acknowledges the drivers of railroad O&M costs. However, there is little in the way of substantiation, particularly when compared to the level of detail provided for operating the HSIPR service,

and rolling stock maintenance. Interfacing with an existing railroad manager in the manner proposed will bring significant risk (and potentially opportunity). As an example, the cost do not appear to consider the impact of the poor performance of one operator's trains on another and the costs of contract management.

SNCF, California High-speed Rail Corridor, 2009

This project assumes that the HSIPR operator will be landlord of the new railroad. The operations and maintenance of the railroad will be the responsibility of a centralized control center, referred to as an Operations Control Center (OCC).

The costs of maintenance of the railroad is charged as a combination of:

- Fixed cost (for civil works maintenance);
- Operation control center (OCC) maintenance;
- General inspections (using track and other recording vehicles); and
- A cost per train mile to cover power supply maintenance, track, catenary, signaling and telecoms maintenance.

The elements described form all the key drivers of railroad O&M cost but the information is not presented in a manner which can be reviewed.

Halcrow - Sinergia, Brazil TAV, 2009

This project assumes that the HSIPR operator will be the landlord of the proposed new railroad.

The report identifies two OCCs which will manage the entire route. Staff who will manage these centers are included in the total operating costs but the number of control center staff is not stated as they are presented in combination with station staff.

Maintenance costs are estimated in a top down manner using rates per route mile for way, signaling and communications and overhead catenary which have been benchmarked against other railroads. Estimates for maintaining stations, earthworks and structures are taken as a proportion of their construction cost.

The capital cost estimate contains provision for depots to maintain the railroad and an extensive list of plant and equipment is also detailed. It should be remembered that this report is pitched at final stage and sufficient design has been undertaken to have reasonably accurate quantities of the key assets which require maintenance such as length of way, number of switches, number of power supply stations, length of overhead catenary and number of bridges. Given this information exists, it is felt reasonable to use it in conjunction with an inspection and examination regime to estimate labor and material requirements. The output of this calculation could have then been verified through use of the benchmark rates per route mile.

However, the key area which leads to confusion is the manner in which the cost estimates for each asset are then profiled over a 30 year concession period. This profiling assumes that there is little need for maintenance in the first ten years of operation and then after a period of time life expired components will be replaced. For major assets such as the way or electrical transformers, this is usually treated as a capital rather than operating cost. Treating renewals or heavy maintenance as an operating cost is not a problem, providing it is clear what proportion of cost is for the renewal and what is for day to day maintenance. The estimated life of the asset should be stated along with the overall cost of replacement and the expenditure profile as some assets such as the way and overhead catenary will be replaced over five or so years.

European Mainland Case Study, 2010

In this case study, "railroad costs" are referred to as "access costs", as the railroad is owned, operated and maintained by a separate independent infrastructure company. The access costs include electric power for traction power costs.

Access costs are charged according to the number of train miles on the HSR network and the “conventional” (non-HSR) network. A different rate is charged for each of the two networks: \$15.5 per train mile on the HSR network and \$3.50 per train mile on the conventional network. It is understood that these costs are derived on the basis of the costs of operating and maintaining the network (possibly including some of the capital costs of the high-speed line) net of government grant. This net cost is then apportioned (by the infrastructure owner) to operators on the basis of a number of factors including train mileage, train type, speed, time of day and level of congestion of the rail network. Since it is not clear what proportion of operations and maintenance costs are covered by the government grant, it is not possible to benchmark the costs against other HSR operations.

Train miles estimates include train miles in passenger service and empty train workings where the latter reflects planned and unplanned transfers between stations and depots, stabling locations and locations on the network (to cover for “back-up” trains).

Annual increases in access charges are included for the HSR network but not for the conventional network or the electric traction element of costs. This represents a significant omission in costs (as total access costs on the conventional network are similar to those on the HSR).

The document notes that the costs of renting and staffing a number of stabling yards are included in costs. It outlines the assumptions which underpin the estimate of stabling capacity required.

High-speed 2 (HS2), London to West Midlands, 2010

The infrastructure operations and maintenance cost is estimated as a fixed cost of \$231,000 per track mile. This is based on an assessment of existing costs of the London to Channel Tunnel HSR and IPR in the UK.

Information is provided on the maintenance regimes which will be required and the facilities and number of depots required to service the railroad.

No detail is provided on renewal or heavy maintenance costs.

Network Rail, New Lines Program, 2009

The infrastructure operations and maintenance costs was estimated as a fixed cost of \$205,000 per track mile and benchmarked against the average cost of operating and maintaining the UK rail network; the costs for the HS1 between London and the Channel Tunnel and published costs for other European high-speed routes.

A railroad maintenance depot is assumed to be provided every 95 miles but no details are given on the facilities, plant and equipment provided under capital costs.

The assumed lifespan of different assets are presented and the proportion of the initial capital cost required to renew them under heavy maintenance is discussed. For example, when way is replaced, the rail, sleepers and ballast are generally renewed; so the cost is comparable with 100% of the initial installation costs. However, when overhead catenary is renewed, it is generally only the power carrying wires and switchgear which is life expired and the supporting masts, foundations and buildings do not need replacement. This means that the cost of replacement is perhaps 65% or so of the initial installation.

Discussion on study strengths and weaknesses

Each of the six case studies was different but it is clear that significant design development input has been expended on Brazil TAV and HS2 in particular. However, some historical work had been undertaken on Calgary to Edmonton and California; and the Mainland Europe HSR project utilizes an existing railroad for its operations. Therefore, the New Lines study was the only one which started without the benefit of historical design assessment or included significant design effort in the study.

Given this context, it is surprising how differently each study treats operating cost and the variety in confidence a reviewer would have in any of the estimates.

Only three studies applied contingency - the European Mainland case study included contingency as 5% of operating costs, while the two UK studies included contingency at a high rate of 41% (in accordance with UK Treasury guidance). This level of contingency has been applied because of the process in which the UK presents CBA and is effectively mandatory. The fact that mandatory application of a large contingency level may have discouraged both studies from developing detailed cost estimates because the resulting overestimate would detrimentally impact the CBA. While HS2 had a lot of substantiating information in appendices to the cost plan, it was not presented in a manner which allowed it to be directly related to the costs used - for example, huge detail is given on rolling stock maintenance regimes and requirements but nothing links this to the \$4.4 per train mile cost used.

The range of quality between the estimates produced by each study is wide and no single study is “best” in all areas. Calgary to Edmonton and HS2 give the largest levels of confidence on the information provided. Other specific points arising are discussed in the following paragraphs.

Presentation of data

Calgary to Edmonton was the only estimate which identified key cost areas and allocated costs against them in a clear disaggregated manner. This means it is relatively straightforward for a reviewer to sense check average rates and the key cost drivers such as annual train miles.

The other studies generally discuss cost areas and then apply a generic rate per train mile and route mile for operating and maintenance costs of the rolling stock and railroad, respectively. In the UK studies, traincrew costs are even presented as a cost per train hour rather than cost per staff role per year. The SNCF California HSR study discusses drivers of operating cost but does not present any disaggregated data. It is impossible to have assurance in the validity of these costs without seeing the build-up.

The two UK studies do not even present a total annual operating cost. Here it appears to be more important to provide a 60 year present value as part of the cost benefit analysis (CBA) than clearly present the annual HSIPR cost. This obscures the true cost of the HSIPR operation with respect to the farebox revenue generated.

The Brazil TAV study and SNCF California studies are the only ones which present a profile of operating cost for each year of the planned concession period. This is very useful because it shows the impact of service levels being increased to accommodate ridership growth.

All studies present the train service specification in clear manner which can be cross referenced against the ridership forecasts.

In conclusion, considerable effort was required to extract the information from each study needed to form a view of the accuracy of the operating cost estimates. The lack of a standardized presentation format hindered efficient review. Of the six studies, only Calgary to Edmonton and Brazil TAV presented their operating cost estimates in the form of a cost plan which is easy to review and shows a clear annual total. However, Calgary to Edmonton, although at intermediate level (rather than the final stage of the Brazil TAV), provided more comprehensive documentation on the assumptions behind the costs. Using a cost plan format lends itself to easily presenting greater detail as the project progresses through the project lifecycle and more information becomes available. This allows backward checking with previous estimates. With the information presented in the two UK and the SNCF California study, it would be a huge task to understand the drivers of variances in any future estimates.

The presentation of the Calgary to Edmonton operating cost forecasts would have been improved if (in addition to the single year estimate of costs which were stated) selected future year operating costs had been presented.

Range of costs

The case studies clearly show how difficult it is to apply costs incurred in other systems with any degree of accuracy. All projects proposed use of similar rolling stock yet estimates per train ranged from \$26M to \$68 million. Assumptions on railroad maintenance per route mile varied as dramatically as did the energy cost for ostensibly the same trains being deployed in similar operating conditions.

This clearly illustrates the dangers of using benchmarked rates (particularly from rail operations in other countries) to derive estimates. The clear preference is to produce an estimate based on the knowledge of this specific project and then sense check it against benchmarks.

Application of standards

The two UK studies were very clear on the standards being assumed and demonstrated their fit with the national regulatory regime. At the time of the study, agreed HSIPR standards did not exist in Canada so the Calgary to Edmonton study showed where there was divergence from current national standards and also compliance with FRA standards on the reasonable assumption that Canadian Authorities would use these as a basis for developing their own interpretation.

The California and Brazil TAV acknowledged the plan to use European technology in the respective studies but provided no context of the risk of compliance with USA and Brazilian requirements.

The Brazil TAV study made extensive use of European benchmarks to develop its estimates for rolling stock and railroad maintenance costs. These accounted for 77% of the total annual operating cost estimates meaning a huge potential impact if the standards underpinning the European railroads operation were deemed unacceptable in Brazil.

Omissions

The presentation of cost data in the HS2, New Lines and California studies means it is very difficult, if not impossible, to verify what costs are actually included in the estimates as well as forming a view as to how accurate the cost is. For example, the New Lines study presents a good evidence as to how the cost of a driver is calculated per train hour from a base salary. However, the calculation is not repeated for conductor and customer service staff, therefore while we know these roles have been accounted for, we have no assurance as to whether reasonable salaries or working hours have been assumed.

The New Lines study does not have a cost for rolling stock maintenance and it is only through comparison with the HS2 study published at a similar time that a review could conclude that this is incorporated in the very high energy cost rate (in comparison with the assumption used in the HS2 study). However, the presentation of the data, with no total cost shown, makes it impossible to confirm whether this is an omission or not without knowing further details of the CBA model.

The general and administrative costs do seem to have been omitted or underestimated in all but the Calgary to Edmonton study.

Railroad renewals

While renewal of life expired equipment such as the way and overhead catenary is normally treated as a capital cost, it is essential to understand how it is being treated in order to validate the estimate of the day to day operating and maintenance cost.

Only the New Lines and Brazil TAV study mentioned renewal of life expired equipment and both treated it in different ways: New Lines as a capital cost based on assumed asset life and a proportion of the initial

investment cost of providing the asset; Brazil TAV treated renewals as an operating cost but did not specify the proportion of renewal and day to day maintenance cost for each year of the profile making it impossible to validate.

Rolling stock

All studies specified the characteristics of the required rolling stock appropriately in terms of performance and seating capacity. However, only Calgary to Edmonton and HS2 considered maintenance requirements in any detail. This is a major component of operating cost and it is reasonable to expect estimates of the number of examinations per train and for the fleet per year in order to demonstrate that appropriate maintenance resource has been allocated.

Data analysis

We summarize the key elements of five of the case studies in Table 3-1 and Table 3-2 below. Due to the lack of disaggregated information, California HSR has been omitted from these tables.

TABLE 3-1. CHARACTERISTICS OF EACH STUDY

	Calgary - Edmonton	Brazil TAV	Mainland European	High Speed 2	New Lines
Route distance (miles)	185miles	320miles		311miles	480 miles
Annual train miles	0.8m (1.3m)	16.4m	7.5m	15.2m	41.3m miles
Annual train hours	10,655	118,000	n/a	n/a	360,000
Number of stations	5	8	12	9	8
Number of drivers	15	264 traincrew (incl. drivers)	110	Total not specified.	450
Number of other traincrew	113		482		405
Number of trains	5	42	25	61	53x10-car plus 20x5-car
% of trains as maintenance spares	20%	7%	Not specified	20% (some designated as "hot spares")	10%

TABLE 3-2. KEY COST PROPORTIONS FOR EACH STUDY

Percentage of total	Calgary - Edmonton	Brazil TAV	Mainland European	High Speed 2	New Lines
Traincrew	16%	2%	9%	11%	8%
Energy costs	6%	10%	Included in railroad access	23%	47%
Station costs (staff, utilities and maintenance)	4%	2%	3%	9%	6%
Rolling stock maintenance	32%	50%	12%	27%	13%
Railroad O&M/Railroad access	24%	28%	40% (includes energy)	30%	25%
General & Admin	19%	8%	38%	0%	0%
Total	100%	100%	100%	100%	100%

While the route distances of the proposed HSRs are of order of magnitude similar, the annual train miles and train hours vary considerably. The low train frequency on the Calgary - Edmonton HSIPR project results in very low annual train hours and miles. This will have a significant impact on the proportionality of costs and it would be unwise to include this study in any benchmarking analysis of costs per train mile.

While generally consistent with the proportions of cost presented in Figure 1-2, the information in Table 3-2 clearly shows a wide divergence between the studies. This is to be expected given that the projects (with the exception of HS2 and New Lines) are very different to each other and also that costs have generally been calculated in an aggregated manner. While this makes preparing estimates easier, it means that gaps and omissions are more difficult to spot.

Despite the differences, it can be seen that the largest areas of cost is rolling stock maintenance and railroad operations and maintenance (or access if the HSIPR operator is a tenant).

What is noticeable is that the proportion of operating costs accounted for by energy costs varies considerably between the studies. However, based on a brief analysis of the case studies:

- Energy costs for Calgary - Edmonton are low relative to other costs because of the low train mileage;
- Energy costs for Brazil TAV are thought to be significantly underestimated;
- Energy costs on the New Lines study appear to be over-estimated; and
- Energy costs for the Mainland Europe study cannot be compared on a like-for-like basis with other studies as in this case study the energy costs are “wrapped up” in railroad maintenance costs, where the latter are apportioned between two HSR operators.

It is therefore considered that energy costs are likely to account for approximately 20-25% of operating costs, unless the HSIPR rail service has a low train frequency (for example, 10 trains a day or fewer) and route distance.

Analysis has also indicated that the traincrew costs in the Brazil TAV case study are under-estimated.

There are large variations in the studies between general and administrative costs and this is felt to be due to some studies paying insufficient attention to these costs.

A lesson from the Mainland Europe HSR project is that a large head office function is still required even if the majority of the operating cost base (rolling stock maintenance and railroad access) is sub contracted. Managing such large contracts takes considerable effort.

The review of the case studies highlighted the difficulty in comparing HSIPR proposals which are prepared to different levels of detail, and where limited information is provided on how costs were estimated. These differences are not considered to be due to the stage of development (preliminary, intermediate or final) of each proposal, but reflect the fact that there is no “standard” approach to the presentation of costs. Compared to the ridership and revenue forecasts for the case studies, the published documentation of the operating cost forecasts was relatively brief.

In Table 3-3 through Table 3-8 on the following pages, we test the quality of information provided by each study against the discrete drivers of cost discussed in Section 1 and the level of information which would be expected for the particular stage of the project lifecycle discussed in Section 2.

TABLE 3-3. COMPARISON OF ROUTE ALIGNMENT & TRAIN SERVICE SPECIFICATION INFORMATION

	Preliminary Intermediate Final	Brazil TAV	California High-speed Rail	Calgary - Edmonton	Mainland Europe Case Study	New Lines	High Speed 2
Route alignment and distance provided							
High-level view with potential “risks” identified	Preliminary-Intermediate		Yes, though no mention of “risks”	Yes	No (not applicable as the proposed HSR service will be operating on existing railroad)	No	-
Detailed route alignment based on engineering plans	Final	Yes				No	Yes
Terminating & intermediate stations identified.	All	Yes	Yes	Yes	Yes	Yes	Yes
Train frequency and trip times specified based on: High-level assessment	Preliminary			Yes	Railroad manager has confirmed (via a framework agreement) that paths are available for the proposed train service. HSR promoter has undertaken detailed analysis using train graphs	Yes	Yes
Simulation modeling	Intermediate, Final	Yes. RailSys and VisionPlan.	Yes. Based on passenger demand.				
Variations in train service specified by time of day, day of week	Intermediate, Final	Yes	Yes	Yes	Yes	No	Yes
Train miles & hours specified	All	Yes	No	Yes	Train miles specified	Yes	No
Proposed rolling stock identified in terms of:							
Traction power	All	Yes	No	Yes	Yes	Yes	Yes
Max speed	All	Yes	No	Yes	Yes	Yes	Yes
Formation	All	Yes	No	Yes	Yes	Yes	Yes
Seats	All	Yes	Yes	Yes	Yes	Yes	Yes
Example provided	All	Yes	No	No	Yes	No	No
Provider identified	Final	No	No	No	Yes	No	No

TABLE 3-4. COMPARISON OF TRAINCREW & STATION STAFF COSTS

	Preliminary Intermediate Final	Brazil TAV	California High-speed Rail	Calgary - Edmonton	Mainland Europe Case Study	New Lines	High Speed 2
Staff costs included in operating cost forecasts	All	Yes	Yes	Yes	Yes	Yes	Yes
Annual staff costs stated	All	Yes	No	Yes, split by function	Yes	No	Yes
Staff roles and responsibilities (“function”) described Drivers and “other” traincrew All traincrew by function	Preliminary Intermediate, final	No	No	Yes	No	Yes	Yes
Total staff numbers specified by “function” Drivers and “other” traincrew All traincrew by function	Preliminary Intermediate, Final	No	No	Yes	Yes	No	No
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	All	No	No	No But salaries vary by function. No reference to overheads, source of estimates or risks	Yes Yes No Risks included in costs	Partially Salary for drivers stated. Upelevators for each overhead and assumed productivity provided	Salaries and overheads not specified but traincrew costs presented as a cost per train hour
Traincrew staff numbers quantified through: Pragmatic assumptions e.g., related to train hours Rostering/diagramming	Preliminary, Intermediate Final	Appear to be related to train hours	Yes: related to train miles & hours operated	Appear to be related to train hours	 Yes	Yes: related to train hours	Yes: related to train hours
Station staff numbers determined by: Number of stations and station size Platforms, passenger demand, ticket sales / customer services plan etc.	Preliminary Intermediate Final	No No	Yes (related to train operating metrics)	Staff numbers vary according to passenger demand	Yes Yes	Yes, number of stations and number of platforms	Staff numbers per function stated and number of platforms

TABLE 3-5. COMPARISON OF ROLLING STOCK COSTS (INCLUDING ROLLING STOCK MAINTENANCE STAFF)

	Preliminary Intermediate Final	Brazil TAV	California High-speed Rail	Calgary - Edmonton	Mainland Europe Case Study	New Lines	High Speed 2
Method of procuring rolling stock confirmed (lease or own)	All	Yes	Yes	Yes	Yes	Yes	Yes
Rolling stock maintenance costs included in operating cost forecasts?	All	Yes	Yes	Yes	Yes	Yes	Yes
Maintenance Plan described	All	No	No	Yes	Maintenance plan is not described in the review report however, the rolling stock contract (including maintenance) has already been agreed and signed.	No	Yes
Components of maintenance costs described: depots, staff, materials	All			Yes		Yes	
Frequency of different types of maintenance and exams described	Intermediate, Final					Yes	
Calculation of train maintenance costs described:		Yes	Yes	Yes	Yes (report confirms that a detailed business case has been prepared which specifies the light and heavy maintenance and fuel and water requirements). These underpin the rolling stock contract which has been signed.	No	Yes
Pragmatic assumptions: costs of train maintenance (per train) specified	Preliminary, Intermediate	Yes	No	Yes		No	Yes - based on similar HS trains and reviewed by independent technical experts
Costs of maintenance calculated bottom-up from maintenance/exam program and resulting resource requirements.	Final	No		Yes			
Depot costs included		Yes	Brief mention of number of maintenance depots required, but no costs described.	Yes	Maintenance depots included in rolling stock contract. Cost of nominated stabling yards is included in operating costs.	No	Yes
Pragmatic assumption on number, location, size and cost	Preliminary, Intermediate	Yes		Yes			Yes
Locations and size based on validated timetable	Final	No		Yes			Yes

TABLE 3-6. COMPARISON OF RAILROAD OPERATIONS AND MAINTENANCE COSTS

	Preliminary Intermediate Final	Brazil TAV	California High-speed Rail	Calgary - Edmonton	Mainland Europe Case Study	New Lines	High Speed 2
Railroad operations and maintenance costs included in operating costs?	All	Yes	Yes	Maintenance costs (no mention of operations costs)	Yes	Yes	Yes
Stations maintenance costs included		Yes	No reference to station maintenance costs	Yes	Yes	Yes	Yes
Railroad Manager confirmed? HSR/IPR operator is also railroad manager? Third party is railroad manager?	All	HSR/IPR operator is railroad manager	Unclear who will be railroad manager	Yes (Depends on option considered)	Yes Third part is railroad manager	Unclear who will be railroad manager	Unclear who will be railroad manager
Mix of operators on railroad described? HSR/IPR services form all/majority of services?	All	No Yes	Yes Yes	Yes Yes	No No	Yes On HSR Line: Yes On "classic lines": No	Yes
Railroad operations costs described : Summary Detail	All Preliminary, Intermediate Final	Yes	Yes	No mention of railroad operations and costs	No	No	No
Railroad maintenance costs described? Summary Detail	All Preliminary, Intermediate Final	Yes	Yes	Yes	No	No	No
Method of charging for railroad operations and maintenance costs described?	All	No	Yes (fixed and variable charge)	Yes (to cover maintenance): no access fees for first 5 years then a rate per train mile	Yes	A rate per single track mile is assumed (based on comparison of other HSR railroad O&M costs)	A rate per route mile is assumed (based on the existing High-speed 1 route)
Method of charging for stations maintenance costs described?	Intermediate, Final	No	No reference to station maintenance costs	No	Yes, included in lounge rental costs	Yes, based on size of station and existing maintenance costs	Yes, based on size of station and exiting maintenance costs

TABLE 3-7. COMPARISON OF ENERGY (FUEL/TRACTION) POWER COSTS

	Preliminary Intermediate Final	Brazil TAV	California High-speed Rail	Calgary - Edmonton	Mainland Europe Case Study	New Lines	High Speed 2
Traction power costs included in operating costs?	All	Yes	Yes	Yes	Yes	Yes	Yes
Method of calculation of power costs described	All	Yes	No	No	Included in the cost of access to railroad	No	Yes
Driver of traction power costs specified Train hours/train miles	All	Yes	Yes (train miles or train hours)	Yes (train hours)	Yes (train miles on each route section)	Yes	Yes
Unit cost of power stated (e.g., per KWhr or US gallon)	All	Yes	No	Yes (KWhr)	No	Yes	Yes
Power consumption of rolling stock stated, based on: Pragmatic assumptions Power consumption modeling for rolling stock selected	Preliminary, Intermediate, Final	Yes	Document refers to Appendix 10 (not supplied) where some examples of "amount of power required for a variety of operating conditions"	Yes (train simulations)	Based on a railroad access cost calculator provided by railroad manager. Unclear on what this calculator is based.	Yes	Yes
Risks to energy prices identified Risks described Risks quantified	Preliminary, Intermediate Final	No	No	No	No	No	No

TABLE 3-8. COMPARIOSN OF OTHER GENERAL AND ADMINISTRATIVE COSTS

	Preliminary Intermediate Final	Brazil TAV	California High-speed Rail	Calgary - Edmonton	Mainland Europe Case Study	New Lines	High Speed 2
“General & admin.” included in operating cost estimates: Estimated as a single line item Estimated for component elements?	All Preliminary, Intermediate Final	Yes Yes No	Yes (included within total operating costs)	Yes Yes	Yes Yes	Only HQ costs	No mention of costs that might represent general and admin costs
Component costs: Listed with little description Described in detail	Preliminary, Intermediate Final	No-	Listed, no description	Yes	Yes	Only one cost (HQ) mentioned	No information
Headquarters (HQ) staff included in operating costs?	All	Yes. Staff only	Unclear	No reference to HQ costs	Yes	Yes	No reference to HQ costs
Staff numbers stated based on: Pragmatic assumptions Organogram	Preliminary, Intermediate Final	-Unclear	Unclear	No reference to HQ costs	Yes	Yes (bottom up)	No information
Headquarters staff salaries stated (including overheads) Average employee salary Role specific salaries	Preliminary, Intermediate Final	-Unclear	No	No reference to HQ costs	Yes	No	No reference to HQ costs
Marketing and advertising costs included	All	Yes	Yes	Yes	Yes	Unclear	No reference to these costs

The range in the quality and detail of information provided by each study is quite surprising. A suspicion is that for studies where a new railroad is being constructed, the HSIPR operators' focus is on developing the alignment and estimates of capital cost, and less effort is applied to operating cost as this is perceived as being smaller in magnitude.

In developing best practice guidance, we can take some clear messages from the case study analysis:

- Rolling stock maintenance costs form a significant element of cost for an HSIPR operator. Information exists, even at preliminary stage to estimate the workload which will be required at depots allowing staff numbers and the number of sidings (or maintenance roads) required to be estimated with reasonable accuracy. This is generally not being done, perhaps because HSIPR operators are planning from the outset to sub-contract the maintenance to the train manufacturer. However, how the HSIPR operator procures the work is irrelevant because the costs will be of a similar magnitude and it therefore seems a false economy not to spend effort in properly estimating this cost area. The costs associated with utilities and maintaining the depots and their equipment often appear to be omitted;
- In total, staff costs will form around 50% of HSIPR operating cost. This means the HSIPR operator's relationship with unions and plans to comply with legislation are of critical importance. A small omission affecting all staff, such as allowances or underestimate in overheads will have a noticeable impact on the bottom line operating cost. However, the case studies demonstrate that aggregating staff over a variety of functions encourages underestimating. We conclude it is much more effective to split the staff into their key functions namely traincrew, stations, rolling stock maintenance, railroad maintenance and general and administrative and prepare estimates based on each; and
- The level of effort applied to general and administrative varies considerable between the studies from negligible to significant. The late increase in cost in this area experienced by the European Mainland HSR study illustrates that there may be a tendency to include costs in this category which should be placed in other cost categories and/or to include costs in this category which are not identified until the last stages of HSIPR development. It is considered that this issue would be mitigated by disaggregating staff into their discrete areas discussed in the point above, by presenting depot and station maintenance, utility and property tax costs in their stand alone categories and by identifying the cost items which will be included in this category (together with an estimate of them) throughout the stages of project development. The other key message in this area seems to be how ticket sales are treated and where those costs are presented. We would suggest that tickets sold via internet or call centers are included in general and administrative whereas the cost of selling tickets at stations is included in the station category.

The following sections seek to apply the information gathered from the case study analysis and present best practice guidance for reviewers of HSIPR operating costs.

4 Best practice: preliminary stage proposals

Introduction

There is no standard template for presenting operating costs and we suggest the following seven key cost areas that provide clear headings under which costs can be categorized:

- **Traincrew:** comprising of the drivers, conductors and guards to operate the trains and staff providing on-board customer services;
- **Energy:** the cost of powering the train, usually diesel or electricity;
- **Stations:** comprising staff to provide ticket sales, customer information and train dispatching services. The station buildings will incur utility and maintenance costs.
- **Train (“rolling stock”) costs:** HSIPR trains may be purchased by the HSIPR operator (in which case they are treated as a capital cost rather than an operating cost) or they may be purchased and owned by a 3rd party (for example, a financier) and the HSIPR operator pays an annual lease charge for their use. In this latter case, the annual charge for leasing the trains is considered as an operating cost;
- **Train maintenance:** comprising of the routine planned maintenance of trains as well as reactive maintenance as a result of vandalism and accidents. Train cleaning is also included within this cost area. Costs will include those of staff, materials and depot facilities, including utility costs and their maintenance. HSIPR trains require inspection and minor component changes every 1 to 3 days depending upon the mileages operated, major component change every few years and a full train refurbishment approximately every 15 years;
- **Railroad:** comprising of the costs to operate and maintain the railroad in order for the specified train service to operate, including switching, planned and reactive maintenance; and
- **General and administrative:** including management, marketing, telephone or internet ticket sales, staff travel and subsistence expenses, staff bonuses, uniforms and office overheads.

The proposal will be very difficult to review if it is not clear how it treats the components of each cost area, for example, what staff functions are included in the each category, how they were quantified and what unit cost rates were assumed in their monetization. It is suggested that any reviewer specify the format in which cost estimates should be submitted with clear guidance as to the expected content in each cost area.

At preliminary stage, the HSIPR operator must demonstrate that the estimates of costs are based upon the proposed railroad and the train service specification used to calculate the ridership and benefits forecasts.

This section describes the level of detail to which the railroad will have been defined and the train service specification developed. It explains how the costs associated with the submission are expected to have been calculated.

Typically a good preliminary stage proposal will consider between 6 - 8 different options and should explain the rationale for each option. The differentiating factors between options may be the railroad network, stations served, train frequency and trip time or rolling stock type. The proposal should provide a clear summary of the relative strengths and weaknesses of each option. Where possible this comparison will draw on quantified numbers (either of the physical attributes of the HSIPR such as track miles or rolling stock numbers, train frequencies and ridership numbers), but in some instances it may not be possible (at preliminary stage) to quantify aspects of the proposal and in these instances the documentation should clearly describe the relative qualitative attributes of each option.

Train service offer

While the train service offer comprises two key elements: the proposed train service specification and the proposed approach to delivery of the service (including the customer services such as ticket sales and train information), at preliminary stage it is usually the case that it is the proposed train service specification that is the differentiator between options rather than how the service will be delivered. While the costs arising from both elements of the train service offer will be quantified, greater focus will be paid to estimating the costs arising from the train service specification. The key elements of the train service offer are summarized in Table 4-1.

Train service specification

At preliminary stage, the key elements of the train service specification are:

- Route operated;
- Key stations served;
- Train frequency;
- End-to-end service trip time and distance;
- Required turnaround times;
- Daily number of seats provided;
- Days of operation; and
- Time of first and last services each day.

The information presented in the train service specification will allow annual train hours and train miles to be calculated: these are critical drivers of operating cost which determine key resource needs such as number of trains, energy, train maintenance and traincrew.

At the preliminary stage, the HSIPR operator will not be expected to prepare a full timetable taking into account the operators of other services. It is sufficient for the HSIPR operator to state the proposed frequency and timings of the services on the route (for a standard hour and peak hour) and, in this way, illustrate that there is sufficient capacity on the route, and to carry the forecast ridership. Where the proposed HSR services will share the railroad with other passenger services or freight services, the proposal should provide a commentary on the interaction between these services focusing on where railroad capacity may be an issue and how this has influenced the railroad proposed, service pattern or alternative railroad or train service options.

The objective of the preliminary stage is to prepare operating cost forecasts for each option which have been developed using a consistent approach and with consistent assumptions and unit cost rates. This enables the operating costs of the options to be compared and when revenue and public benefits forecasts are taken into account, the options delivering the highest value should be evident. Where the costs for an option have been forecast using different assumptions or cost rates, the proposal should state the reason for this.

The conclusions of a good preliminary stage proposal will identify a shortlist of two to three options to be taken forward to the next stage of development. The selection of this shortlist should be consistent with the financial assessment of the options as presented in the proposal and the relative strengths and weaknesses of the options (where some qualitative assessment may be included).

Quantification of costs

The HSIPR operator will have to make a number of key assumptions in order to prepare forecasts of costs, and these assumptions should be based on experience and in-depth analysis of rail services and railroad operation

in the US and other comparable countries. The source of assumptions should be described and referenced in the proposal.

Traincrew

The HSIPR operator should state the number of staff on each train, particularly noting the numbers of drivers on the train and how this is consistent with FRA regulations. A high-level approach to forecasting the total numbers of drivers and other traincrew for the HSIPR operation is acceptable at the preliminary stage (in other words, a detailed rostering exercise would not be expected). For example, the number of each member of traincrew may have been forecast based on the number of train diagrams required, the number of shifts required to cover each diagram (to take into account booking on and off of staff and preparation of trains for mobilization by drivers) and a percentage uplift to provide cover for staff training, holidays and sickness.

It is appropriate to use only two composite rates for traincrew - one for drivers and one for all other staff. The composite rate should be higher than the average salary in order to account for retirement funds, bonus, employers taxes and other relevant overheads. It is not necessary at preliminary stage to consider how traincrew costs will vary over time, unless this is a key element of the particular HSIPR option (as will be discussed in the rolling stock section).

Table 4-2 illustrates how traincrew costs will be quantified at preliminary stage.

Energy costs

The costs of fuel or traction power are determined by the distances operated by the HSIPR, the expected fuel consumption rate and the cost of fuel.

Estimates of train mileage should always be a standard metric presented. At the preliminary stage, the HSIPR operator should have a view of the type of rolling stock which they will operate (and therefore the maximum power rating) and be able to make a reasonable estimation of energy consumption (either electricity kWh per train mile or gallons of diesel per train mile) by considering the published energy consumption rates for other HSIPR services and the characteristics of these services and those of their proposed HSIPR (in particular number of stops and distance between stops, route gradients, maximum speed and the level of acceleration required) service.

The HSIPR operator should carefully consider what price they will be required to pay for energy consumed (in terms of a cost per kWh or gallon) and at preliminary stage, it would be expected that this unit cost would be consistent with current energy prices for the transportation sector and geographical region of operation.

Table 4-3 provides further details on how Energy costs will be estimated at preliminary stage.

TABLE 4-1. ROUTE ALIGNMENT & TRAIN SERVICE OFFER AT PRELIMINARY STAGE

Driver of cost	Description
Route alignment	
Route Alignment and distances	<p>The proposal must describe the characteristics of the railroad such as maximum linespeed, minimum curvatures and maximum gradients. The proposal must describe the likely proportions of the railroad which will be newly built and those which will make use of existing railroads.</p> <p>The route and track mileage of the railroad must be specified and the proposal must explain how these distances have been estimated.</p> <p>Key geographical characteristics of the line of route must be described, including whether the railroad will have significant gradients and where the route will have to negotiate natural or man-made obstacles such as mountains, major highways or built-up areas. The scale of the obstacles to be negotiated are likely to be the key differentiators between the different route options under consideration.</p> <p>The description must describe the main conurbations which will be served by the HSL.</p> <p>The proposal must concisely describe the differentiating factors between the route alignment options under consideration.</p>
Terminating & intermediate stations	<p>The proposal must state the stations which will be served by the proposed HSIPR services, confirming which stations are new, existing or upgraded.</p> <p>A short description of each station must be provided which should describe any notable characteristics of the station (e.g., if it is an airport station).</p> <p>An initial estimate of the number of platforms at each station must be provided.</p> <p>The proposal must concisely describe the different stations being served under each HSIPR route alignment and train service option.</p>
Train service specification	
Train frequency and trip times	<p>The proposed HSIPR train service must be described in terms of the frequency, trip time (end to end and between key stations), station stops, distance and train formation.</p> <p>Where different HSIPR services are proposed (e.g., long distance and short distance or peak period services), the service specification must be described for each.</p> <p>The proposal must describe the markets served by the proposed train service and any specific features required to attract ridership such as end to end trip times or quality of on board service .</p> <p>The proposal must state the proposed hours of service.</p> <p>It should be clear that the proposed service specification, which is used for forecasting costs, is consistent with that used to prepare ridership and benefits forecasts.</p> <p>The proposal must provide a table summarizing the service characteristics of each train service option under consideration and concisely explain the rationale for the different train service.</p>
Annual train miles & train hours	<p>The proposal must state the total annual train miles and train hours and present how these have been calculated with reference to distances, trip times and the service specification previously stated. Any assumptions (e.g., annualization factors) used to estimate annual train miles and train hours must be stated and the rationale for their selection stated.</p> <p>Where the HSIPR service comprises different origins and destinations or calling points, train types or formations, train miles and hours must be stated for each.</p>
Shared routes	The proposal must state where the HSIPR services may share the railroad with existing services.
Railroad capacity	The proposal must indicate that the capacity of the railroad has been considered in preparing the train service specification.
Train service offer and delivery	
Key statutory requirements	The proposal must state what statutory requirements have been taken into account in preparing the HSIPR proposal, in particular, in relation to safety.
Proposed rolling stock	<p>The proposal must state the proposed rolling stock which will operate the HSIPR services. At preliminary stage, it is acceptable for the promoter to reference an existing type of rolling stock, where this provides the required passenger carrying capacity and delivers the performance required by the train service specification.</p> <p>The proposal must specify the type of traction power which will be used, the maximum speed, maximum power at wheel, approximate weight, any special</p>

Driver of cost	Description
	<p>requirements (e.g., need for tilt), assumed formation and train length and assumed number of seats.</p> <p>The proposal should make reference to railway standards which will need to be met by the train (e.g., safety and impaired mobility passenger facilities) and whether these have been taken into consideration in the train specification and cost forecasts.</p> <p>If different rolling stock types are proposed for the various service and route alignment options being considered, the proposal must provide a table summarizing the characteristics of each.</p>

TABLE 4-2. QUANTIFYING TRAINCREW COSTS AT PRELIMINARY STAGE

Cost element	Description
Number of staff on each train	<p>The proposal must specify the number of drivers on each train and the number of other traincrew on each train.</p> <p>The proposal should explain how this conforms with legislation (e.g., need for second drivers).</p> <p>Where the numbers of staff on each train vary between options, the proposal must concisely explain the reasons why.</p>
Description of approach used to quantify numbers of traincrew for each Role	<p>The approach used to estimate the number of traincrew must be described. A high-level approach to forecasting the number of staff in each category is acceptable, for example, traincrew may be forecast by calculating the total train hours of operation each year and dividing this by an assumed number of productive hours per staff member per year. It is not necessary at preliminary stage to undertake a rostering exercise.</p> <p>The source of any assumptions in the estimation of staff numbers (e.g., productive hours assumption) must be explained and it should take account of unproductive time (annual leave, sickness, training, and train preparation time).</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>The proposal must specify the annual salary assumed for traincrew and confirm the source and rationale for this assumption.</p> <p>It is preferable for a different annual salary assumption to be used for train drivers as opposed to other traincrew.</p> <p>An allowance (in addition to annual salary) must be made for employers overheads including insurance and retirement contributions. The level and source of this overhead should be specified.</p> <p>At the preliminary stage, it is not expected that risks to these cost estimates would have been identified.</p>
Presentation of staff numbers and costs	<p>The proposal must state the total number of drivers required.</p> <p>The proposal must also state the number of other traincrew staff required.</p> <p>The proposal must state the total annual costs of drivers and the total annual costs of other traincrew.</p> <p>It must be clear where the employers overheads are included in the cost forecasts (e.g., these may be stated as an individual line item for all traincrew, as separate line items for drivers and other traincrew, or included in the total traincrew staff costs).</p>

TABLE 4-3. QUANTIFYING ENERGY COSTS AT PRELIMINARY STAGE

Cost element	Description
Method of calculation	The proposal must state how the costs of traction power have been forecast, including the consumption rates, the cost per unit (e.g., kwh or US gallon) of energy and the number of train miles.
Unit cost of energy	The proposal must specify the assumed cost of energy per unit (for example, the cost per US gallon of diesel or cost per kwh of electricity). The source of this unit cost and the rationale for its selection must be specified.
Energy consumption of rolling stock	<p>Energy consumption rates (e.g., electricity kwh per train mile or US gallons of diesel per train mile) for the proposed HSIPR service must be stated. It is acceptable to use energy consumption rates based on research into typical high-speed rolling stock and other HSR services. It is not necessary at preliminary stage to undertake power consumption modeling.</p> <p>If this is the case, the selection of the consumption rate(s) should be influenced by the relative characteristics of the proposed HSIPR service and the HSIPR services from which information from the benchmarking has been drawn. The key characteristics (which drive the consumption rates) which should be compared should include the physical characteristics of the route such as gradients, the power of the train, the number of intermediate station stops and the distance traveled.</p> <p>Where the energy consumption rates vary between options, the proposal must concisely explain the reasons why.</p>
Energy costs	It must be evident that the estimate of energy costs is consistent with the proposed train service specification.

Stations

The number and size of stations on the route will be determined from the train service specification (which will have been influenced by the market analysis and ridership forecasts).

Station staff numbers will need to reflect size of the station, in terms of the number of platforms and the required functions which are to be covered by station staff. The HSIPR operator should state how many staff will be required at terminal and intermediate stations, taking into consideration the tasks that these station staff will need to undertake (for example, these tasks may include dispatching trains, selling tickets, providing assistance and information to customers and undertaking light cleaning of stations).

At preliminary stage, a rostering exercise is not required to estimate the number of staff at each station. However, the number of staff should include sufficient cover for holidays, sickness, training and the hours of operation of the train service. Staff numbers at preliminary stage are sometimes estimated by calculating the number of staff hours required per station per year and then dividing this by the number of productive hours per year of a typical member of station staff.

Utility, building and equipment maintenance and (if relevant) property tax costs should for each station should also be included in this cost area. At preliminary stage, these are likely to be high-level estimates based on benchmarked costs from other HSIPR operations.

Table 4-4 provides further details on how station costs will be estimated at preliminary stage.

Train (rolling stock) costs

At preliminary stage, an HSIPR proposal is likely to include a number of options with alternative (sometimes significantly different) rolling stock technologies (for example, different speeds, different traction types or different train formations) and at this stage the analysis may focus more on the impacts of these on ridership and flexibility of operation. An important aspect of an HSIPR proposition is the mechanism of procuring trains - will they be owned by the HSIPR operator and capital funded or will they be owned by a third party, such as the manufacturer or a financier and leased? At the preliminary stage, it reasonable to assume that trains will be purchased and owned by HSIPR operator.

At the preliminary stage, the HSIPR operator is likely to estimate the purchase or lease cost for each train based on a review of existing trains with similar characteristics. It is essential that an upward allowance to reflect the risk on the price is included. When comparing prices for purchasing or leasing similar trains, the HSIPR operator should make reference to whether the price of the comparators included an element of train maintenance.

The other principal driver of train procurement costs is the number of trains required to operate the train service - including diagrammed trains and spare sets. This is calculated from the criteria identified in Table 4-5 and underpinned by the assumptions derived from the train service offer.

At the preliminary stage, the HSIPR operator should specify the number of trains required, including "spares" (spare trains to cover when others are undergoing significant maintenance or in the event of incidents). The proposal should describe how the number of trains required was estimated: at preliminary stage, a fairly simple estimate based on the proposed service specification and taking into account end-to-end trip time, train frequency and turnaround time is sufficient. The turnaround time should be estimated based on the level of train servicing which is required at the end of each trip (e.g., cleaning, refueling and refreshments renewed) and should consider turnaround times of other HSIPR services with similar frequencies and end-to-end trip times.

At this stage in the proposal development, it would be sufficient for the number of “spares” to be calculated as a proportion of the fleet - probably of the order of 5-10% of the trains required to operate the service each day. However, where the fleet is small in size, a minimum 1 or 2 trains as spares is required.

Train maintenance

As explained above, at the preliminary stage of an HSIPR proposal, the HSIPR operator will only have a high-level specification of the type of trains which will operate the service and is unlikely to have been in discussions with suppliers. It is therefore unlikely that a preliminary stage proposal will define a train maintenance plan. However, the proposal should provide evidence of understanding the types of train maintenance that would need to be undertaken, including servicing and light and heavy maintenance. Rolling stock costs at preliminary stage should also include an estimate of the costs of cleaning trains.

At this stage, it is acceptable for the HSIPR operator to estimate train maintenance costs as a cost per train per year or cost per train mile, where this cost per year or train mile is derived from benchmarking the maintenance costs of existing HSIPR trains, or through experience of operating HSIPR services. This benchmarking should take into account whether the other HSIPR maintenance costs include labor costs, materials costs and depot costs (e.g., utilities and equipment hire), and should reflect the findings in the cost rate chosen.

TABLE 4-4. QUANTIFYING STATION COSTS AT PRELIMINARY STAGE

Cost element	Description
Station specification	The preliminary stage proposal must state the location and size of each station (in terms of the number of platforms at each station).
Total staff numbers specified by role	<p>The proposal must estimate the number of station staff required for the main terminus stations and the “typical” number of staff required at intermediate stations.</p> <p>It is not necessary at preliminary stage to undertake a rostering exercise but the assumptions used to extrapolate estimates of staff required per shift into full time equivalents (confirming adequate cover for holidays, training and illness) should be clearly stated .</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>At preliminary stage, it is reasonable to assume a single salary covering all roles of station staff. The proposal must specify the annual salary assumed and confirm the source and rationale for this assumption.</p> <p>An allowance (in addition to annual salary) must be made for employers’ overheads including insurance and retirement contributions. The level and source of this overhead should be specified.</p> <p>At the preliminary stage, it is not expected that risks to these cost estimates would have been identified.</p>
Fixed costs	<p>Costs will be incurred for utilities, building maintenance, equipment maintenance (display screens, public address, ticket machines) and possibly property tax. At preliminary stage, a high-level estimate of costs is sufficient but this should be proportional to the size of each station and the source of the assumed cost must be clearly stated.</p> <p>The proposal must state what assumption has been made with respect to how costs will change over time.</p>
Presentation of station costs	<p>The preliminary level proposal must state the total number of station staff employed.</p> <p>The proposal must state the total annual station staff costs. It must be clear where employers’ overhead costs are included.</p> <p>Fixed costs of stations must be included as one or more line item in the operating cost forecasts.</p>

TABLE 4-5. QUANTIFYING ROLLING STOCK COSTS (INCLUDING MAINTENANCE) AT PRELIMINARY STAGE

Cost element	Description
Method of procuring rolling stock	The proposal must state whether HSIPR trains will be purchased through capital funding or financed by a third party and leased. Lease costs must be clearly identified on a per train or vehicle per year basis.
Rolling stock fleet required	The proposal must state the number of trains required to operate the HSIPR service. At preliminary stage, it is acceptable for the number of trains required to be calculated using a high-level estimate: for example, as a function of return trip time plus turnaround time and train frequency. Where different types of service are operated (e.g., long distance/short distance), the number of trains must be forecast for each service type. A reasonable proportion of trains (around 5-10%) must be included for use as maintenance spares.
Rolling stock ownership or leasing costs	Where trains are leased, rolling stock leasing costs must be included as one or more line items in the operating costs forecasts. The cost of purchasing or leasing each train may be based on published costs for similar, recently delivered rolling stock. If the proposal uses existing rolling stock used in Europe or Asia as the basis for their cost estimate, the proposal must consider how US technical and safety standards will be met.
Inclusion of rolling stock maintenance costs	Rolling stock maintenance costs must be included as one or more line items in the operating cost forecasts.
Maintenance plan described	At preliminary stage, it is not necessary for a maintenance plan to be described.
Approach used to estimate train maintenance costs	The proposal must describe how the costs of train maintenance are forecast. The maintenance cost rates must be clearly stated, either as a cost per train or vehicle per year or a cost per train mile. Confidence in the estimate is improved if it is benchmarked against published evidence from other HSIPR operations, with similar rolling stock, train service and route characteristics. Where the unit cost assumed for train maintenance varies between options, the proposal must concisely explain the reasons why.
Fixed costs included	Even at preliminary stage, the depot facilities required to maintain the train fleet should be estimated.
Changes in rolling stock costs over time	At preliminary stage, assumptions as to how costs will change over time should focus on changes arising from: timetable alterations affecting the number or frequency of services and longer trains required to increase passenger capacity.

Railroad

If the HSIPR operator is going to introduce new services on an existing railroad it is critical for them to provide evidence that sufficient capacity exists to operate their proposed service without disrupting existing services on the route. This applies equally if the railroad is owned by the HSIPR operator or if they are planning to act as a tenant to another railroad manager.

If a new railroad is to be constructed to support the service, it is reasonable to assume at preliminary stage that it will be designed to accommodate the planned service levels. However, if the proposed HSIPR service is to operate wholly or partially on a railroad owned by another railroad manager, at preliminary stage the proposal should describe any risks around the capacity which has been identified as being “spare” to allow the HSIPR service to run.

In terms of the operating costs of the railroad, where an HSIPR service is planned to operate as a tenant on an existing railroad, access charges are calculated on a \$ per train or vehicle mile basis. Sometimes a fixed charge per year for annual mileage bands may be applied. In such instances, the HSIPR operator of the project can provide an estimate of the costs of accessing the railroad by straightforward multiplication of the annual vehicle miles to be operated by the published charge per vehicle mile.

Where the HSIPR operator is the landlord, the railroad costs should be estimated as a function of the number of track miles (note: a common error is confusing route miles - i.e. physical distance between point A and point B which does not distinguish if the railway is single, twin or four track - with single track miles, the sum of all track on the route, irrespective of the layout) and a unit cost (\$ cost per single track mile) to maintain the railroad, where the latter is usually based on research and benchmarking of comparable HSIPR operations. When selecting the unit cost rate to apply, the proposal should provide evidence that it is consistent with the technologies to be used to run and regulate trains (e.g., overhead electrification, in cab signaling and telecommunications) and the physical characteristics of the railroad (e.g., the type of terrain traversed and the volume of structures such as bridges and tunnels), which will influence the cost of maintaining the railway.

Table 4-6 summarizes the key elements of estimating railroad costs at preliminary stage.

TABLE 4-6. QUANTIFYING RAILROAD COSTS AT PRELIMINARY STAGE

Cost element	Description
Railroad operations and maintenance costs included in operating costs	Railroad operations and maintenance costs must be included as one or more line items in the operating cost forecasts. Where the HSR service will operate as a tenant on a railroad the costs may be presented as “railroad access costs”.
Railroad landlord or tenant?	At preliminary stage, the proposal must state whether the HSIPR operator will be a landlord and own the railroad. This is generally the case if the proposal involves construction of new railroad. Where the HSIPR operator is a tenant, the proposal must state the nature of the landlord, for example, is it public or private and is it responsible for operating train services?
Capacity of railroad	The proposal must confirm whether the HSIPR services are the only users of the railroad, and if the railroad is shared, the mix of traffic should be described (in terms of operators and passenger or freight, high speed or conventional). The proposal must state where there may be capacity constraints which may constrain the deliverability of the proposed service.
Approach to estimating railroad operations costs described	The proposal must describe how the railroad costs have been estimated and include assumptions (and their sources) for: <ul style="list-style-type: none"> • The number of signaling and control centers that are required; • The number of operations staff taking into account the hours of operation of the service and the need to include staff cover for holidays, sickness and training; and • An estimate of the annual salary and employers overheads for these staff.
Approach to estimating railroad maintenance costs described	The proposal must describe how the railroad maintenance costs (or access costs, if the HSIPR operator is a tenant) have been estimated. At preliminary stage, it is acceptable for the costs to be estimated at a high-level, for example, by applying a unit cost rate per track mile (derived from benchmarking other similar HSR railroads).

General and administrative

At the preliminary stage of an HSIPR proposal, it is reasonable to forecast general and administrative costs as a percentage increase over the sub total of the other operating cost elements. However, the proposal should list the types of costs which will be incurred under the general and administrative category, to show that the cost estimate has been prepared mindful of the many critical items of which this category is comprised.

At preliminary stage, the proposal should estimate the number of headquarters staff who will be employed and provide an estimate of these costs based on a generic salary and overheads cost per person.

It is not acceptable for the HSIPR operator to simply ignore the existence of “other costs” or to advise that there are costs related to the proposed HSIPR which are not quantified. This category generally forms at least 10% of the total operating cost.

Table 4-7 summarizes the key elements of estimating general and administrative costs at preliminary stage.

TABLE 4-7. QUANTIFYING GENERAL AND ADMINISTRATIVE COSTS AT PRELIMINARY STAGE

Cost element	Description
Inclusion of general and admin. costs	An estimate of costs of general and administrative costs must be included as one or more line items in the operating cost forecasts. In preliminary stage, it is acceptable for this element to be forecast as a percentage of total operating costs.
Staff roles and responsibilities	Assuming traincrew, maintenance, station and railroad staff have all been accounted for in the separate cost categories described above, staff in the general and administrative function will consist of headquarters staff.
Total staff numbers specified by "function"	The proposal should estimate the size of the headquarters operation.
Non staff costs	Examples of the likely non staff components of general and administrative costs must be noted in the proposal and should include IT equipment and maintenance, marketing and advertising, professional services such as legal and engineering advice and insurance. Internet and telephone ticket sales are sometimes included in general and administrative costs as are facilities management costs such as utilities, buildings maintenance and property taxes.

Risk assessment

At preliminary stage, a high-level of contingency should be applied to compensate for the large number of assumptions rather than detailed calculations which underpin the supporting plans.

At this stage in the project lifecycle, 40-50% would reasonably be applied to the sub total of the six main categories of cost discussed in the preceding paragraphs. The level of contingency applied should be proportional to the volume of assumptions made in quantifying the operating costs and the availability of information from other comparable HSIPR operations which has been available to inform assumptions and prepare cost forecasts.

The HSIPR operator should record the assumptions they have used in developing the options being tested at preliminary stage. An example of the elements which should be considered by the assumptions register is provided in Table 4-8 below. A good assumptions register will permit a reviewer to quickly ascertain that assumptions are consistently used between the characteristics of the railroad proposed, ridership forecasts and operating cost estimates.

TABLE 4-8. ASSUMPTIONS REGISTER EXAMPLE ENTRY

Criteria	Information
Identifier number	1
Assumption	Train acceleration is 1.2m/s ² .
Source	Train weight and traction packages similar to Siemens ICE 3 trains.
Verification	Partial: at intermediate stage following production of a rolling stock performance specification and market testing with manufacturers. Full: at final stage following confirmation of a preferred supplier for the trains.
Dependents	Train trip times. Energy consumption calculation. Ridership and revenue forecasts. Rolling stock calculation to determine number of trains required to operate timetable. Traincrew resourcing estimate. Maintenance resourcing estimate.
Owner	Rolling stock engineer

The assumptions register is a useful document for assessing how well risk has been managed to date and to give an indication of how robust the process is for future risk management. For a project as complex as introducing and operating new HSIPR services, the list of assumptions - which underpin the cost estimate and contingency overlay - should be extensive and the process by which each will be verified and validated clearly identified.

Some commentary should be provided on the key risks for each option being considered at preliminary stage. It is important to be able to understand whether the option which provides the best benefits for the lowest operating cost is actually deliverable without significant risk. For particularly complex HSIPR proposals, it may be appropriate to develop risk registers for each option. These are discussed in more detail in the following section on intermediate stage proposals.

Common shortcuts leading to poor quality estimates

The main reason for poor quality operating cost forecasts at the preliminary stage is a failure to reflect the specific characteristics of the HSIPR service being proposed. Without a clear understanding of the railroad route, the level and quality of train service that will be offered and the standards that must be complied

with, it is likely that costs will be incorrect by an order of magnitude, through a combination of underestimation of some elements and omission of others.

Estimates developed at preliminary stage are primarily used to compare between different railroad alignment and train service alternatives, but can often be misrepresented as also giving an accurate value for the likely cost of operating the HSIPR service. If a large contingency is not applied, the high-level nature of preliminary stage estimates will generally underestimate the true cost of operating the HSIPR service.

At preliminary stage, it is common for HSIPR proposals to fail to identify and allocate a reasonable estimate against all sources of operating cost which are likely to be incurred for the presented train service specification. Developing estimates around the six standard cost headings discussed in this section will help identify where elements of cost have been omitted or treated inappropriately.

Staff

At this level, the HSIPR operator may underestimate the number of staff required to operate trains by over-estimating the productivity of traincrew and/or underestimating the number of “other” staff required on each train.

Similarly, station staff numbers may be under-estimated if the operator does not understand the key tasks which station staff will need to undertake (a particular example being train despatch). Due to the high-level nature of the preliminary estimate, some staff costs may be erroneously omitted altogether, for example, headquarters, control room and train cleaning staff.

At preliminary stage, incorrect estimates of staff costs also arise from failing to annualize staff numbers properly, or failing to apply accurate estimates of staff employments costs (including under-estimating salaries, omitting employers overheads such as retirement and insurance payments and other staff related costs).

Energy

At preliminary stage, energy costs are often under-estimated as a result of a failure to understand the quantum of power required to operate the train service. This arises through insufficient consideration of the level of power required to meet the proposed trip times while stopping at all the calling points. A lack of care in forecasting annual train miles (which influences energy costs) and the cost of energy per kWh or US gallon has also resulted in incorrect forecasts in preliminary studies.

Rolling stock

The low level of timetable development work and the lack of a detailed specification for rolling stock at this stage in the project lifecycle can mean that the numbers of trains required to provide the specified service is underestimated.

The base number of trains is driven by the service frequency, turnaround times and trip times - for all of which assumptions can be made with reasonable accuracy. However, a standard all day timetable is often used and costs associated with providing strengthening or additional services in the peak are omitted.

The number of spare trains to allow maintenance to be undertaken as well as the selection of a maintenance cost per train mile or train per year are often underestimated. The maintenance cost per train may be selected from benchmarking other studies without consideration of how closely the services compare (train maintenance costs are very closely linked to annual mileages operated but it is not always a directly proportional relationship) or without fully considering the implications of compliance with FRA standards, when using standard European or Asian benchmarks.

Railroad costs

International benchmarks are often used to estimate the cost of railroad operations and maintenance by applying an average \$ per route mile to the physical size of the HSIPR operation. At preliminary stage, this is reasonable but extreme care must be taken with the benchmarks used. National safety and regulatory standards will influence how an HSIPR operator determines their maintenance strategy. In Europe, all train operators are bound by the same standards. However, differing national interpretations of these standards combined with specific requirements of some authorities means there is 50% difference between the least and most expensive authorities on a per route mile basis. It has to be determined upfront whether it is appropriate to apply the average of this wide range to a new railroad in the USA.

General and administrative

The individual components of this element can add up to be a reasonable proportion of the overall HSIPR operating cost and often at preliminary stage only a few, if any, of the elements are properly captured in the estimate. It is usually the case that preliminary stage proposals underestimate general and administrative costs. For example, the headquarters resource effort to manage a large HSIPR operation will be significant, and significant costs may be incurred in marketing and advertising the HSIPR and to pay third parties for selling tickets.

5 Best practice: intermediate stage proposals

Introduction

Intermediate stage proposals will consider only two or three potential train service options each of which will be underpinned by concept or feasibility level design to prove it is deliverable. Intermediate stage proposals will produce estimates which are significantly more accurate than those developed at preliminary stage. The focus is now on understanding the likely cost of providing an HSIPR service, rather than determining which are the best options to invest effort in, as was the case at preliminary stage. It is therefore necessary for an intermediate stage proposal to consider how costs will change over time, both in response to factors within their control (such as train service and customer offer) which usually affect the quantum of resource required, but also factors which cannot easily be influenced such as wage rates and energy prices. The proposal should state what assumptions have been made on how costs will change over time, and estimates of operating costs at 5-yearly intervals for 30 years would be expected.

The cost estimate is still constructed using the six key categories used to develop the preliminary stage forecasts. The train service specification is now more detailed with trip and turnaround times verified through timetable modeling. Key characteristics of the trains to be operated (maximum speed, axle weight, maximum power, train length and formation) are now defined with greater confidence. Requirements specific to the proposed HSIPR operation such as the need for tilt, passenger capacity and passenger facilities can now be specified.

Train service offer

In the preliminary stage, the train service offer was treated qualitatively. At intermediate stage, key details such as who will sell tickets, whether the service is a “high value” offer and what form of catering will be offered will be defined and cross referenced with the ridership forecasts.

Table 5-1 provides a summary checklist of the elements which a good intermediate stage proposal will contain over and above a preliminary stage proposal for the route alignment and train service offer.

TABLE 5-1. ROUTE ALIGNMENT & TRAIN SERVICE OFFER FOR INTERMEDIATE STAGE

Driver of cost	Description
Route alignment	
Route alignment and distances	<p>The proposal must explain the rationale for the preferred route alignment, as a range of alternative options are expected to have been considered prior to selecting the option which is taken forward as the basis for ridership, benefits and costs forecasts.</p> <p>The proposal must describe the line of route of the proposed train service, particularly focusing on those elements of the route which are new high-speed lines or upgrades of existing railroads.</p> <p>The distances covered by the new or upgraded railroad must be specified and be presented for each of the key route sections between major stations. The proposal must explain how these distances have been estimated.</p> <p>Key geographical characteristics of the line of route must be described, including whether the railroad will have significant gradients and where the route will have to negotiate natural or man-made obstacles such as mountains, major roads or built-up areas.</p> <p>The description must describe the main conurbations which will be served by the high-speed line.</p> <p>Risks to constructing or upgrading new railroad must be briefly described, and the proposed plan for investigating and mitigating these risks must be explained.</p>
Terminating & intermediate stations	<p>The proposal must state the stations which will be served by the proposed HSIPR services, confirming which stations are new/existing/upgraded.</p> <p>A short description of each station must be provided which should describe any notable characteristics of the station (e.g., if it is an airport station).</p> <p>An initial estimate of the number of platforms at each station must be provided.</p>
Train service specification	
Train frequency and trip times	<p>The proposed HSIPR service must be described in terms of the frequency, trip time (end-to-end and between key stations), station stops, distance and train formation.</p> <p>Where different HSIPR services are proposed (e.g., long distance and short distance or peak period services), the service specification must be specified for each. The proposal must state whether it is expected that the same train service will operate throughout the day. Where it varies, the assumed time periods of each train service should be specified.</p> <p>The proposal must describe how the train service specification has been defined, for example, what determines the service frequency and train formation (ridership is often a key factor) and give assurances that trip times are deliverable with the proposed infrastructure, stopping pattern and rolling stock specification (especially maximum speed).</p> <p>The proposal must describe the rationale underpinning the proposed train service and must briefly mention other service options that were considered.</p> <p>It should be clear that the proposed service specification which is used for forecasting costs is consistent with that used to prepare ridership and benefits forecasts.</p>
Variations in train service	<p>The proposal must state the proposed hours of service, whether there is a defined peak period when the train service is different from the rest of the day, and what has been assumed for weekend train services.</p>
Annual train miles & train hours	<p>The proposal must state the total annual train miles and train hours and present how these have been calculated with reference to distances, trip times and the service specification previously stated. Any assumptions (e.g., annualization factors) used to estimate annual train miles and train hours must be stated and the rationale for their selection stated.</p> <p>The forecast should include train miles and hours for empty train workings (e.g., to depots), however, a high-level estimate of these is acceptable at intermediate stage.</p> <p>Where the HSIPR service will operate on a combination of new HSL and existing routes, train miles and train hours should also be estimated separately for the two railroads. Similarly, where more than one train formation or train type will be operated, train miles and hours must be stated for each.</p>
Shared routes	<p>The proposal must state where the HSIPR services will share the railroad with existing services, or where there is a high probability of another train operator entering the market.</p> <p>The impacts of sharing the railroad must be considered and any assumptions made in terms of preparing the train service specification, ridership and cost forecasts must be stated.</p>

Driver of cost	Description
Railroad capacity	The proposal must provide evidence that the capacity of the railroad (including stations and the impact of existing train services on the railroad) has been considered in preparing the train service specification. Any locations where there is a high-level of capacity utilization should be identified.
Train service offer and delivery	
Key statutory requirements	The proposal must state what statutory requirements have been taken into account in developing the HSIPR service, in particular in relation to safety.
Proposed rolling stock	<p>The proposal must state the proposed rolling stock which will operate the HSIPR services. At intermediate stage, it is acceptable for the promoter to reference an existing type of rolling stock, where this meets the criteria necessary to deliver the train service specification and passenger capacity of the proposed services.</p> <p>The proposal must specify the type of traction power which will be used, the maximum speed, maximum power at wheel, approximate weight, any special requirements (e.g., need for tilt), assumed formation and train length and assumed number of seats (splitting this by “class” of accommodation).</p> <p>The proposal may give an example of the train (if one currently exists).</p> <p>The proposal should make reference to railway standards which will need to be met by the train (e.g., safety and impaired mobility passenger facilities) and whether these have been taken into consideration in the train specification and cost forecasts.</p>
Customer service offer and service delivery	<p>The proposal must confirm the key customer service characteristics of the proposed HSIPR service, including whether there will be different classes of accommodation on trains (and what differentiates these), what on-train catering is proposed and how tickets will be sold.</p> <p>The proposal must confirm how trains will be dispatched from stations, including whether this will be a responsibility of on-train and/or station staff.</p>

Quantification of costs

Intermediate stage estimates are prepared to a much greater level of detail than those at preliminary stage and therefore require a larger number of inputs. Some of these will be generated by the concept or feasibility design but others will have to be based on assumptions until they can be verified by design at final stage. At intermediate stage, the HSIPR operator will have had little communication with potential suppliers of services. The greater knowledge obtained during this phase makes it easier to identify the similarities and differences of the proposed service against other HSIPR operations which can help with cost benchmarking.

Traincrew

The number of staff on each train and in each role should be specified based on the proposed approach to delivering the train service and customer offer. At preliminary stage, it was acceptable to name the roles but only estimate quantities of drivers and “other” staff. The reviewer should therefore be clear about how many drivers per train have been assumed, how many conductors and/or guards are on-board and the number of catering, customer service and ticket sales staff.

It is still acceptable to continue to forecast numbers of traincrew using a high-level approach rather than detailed rosters. However, the number of staff required for each role should be estimated and costs should be calculated using an estimate of the salary and overhead costs of each staff role. The cost forecast should also reflect the HSIPR operators’ better understanding of staff productivity and the levels of staff salaries and overheads for each role.

Forecasts of staff numbers and costs should also be prepared for future years, and should reflect any planned changes in train service and reasonable expectations of how unit cost rates (in particular salaries) will change over time.

Table 5-2 provides further details on how traincrew costs will be estimated at intermediate stage.

Energy costs

At intermediate stage, it is acceptable for energy costs to continue to be estimated based on benchmarking of other HSIPR operations. However, the proposal should refer to the factors that influence power consumption and provide evidence that these have been taken into account when selecting the energy consumption rate. At this stage of proposal development, it would be expected that operators would prepare an independent assessment of power consumption rates using a simple spreadsheet models which models the affect on power consumption of the power of the train, number of station stops, gradients of the route and trip times and distances.

The forecasts of energy costs should be based upon a more accurate estimates of train mileage. Train mileage forecasts will now be prepared with greater clarity of the standard hour (and peak) train specification, and train service specifications for weekends should also have been prepared. Hours of service are likely to have been considered with greater care, and the empty train movements should also be quantified, as a minimum, as a percentage overlay of train miles in passenger service.

The assumption of what energy price (per kWh or US gallon) will be paid should have been given consideration in the intermediate stage. This is likely to have changed from the preliminary stage at least in part as a result of HSIPR operators now realizing that it is a key assumption which impacts the overall level of operating costs and researching this unit cost more thoroughly is warranted.

The future price of energy will be a key uncertainty throughout the HSIPR proposal development and at intermediate stage, the operator should make an informed but high-level assumption of energy prices in the future.

Table 5-3 provides further details on how energy costs will be estimated at intermediate stage.

Stations

At intermediate stage, the HSIPR operator should have identified how the train service will operate (including how trains will be despatched and tickets checked) and the type of customer services (such as ticket sales and catering) that will be offered. The proposal should specify whether (and if so, how) station staff will dispatch trains, sell tickets, provide assistance (and information) to customers and undertake light cleaning of stations.

The estimate of station staff costs should therefore be underpinned by a definition of the roles and responsibilities of station staff and the number that are required for duty at any one time at each station. The number of staff required will not only be a function of the duties covered by station staff, but also the the number and layout of platforms, frequency of trains, passenger volumes, profile of ridership and types of passengers using the station.

In addition to costs for station staff, the intermediate stage proposal should forecast non-staff costs such as utilities, building and equipment maintenance and (if relevant) property tax costs. At intermediate stage, these are likely to be high-level estimates based on benchmarked costs from other HSIPR operations.

Table 5-4 provides further details on how station costs will be estimated at intermediate stage.

TABLE 5-2. QUANTIFYING TRAINCREW COSTS AT INTERMEDIATE STAGE

Cost element	Description
Staff roles and responsibilities described	The proposal must state the role (e.g., managers, drivers, trainee drivers, guards, ticket examiners, customer service) and responsibilities of each member of traincrew. It should be clear from the proposal that the traincrew described meet the train service offer and delivery proposal as described in the checklist for these (for example, catering staff are included and staff are included if train dispatch is to be undertaken by traincrew).
Number of staff on each train	The proposal must specify the number of staff on each train and the roles they undertake. The proposal must clearly explain how this conforms with legislation (e.g., need for second drivers).
Description of approach used to quantify numbers of traincrew for each role	The approach used to estimate the number of traincrew must be described. A high-level approach to forecasting the number of staff in each category is acceptable, for example, traincrew may be forecast by calculating the total train hours of operation each year and dividing this by an assumed number of productive hours per staff member per year. It is not necessary at intermediate stage to undertake a detailed rostering exercise. The source of any assumptions in the estimation of staff numbers (e.g., productive hours assumption) must be explained and it should take account of unproductive time (annual leave, sickness, training, and train preparation time). The quantification of traincrew must consider the responsibilities of each member of traincrew.
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	The proposal must specify the annual salary assumed for each of the staff roles and confirm the source and rationale for this assumption. It is preferable for a different annual salary assumption to be used for train drivers as opposed to other traincrew. An allowance (in addition to annual salary) must be made for employers overheads including insurance and retirement contributions. The level of this overhead should be specified and the source of this specified.
Changes in staff costs over time	The proposal must consider and make assumptions with respect to how staff costs will increase over time. This should include: <ul style="list-style-type: none"> • Whether salaries will increase over time; and • How the numbers of staff in each function will vary with any proposed change in train service level, passenger volumes or changes in train formation. The rationale behind the assumptions adopted must be explained.
Presentation of staff numbers and costs	The proposal must state the total number of drivers required. The proposal must also state the number of other traincrew staff required, and preferably these should be disaggregated by staff role. The proposal must state the total annual costs of drivers and the total annual costs of other traincrew, preferably the latter should be split by role. It must be clear where the employers overheads are included in the cost forecasts (e.g., these may be stated as an individual line item for all traincrew, as separate line items for drivers and other traincrew, or included in the total traincrew staff costs).

TABLE 5-3. QUANTIFYING ENERGY COSTS AT INTERMEDIATE STAGE

Cost element	Description
Method of calculation	The proposal must state how the costs of traction power have been forecast, including the consumption rates and the cost per unit (e.g., kwh or US gallon) of energy. This calculation should refer to the drivers of power consumption, in particular, the gradients of the route, the power of the train, the acceleration rates required, the stopping pattern, the distance and trip times.
Unit cost of energy	The proposal must specify the assumed cost of energy per unit (for example, the cost per US gallon of diesel or cost per kwh of electricity). The source of this unit cost and the rationale for its selection must be specified.
Energy consumption of rolling stock	<p>Energy consumption rates (e.g., electricity kwh per train mile or US gallons of diesel per train hour) for the proposed HSIPR service must be stated. The source of the consumption rates assumed and the rationale for their choice must be clearly described.</p> <p>At intermediate stage, it is acceptable to use energy consumption rates based on research into typical high-speed rolling stock and other HSR services. However, if this is the case, the selection of the consumption rate(s) should be influenced by the proposed rolling stock characteristics (e.g., speed, power and weight) and route alignment characteristics (stopping pattern and gradient profile).</p> <p>It is reasonable to expect promoters to base their forecasts on simple spreadsheet models which estimate (at a high level) the power consumption rates based on the power of the train, number of station stops, gradients of the route and trip times and distances. It is not necessary at intermediate stage to undertake detailed power consumption modeling.</p>
Energy costs	It must be evident that the estimate of energy costs is consistent with the proposed train service specification (as a minimum, the estimate of train service miles or hours).
Changes over time	There is considerable uncertainty as to how energy costs will change in future. The proposal should consider the risk of energy price variations and state the assumptions as to how they will change over time.

TABLE 5-4. QUANTIFYING STATION COSTS AT INTERMEDIATE STAGE

Cost element	Description
Station specification	The proposal must describe the location and size of each station including the number of platforms and estimated footfall. The operating days and hours should be clearly stated and be consistent with the train service specification.
Staff roles and responsibilities	The proposal must state the key roles of each grade of station staff. As a minimum this will specify who is responsible for dispatching trains, selling tickets, checking tickets, providing refreshments, security and CCTV monitoring and general customer assistance. Management and supervisory requirements should be identified.
Total staff numbers specified by role	<p>The proposal must estimate the total number of station staff to cover the specified functions.</p> <p>As a minimum staff numbers must be presented separately for each terminal station and an estimate for provided for a typical intermediate station.</p> <p>It must be evident that the estimate of the number of station staff has been calculated taking into account the number and size (in terms of platforms, layout and number of passengers) of the key stations, the roles of staff (e.g., ticket sales and train dispatch) and hours of operation of the train service.</p> <p>It is not necessary at intermediate stage to undertake a detailed rostering exercise, but the assumptions used to extrapolate estimates of staff required per shift into full time equivalents (confirming adequate cover for holidays, training and illness) should be clearly stated and be consistent with relevant safety and employment regulations.</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>At intermediate stage, it is reasonable to assume a single salary covering all roles of station staff, with a higher rate for management or supervisory staff. The proposal must specify the annual salary assumed and confirm the source and rationale for this assumption.</p> <p>An allowance (in addition to annual salary) must be made for employers' overheads including insurance and retirement contributions. The level and source of this overhead should be specified.</p>
Changes in staff costs over time	<p>The proposal must consider and make assumptions with respect to how station staff costs will increase over time.</p> <p>This should include:</p> <ul style="list-style-type: none"> • Whether salaries will increase over time • How the numbers of staff in each function will vary with any proposed change in train service level, passenger volumes or changes in train formation. <p>The rationale behind the assumptions adopted must be explained.</p>
Fixed costs	<p>Costs will be incurred for utilities, building maintenance, equipment maintenance (display screens, public address, ticket machines) and possibly property tax.</p> <p>At intermediate stage, a high-level estimate is sufficient but this should be proportional to the size and footfall for each station and the source of the assumed cost clearly stated.</p> <p>The proposal must state what assumption has been made with respect to how costs will change over time.</p>
Presentation of station costs	<p>The intermediate stage proposal must state the total number of station staff employed, preferably split by role.</p> <p>The proposal must state the total annual station staff costs, preferably split by role. It must be clear where employers' overhead costs are included.</p> <p>Fixed costs of stations must be included as one or more line item in the operating cost forecasts.</p>

Train (rolling stock) costs

The remaining options considered at intermediate stage will be dependent upon a more defined rolling stock performance than at preliminary stage. There should be clarity on the preferred power source, and train length and seating capacity split into economy and business class if appropriate. For the purpose of developing cost estimates, a comparable type of train already in service should be identified.

Intermediate stage proposals will generally continue to assume that rolling stock is purchased outright by the HSIPR operator, rather than leased. If this is the case, the operating costs should include the costs of financing the capital expenditure (with the purchase costs included in the capital costs of the HSIPR); whereas if they are to be leased, the lease costs should be included in the operating costs.

Reflecting the greater certainty of the specification of rolling stock that will be used on the HSIPR, the capital costs of purchasing the trains (or leasing them) should be based upon research into the costs of trains with similar characteristics, and possibly through initial contact with potential manufacturers and financiers. It is essential that an increase to reflect the risk on the price is included and care taken in understanding whether all or some of the costs of train maintenance is included in the prices of comparators.

At intermediate stage, the number of trains (both trains in service each day and spare sets for maintenance) should be estimated using a simple diagramming exercise. This should be based upon the more refined train service specification that is available at preliminary stage and also reflect the performance characteristics of the preferred train type. The diagramming exercise is likely to be undertaken using a simple spreadsheet model, with the key parameters being end-to-end trip time, train frequency, turnaround time but also proposed train depot and stabling locations and traincrew depots. At the intermediate stage, the turnaround time should be consistent with proposed train servicing plan (train cleaning, catering replenishment, seat reservation allocation).

The estimate will also reflect that different frequencies of service (and trip times) may be offered at different times of day and days of week. Where more than one type of rolling stock is proposed (for example, different train types or formations operating different types of service e.g., regional commuter services and long distance express services), these “restrictions” should also be included in the diagramming exercise.

The number of “spares” is generally calculated, as in the preliminary stage, as a proportion of the fleet (usually 5- 10% of the trains required to operate the service each day). However, there is merit in the HSIPR operator confirming their confidence in the number of spares proposed (particularly when different train types are operated) and the extent to which there is a trade-off between how train maintenance is undertaken (and therefore train maintenance costs) and the number of spares required.

Train maintenance

As explained above, at the intermediate stage of an HSIPR proposal, the HSIPR operator will only have a high-level specification of the type of trains which will operate the service and is unlikely to have been in anything more than indicative discussions with suppliers. It is therefore unlikely that an intermediate stage proposal will define the train maintenance plan in detail. However, the proposal should provide evidence of understanding the types of train maintenance and inspections that would need to be undertaken and what frequency. A good train service specification will have been developed giving consideration as to where the train maintenance depots may be located, and where there may be existing pools of suitably skilled labor.

The HSIPR operator knows the anticipated annual mileage of each train and from the specification of the type of train required will be able to match this to other generic types to derive assumed maintenance requirements. At intermediate stage, this will be high-level and take a similar form to the bullet points below:

- Bogies and wheels inspection - every 2,500miles;
- Roof mounted equipment inspection - every 5,000miles;
- On board equipment - every 60,000miles;
- Major examination - every 250,000miles;
- Major overhaul - every 1,000,000miles;
- Tire turning - every 125,000miles.

The first three items would be classified as light maintenance and the last three as heavy maintenance. This categorization can be used to estimate the number of examinations which will be required per day, week and year. From this, the labor, materials and facilities required to undertake the work can be estimated (which in turn permits an informed view to be taken of the number and size of depots required to deliver the likely maintenance regime).

As well as heavy and light maintenance of the trains, staff will be required to service the trains. Some of these will be based at key locations on the route to repair minor faults while the trains are in operation. There will also need to be a light interior cleaning of the trains at the end of every trip. Cleaning staff will also be required at all locations where trains are stabled each night to undertake a more thorough interior cleaning, where surfaces are wiped down and carpets are vacuumed.

As well as maintenance staff at depots, drivers and switching staff will be required to move the trains around the yard.

Fixed costs such as depreciation of the cost of constructing the depot (or lease charges), utilities and equipment hire will be a function of the number and size of locations required to maintain and service the train fleet. An annual cost to cover materials required for exams and vandalism will be proportional to the size of the train fleet and number of miles operated.

A full disaggregation of the total cost of train maintenance into staff (cleaning, maintenance, switching and depot driving) materials and depot costs is helpful but unlikely to be determined with any accuracy due to the generic assumptions being applied. Therefore at intermediate stage, an HSIPR operator is likely to present train maintenance costs (the total costs of which should have been calculated as described) as a cost per train per year or cost per train mile. To give confidence to the reviewer that the total cost estimated for train maintenance (the cost per mile multiplied by the total annual train miles or cost per train multiplied by the number of trains) can fund the volume of work required, the HSIPR operator should present high-level sense checks showing how many staff and depots will probably be needed to deliver the assumed workload. Further confidence is also gained if an informed benchmarking of maintenance cost rates (for the proposed HSIPR and other existing HSIPR services) is presented.

Table 5-5 provides further details on how train (rolling stock) costs will be estimated at intermediate stage.

TABLE 5-5. QUANTIFYING ROLLING STOCK COSTS (INCLUDING ROLLING STOCK MAINTENANCE) AT INTERMEDIATE STAGE

Cost element	Description
Method of procuring rolling stock	<p>The proposal must state whether HSIPR trains will be purchased through capital funding or financed by a third party and leased.</p> <p>Trains purchased through capital funding may be depreciated as an operating “cost”.</p> <p>Lease costs must be clearly identified on a per train or vehicle per year basis and the source of this cost must be clearly stated and explained.</p>
Rolling stock fleet required	<p>The proposal must state the number of trains required to operate the HSIPR service and the approach used to quantify this explained.</p> <p>At intermediate stage, it is acceptable for a high-level diagramming exercise, rather than detailed simulation to be undertaken.</p> <p>A reasonable proportion of trains (around 5-10%) must be included for use as maintenance spares.</p>
Rolling stock ownership or leasing costs	<p>Where trains are leased, rolling stock leasing costs must be included as one or more line items in the operating costs forecasts.</p> <p>The cost of purchasing or leasing each train may be based on published costs for similar, recently delivered rolling stock.</p> <p>If the proposal uses existing rolling stock as the basis for their cost estimate, a commentary must be provided the extent to which it may need to be modified to meet US technical and safety standards and cost for these modifications included in the forecast.</p>
Inclusion of rolling stock maintenance costs	<p>Rolling stock maintenance costs must be included as one or more line items in the operating cost forecasts.</p> <p>The proposal must describe the components of maintenance costs, with reference to different levels of maintenance (servicing, light and heavy) and comprising of the labor, materials and fixed cost elements.</p>
Maintenance plan described	<p>A generic rather than specific maintenance plan is expected. This will identify the number of inspections required per day, week and annually and use this to estimate the location and size of depot facilities, staff, equipment and materials required.</p> <p>The maintenance plan must demonstrate consistency with the train service specification, particularly with respect to the annual train miles being operated and the start and finish times and locations of services.</p>
Approach used to estimate train maintenance costs	<p>The proposal must describe how the costs of train maintenance are forecast.</p> <p>The proposal must state clearly what it understands the maintenance costs to cover (in terms of labor, materials and depots) and what maintenance it assumes is covered (including whether it understands the costs to cover daily items such as water, fuel and cleaning).</p> <p>The maintenance cost rates must be clearly stated, either as a cost per train or vehicle per year or a cost per train mile or vehicle mile.</p> <p>Confidence in the estimate is improved if it is benchmarked against published evidence from other HSIPR operations, with similar rolling stock, train service and route characteristics.</p> <p>A sense check should be presented to demonstrate the total cost estimated is adequate to cover the staff, materials and facilities needed to provide daily servicing and the forecast number of inspections. An indication of the total staff required, the functions they will perform (maintenance, cleaning, depot driving) and average salaries should therefore be provided to support the estimate.</p>
Fixed costs included	<p>The fixed costs for providing the depot facilities should be estimated and presented separately or appropriate provision included in the cost estimate per train per year or per train mile.</p> <p>The proposal should clearly state the functions to be carried out at the depot and the equipment required including numbers of stabling sidings and inspection roads with pits elevated walkways to permit underframe and roof access to the HSIPR trains. The capacity of the depot in terms of maintenance inspections per day, week and year must be described and shown to be consistent with the trains service specification.</p>
Changes in rolling stock costs over time	<p>The proposal must state assumptions as to how rolling stock and maintenance costs will change over time. There is less of inflationary risk where rolling stock has been purchased outright by the HSIPR operator. Changes may arise from: timetable alterations affecting the number or frequency of services; longer trains required to increase passenger capacity; and inflationary pressure on salaries and materials.</p>

Railroad

Intermediate stage proposals should be able to provide significantly greater confidence to the reviewer that sufficient capacity is available on the railroad to operate the proposed train service.

Where the railroad is new and is operated by the HSIPR operator, the train service and railroad design presented at the intermediate stage are both likely to have been adjusted to accommodate the constraints of the other (and often to reduce costs which tend to increase as an HSIPR proposal is developed through the stages), although some evidence based on feasibility design should be provided to support this.

Where the railroad is owned and operated by another railroad manager, evidence will usually take the form of correspondence from the railroad manager confirming the conditions against which the required timetable paths could be made available. This correspondence would also contain details of assumptions and constraints such as rolling stock performance requirements, start and end points, service frequency and times of first and last services. These constraints should be consistent with the train service specification proposed by the HSIPR operator. At this stage, confirmation of available timetable paths from the railroad manager would not be contractually binding.

The operating costs of the railroad where an HSIPR service is planning to operate as a tenant on an existing railroad are likely to be represented as access charges on a \$ per train or vehicle mile basis, possibly with a fixed charge per year for annual mileage bands applied. It is prudent at intermediate stage for an HSIPR operator (and reviewer) to sense check the revenue the landlord will expect to receive for supporting the new HSIPR services compared to the likely increase in workload they will experience. If the cost of access is lower than what would be expected and no explanation is given, there is a risk the costs have been underestimated or misrepresented.

Where the HSIPR operator is the landlord, the railroad costs should be estimated by considering:

- Number of track miles to be managed (note: a common error is confusing route miles, i.e. physical distance between point A and point B which does distinguish if the railway is single, twin or four track, with single track miles, the sum of all track on the route, irrespective of the layout);
- High-level specification of technologies to be used to run and regulate trains, for example, slab track, overhead electrification, in cab signaling and telecommunications;
- Cost per single track mile for materials;
- Annual lease cost of heavy plant to maintain the route, for example, ballast cleaners, rail grinders, overhead line access platforms;
- Number of maintenance staff per fixed distance, for example, 10 staff per night shift per 100 route miles;
- Number of signaling and control centers for the route;
- Number of staff per signaling and control center;
- Average salary costs for maintenance and signaling staff; and
- Proportional increase for head office function.

The sum of this bottom up approach can be tested for robustness by comparing with generic \$ cost per single track mile metrics from comparable railroads.

Table 5-6 summarizes the key elements of estimating railroad costs at intermediate stage.

TABLE 5-6. QUANTIFYING RAILROAD COSTS AT INTERMEDIATE STAGE

Cost element	Description
Railroad operations and maintenance costs included in operating costs	<p>Railroad operations and maintenance costs must be included as one or more line items in the operating cost forecasts.</p> <p>Where the HSR service will operate as a tenant on a railroad, the costs may be presented as “railroad access costs”.</p>
Railroad landlord or tenant?	<p>The proposal must state whether the HSIPR operator will be a landlord and own the railroad. This is generally the case if the proposal involves construction of new railroad.</p> <p>Where the HSIPR operator is a tenant, the proposal must state the nature of the landlord, for example, is it public or private and is it responsible for operating train services?</p> <p>Where the HSIPR operator is a tenant, the assumptions underpinning the railroad access costs must be described and access arrangements demonstrated to be consistent with the train service specification. The railroad access costs will be charged on a \$ per vehicle train mile basis, sometimes with an additional fixed cost per year and evidence should be provided that this is proportional to the costs which are likely to be incurred by the landlord to support the new services.</p>
Capacity of railroad	<p>The proposal must confirm whether the HSIPR services are the only users of the railroad.</p> <p>Where other rail services will use the railroad, the proposal must describe the mix of traffic, both in terms of operators and types of traffic, for example, passenger or freight and passenger high-speed or passenger “conventional”). Evidence should be provided that sufficient capacity exists on the railroad for all services and potential conflicts between services have been resolved.</p> <p>Where a new railroad is being constructed for the HSIPR service, the feasibility design must provide evidence that the capacity accommodates the requirements of the train service specification.</p>
Approach to estimating railroad operations costs described	<p>The proposal must describe how the railroad costs have been estimated and include assumptions (and their sources) for:</p> <ul style="list-style-type: none"> • The number of signaling and control centers that are required; • The number of staff per signaling and control center (where the number must take into account the hours of operation of the service and the need to include staff cover for holidays, sickness and training); and • An estimate of the annual salary and employers overheads for these staff.
Approach to estimating railroad maintenance costs described	<p>The proposal must describe how the railroad maintenance costs have been estimated. At intermediate stage, it is acceptable for the costs to be estimated at a high-level, for example, by quantifying the following:</p> <ul style="list-style-type: none"> • Number of single track (not route) miles to be maintained; • High-level specification of technologies used to run and regulate trains (overhead electrification in cab signaling etc.); • Number of stations to be maintained and their size (in terms of platforms); • Cost per single track mile for materials; • Number of maintenance staff required (typically estimated on the basis of a certain number of staff per 100 track miles); and • Estimate of the annual salary and employers’ overheads of railroad maintenance staff. <p>Costs incurred by other HSIPR operators can be used as a benchmark, but it is preferable that these rates are not used as the sole source of the estimate.</p>
Changes in costs over time	<p>The proposal must state what assumptions have been made in terms of how costs will change over time. Of particular importance are the assumptions regarding how staff and material costs will be affected by inflation.</p>

General and administrative

The quantification of general and administrative costs at intermediate stage should be focused on identifying the cost items which reside in this category. The HSIPR operator should provide examples of the types of costs included, with priority given to those which are of the largest magnitude.

At the intermediate stage, the proposal should describe the different functions within the headquarters (including human resources, marketing, finance, strategic planning, customer services, training, procurement and contract management) and estimate the number of staff in each function. The costs of each function should reflect different salaries for senior and junior grades. Generally, headquarters staff receive a significantly higher than average salary compared to other HSIPR staff (with the possible exception of drivers) and therefore while the number of headquarters staff may not be high, the staff costs may be.

The proposal should prepare high-level estimates of the costs which are identified as comprising general and admin costs. In particular, these costs should include payments to third parties in return for the provision of services or support (such as ticket sales via telephone call centers or an internet provider, professional services such as legal and accountancy), advertising and marketing, IT and telecommunications costs and utilities.

As with other cost categories, the intermediate stage proposal should forecast general and administrative costs for 5-yearly intervals over the forecast period. In doing this, it should be specified how key components of general and administrative costs change over time - some changing in response to the level of train services and/or ridership levels.

Table 5-7 summarizes the key elements of estimating general and administrative costs at intermediate stage.

TABLE 5-7. QUANTIFYING GENERAL AND ADMINISTRATIVE COSTS AT INTERMEDIATE STAGE

Cost element	Description
Inclusion of general and admin. costs	An estimate of general and administrative costs must be included as one or more line items in the operating cost forecasts.
Staff roles and responsibilities	<p>Assuming traincrew, maintenance, station and railroad staff have all been accounted for in the separate cost categories described above, staff in the general and administrative function will consist of:</p> <ul style="list-style-type: none"> • Directors and senior management; • Specialist support such as technical standards, procurement and contract management; • General support such as administration, marketing, human resources, training and finance; and • Operations - control center for day to day management and separate strategic planning.
Total staff numbers specified by “function”	<p>The proposal must specify the total number of staff in the key categories described above.</p> <p>Most of these functions are Monday to Friday only but where support is provided on a 24/7 basis then assumptions behind the calculation to increase the staff per shift to an annual full time equivalent basis should be clearly presented.</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>At intermediate stage, it is reasonable to assume a few salary bands can cover all general and administrative staff functions, with a higher rate for senior management and specialist staff and a lower rate for general support and operations staff. The proposal must specify the annual salary assumed, the roles it represents and confirm the source and rationale for this assumption.</p> <p>An allowance (in addition to annual salary) must be made for employers’ overheads including insurance and retirement contributions. The level and source of this overhead should be specified.</p>
Non staff costs	<p>Examples of the likely non staff components of general and administrative costs must be noted in the proposal and should include IT equipment and maintenance, marketing and advertising, professional services such as legal and engineering advice and insurance.</p> <p>Internet and telephone ticket sales are sometimes included in general and administrative costs as are facilities management costs such as utilities, buildings maintenance and property taxes. The facilities costs will be significant for stations and depots and it is preferable to see these discretely presented in the respective stations and train maintenance sections of the estimate to have confidence that the estimate is of the appropriate quantum.</p> <p>It is acceptable for the non staff elements of general and administrative costs to be forecast using a high-level estimate of component costs.</p>
Changes in costs over time	<p>The proposal must consider and make assumptions with respect to how staff costs will increase over time.</p> <p>This should include:</p> <ul style="list-style-type: none"> • Whether salaries will increase over time; and • How the numbers of staff in each function will vary with any proposed change in train service level, passenger volumes or changes in train formation. <p>The rationale behind the assumptions adopted must be explained.</p> <p>Inflationary assumptions which grow the non staff costs over time should be clearly explained.</p>

Risk assessment

While there is increased detail in the operating cost estimate at intermediate stage, a large level of contingency should be applied in order to reflect the large number of assumptions which the estimate is based on. Furthermore, while the key quantities which drive operating cost (e.g., staff numbers, annual train miles, numbers of trains and single track miles of railroad) are all more accurately defined, the unit cost rates applied to derive the cost estimates are still likely to be subject to considerable uncertainty because they generally reflect benchmarked rates across a variety of HSIPR operations and are not specific to the options covered by the proposal.

An increase in operating costs of between 20-40% would reasonably be applied to the sub-total of the key cost elements at intermediate stage. The level of contingency applied should be proportional to the level of detail and disaggregation of the estimate and the extent to which the technologies proposed are “tried and tested” in the US. For example, a higher contingency would be appropriate if the proposal was based on European technology and operating practices which had not yet been introduced elsewhere in the US. Similarly, an estimate with little breakdown of cost in each of the areas would be expected to have contingency closer to the 40% than the 20% level.

At intermediate stage, the qualitative descriptions of risks associated with each options should now be replaced by a more comprehensive register of risks which have been identified during the project development process. Table 5-8 provides an example of the elements forming part of a good quality risk register.

TABLE 5-8. RISK REGISTER EXAMPLE ENTRY

Criteria	Information
Identification Number	1
Risk	Uncertainty of long term energy prices.
Cause	Factors out of the control of the HSIPR operator mean it is not possible to cost effectively fix the cost of traction electricity for more than 3 years.
Effect	An increase in traction energy purchase cost of 10% causes the total operating cost to increase by 2%.
Probability	Usually a scale of 1 to 3 (Low, Medium, High) or 1 to 5. 80% that energy costs will increase at a higher rate than general inflation.
Impact	Usually a cost scale of 1 to 5. 20% increase in energy costs on the forecast consumption rate will increase annual operating cost by \$20m.
Severity	The score of probability x impact, allowing risks to be ranked.
Treatment	Avoid/mitigate/transfer/accept Transfer - estimate based on inflation +2% year on year increase. Funder will be requested to permit increases above this rate to be subject to a contract variation.
Owner	HSIPR commercial manager.

A quantified risk analysis (QRA) applies probability (or Monte Carlo) modeling to the risk register and outputs a contingency value. Standard project management software packages are available to undertake this analysis and this is recognized and good project management practice. However, at the intermediate stage of project development, the risk register will contain more generic rather than project specific risks and if modeled, the QRA outputs could give the appearance of more robust project control than is actually being applied. At this stage, it would be preferable to have a well populated register of identified risks and proposals as to how they will be avoided or their impact mitigated in later stages of project development.

Where HSIPR proposals at this early stage of project development are accompanied by a long list of elements which are not covered by the base cost estimate and are therefore assumed to be covered by contingency, it indicates that effort is being made to present costs less expensively than they will be in reality; or that the HSIPR operator has not developed all areas of cost to the same level of detail and is therefore unaware of which have the largest impact on the service. Prudent project management would suggest that if a cost area has been identified, an estimate can be placed against it. The risk then becomes that the estimate is incorrect. This would be a reasonable use of contingency, i.e. provision to cover the unknowns.

At intermediate stage, the HSIPR operator should have updated and expanded their “assumptions register” from the preliminary stage, with this document now becoming a critical component of the HSIPR proposal, both from the perspective of the HSIPR operator and the reviewer. The assumptions register should be presented in a form consistent with the “good practice” example presented in Table 5-8.

Where risk and assumptions registers are not provided in an intermediate stage proposal then concerns should be raised as to how the HSIPR operator has ensured discrete assumptions are consistently used throughout all aspects of the project and plans to prevent risks affecting the integrity of the outputs.

Common shortcuts leading to poor quality estimates

At intermediate stage, it is common for HSIPR proposals to fail to identify and allocate a reasonable estimate against all sources of operating cost which are likely to be incurred for the presented train service specification.

Staff

At this level, the HSIPR operator may roll up a variety of staff roles into single headings such as traincrew (driver, conductors, revenue protection and customer service staff), station (ticket sales, train dispatch, customer information, revenue protection and maintenance staff) and maintenance (skilled and unskilled technicians, engineers, train cleaning, depot drivers and administration). However, in presenting the estimate of total staff numbers, some duties are often omitted in their entirety. This means that not only is the total quantity of staff low but often the average salary used in the calculation is incorrect.

This underestimate can be compounded by failing to annualize staff numbers properly, in particular taking account of the hours of operation each day and the need for cover for staff sickness, training and holidays.

Rolling stock

The low level of timetable development work and the lack of a detailed specification for rolling stock at this stage in the project lifecycle can mean that the numbers of trains required to provide the specified service is underestimated.

The base number of trains is driven by the service frequency, turnaround times and trip times all of which assumptions can be made with reasonable accuracy. However, a standard all day timetable is often used and costs associated with providing strengthening or additional services in the peak are omitted.

The number of spare trains to allow maintenance to be undertaken as well as the number and type of facilities required to do this work are often underestimated. Often the cost of driving trains from the termini stations at the end of a working day to the maintenance facility is omitted from forecasts, or the need and time taken to undertake regular inspections (roughly every 2 days) of trains at maintenance depots is ignored. The rule of thumb is to have between 5% and 10% of a rolling stock fleet as “spare” in order to operate a reliable service.

General and administrative

Stations, depots and offices have costs associated with utilities, maintenance and property taxes. On large systems, this can be a significant sum and is often omitted or underestimated. The proposal may imply

management and operating costs for all buildings are included in the general and administrative category but the reality is that the provision is only for offices for management and support staff.

The headquarters resource effort to manage a large HSIPR operation will be significant - as well as the management of large numbers of staff. Significant effort is required to monitor competency and deliver refresher training due to the safety critical nature of many posts.

Sales and marketing, insurance, supply chain management all incur cost as does ensuring technical and regulatory compliance with standards. High-level estimates of all costs which comprise general and administrative costs should be presented and will show that the individual components of this element can add up to be a notable proportion of the overall HSIPR operating cost.

Benchmarking

International benchmarks are often used to estimate the cost of railroad operations and maintenance by applying an average \$ per route mile to the physical size of the HSIPR operation. At intermediate stage, this is reasonable but extreme care must be taken with the benchmarks used. National safety and regulatory standards will influence how and HSIPR operator determines their maintenance strategy. In Europe, all train operators are bound by the same standards. However, differing national interpretations of these standards combined with specific requirements of some authorities means there is 50% difference between the least and most expensive authorities on a per route mile basis. It has to be determined upfront whether it is appropriate to apply the average of this wide range to a new railroad in the USA.

Benchmarks are useful for sense checking the validity of estimates but caution must be deployed before using them as the basis of providing the estimate in the first place.

6 Best practice: final stage proposals

Introduction

A single train service specification should only be presented at the final stage, and the rationale for the selection of this along with differences from the specification(s) presented in the intermediate stage, explained. It is likely that the train service specification will have changed as a result of further work undertaken since the intermediate stage, with the usual causes being a better understanding of potential ridership (and refining the supply side to match this) and the need to reduce costs. Changes to the train service specification should not be viewed as a weakness.

A final stage proposal will be supported by design and modeling or simulation work. The HSIPR operator's focus should be to convince reviewers that their project is deliverable, provides the required benefits and is affordable. This analysis can be effectively presented in the form of a set of inter-linked "delivery plans" which will specify how the different elements of the HSIPR operation will be managed in order to provide a coherent service which is attractive to passengers. The plans will cover every aspect of the train service and define the activities and resources required to deliver it.

The next stage of project development (commercial closeout) will involve obtaining firm prices from the market place prior to awarding any concession. Therefore the final stage represents the last point to challenge and refine the proposed HSIPR solution, without incurring significant cost.

There will be iteration both between the plans and the cost forecasts, and between the plans themselves. For example, if the traincrew costs arising from the proposed timetable are too high, this may require the timetable to be revised. Similarly, the timings of the timetable will affect the rolling stock required. The iteration will be driven by the relationships previously explained in Figure 2-1.

Preparing the delivery plans will require the HSIPR operator to consider every aspect of providing the service. If a poor quality estimate was provided at intermediate stage, this process can result in the estimate increasing as additional cost items are identified and previously identified costs are more tightly defined.

Preparing the plans will force the HSIPR operator to have a greater understanding of the drivers and components of costs, addressing and deriving answers to issues that were unresolved at the intermediate stage. This will reduce the level of uncertainty associated with costs. Overlays to reflect risk and uncertainty usually reduce in size at the intermediate stage. The indication of a good quality estimate provided at intermediate stage involves the total cost remaining generally constant - the sum of the defined cost elements may increase but contingency reduces by at least a comparable amount. New cost issues will almost certainly arise in the final stage.

An assessment of a final stage proposal must provide assurance that the proposed service is deliverable: without this assurance there is little point taking the proposal through to the commercial closeout stage where contractual negotiations are usually the focus.

Train service offer

The fundamental deliverable from the HSIPR operator is the provision of train services in accordance with a defined timetable. Three key inter-linked delivery plans are central to defining the final stage proposal:

- Railroad operations plan;
- Rolling stock plan; and
- Timetable plan.

At the final stage, an outline engineering design for the railroad (where new or enhanced railroad is required) will be prepared. This together with an evolved train service specification and offer from the intermediate stage will form the critical inputs to the development of these three key plans.

The three key plans provide the guiding principles and specifications against which the HSIPR operator will manage the train service. A lower tier of management plans will detail how the service will be delivered. The development of the suite of plans is an iterative process, and although these three key plans must be prepared first, one would expect them to change as issues related to other plans are understood and modifications made. For example, the decisions which will need to be made to define the train stabling and maintenance plan are likely to require some changes to the timetable and thus the timetable plan.

Table 6-1 provides a summary checklist for elements which a good final stage proposal will contain over and above an intermediate stage proposal for the route alignment and train service offer. The description of the delivery plans provides details on how the information will be sourced and estimated.

TABLE 6-1. ROUTE ALIGNMENT & TRAIN SERVICE OFFER FOR FINAL STAGE

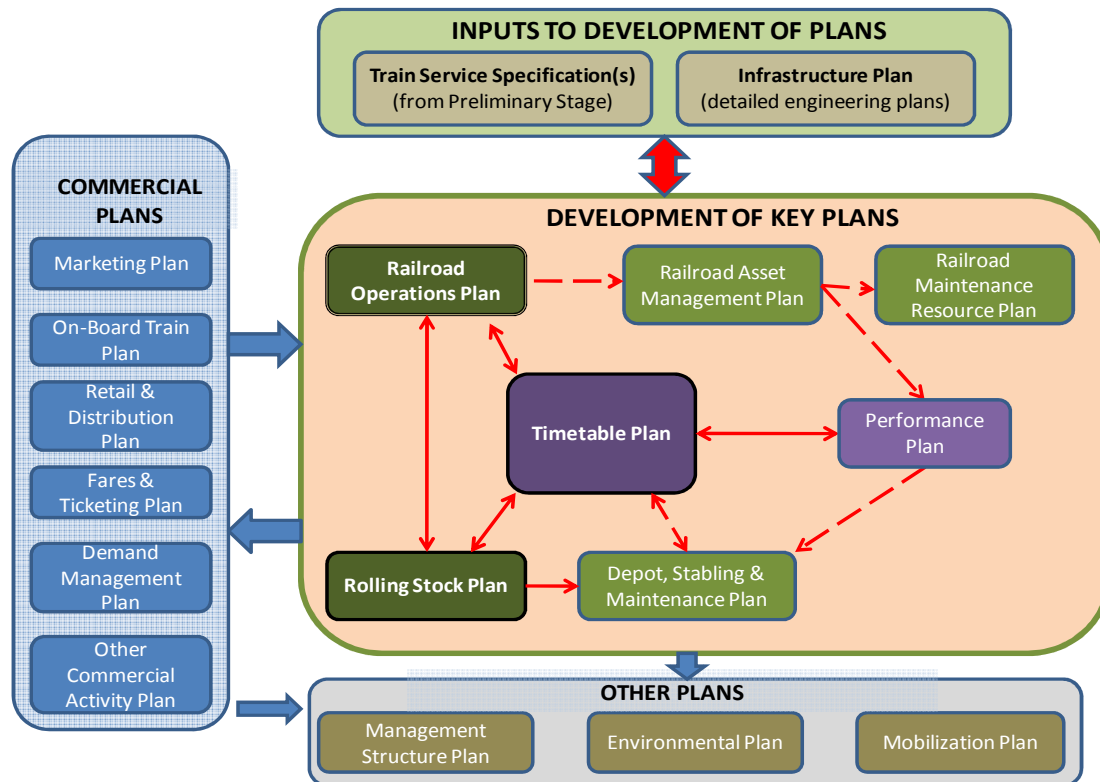
Driver of cost	Description
Route alignment	
Route alignment and distances	<p>The main differences between intermediate and final stage proposals is that the HSIPR route (assuming it is new or an enhancement of an existing railroad) will have been designed to outline level of detail - this would be sufficient to be used for “design and build” procurement.</p> <p>Route distances (which underpin many operating costs) will be accurate to within 100m or so.</p> <p>The characteristics of the railroad will now be prescriptively specified, with signaling and control systems, traction power systems and curves and gradients fully defined. All of these directly impact the train timetable.</p>
Terminating & intermediate stations	<p>The proposal must confirm the stations which will be served and the layout of these stations including customer facilities (such as elevators, escalators, ticket sales points, customer lounges and information points) and platforms (including platform length, customer information points and lighting/passenger security).</p> <p>Additional station facilities such as car parking lot sizes and facilities, whether the station has been designed for automatic ticket gates and the level of retail opportunities/floor space at the station, must be identified for each station.</p>
Shared routes and stations	<p>The train service simulation modeling must include all train services on the railroad, to confirm that there is sufficient capacity on the railroad for all operators.</p>
Railroad capacity	<p>Simulation modeling will have been undertaken to demonstrate the new railroad has sufficient capacity to allow the specified timetable to operate reliably.</p>
Risks to the HSIPR alignment	<p>The proposal must describe key issues which have arisen during the development of the proposal. For example, these may be presented in the form of a risk register with a description of the risk, the potential outcome, the probability and impact of the risk materializing and how the risk has been closed out or whether it remains live.</p> <p>The proposal must refer to the risk register, identify the key risks and how these will be addressed.</p>
Timetable	
Train frequency and trip times and variations in train service	<p>The train service must now be presented in terms of a validated working timetable, underpinned by modeling using a recognized train service simulation package. This modeling must be based upon the detailed engineering specification of the railroad, the rolling stock characteristics, the proposed train service and the railroad operations plan. The working timetable will specify train passing times at regular measuring locations to the nearest 30 seconds as a minimum.</p> <p>The timetable will confirm the details of the train service from start up to close of service each day (including weekends). This will include the arrival and departure times at each station and at critical points on the railroad (e.g., junctions). The train formation for each service will be defined.</p> <p>The timetable must include all train workings including empty stock workings (for example, to and from depots and stabling sites).</p> <p>The final stage proposal must be accompanied by outputs from the train service simulation modeling, including confirmation of the input assumptions.</p>
Annual train miles & train hours	<p>The total annual train miles and train hours must be stated and the calculation presented to prove these have been outputs from the train timetable (and train service simulation).</p> <p>Empty stock workings must now be modeled to the same level of detail as the passenger timetable and an allowance must be made for unplanned empty workings.</p> <p>Where the HSIPR service will operate on a combination of new railroad and existing routes, train miles and train hours should be estimated separately for the two railroads. Similarly, where the train service is operated by more than one train formation or train type, train miles and hours must be specified for each.</p>
Proposed rolling stock	<p>The proposal must confirm the full technical specification of the rolling stock which will be operated and must provide evidence that rolling stock manufacturers are able to deliver trains to this specification and to the technical, safety and other standards set by US authorities.</p> <p>The technical specification must include the following items:</p> <ul style="list-style-type: none"> • Train and vehicle length, train weight, maximum speed, maximum power, traction type, regenerative braking ability, performance monitoring equipment (to identify potential systems failures) etc.; • Internal layout diagrams of the rolling stock, including seating plans in all classes of accommodation and passenger facilities (such as toilets, luggage areas and restaurant cars). The layouts should also identify traincrew accommodation and facilities including guards compartments, kitchens and refreshment storage points; and • Other factors which affect the passenger environment including seat width and pitch, air conditioning, power points and wi-fi points and the noise and

Driver of cost	Description
	ride quality indicators. The number of seats in each class of accommodation must be consistent with the ridership and revenue forecasting.
Risks to the HSIPR timetable	The proposal must describe issues which have arisen during the transition from intermediate to final stage. For example, these may be presented in the form of a risk register with a description of the risk, the potential outcome, the probability and impact of the risk materializing and how the risk has been closed out or whether it remains live. The final stage proposal must refer to the risk register and identify the risks and how these will be addressed.
Train service delivery and customer service offer	
Key statutory requirements	The final stage proposal will address all the known statutory requirements to which it must adhere. It must be evident from the proposal that the statutory requirements and their implications are understood, and that the proposed approach to meeting them is deliverable and will meet the requirements.
Train service delivery	The proposal must state how trains will be regulated on the railroad to provide safe operation of services. The proposal must also explain the operation of trains at stations, including how trains will be dispatched (and by whom).
Customer service offer	The final stage proposal must specify passenger offer that the HSIPR proposal will provide. This must include, but not be limited to a description of: <ul style="list-style-type: none"> • Classes of travel available and the differentiating factors between them; • The fares and tickets that will be offered, and how the tickets will be purchased; • The customer assistance that will be provided, both on-train and at stations, including for the disabled; • How service information will be provided, including when train services are disrupted; and • Whether passengers will be compensated for delayed trains.

Delivery plans

The plans and the key linkages between them, which underpin a good HSIPR proposal at final stage are presented in Figure 6-1.

FIGURE 6-1. TRAIN SERVICE DELIVERY PLANS



The elements covered by each plan are described in the following paragraphs. The set of plans should be balanced in terms of the level of detail to which each is prepared (specifically one plan should not be in minute detail while others are discussing trains at a generic level). Plans must be consistent and inter-dependencies between plans must be evident.

At the final stage, the plans will form a significant document in themselves. Some plans, such as the timetable plan, rolling stock plan and depot, stabling and maintenance plan will comprise 10 - 20 pages each (further supported by analysis and evidence in an appendix). While other plans may be more brief (2-3 pages in length), their content should still be sufficient to assure the assessing authority that the plan is specific, credible and deliverable.

Railroad operations plan. Where the HSIPR service operator is also the railroad manager (or landlord), it will produce a railroad operations plan to define how the railroad must be accessed and services are safely regulated and controlled. This document will define the rules to which signalers and control room staff must adhere as well as the responsibilities of those operating train services. It will define the periods when the railroad should be closed to permit maintenance and the constraints when undertaking maintenance at the same time trains are operational; for example, staff may not be permitted close to the running lines or to physically touch operational signaling equipment.

The number of signaling and control center staff will be determined by the size of the rail network being managed from each discrete location, the number of trains operating at any one time and even perhaps the number of different train service providers who are operating on the network. The railroad operations plan will also define requirements for staff out based from control rooms who will be required to assist in the safe regulation of trains in the event of signaling and telecommunications failures. The signaling and control center is almost always a 24/7 operation and needs to be staffed on this basis.

Where the railroad is electrified, control of the power distribution system is usually undertaken by separate staff to those managing the signaling system and this requirement should be identified in the estimates of staff numbers.

Where the HSIPR operator is a tenant to a separate railroad manager, there will usually be a requirement to log and manage delay and performance data to monitor contractual compliance.

For new railroad, it would be expected that preliminary/outline design will have been completed by this final stage. This will be of sufficient detail to quantify all key assets which will require maintenance. The locations and quantities of these should be detailed in some form of asset management plan.

Rolling stock plan. The type of trains which will be used to operate the proposed service will be described in this plan, together with the rationale for the choice. The technical specification of the chosen rolling stock should be described, with reference to how this meets the requirements that are implicit in the timetable plan. The interior specification, for example, business and standard class seating capacity, seat formation, seat type, provision of tables, power points and Wi-Fi, provision of washrooms, and catering facilities, of the train must be specified.

The HSIPR operator must identify the likely sources of the rolling stock - and the timeframe to which it will be available. Estimates of the costs of securing the required volume of stock should also be provided, with supporting evidence from the potential providers. If the trains are to be leased or financed, the plan should confirm how long the stock is available for, whether there are any “break points” in the contract and the potential and terms for further orders of the stock. If the HSIPR operation is to be let as a fixed term concession then the rolling stock plan should explain how this will be dealt with in the rolling stock contracts (since the “train life” may exceed that of the operating concession).

An outline purchase or leasing contract should also be provided, with the terms of the contract clear and some mention of who will be responsible for train maintenance and mid-life refurbishments. Of particular importance is also where the roles and responsibilities lie in terms of ensuring sufficient rolling stock is available to operate the passenger service consistently and to the level of performance required by the FRA. For example, the HSIPR operator may bear this risk - securing a given number of units to provide sufficient resources for planned and unplanned maintenance. Alternatively, the HSIPR operator may transfer the risk to the rolling stock provider by specifying the number of diagrams that must be covered, and allowing the provider to quote for this (implicitly taking a view on the number of units they should provide for maintenance cover).

The outline contract should also outline the incentive regime which is to be implemented to ensure that the rolling stock is delivered according to plan.

A firm price for the provision of the rolling stock is not expected at this point; however, factors which would affect the price should be specified and areas in which the negotiations will focus during commercial closeout will also be outlined. These may include numbers of trains ordered, whether a mixed fleet is required, exchange rates (if trains are to be built abroad), the availability of finance and the level of competition between manufacturers for the provision of the rolling stock.

Timetable plan. This plan will include evidence to confirm that the service is operable given the timetable of other operators (passenger and freight) and the railroad available.

The train service specification provided at the intermediate stage will be replaced by a “working timetable” for the proposed service and other services on the affected network. Timings at each station, junction and critical point on the network will be specified for all trains. Therefore, implicitly there will need to be an understanding of the physical characteristics of the line: a set of (near finalized) detailed engineering plans of the HSIPR route is a critical input to the development of the timetable plan.

The timetable plan is also dependent on the operational plans for the railroad (how the operation of trains will be regulated by signalers and control centers and when the network will be closed for maintenance) and the rolling stock plan.

The working timetable will be that developed from the train service simulation exercise which will use the railroad, proposed rolling stock, calling points and frequency of the proposed HSIPR service and any other train services on the route. The train service simulation package will confirm whether point-to-point times are achievable (given the proposed infrastructure and rolling stock) and the train service deliverable (it will quantify any performance impact on other train services).

Train diagrams will have been prepared using the working timetable and the train which forms each service will be specified in the timetable. The rostering exercise used to forecast traincrew will also have been forecast using the working timetable.

Supporting detailed plans

Performance plan. The performance plan considers the day-to-day running of the railway in real time, including train control and supervision. The plan will specify how the delivery of the train service is monitored, including the response to train service delays (both to minimize the impact on passengers but also to facilitate the return to normal working of the timetable) and the identification of the causes of delays (“delay attribution”). Understanding the cause of delay is an important part of the feedback loop to continually improve performance.

The plan should specify what process will be followed by train control when a train is delayed or when an incident occurs on the railway. This includes the onward carriage of passengers, which may be by alternative modes or (where it is an option) by trains operated by other operators.

The performance plan should outline the plans for emergency train maintenance while in service and plans to mitigate the impact of failed trains. The monitoring rail authority or funding body may require the HSIPR operator to deliver specific performance targets. These could be defined around the percentage of actual trains out of those planned which must run every day and which must arrive at their destination station within “x minutes” of their timetabled time. Financial incentives can be linked to these targets.

Similarly, where the HSIPR services share the rail network with other operators, they may be required to financially compensate other operators for delays caused by the HSIPR operations.

Implicitly, the performance of the train service will be dependent on the performance of the railroad and the rolling stock. It would be expected that at the final stage the HSIPR operator will have considered these interactions and identified the level of performance required from these “inputs”. For example, the performance plan should propose the key areas where targets will be put in place in the concession contract; these will include:

- Availability of the network (associated with weekend or overnight engineering work and the over-running thereof);
- Number of signal failures, number of broken rails etc. each year; and
- Average number of train miles expected without train failure.

Delivery of a reliable train service is fundamental to meeting passenger revenue forecasts and will drive a significant proportion of costs. It is critical that the performance plan is detailed and clear links are evident with the operating costs. Where a performance plan is inadequate or missing, one would expect operating costs to be significantly under-estimated.

The performance plan must include a description of how the HSIPR operator will convey information to passengers in the event of part of the rail network being closed (both due to planned or unplanned events) or in other exceptional circumstances such as staffing disruption or significant train failures (for example, due to weather).

Railroad asset management plan. This plan is prepared by the railroad manager and will not be required for projects where the HSIPR operator is a tenant on a railroad owned by another organization. The HSIPR operator will prepare this plan where a new railroad is being constructed to support the HSIPR train services. The plan will clarify locations of each type of equipment being provided; the schedules of preventative maintenance and servicing inspections; consumable materials such as filters required; and the estimated time required to undertake each type of inspection. From this, a rolled up summary of maintenance effort in terms of time and material required for each asset (or staff skill) area (or staff skill base) can be developed.

The asset management plan is a subordinate document to the railroad operations plan and should therefore reflect its definitions of when maintenance access will take priority over the operation of train services and those maintenance activities which can be undertaken when trains are operational.

The asset management plan should therefore clearly identify constraints around each type of maintenance activity, for example, those which can be only undertaken when no trains are running (i.e., at night); and those which can be undertaken in accordance with developed safety systems - when trains are operational - for example, inspection of equipment rooms or repair of boundary fencing.

Railroad maintenance resource plan. Where a new railroad is being provided as part of the project, the HSIPR operator should provide a developed maintenance resource plan to deliver the maintenance of the railroad which is identified in the asset management plan. This would include works which are generally more efficiently subcontracted than done in house, for example, maintenance of elevators and escalators, high voltage switchgear and some telecommunications equipment. The resource plan must reflect the access constraints defined in the asset management plan. For example, there is generally many more staff on nightshift than dayshift because more activities can be undertaken when trains are not operational.

The plan will also detail those activities which are planned to be mechanized rather than labor intensive, for example, undertaking track safety inspections by a road/rail vehicle or train fitted with cameras and suitable measuring equipment to identify rail defects.

Large items of plant and machinery such as ballast cleaners, rail profile grinders and access platforms for overhead line equipment should be clearly identified along with purchase or lease costs.

At this stage, locations and layout plans for maintenance staff and equipment depots along the line of route would be expected. The proximity of these combined with the quality of road access to the key work locations, such as switches and crossings, will have a significant bearing on the amount of productive hours per staff.

Staff productive hours will be dictated by the shift pattern (predominantly nightshift usually means more rest days), average travel time from the depot to place of work and the more normal allowances for sickness, training and holidays.

The plan should identify staff requirements for reactive maintenance such as “on call” maintenance staff.

Train stabling and maintenance plan. The credibility of this plan is fundamental to the deliverability of the service proposition. There are a large number of approaches to maintaining trains: both in terms of who is

responsible for undertaking different types of maintenance (and bears the associated risks) and what maintenance regime is selected. The plan must state who is responsible for undertaking train maintenance, and confirm that this includes all inspections and maintenance. The plan should also confirm who is responsible for cleaning and servicing trains (both between trips and at the end of the days service).

This plan will confirm the frequency and scope of inspections, planned maintenance, cleaning and servicing inspections. The plan should also describe how trains will be monitored in order to identify any pre-emptive maintenance required. An assessment of the extent of unplanned maintenance (arising from unforeseen events, including those outside the control of the HSIPR operator) should also be presented.

The plan will provide details of the anticipated workload at each maintenance location on a typical night and day shift as well as weekends. This will take into account the arrival time of trains onto the depot and also the departure times to form services the next morning. These details will also identify the “spare” capacity on each shift - both in terms of sidings in the depot equipped to provide underframe and roof access to trains and staff available to undertake any unplanned work.

Where the HSIPR operator is responsible for one or more aspects of maintenance, cleaning or servicing the plan should specify the time taken to undertake each task (including how this was derived), together with the resources required (including staff, materials, plant and depot space). From this, a rolled up summary of maintenance effort in terms of time and material required for each asset (or staff skill) area (or staff skill base) can be developed.

Where maintenance, cleaning and servicing is undertaken (either entirely or partly) by the manufacturer or third party, the plan should fully describe - the activities that will be undertaken and the terms under which it will be contracted; and incentives (both for the operator and the train maintenance entity) and how the estimate of the cost of maintenance was prepared.

On-board train plan. This plan will describe the on-board service which passengers will experience. The HSIPR operator should specify the minimum level of on-board passenger service: including refreshments/catering provided, washroom facilities, staff providing customer information and checking tickets. It should be clear whether customer service staff also have operational responsibilities such as train dispatch. Similarly, if different classes of accommodation are provided on the train (such as first and business class), the HSIPR operator should differentiate between the levels of on-board service provided and the number of traincrew per train and functions of traincrew required to deliver the service.

Fares and ticketing plan. This will describe what fares will be charged on the HSIPR services and how these fares will have been set. These may need to take into account fares setting by other operators (particularly those who offer services to common stations) and how fares are set for passenger trips where the HSIPR service provides only part of the end-to-end trip. Understanding the potential of yield management will be critical to preparing a commercially attractive rail service while providing travel opportunities to all passenger types.

The plan should confirm whether the broad offer of the HSIPR service will be high quality/high price, or whether the approach will be to attract higher volumes of passengers at lower prices (with corresponding quality).

The fares and ticketing plan should be consistent with the ridership forecasts (the HSIPR operator should cross reference the appropriate section of the ridership forecasts), both in terms of the level of demand forecast (which will be dependent on generalized costs) and the yields which are applied to the forecasts.

Retail and distribution plan. The proposed approach to the selling and distribution of tickets is the subject of this plan.

The plan should describe the range of ways in which tickets will be sold, which might include:

- Station ticket offices;
- Self-service ticket machines;
- On-trains;
- Travel agents;
- Telephone sales;
- Internet sales; and
- Other travel operators (including train companies and bus operators).

The HSIPR operator should provide evidence that the advantages and disadvantages of each have been considered, including those issues which specifically relate to the HSIPR service being proposed. The HSIPR operator should confirm which channels they propose to sell tickets and indicate the target proportion of tickets to be sold through each. This, combined with the demand forecasts, will allow the HSIPR operator to forecast the volumes of tickets sold each day through each channel - and the level of resources (people, materials and overheads) required to deliver these forecasts.

There should be consistency between the detail of this plan and the cost forecasts. The plan should be consistent with the operating costs forecasts, for example, with ticket sales staff included in the staff costs and ticket machine leasing evident in the “other costs” category. Commission payable to other operators or third parties for the sale of HSIPR tickets should also be included in the general and administrative costs category.

The plan should also be consistent with any proposals which use pricing for demand management (see the demand management plan).

Demand management plan. Demand for the HSIPR service will vary by time of day, day of week and possibly seasonally. The times of peak demand will depend on the markets being served and the fare structure. The plan should explain when (by time of day, route section and direction) demand will be at its highest. Understanding when high-levels of demand may adversely affect the operation of the HSIPR service or stations is likely to require more detailed analysis of demand than is required for the ridership and revenue forecasts, however, the assumptions underpinning each must be consistent.

The plan should state whether it will be mandatory for all passengers to have seats, and consider (with reference to the ridership forecasts) whether this would present problems during periods of peak demand, particularly where trains are only heavily loaded on certain route sections (and directions). It should outline how high-levels of demand will be managed in order to operate the train service (and stations) safely, consistent with any regulations (for example, if standing passengers are prohibited) and the “level of passenger comfort” which is proposed elsewhere in the HSIPR proposal.

The HSIPR operator should consider a variety of approaches to demand management including pricing and supply responses (for example, lengthening trains or de-classifying business class). The plan should clearly state any restrictions on travel on certain tickets (for example, travel on off-peak tickets in the evening peak), including how these restrictions will be explained to the potential users.

The plan should also consider how demand will be managed when there are disruptions to services, in particular, how large volumes of passengers on station platforms will be managed safely. Where the HSIPR provides access to locations holding “special events” (e.g., sporting events or concerts), special arrangements may need to be put in place to handle the additional demand flows at the station and on the trains.

Marketing plan. This plan will describe how the HSIPR service will be launched to the market place. It should indicate the advertising that is planned, both prior to the start of service and after the service commences. The plan should confirm how information on the train timetable, fares, classes of

accommodation and any travel restrictions (such as the need to book a seat) will be conveyed to both existing rail users and people who currently do not travel by rail. On-going marketing such as seasonal campaigns and special offers (e.g., marketing of discounted rail travel for the elderly) or time-limited campaigns should also be described in the plan.

Targets should be set for the marketing, such as population covered by the campaign and proportion of catchment populations who are aware of the new HSIPR service (including proposed surveys to confirm whether targets have been met).

Other commercial activity plan: This may include car parking, maintaining trains for other operators, property development or provision of property to other operators, sub-leasing staff/rolling stock to other operators, selling tickets for other operators, on-board advertising for third parties etc. The costs and revenue arising from these commercial activities should be clearly identified in the revenue and cost forecasts of the HSIPR proposal.

Management structure plan: An organogram of the HSIPR management structure, together with descriptions of the responsibilities of all staff identified, is a fundamental element of the management plan. It should clearly specify all those in management roles, from train driver managers, station managers, depot managers, operations control center managers, through to those in the HSIPR headquarters. Headquarters staff will include, but are not limited to the following departments: operations, human resources, traction and rolling stock, railroad, business planning, customer service, accounts, finance and marketing.

The HSIPR operator should be clear where roles are performed by individuals employed by a parent company, for example, payroll, customer services and accounts. The number of people in these roles should be identified and costed. They should not be included as an aggregate cost to a supplier.

The management structure plan should explain how on-going training and development will be provided to staff, in particular frontline staff. The costs of training are significant, and must be underpinned by a carefully specified training program which encompasses the skills required and the frequency with which it needs to be undertaken.

Mobilization plan. This will describe how the HSIPR operator will ensure that the service operates as planned on day 1 and (if the full service is not to be provided from the outset) how the train service will build-up and over what time period. The processes that will need to be set in place will be defined and a project delivery timeline will be developed (which will include dates for formal confirmation of access to the network, train availability, drivers trained etc.). Mobilization teams will be required to facilitate all this, and will need to continue to work with the on-going staff teams during the first few weeks of operation. The operating costs should be consistent with the mobilization plan, in terms of the additional and specific resources needed prior to the introduction of service and any savings that can be made if the full train service is not planned to operate from day 1.

The plan should be consistent with the management structure plan, in particular in relation to training and the structure of the organization which will remain in place after the mobilization period.

Environmental plan. This plan will describe how resources will be conserved (e.g., how trains will be driven to use fuel efficiently) and what materials will be recycled and how. The plan should describe what will be monitored and how, and how targets will be set. Where penalties for not meeting regulations are not defined by law, the proposal should specify what potential penalties might there be (even if they are not financial).

Quantification of costs

The delivery plans discussed above will provide the underpinning data for development of the cost estimates. It is essential that there is evidence of consistency between the cost forecasts and the delivery plans and that all elements mentioned in the plans are included in the costs.

Compared with the intermediate stage, the final stage cost estimate will be presented in much more detail (less aggregated) - for example, with approximately 100 cost line items, driven by 50+ volume drivers (many of which will be different grades of staff to fulfill the different roles identified in the plans) and a similar number of unit cost estimates.

While it is not yet appropriate for the HSIPR operator to have contractual commitments with suppliers, they will have undertaken some form of discussion with suppliers of services and equipment to provide a better understanding of availability and cost and to allow informed decisions to be taken on the trade-offs between how the HSIPR is delivered on a day-to-day basis and the associated costs of different approaches. At final stage, the HSIPR operator should be reasonably confident (through market testing) that the proposed means by which the service will be delivered (as described in the plans) is consistent with the implicit pricing of the plans within the operating cost forecasts.

Traincrew

The timetable plan, verified by simulation modeling provides the template against which traincrew must be allocated. The rolling stock and on-board train plans will confirm the staff responsibilities in operating each train and providing the required level of customer service. Actual staff numbers by function (such as driver, guard, ticket inspector and catering/customer service) can be set out for each train service. Once rest periods are overlaid with arrival times at changeover stations and permissible working hours are taken into account, a daily roster for each traincrew function can be developed. At final stage, a roster for each function would be expected as employment terms and conditions are likely to be different for each type of staff.

Resource allocation software packages should then be used to calculate how many full time equivalent staffs are required for each function to deliver the timetable. Given the ready availability of such software and the fact that the timetable has been verified by modeling, it is not acceptable to receive estimates for traincrew based on high-level assumptions.

At final stage, a full “balancing” exercise may not have been finalized - this is where staff end up at a different location to where they started their shift. The rostering exercise can inform where staff depots will be located.

Unit costs would be applied to each grade reflecting their terms and conditions, overheads, and any allowances such as retirement contributions and bonuses. An allowance should be made for expenses covering staffs who require accommodation or transportation where they finish a shift at a different location from their “home” depot.

The ratio of managers and supervisors to staff must be clearly explained - this may be different for each function, and appropriate costs provided.

The final stage checklist for traincrew is presented in Table 6-2.

Energy

Traction energy costs can be estimated to a much more detailed level at final compared with intermediate stage.

Most timetable simulation packages can estimate the energy consumption for defined train performance characteristics and route alignments (curves, gradients and line speeds).

The energy consumption for delivering the timetable will therefore be a specific output from the modeling required to verify the timetable plan.

The key elements to check in the modeled outputs are:

- That the train performance characteristics modeled are consistent with those defined in the rolling stock plan;
- For electric traction power, that an allowance is made for regenerative braking; and
- For electric traction, an allowance is made for electricity losses - energy required to power the train to meet the timetable will be less than the energy input to the system (and therefore paid for) at substations.

The key risk on energy costs is the tariff payable to the energy provider. Energy costs are presently volatile and the HSIPR operator should present the assumptions about what their tariff is based upon. This should include the level of confidence in the rate for the medium and longer terms.

The final stage checklist for energy costs is presented in Table 6-3.

TABLE 6-2. QUANTIFYING TRAINCREW COSTS AT FINAL STAGE

Cost element	Description
Staff roles and responsibilities described	<p>The roles of traincrew (e.g., drivers, conductors, catering staff) and their responsibilities must be stated.</p> <p>It must be clear from the descriptions which roles are critical to operate the train service (e.g., dispatch trains) and to meet statutory requirements.</p> <p>It must be clear from the descriptions whether traincrew are responsible for a) selling tickets b) checking tickets c) providing customer information d) provide refreshments, and which staff categories perform these tasks.</p>
Number of staff on each train	<p>The proposal must specify the number of staff required on each train and the role of each member of staff.</p> <p>Where the number of staff per train varies with train formation or train type (if more than one train formation or type operates) then the number of staff and the number in each role on each train must be specified.</p> <p>The number of staff on each train must take into account the requirement to operate the train service safely, and any other relevant regulatory requirements.</p>
Description of approach used to quantify numbers of traincrew	<p>Numbers of staff for each traincrew staff role must be quantified based on the proposed train timetable and a detailed staff rostering exercise.</p> <p>The rostering exercise must reflect the different responsibilities of each staff role (for example, some train drivers may be required to prepare the train at the start of the day, while some other traincrew roles will be able to join the train at the first passenger station).</p> <p>At final stage, the number of trainee drivers required must be forecast and take into account the expected time to train drivers and the availability of suitably skilled resources. The assumed turnover of trained drivers must be specified.</p> <p>It must be clear that analysis has been undertaken to confirm that the HSIPR service and the customer service offer can be delivered with the quantum of staff forecast (e.g., if the ticketing and distribution plan states that 50% of passengers will buy their ticket on-board, the number of staff on-board responsible for selling tickets must be able to fulfill this obligation at times of peak demand).</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>The proposal must specify the annual salary assumed for each staff role.</p> <p>The source and rationale for the salary assumed is not required: it is assumed that the promoter has undertaken sufficient research to assure themselves that the salaries are appropriate. However, the salary assumptions will be expected to pass the “sense test”.</p> <p>The promoter must confirm the salary of trainee drivers and other trainee operations critical staff.</p> <p>The estimate of employers’ overhead costs must take into account all relevant component costs, and must be presented at the component levels, for each staff function. The source of the assumptions underpinning these estimates (for example, employers’ insurance contributions) must be specified and, where different to “the national norm”, must be explained.</p> <p>The terms and conditions of the main staff roles must be specified.</p> <p>At final stage, the proposal should have considered the availability of labor for each of the roles and the impact this may have on salaries. They should also have considered the potential impact of trade unions on salaries and potential risks to terms and conditions.</p>
Changes in staff costs over time	<p>The promoter must forecast, in detail, changes in staff costs as a result of changes in the train service/train formation/passenger volumes.</p> <p>Assumptions regarding changes over time in salaries and employers overheads must be refined and their rationale explained.</p>
Presentation of traincrew costs	<p>Final stage proposals must present the total number of staff employed in each role as a separate line item.</p> <p>Staff costs must also be presented as multiple line items, one for each staff role.</p> <p>Employers overhead costs must be included as separate line items for each component cost and for each role.</p>

TABLE 6-3. QUANTIFYING ENERGY COSTS AT FINAL STAGE

Cost element	Description
Method of calculation	The proposal must state how the costs of traction power have been forecast, including the consumption rates and the cost per unit (e.g., kwh or US gallon) of energy. This calculation should refer to the drivers of power consumption e.g., train hours or miles, stopping pattern, route and train characteristics.
Unit cost of energy	The proposal must specify the assumed cost of energy per unit (for example, the cost per US gallon of diesel or cost per kwh of electricity). These unit costs must be based on initial negotiations with suppliers of energy, and should vary by region and time of day. The proposal should explain how energy will be bought, in particular, to mitigate energy price fluctuations and to exploit discounts in energy prices for bulk buyers.
Energy consumption of rolling stock	The quantity of energy consumed by the HSIPR operation must be based on the train service simulation (which itself is defined by the detailed specification of the railroad and the rolling stock technical specification). The proposal must state the quantity (kwh or US gallons) of energy consumed by the HSR service per year, both in total and split by service type (where not all trains operate between the same origin and destination station or have the same stopping pattern) and by train formation and type (if more than one is operated). The proposal should present the quantity of energy consumed on each route section, with reference to the gradients trains speed profile on that route section and the train stopping pattern. For electric HSIPR operation, the proposal must consider whether regenerative braking is feasible and delivers realizable benefits given the proposed railroad and the services operating it. If the proposal claims that regenerative braking can be implemented, it must explain how the calculation of energy cost savings was estimated. If the cost benefits of regenerative braking are claimed in the cost forecasts, the proposal must give a clear technical explanation of how the energy returned to the system will be used, with reference to the trains operating on the route and whether they will be able to use the energy.
Changes over time	The proposal must consider the risk of energy price variations and state the assumptions as to how they will change over time.
Risks to energy costs	The proposal must acknowledge the uncertainties regarding the energy consumption of new trains on a new railroad. Given the significant proportion of HSIPR operating costs accounted for by energy costs, the proposal should propose how these risks, and their impact on operating costs will be addressed.

Stations

The fares and ticketing, retail distribution and timetable plans will determine the level of staffing required at stations by establishing with some certainty the times of the first and last trains, the headway between trains and the roles station staff will have in selling tickets to HSIPR passengers. The demand management plan will identify whether station staff are required to manage demand during period of peak demand.

As with traincrew, a detailed daily plan can now be drawn up showing how many staff are required throughout the day to deliver the required service. The information exists from the plans to develop this for each function or grade rather than aggregated for station staff as a whole.

Resource allocation software can then be used to estimate the number of full time equivalent staff taking into account their terms and conditions and maximum hours of duty.

Unit costs reflecting salaries, overheads and allowances will be different for each grade or function. Management and supervisory costs must also be discretely identified and underpinning assumptions stated.

The railroad design work undertaken at final stage will provide the evidence base against which maintenance and utility costs can be estimated. The asset management plan and maintenance resource plan will list the items that require to be maintained, their frequency of inspection and how unplanned works will be resourced.

Specialist maintenance to telecommunication and customer information equipment, ticket vending machines and elevators and escalators may be subcontracted. In this case, discussions with suppliers should have been undertaken and the estimate underpinned by some evidence.

Cleaning and security are also activities which are often subcontracted and again rates which have been tested against the market should be presented.

Station staffing and maintenance is an area which is often underestimated and if the HSIPR operator presents aggregated staff estimates with costs per sq. ft. for cleaning and maintenance then it is a good indicator that the estimate is of poor quality.

Modern standards generally require estimates of energy consumption and efficiency to be prepared in conjunction with building design. This information should be used by the HSIPR operator in conjunction with tariffs which have been sense checked against similar facilities in the same neighborhood.

The last element of station costs are those payable to 3rd parties. These may include property taxes but also fees to bus operators to provide connecting services to other locations, car parking management services or maintenance of specialist customer information equipment. These costs may instead be included in general and administrative costs category.

The final stage checklist for station costs is presented in Table 6-4.

TABLE 6-4. QUANTIFYING STATION COSTS AT FINAL STAGE

Cost element	Description
Station specification	<p>The final stage proposal must describe the location, size and facilities of each station, consistent with the detailed engineering plans for the HSIPR, the forecast footfall and the type of passengers who are forecast to use the station.</p> <p>The proposal must describe key operational activities of the station and the how the station will operate day-to-day and when there are delays to train services.</p> <p>The proposal must state the opening hours of each station and the number of trains stopping at each station in the peak hours and during a “standard hour” and the number of passengers boarding and alighting trains in the peak hour and the standard hour (as these will determine the “capacity” of the customer facilities that will need to be provided).</p> <p>The proposal should outline the retail facilities that will be provided at the station, including their business (e.g., food and beverages, newspapers/magazines, clothing), their size, expected customer footfall and annual turnover. Potential retailers, who it is hoped will occupy the sites, may be listed.</p>
Staff roles and responsibilities	<p>The proposal must state roles of each member of station staff and, where applicable, the relative grades of these staff.</p> <p>The station staff roles that must be described in this way must include (but not be limited to): ticket sales staff, ticket checking staff, train dispatch staff, other operational critical staff, cleaning staff and CCTV monitoring and general customer assistance staff.</p> <p>The descriptions must include identification of management and supervisory staff including those with ultimate responsibility for key functions (e.g., train service, ticket sales, customer information and customer safety).</p>
Total staff numbers specified by role	<p>The proposal must estimate the total number of station staff to cover the specified roles.</p> <p>The forecast number of staff at each station must take into account:</p> <ul style="list-style-type: none"> • The number and size (in terms of platforms, layout and number of passengers) of the station; • The hours of operation of the train service; • The proposed customer offer at the station (for example, the proposed opening hours of ticket offices or the need to provide a greater level of customer support/information at some stations); and • The responsibilities of each role. <p>The number of station staff required at each station must also be underpinned by a detailed rostering exercise which will allow an efficient staffing roster to be prepared, and to ensure that safety and employment regulations are reflected and that there is sufficient cover for holidays, training and sickness. Assumptions made in the rostering exercise must be clearly stated.</p> <p>The proposal must include the outputs from the rostering exercise and these must be referred to in the quantification of staff numbers and costs.</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>The proposal must specify the annual salary assumed for each staff role.</p> <p>The source and rationale for the salary assumed is not required: it is assumed that the promoter has undertaken sufficient research to assure themselves that the salaries are appropriate. However, the salary assumptions will be expected to pass the “sense test” and the promoter must explain reasons for any significantly high or low salaries.</p> <p>The estimate of employers’ overhead costs must take into account all relevant component costs, and must be presented at the component levels, for each staff function. The source of the assumptions underpinning these estimates (for example, employers’ insurance contributions) must be specified and, where different to “the national norm”, must be explained.</p> <p>The proposal must specify the terms and conditions of the main staff roles.</p> <p>The proposal should have considered the availability of labor for each of the roles and the impact this may have on salaries. They should also have considered the potential impact of trade unions on salaries and potential risks to terms and conditions.</p>
Changes in staff costs over time	<p>At final stage, the promoter must forecast, in detail, changes in staff costs as a result of changes in the train service/train formation/passenger volumes/station footfall.</p> <p>Assumptions regarding changes over time in salaries and employers overheads must be refined and their rationale explained.</p>
Fixed costs	<p>The cost forecasts must be evident that the costs have been forecast on a bottom-up basis. Therefore the costs of utilities, building maintenance, equipment maintenance (display screens, public address, and ticket machines) and possibly property tax must be forecast for each station, given the differing physical characteristics and customer requirements of that station. For example, the number of display screen at each station will need to be quantified.</p>

Cost element	Description
	<p>At final stage, the cost “per unit” of utilities, maintenance and property tax must be based on initial negotiations with potential suppliers of utilities or maintenance (it is unlikely that specialist station equipment could be maintained by the HSIPR operators own staff). Original documented evidence of the proposed prices of potential suppliers must be provided in the proposal.</p> <p>The proposal must also forecast changes in fixed costs over time, explaining how these have been derived and the assumptions made.</p> <p>It must be clear that there is no double counting or omissions between cost items (e.g., railroad maintenance costs).</p>
Presentation of station costs	<p>The final stage proposal must state the number of station staff employed at each station, split by role. The total number of staff for all stations must also be presented, split by role.</p> <p>The proposal must state the total annual station staff costs per station, split by role. The total annual staff cost for each role, across all stations, must also be specified.</p> <p>Employers overhead costs must be included as separate line items for each component cost and for each role.</p> <p>Fixed costs of stations must be included as multiple line items, one for each component cost. As a general rule, one would expect there to be at least 10 line items for fixed station costs.</p>

Trains (rolling stock)

The rolling stock plan will specify the performance and capability of the trains required to meet the timetable plan. The simulation modeling undertaken to verify the timetable plan will also verify that if trains of the specified performance are procured, the timetable will be deliverable in a reliable manner.

A diagramming exercise will be undertaken on the working timetable to allocate specific trains to each service. Resource allocation software should be used to ensure this is undertaken in the most efficient manner. This will identify the optimum number of trains required to deliver the daily service.

The train stabling and maintenance plan will identify how many trains are required for maintenance purposes each day and are therefore not available for service. The performance plan will state the required level of reliability of service that may result in the need for additional trains on standby to quickly replace any “in-service” failures.

If trains are not being purchased as a capital item then the lease or financing costs should form part of the operating cost estimate.

Train maintenance

In the final stage submission, there will be considerably more clarity regarding the maintenance of rolling stock, both in terms of whose responsibility it is and how often it is required. Issues such as preventive maintenance will also have been considered. It would be expected that maintenance costs will now be forecast based on discussions with potential maintenance providers (e.g., train manufacturers) - in which case they would be costs on a per train per year, within certain mileage bands, or based on the depot, staffing and materials costs for the HSIPR operator.

The train stabling and maintenance plan will define the daily workload for each depot. The type of train specified in the rolling stock plan will determine the mix of staff skills required to maintain the trains. Sufficient information exists at final stage to plan staff requirements on a shift by shift basis for each depot location. Resource allocation software should be used to determine the number of full time equivalent staff required.

Out-of-station staff that undertake routine repairs must be included in these calculations, along with cleaning staff based at depots, stabling yards and terminus stations.

Numbers of shunting and switching staff based in the yards and depots must be proportional to the numbers of trains arriving and departing at peak periods.

As with station and traincrew, rosters must be defined for each grade of staff and costs applied reflecting different terms and conditions, overheads and allowances. Maintenance depots require a reasonably large support function to provide technical, warranty, purchasing and administration support.

As with stations, the outline design work will be used to identify building maintenance requirements for the depots and stabling yards. A key point to check in the asset management and maintenance resource plans is the regular maintenance of plant and equipment - lifting equipment such as cranes and bogie drops requires regular inspection; and the train wash plant and toilet discharge plants are essential to the delivery of the correct quality product to the customer. The checklist is presented in Table 6-5.

TABLE 6-5. QUANTIFYING ROLLING STOCK COSTS (INCLUDING MAINTENANCE) AT FINAL STAGE

Cost element	Description
Method of procuring rolling stock	<p>The proposal must state whether HSIPR trains will be purchased through capital funding or financed by a third party and leased. Trains purchased through capital funding may be depreciated as an operating “cost”. Lease costs must be clearly identified on a per train or vehicle per year basis.</p> <p>Whether the trains will be leased or purchased, at final stage, the promoter must provide evidence that expressions of interest to supply the rolling stock have been sought, and evidence of how a small number of potential suppliers has been shortlisted.</p> <p>While it is acknowledged that there are issues of commercial confidentiality for bidders to supply rolling stock (given the “competition” for the rolling stock order), the promoter must provide evidence that the rolling stock is deliverable in line with the HSIPR proposal. This may require the reviewer to sign a confidentiality agreement in advance of reviewing the proposal.</p> <p>The proposal must provide evidence of the current state of play of negotiations with the shortlisted providers of rolling stock, including the type of contract (whether it includes any element of train maintenance), timescales for delivery (design, build, test and entrance in to passenger service of the full fleet of rolling stock) and cost per train or vehicle. Information must also be provided that confirms whether options for additional orders of rolling stock (compatible with the initial fleet, both as trains and as individual cars to lengthen trains) have been addressed (for example, to operate increases in train service or passenger ridership in the medium and long term).</p>
Rolling stock fleet required	<p>The proposal must state the number of trains of each formation and type required to operate the HSR service. This must be based upon a detailed diagramming exercise underpinned by the timetable prepared from the train service simulation modeling.</p> <p>The proposal must describe, in detail, how the technical specification of the train has been defined, including the decisions made regarding trade-offs between costs, speed, track damage and customer experience.</p> <p>Where a single train type and formation is selected for all HSR services, the promoter must explain the rationale for this, and the advantages and disadvantages thereof (e.g., operating cost benefits of operating shorter trains in services with lower demand). Where a mixed fleet is selected, the promoter must also explain the rationale and advantages/disadvantages of this (for example, the impact on the price per train compared to a single fleet and the additional costs of maintaining a differentiated fleet).</p> <p>The number of spare trains required must be estimated based on whether a mixed fleet is operated, a detailed assessment of the rolling stock maintenance plan and consideration of the performance plan.</p> <p>Where a “power by the hour” rolling stock contract is being proposed, the total number of trains must be specified and the promoter must describe the basis on which they have been assured that the train service is deliverable with the total fleet size.</p>
Rolling stock ownership or leasing costs	<p>The proposal must state the cost per train if they are to be procured. This price should be based upon initial negotiations with potential suppliers. Where possible, the price must be compared with the price of other, existing rolling stock, with the differences explained.</p> <p>It is expected that the price per train quoted at final stage should be within 20% of that at commercial closeout.</p> <p>The proposal must provide evidence that risks associated with the provisions of rolling stock have been identified, their impacts assessed and ways to address these risks must be stated and in progress.</p> <p>Where the rolling stock will be leased the proposal must state the length of the proposed lease, whether the trains will be leased directly from the manufacturer or through a third party. The expected terms of the lease must be described. The lease cost per train or vehicle per year must be stated.</p>
Inclusion of rolling stock maintenance costs	<p>Rolling stock maintenance costs must be included as one or more line items in the operating cost forecasts.</p> <p>The proposal must describe the components of maintenance costs, with reference to different levels of maintenance (servicing, light and heavy) and comprising of the labor, materials and fixed cost elements.</p>
Maintenance plan described	<p>At final stage, the proposal must describe the specific maintenance plan that is proposed for the HSIPR rolling stock. This is irrespective of who will undertake the maintenance (the HSIPR operator or a third party). This must include:</p> <ul style="list-style-type: none"> • How train equipment will be monitored and pre-emptive maintenance undertaken (including the trade-offs of the cost of this with better train performance/reduction in delays); • Assumptions regarding un-planned maintenance (e.g., for vandalism) must be explained, including how these are included in the quantification of maintenance activities and resources; • Description of the scope of each type of inspection and maintenance which will be undertaken (including those undertaken prior to every train trip and

Cost element	Description
	<p>fleet overhauls/refurbishments);</p> <ul style="list-style-type: none"> • Frequency of each type of inspection and maintenance (noting where these are statutory), both on a mileage basis and on a calendar basis (translated into the latter using the proposed HSR timetable); • Where each type of inspection and maintenance will be undertaken and who will be responsible for undertaking them; • Resources (labor, materials, equipment and plant) required to undertake each type of inspection and maintenance, including the provider of these resources; • Units costs of each type of inspection and maintenance; • The number of inspections and maintenance activities required per day, week, month and year; • How the specifics of the maintenance plan, described in the above items, has been used to estimate the number and size of depots, number of maintenance staff required and significant elements of maintenance plant and equipment; and • The number of inspections and maintenance activities required. <p>The proposal must provide evidence that the location of the depots is appropriate given the timetable and the maintenance plan, in particular, in relation to the trade-offs between empty train mileage costs to access fewer depots and the efficiencies of scale of fewer depots.</p> <p>The proposal must confirm that sufficient fleet is available to operate the HSIPR service when major overhauls are planned and trains are out of service for a period of time.</p> <p>This information must be provided even if the maintenance is to be undertaken by a third party to assure both the HSIPR operator and the reviewer that the HSIPR proposition is deliverable (which, without a credible maintenance plan, doesn't provide the required confidence).</p> <p>Where a mixed train fleet is operated, the maintenance plan must explain how this will necessarily impact the maintenance resources required (different train types and possibly formations will mean a higher than average cost of maintenance than a single fleet)</p>
Approach used to estimate train maintenance costs	<p>The proposal must describe how the costs of train maintenance are forecast - this must be prepared on a bottom-up basis from the train maintenance plan described above. There should be evidence of the trade-offs which are necessarily considered when preparing a maintenance plan and the associated costs of maintenance.</p> <p>The different depot staff roles must be specified, including their responsibilities.</p> <p>The number of inspections undertaken each day, week month and year should be used to estimate the quantum of resources that are required.</p> <p>A detailed rostering exercise must be undertaken to forecast the number of each staff in each role required, this must ensure that sufficient cover is provided for training, holidays and sickness.</p> <p>Salaries must be quoted for each role. At final stage, the source and rationale for the salary assumed is not required - it is assumed that the HSIPR operator has undertaken sufficient research to assure themselves that the salaries are appropriate. However, the salary assumptions will be expected to pass the "sense test" and the promoter must explain reasons for any significantly high or low salaries.</p> <p>The estimate of employers' overhead costs must take into account all relevant component costs, and must be presented at the component levels, for each staff function. The source of the assumptions underpinning these estimates (for example, employers' insurance contributions) must be specified and where different to "the national norm", must be explained.</p> <p>The proposal must specify the terms and conditions of the main staff roles.</p> <p>The availability of skilled labor to fulfill depot staff roles should be specifically considered by the proposition at final stage, together with the impact this may have on salaries. They should also have considered the potential impact of trade unions on salaries and potential risks to terms and conditions.</p> <p>The proposal must state whether there is a step-change in maintenance costs (i.e., If maintenance costs are not directly proportional to train miles or vehicle numbers) if there is a significant change in timetable (train miles or hours) - for example, this may be the case if a new depot is required.</p> <p>As a sense check, the maintenance costs should be converted into a cost per train per year and a cost per train and vehicle mile.</p>
Fixed costs included	<p>At final stage, the fixed costs for providing the depot facilities should be estimated and presented separately.</p> <p>The proposal must clearly state the functions to be carried out at the depot and the equipment required including numbers of stabling sidings and inspection roads with pits elevated walkways to permit underframe and roof access to the HSIPR trains. The capacity of the depot in terms of maintenance inspections per day, week, month and year must be described and shown to be consistent with the maintenance plan.</p> <p>The number of each type of maintenance equipment at each depot must be stated - this must be consistent with the maintenance plan (in particular, the inspections and maintenance undertaken daily, weekly, monthly and annually. It must be clear that there is some spare capacity for unplanned maintenance.</p>

Cost element	Description
	<p>The proposal must state the proposed suppliers of equipment and materials, and provide evidence of initial negotiations with these suppliers.</p> <p>The proposal must confirm that the depots and equipment can be delivered in accordance with the timescales of the HSR proposition, and unit costs for these must be stated.</p>
Changes in rolling stock costs over time	<p>The proposal must state assumptions as to how rolling stock and maintenance costs will change over time. Where trains are leased, this must include the assumed change in costs when a new lease is signed.</p> <p>Changes may arise from - timetable alterations affecting the number or frequency of services; longer trains required to increase passenger capacity; and inflationary pressure on salaries and materials.</p> <p>For maintenance costs, the proposal must differentiate between changes in labor and materials/equipment costs over time.</p>

Railroad

Unless the HSIPR operator will provide services as a tenant on another railroad, presentation of a standard \$ per track mile is not acceptable as the basis of an estimate at final stage. A list (including the location) of all assets requiring inspection and maintenance is a readily obtained output from modern CAD software packages.

The design must also consider the optimum location of railroad maintenance depots trading off the need to have a reliable railroad, minimizing the time staff spend travelling to worksites with having as few depots as possible in order to save capital cost.

The railroad operations plan will define the numbers of signaling, electrical distribution and control center staff. 24/7 rosters must be developed and the number of full time equivalent staff calculated based on resource allocation software.

Maintenance staff numbers will be determined by the number of depots, average time spent travelling to worksites and the volume of work. The asset management and maintenance resource plans will provide information to permit daily rosters to be prepared and full time equivalent staff estimated using the standard resourcing software.

Where new train services are being added to an existing rail operation, the railroad manager (or landlord) will provide the HSIPR operator with a revised estimate of cost based on the increased level of detail now available for the train service plan and the actual type of rolling stock to be used. This will result in many of the assumptions being used in the intermediate stage estimate being verified and accepted or revised. For shared railroads, the landlord will not provide commitments which are contractually binding but some form of Memorandum of Understanding would be expected that sets out the parameters through which the landlord will engage with the project and the services they are prepared to offer.

Table 6-6 summarizes the key elements of railroad costs expected at final stage.

General and administrative

Table 6-7 presents the checklist criteria for general and administrative at final stage. By final stage, it must be clear what costs remain in general and administrative and robust bottom-up estimates provided for each. The definition provided by the delivery plans will mean that there are few, if any, non head office costs which remain unallocated.

In terms of headquarters costs, a wider variety of staff roles and responsibilities will be included - so it may still be appropriate to apply several cost bands to reflect different levels of specialism, for example, general administration, general management (finance, marketing, training, HR), specialist (legal, commercial, engineering) and senior management (directors).

The preparation of detailed delivery plans at final stage will have resulted in the HSIPR operator having a thorough understanding of what is required to deliver and operate the HSIPR. This process is likely to result in a more extensive list of cost items included in the general and administrative costs, and the estimation of each cost should be prepared in a careful and thorough manner.

TABLE 6-6. QUANTIFYING RAILROAD COSTS AT FINAL STAGE

Cost element	Description
Railroad operations and maintenance costs included in operating costs	<p>Railroad operations and maintenance costs must be included as multiple line items in the operating cost forecasts.</p> <p>Where the HSIPR service will operate as a tenant on a railroad, the costs may be presented as “railroad access costs” and these must also be presented as multiple line items, in accordance with how access costs are charged.</p>
Railroad landlord or tenant?	<p>The proposal must confirm whether the HSIPR operator will be a landlord and own the railroad. This is generally the case if the proposal involves construction of new railroad.</p> <p>Where the HSIPR operator is a tenant, the proposal must state the nature of the landlord, for example, is it public or private and is it responsible for operating train services?</p> <p>Where the HSIPR operator is a tenant, proposal must submit a draft access agreement as part of the proposal. The access agreement must confirm the following:</p> <ul style="list-style-type: none"> • Sufficient capacity available for the proposed timetable to be operated; and • Times when the railroad will be unavailable for HSIPR service operation due to maintenance. <p>Where the HSIPR operator is a tenant, the assumptions underpinning the railroad access costs must be described and access arrangements demonstrated to be consistent with the HSR timetable. The railroad access costs will be charged on a \$ per vehicle or train mile basis, sometimes with an additional fixed cost per year and evidence should be provided that this is proportional to the costs which are likely to be incurred by the landlord to support the new services.</p>
Capacity of railroad	<p>The proposal must confirm whether the HSIPR services are the only users of the railroad.</p> <p>Where other rail services will use the railroad, the proposal must describe the mix of traffic, both in terms of operators and types of traffic, for example, passenger or freight and passenger high-speed or passenger “conventional”). Evidence should be provided that sufficient capacity exists on the railroad for all services and potential conflicts between services have been resolved.</p> <p>Where a new railroad is being constructed for the HSIPR service, the feasibility design must provide evidence that the capacity accommodates the requirements of the train service specification.</p>
Approach to estimating railroad operations costs described	<p>The proposal must describe how the railroad costs have been estimated and include assumptions (and their sources) for:</p> <ul style="list-style-type: none"> • The number of signaling and control centers that are required; • The number of staff per signaling and control center (roles and responsibilities must be identified and the number of staff must be quantified using a detailed rostering exercise that takes into account the hours of operation of the service and the need to include staff cover for holidays, sickness and training). Management and supervisory staff must be identified; and • Annual salaries and employers overheads for each role must be stated.
Approach to estimating railroad maintenance costs described	<p>The proposal must describe, in detail, the proposed approach to maintaining the railroad.</p> <p>The proposal must state -</p> <ul style="list-style-type: none"> • When planned maintenance will occur (and when HSR trains will not be able to operate on all or route sections of the railroad, or will have limited access to sections of the railroad); • What inspections and maintenance can be undertaken without affecting the proposed HSR timetable, and the actions that must be taken in order for this work to be undertaken safely; • State the frequency of preventative maintenance and servicing inspections of the railroad, the scope of these inspections and maintenance and the time taken for each; and • Which of the inspections and maintenance activities are labor intensive, and which are assumed to be sub-contracted (and the likely suppliers of the resources for sub-contracted work). <p>The proposal must present a maintenance program which shows the inspections taking place on each section of railroad during the year and the resources (labor, equipment and plant) required for each. The labor requirements must be disaggregated by skill type. For the purposes of the review and forecasting operating costs, annual maintenance programs must be presented covering 5-yearly periods.</p> <p>The proposal must forecast the total annual resource requirements to undertake railroad inspections and maintenance. This must include labor (by skill type), equipment and materials requirements. The resource requirements must be forecast for each of the annual programs presented. An assumption of the</p>

Cost element	Description
	<p>resources required in intervening years must be stated.</p> <p>The proposal must explain how reactive maintenance will be resourced while at the same time ensuring that the rest of the railroad is maintained to enable safe operation of HSIPR services. It must identify “on call” maintenance staff for such events.</p> <p>The proposal must state the salaries of each maintenance staff role, their terms and conditions (especially with respect to overnight working and working during national holidays) and employers’ overheads. The unit costs of materials and equipment must be provided. The proposal must state whether significant elements of equipment will be purchased or leased, and the costs of purchase or lease.</p> <p>The proposal must state the locations of maintenance depots along the route, and the rationale for how these were chosen. It must be clear that the labor resources required have been forecast taking into account the location of these depots (since travel time will impact on productive hours).</p> <p>Total annual resource costs must be forecast for each of labor, equipment, materials and depot, for every year.</p>
Changes in costs over time	<p>The proposal must state what assumptions have been made in terms of how costs will change over time. Of particular importance are the assumptions regarding how staff and material costs will be affected by inflation.</p>

TABLE 6-7. QUANTIFYING GENERAL AND ADMINISTRATIVE COSTS AT FINAL STAGE

Cost element	Description
Inclusion of general and admin. costs	Forecasts of general and administrative costs must be included as multiple line items in the operating cost forecasts and they must be forecast on a bottom-up basis.
Staff roles and responsibilities	<p>Assuming traincrew, maintenance, station and railroad staff have all been accounted for in the separate cost categories described above, staff in the general and administrative function must include:</p> <ul style="list-style-type: none"> • Directors and senior management; • Specialist support such as technical standards, procurement and contract management; • General support such as administration, marketing, human resources, training and finance; and • Operations - control center for day-to-day management and separate strategic planning. <p>Each role must be identified and the responsibilities of the role outlined.</p> <p>The costs of head office staff typically account for a significant proportion of general and admin costs and the proposed head office team should be presented in the form of an organogram to confirm that all functions have been covered and there is no double counting. Where head office functions will be covered by a parent company, the proposal should clearly state how these costs are included in the HSIPR operating cost forecasts.</p>
Total staff numbers specified by role	<p>The proposal must specify the total number of staff in each role in the categories described above. The number of staff by role and grade must also be specified, since “other staff” costs are relatively high due to the higher than average salaries which are paid to employees in these roles.</p> <p>Most of these functions are weekdays only but where support is provided on a 24/7 basis (such as the control center), the number of staff must be estimated based on a rostering exercise to ensure that there is sufficient cover for training, holidays and sickness.</p>
Salaries and overheads <ul style="list-style-type: none"> • Basic salaries stated • Overheads • Source specified • Risks identified 	<p>The salary assumed for each role and grade must be stated. While the salaries of many roles will not be dissimilar to other organizations, the salaries of directors should be explained, as these may be significantly higher than for other organizations.</p> <p>An allowance (in addition to annual salary) must be made for employers’ overheads including insurance and retirement contributions. The level of this overhead should be specified and the source of this specified.</p> <p>The estimate of employers’ overhead costs must take into account all relevant component costs, and must be presented at the component levels, for each staff function. The source of the assumptions underpinning these estimates (for example, employers insurance contributions) must be specified and where different to “the national norm”, must be explained</p>
Non staff costs	<p>Non-staff costs will account for the majority of general and administrative costs. Robust cost forecasts can only be prepared if the promoter is clear how the HSIPR business will be supported day-to-day and to cover periodic issues.</p> <p>Cost forecasts must be prepared on a bottom-up basis, reflect initial negotiations with suppliers and include:</p> <ul style="list-style-type: none"> • IT equipment and maintenance/renewals; • Insurance; • Marketing and advertising; • Office supplies including stationary, postage and printing of HSR customer information (e.g., timetables); • Telephone services; • Professional services such as legal and engineering advice and insurance; • Commissions to third parties who sell HSR tickets (including other train operators, travel agents and airlines); • Internet and telephone ticket sales; • Utilities (water, gas, electricity) and waste disposal; • Catering, car park management and maintenance and station security staff, where these are sub-contracted;

Cost element	Description
	<ul style="list-style-type: none"> • Employees uniforms; • Employees expenses (e.g., to cover travel and subsistence for traincrew who finish their shift at a remote location); • Employees bonuses (the proposal must propose how a bonus project would work); • Air/coach costs (where train or railroad failures mean passengers need to be conveyed by an alternative means); and • Facilities management costs such as utilities, buildings maintenance and property taxes (the facilities costs for stations and depots must be discretely presented in the respective stations and train maintenance sections of the cost forecasts). <p>The proposal must include a description of each of these items, an estimate of the number of units required and the frequency of incidence (e.g., the number of computers and staff uniforms required and how frequently they will be replaced/updated) and the unit cost of each.</p> <p>The proposal must give a particularly thorough explanation of marketing and advertising costs and the costs of ticket sales, as these are often poorly scoped and they are critical to achieving the ridership forecasts and the passenger revenue.</p>
Changes in costs over time	<p>The proposal must consider and make assumptions with respect to how staff costs will increase over time.</p> <p>This must include planned variations in staff numbers for each function with any proposed change in train service level, passenger volumes or changes in train formation.</p> <p>The rationale behind the assumptions adopted must be explained.</p> <p>Inflationary assumptions which grow the non-staff costs over time should be clearly explained.</p>
Presentation of general and admin. costs	<p>Numbers of staff in “general and administrative costs” must be presented as multiple line items, one for each role.</p> <p>Total staff costs for staff included in general and admin. costs must be presented as individual line items for each role. Employers’ overheads must be specified as separate line items.</p> <p>Fixed costs must be presented as multiple line items, one for each item of cost quantified.</p>

Risk assessment

Overall, final stage should have fewer unknowns than the intermediate stage. There will still be a large number of assumptions underpinning the proposed costs but these will be more specifically focused and less generic than those used in the intermediate stage and many will have been at least partially verified through the design and modeling work undertaken to date.

It is suggested that with a final stage of detail, 10-20% contingency would typically be applied to the operating cost estimate.

Separate risk and assumptions registers, built upon the format discussed in the intermediate section must be submitted. Without this information, any reviewer will find it extremely difficult to ascertain the potential error in the data underpinning the cost estimate and how exposed the estimate is to external influences. This information really is essential for the reviewer to form their own impression of how accurate (or not) the estimate is.

A review of both registers will give a good understanding of how the HSIPR operator has focused their effort since intermediate stage in increasing detailed knowledge and reducing uncertainty and risk, particularly on the elements which have the largest impact on potential cost.

As with the intermediate stage review, any exclusions from the operating cost estimate should be treated with caution. Design and modeling has been undertaken meaning that some form of estimate should be able to be provided against all cost areas. The commercial issue may be that the risk of change of particular cost element is better managed by a party other than the HSIPR operator, for example, the funder. However, the fact remains that the cost exists, irrespective of the party it is allocated to, and a true picture of the full cost of operating the proposed HSIPR service is only obtained when the costs of all parties are collated.

If the HSIPR operator has not presented full cost information, it is suggested that the review consider the costs being borne by the other parties whose support will be required to deliver a successful rail service. Typical examples of real costs being incorrectly applied are lease costs where sidings are shared with other operators, costs associated with changing employment conditions for existing staff if they are to be transferred into a new organization and compensation to local residents and businesses for disturbance (usually through noise and vibration) once the HSIPR service is operational.

If a large list of exclusions remains at this stage, it indicates that effort is being made to present costs less expensively than they will be in reality or that the HSIPR operator has not developed all areas of cost to the same level of detail and may therefore be unaware of which have the largest impact on the service.

A Quantified Risk Assessment (QRA) should accompany the cost estimate at this level of project development. This will provide a basis for the level of contingency to be applied to the operating cost estimate. Good quality proposals will provide some commentary around the risks with the largest severity (probability x impact) to allow reviewers to understand how sensitive the overall project operating cost estimate is to them.

If a robust QRA has been undertaken, this can provide sufficient confidence to reduce the level of contingency for unknown risk from the suggested 10-20%.

Common shortcuts leading to poor quality estimates

At final stage, the largest pitfall is optimism on either the key metrics driving cost or the unit rates applied to them. By this stage, all potential areas of cost should have been identified but the full extent of costs which are likely to be incurred hasn't been properly explored.

Often the main focus as the project progresses between intermediate and final stages is the engineering development (design) of any new railroad required and the same effort is not expended on improving

knowledge on the timetable, rolling stock and staff requirements. The key areas where final stage errors can arise are discussed in the following paragraphs.

Compliance with national standards

By final stage, it would be expected that dialogue has been held with the relevant enforcement and approval bodies to understand if intermediate stage assumptions remain valid. This is particularly the case where the HSIPR operator is seeking to introduce “off the shelf” European or Japanese technology into the USA. Rolling stock used on these networks may not comply with USA standards and regulations and therefore costs will be incurred in modifying the “off the shelf” product. This may increase the price to that of a customized HSIPR train set and may reduce performance or increase energy consumption by making the train heavier - all of which may have a fundamental impact on operating cost.

Similarly, assumptions on staffing such trains may not comply with these standards; for example, staff costs are one of the largest elements of operating cost and it should be known by this stage how many drivers and conductors (and any other safety critical posts) are required per train. On a large project, to find that a second driver was required on every service when only one had been assumed will increase the total operating cost by more than 10%.

Energy costs

Electric HSIPR train services consume significant quantities of energy and as a result substations supplying electricity are required every 30 miles or so. On new build lines covering large distances over rural areas, the cost of providing power supplies in remote areas can be significant and the costs of investment is often recouped through the tariff charged. In urban areas, variable tariffs are often in place reflecting varying electricity demand at different times of the day and also over the course of a year.

Some modern electric HSIPR rolling stock regenerates electricity when it brakes or coasts. If the infrastructure is suitably equipped and the train service is such that this energy can be used by a subsequent train (or exported externally to the railroad) then this regeneration of electricity can result in a net reduction in the cost of energy. However, while significant savings in energy costs can be achieved through regenerative braking, the proposal must provide evidence that the regenerated electricity can be re-used.

Lastly HSIPR trains do not consume power in a uniform manner for the entire trip- they consume more power to accelerate away from stations and climb gradients than when operating on level track, but also generate energy when braking to stop at stations or coasting on downhill gradients. Therefore, the average consumption for a specific train will be different on different routes. In order to accurately forecast quantity of electricity consumed, a complex simulation is required which reflects the rolling stock type, timetable and route physical characteristics. Standard software packages are available to undertake this modeling. The importance of this modeling is equally relevant to diesel as well as electrically power trains.

At intermediate stage, it was reasonable to obtain an estimate for energy cost by multiplying the annual train miles by an average tariff and rolling stock power consumption rate per train mile. However, due to the factors described above, it is not appropriate to continue this methodology through to the final stage as the risk of under estimation is too large.

Finally, by final stage, some thoughts should have been given to longer term treatment of energy costs - these are often affected by external events and fluctuations over a long concession period can have a large cost impact. The debate as to how this is to be managed should commence at final stage, with the aim of presenting a firm solution by commercial closeout.

Staff numbers

At intermediate stage, staff numbers are usually determined through a combination of annual train hours and station opening hours, which include a productivity factor taking into account annual leave, training and other non-productive time.

Given that staff form one of the largest single elements of operating cost, at final stage it is critical to understand the number and categories of staff that are required to deliver all required facets of the service on a daily basis. Some form of daily rosters should therefore be developed to demonstrate this and these should then be extrapolated to give annual full time equivalent (FTE) staff numbers for each grade. This conversion of daily to annual numbers for a 7 day per week operation can fail to reflect national standards dictating working hours for safety critical staff or the extent of unionization and existing agreements covering other grades of staff.

A simple test, which indicates the degree of thoroughness of staff estimates, is to investigate the volume of overtime hours which appear to be assumed. Cost estimates which assume staff regularly working for 12 (or more) hours per shift or 7 (or more) consecutive days without a rest day, is a definite indicator of underestimation compared to actual costs.

Rolling stock

The trip times in the train service specification will require some form of assumptions on rolling stock performance. As discussed in the paragraph on compliance with standards, modifications may be required to “off the shelf” rolling stock whose performance is reduced - the impact of this on the timetable, energy consumption and maintenance requirements is often omitted from the analysis. Reduced performance can mean longer trip times which mean turnaround times at terminal stations are broken resulting in the need for more trains to operate the same specified service.

The HSIPR operator is unlikely to have stated a preference for a definitive rolling stock type and manufacturer at final stage. However, they should demonstrate proof that the market can deliver their specification for the costs assumed - this will be achieved through consulting a detailed specification with manufacturers via a market sounding exercise.

The specific maintenance requirements of this rolling stock should be clearly defined and schedules provided demonstrating the maintenance facilities being provided are of sufficient size (number of roads and staff) to deliver the required workload. In general, a HSIPR train will require a maintenance inspection every two or three days. The HSIPR operator may demonstrate the total capacity of their maintenance facilities is sufficient to accommodate the planned number of maintenance exams but may not consider whether trains requiring maintenance finish service in the correct terminus stations to minimise empty miles running to depots. This brings the risk that some facilities could be overloaded and other underutilized.

Lastly, capacity for unplanned work arising should be demonstrated - components fail earlier than expected and accidents happen. Does the HSIPR operator have enough trains to provide contingency against some being withdrawn from service because of unexpected incidents and do the maintenance depots have sufficient space and staff to work on these while also delivering the planned workload?

Railroad maintenance

Given the level of design undertaken to inform a final stage proposal, sufficient information exists to produce a plan demonstrating that the railroad is available when required by the HSIPR timetable. Developing this plan requires a reasonable effort and some HSIPR operators produce lists of activities which will be required without considering the staff, plant and material resources required.

If the estimate continues to be based on the average cost per route mile presented in the intermediate stage, even if benchmarked against other HSIPR systems, this constitutes a large risk because the

benchmarks don't reflect the wide differences in standards between systems, particularly between Asia, Europe and the USA.

Contingency/risk allowance

Often no indication is given to the level of contingency applied to the base costs and what risks it covers. At the same stage in the project lifecycle, capital costs will generally be presented within some form of tolerance. Operating costs at this stage, despite outline design having been undertaken, are still underpinned by assumptions which have not yet been verified and therefore should also contain a contingency element. Often this is omitted entirely by HSIPR operators.

7 Best practice: commercial closeout

Introduction

An HSIPR proposal at commercial closeout should be a more refined version of the final stage submission and not a significantly different proposition. The delivery plans produced at final stage and shown in Figure 6-1 will be refined to reflect the increased knowledge gained on the project and the content based on verifiable data rather than assumptions. Verification will be provided by completed design, modeling outputs and contractual commitments from suppliers.

The influence of external and commercial factors on the project may be identifiable where the HSIPR operator has had to compromise on assumptions made in the final stage. For example: rolling stock with an “adequate” specification rather than the original “preferred” specification may have been selected on the basis of cost or delivery timescales; the timetable may have been modified to obtain final acceptance from other operators where HSIPR services share a railroad; union negotiations or recruitment difficulties may result in increased staff salaries or training requirements; and energy prices may have fluctuated significantly.

Those assumptions which remain unvalidated should only be criteria affecting future costs, for example, inflation rates and the impact of legislation. The party taking the commercial risk on such items must be clearly defined along with the any agreed thresholds. For example, the HSIPR operator may take the risk of wage inflation up to an agreed annual percentage with the funder(s) taking the risk of inflation costs above this threshold.

Accepting, mitigating or transferring risks identified at the final stage may result in operating costs increasing. However a well planned and developed proposal will offset the increase by a corresponding reduction in risk or contingency provision, meaning the total cost remains, at worst, consistent with that presented at the final stage.

Conversely, verification of the underpinning assumptions combined with finalizing the delivery plans for HSIPR services often identifies efficiencies in resource requirements.

These factors combined with good risk and contingency management and the commercial pressure on the HSIPR operator to finalize contractual terms mean the commercial closeout cost can be less than that presented at final stage.

Train service offer

By commercial closeout, the HSIPR operator will have: an agreed rolling stock performance and quality specification with the supplier; completed design work required to support rolling stock manufacture; and a firm supply price agreed. Similarly, where a new railroad is being constructed by the HSIPR operator, all design will be completed and construction contracts either awarded or ready to award. This knowledge allows the HSIPR operator to refine the modeling and simulation work undertaken at intermediate stage and produce a final working timetable. The gradients and curvature of the route as well as the final train performance specification permit traction energy consumption to be accurately modeled. Completion of the railroad design along with the working timetable permits the operations and maintenance requirements to be finalized.

The railroad operations, rolling stock and timetable plans developed at final stage continue to form the basis of the train service offer. These will be updated to reflect the increased levels of knowledge on how the service will actually operate but may also be adjusted to reflect the final obligations which the funder (for

example, the FRA) requires the HSIPR operator to contractually commit to. An example of this would be the minimum acceptable performance of the system, specified in terms of the acceptable number of trains late or cancelled and the consequences of not meeting the targets. This is difficult to absolutely confirm until the modeling and design work supporting commercial closeout has been completed. Once the achievability of the draft requirements is known, the benchmarks may be adjusted slightly through negotiation.

The HSIPR operator will then assess the balance between the commercial risk of not meeting the performance requirements with the ridership impacts of adding contingency and increasing trip times or incurring costs to provide additional staff or equipment to reduce the risk of poor performance. In such an example, the HSIPR operator will need to change the timetable plan, performance plan and possibly the rolling stock, depot, stabling and maintenance plans in order to deliver the required service level. Updating the plans is likely to change a number of the cost elements.

As at final stage, the delivery plans will continue to be developed through a process of iteration driven by the relationships previously explained in Figure 2-1. Table 7-1 provides a summary checklist for elements expected at commercial closeout for the route alignment and train service offer.

Delivery plans

All delivery plans will be updated from final stage, and only those which will incur significant changes are described below. The HSIPR operator may present some new plans which sit below the suite developed at final stage. These will take the form of standard operating procedures for use by all staff and define how the HSIPR service will operate on a day-to-day basis. This level of plans is of interest, but not critical to verifying the operating cost estimate - the fact the plans exist is a positive sign of the HSIPR operators preparedness for service.

Prior to completing commercial closeout, a competent HSIPR operator will re-visit the commercial case for the rail operation as part of final due diligence to compare operating costs with passenger revenue. This may result in the HSIPR operator deciding to trim some costs, for example, by altering the level of on-board service compared with that proposed at final stage. This could vary from offering a lower overall level of service or only providing the full service at certain times of day or between specific stations. The revised proposal (which should not differ markedly from the final stage) will need to be described in the on-board train plan and reflected in staff cost estimates and general and administrative costs.

Timetable plan. This will reflect the updated train service simulation modeling and more detailed allocation of rolling stock and traincrew. Marginal changes are expected as a result of operating costs being prepared at a greater level of detail - for example, where the HSIPR operator identifies opportunities while undertaking the more detailed exercise to calculate full time equivalent numbers of staff.

TABLE 7-1. ROUTE ALIGNMENT AND TRAIN SERVICE OFFER AT COMMERCIAL CLOSEOUT

Driver of cost	Description
Route alignment	
Route alignment and distances	<p>The commercial closeout proposal will reflect the approved engineering design which is to be or is already under construction. Some minor alterations should be expected.</p> <p>Route distances should not change, however gradients and curves may alter slightly. The cumulative effect of small changes may alter average line speed and traction energy consumption, and therefore have a small cost impact.</p> <p>The signaling and control systems should be consistent with those specified at final stage.</p> <p>The proposal should be underpinned by final and approved for construction engineering drawings with only small changes apparent from the final stage design. Major changes must be described in full and the reasons for the change clearly presented. A reviewer should consider the competency of the risk management process adopted by the HSIPR operator if major changes arise in the route alignment at this stage in the project.</p>
Terminating & intermediate stations	<p>The proposal will present final station designs which are approved for construction. As with the route alignment, these should be consistent with the final stage proposals. Changes to the number of platforms and facilities provided at stations must be supported by a clear rationale. Anything other than refinement of station layouts indicates a change in the HSIPR's confidence in the ridership forecasts.</p> <p>Where changes are proposed the impacts on train operations, operating costs, customer offer and ridership must be explained.</p>
Shared routes and stations	<p>At commercial closeout, the HSIPR operator must have reached agreement with other train operators and (where relevant) the railroad landlord as to how interfaces will be managed and the minimum service level supported. These agreements must be sufficiently detailed to allow contracts to be exchanged.</p> <p>The discussions to reach contractual agreements may identify opportunities for resources to be shared to save cost.</p>
Railroad capacity	<p>It is expected that there will be no changes to the overall railroad capacity from that specified in earlier stages. There may be small site-specific adjustments to mitigate against performance risks identified in the final stage.</p>
Risks to the HSR alignment	<p>The proposal must explain how issues with alignment, which are found during construction of the HSIPR railroad, will be addressed. This must include the process by which any changes are tested to verify the impact on operating costs - in a large multidisciplinary project such as construction and operation of an HSIPR service, the team constructing the railroad are not always aware of the impact a change in gradient or junction protection signal will have on the ability to meet the specified timetable.</p>
Timetable	
Train frequency and trip times and variations in train service	<p>It is expected that there will be only very minor changes to the timetable, for example, to reflect the detailed design of rolling stock (such as door widths, which would affect station dwell times) and the final route alignment (gradients and curves affecting average line speed).</p> <p>The HSIPR operator must simulate the final route alignment and rolling stock design and produce a final validated working timetable. This will specify train passing time at regular measuring locations to the nearest 30 seconds as a minimum.</p> <p>The working timetable must include all empty stock workings to the same level of detail as the passenger service timetable.</p>
Annual train miles & train hours	<p>Train hours and miles must be presented for all train formations and train types. The reasons for the changes must be explained (for example, cost savings may be possible if more services can be operated with shorter trains). If there is a significant difference from final stage, the impacts on the operating costs, customer offer and ridership must be explained.</p>
Proposed rolling stock	<p>At commercial closeout, the HSIPR operator must have an approved design and firm price agreed with a manufacturer for the supply of rolling stock.</p>
Risks to the HSR timetable	<p>There should be few, if any risks to the timetable. The proposal should describe how the risks identified at final stage were managed and the updated risk register accompany the proposal.</p> <p>Remaining risks should still be considered as "live" and management actions and responsibilities should be presented for each.</p>

Driver of cost	Description
Train service delivery and customer service offer	
Key statutory requirements	Confirmation must be given that all statutory requirements have been met. Where derogations to compliance with specific standards has been sought, appropriate confirmation from the enforcing body must be presented. A good HSIPR operator will also present its management process which ensures it will continue to comply with statutory requirements through the lifetime of the contracted service.
Train service delivery	The proposal would not be expected to include any changes to the processes by which the train service is delivered compared to the final stage. Where changes have occurred, a version of the operating costs must be presented which quantifies the impact of this change alone.
Customer service offer	Where there are changes to the customer service offer compared to the final level, the changes must be clearly described and the reasons for the change explained. The impact on ridership, passenger revenue, benefits and each component of operating costs must be presented and fully explained. Minor changes to the customer service offer often occur at commercial closeout stage in order to find cost savings as operating costs increase in response to other drivers.

Railroad operations plan. This will be developed to a much greater level of detail from the final stage and will contain the top tier of standard operating procedures defining how control room, signaling and (if required) electrical operating staff will regulate the railway, manage the timetable and communicate with train operators and maintenance staff.

This plan will define the periods when the railroad is available for operational use and when maintenance activities can be undertaken. Where the HSIPR operator is a tenant of the railroad, the plan will define the process, timescales, roles and responsibilities for agreeing and implementing timetable changes. The complexity of this process will be determined by the size of the network, number of different train service operators and different types of traffic, for example, if the HSIPR shares a terminal station with commuter services, then the process of optimizing paths into and out of the station for all parties will be more complex than a dedicated HSIPR facility. These elements of the operations plan will define the size of the head office team required to support and deliver the strategic timetable planning rather than day-to-day management process.

The control room, signaling and electrical operating staff numbers should be demonstrated through detailed rosters. These are safety critical roles and time to check competencies and undertake training will be required. Appropriate supervision/management should be built into the rosters as well as on-call staff who would attend incidents to direct operations on site.

Rolling stock plan. This will reflect the exact requirements of the trains being procured and the associated commercial arrangements. The technical specification should be consistent with the final stage plan in terms of number of trains, performance and interior specification. Minor changes would be expected as a result of compromise on commercial negotiations with the manufacturer. The reasons for significant changes must be documented and the impact on operating costs, maintenance, stabling and ridership clearly stated.

The commissioning and acceptance process when new rolling stock is introduced to a railroad is a major risk and the process, timescales, roles and responsibilities must be detailed in the plan.

The responsibility for maintenance of the trains will be defined in the plan: this will either be undertaken by the HSIPR operator directly or by the manufacturer under contract. Unless there has been significant change to the specification of the rolling stock, maintenance requirements will be similar to those defined at final stage.

A good rolling stock plan at commercial closeout will clearly demonstrate the selected trains will:

- Be delivered and available for service when required;
- Meet the timetable requirements in terms of trip, station dwell and turnaround times;
- Carry the forecast number of passengers in an environment of appropriate quality; and
- Be able to be maintained with the specified plant, equipment and staff at specific locations and operate with the required reliability.

The final supply contract between HSIPR operator and manufacturer will be presented along with the payment regime and warranties provided.

Supporting detailed plans

Fares and ticketing plan should confirm the types of tickets offered on the HSIPR service, their key characteristics and the differentiation between them (including the market segments targeted). Other issues which should be confirmed in the plan at commercial closeout are:

- Whether they intend to encourage social inclusion via heavily discounted rail tickets; and
- Whether the HSIPR service will offer discounts, for example, to the military, young or elderly passengers.

The plan should also provide examples of fares for key demand flows (for example, between key cities served by the HSIPR service) based on the main ticket types.

The fares and ticketing plan at commercial closeout must be consistent with overall performance and service level requirements specified by the funder(s). For example, maximum queuing times for passengers buying tickets at stations may be specified and the plan must address this by clarifying how peaks will be managed, for example, by having additional staff on a part time basis.

A final refinement of staff numbers required to sell tickets on each train/at each station will be expected in the plan. This will be based upon “facts” such as ticket office opening hours as well as “forecasts” such as number of peak hour daily ticket sales expected. Actual staff costs will be a refinement from the final stage, reflecting the recruitment process and agreements with unions.

Where tickets will be sold by third parties (for example, travel agents, other train companies or companies specializing in internet sales), the HSIPR operator must confirm what draft contracts have been prepared with these providers and the setup, fixed and variable costs associated with each.

Demand management plan. This will reflect greater analysis and understanding of the extent to which levels of passenger demand will require demand management intervention. The scope of the issue should be explained in some detail.

The HSIPR operator will have identified its preferred approach to demand management and should provide evidence that it adequately deals with the issue and is deliverable. It should be clear that the ridership, revenue and cost (both capital and operating) forecasts presented in the commercial closeout submission are consistent with the demand management plan.

The forecasts should reflect the secondary effects of implementing demand management strategies: for example, restricting the use of return legs of trips on off-peak tickets in the evening peak period is likely to result in these people choosing to travel on the last train before the peak and the first train after the peak, creating new “demand peaks”.

The plan should also explain how they have addressed issues such as the adverse publicity that might arise from implementing demand management policies after a number of years of operation.

Marketing plan. This now describes in detail the specific marketing campaigns to be run, particularly in the first few years of service; the medium in which the marketing would be delivered; the market segments to which the campaigns are focused; the timelines of the marketing; and key messages to be conveyed. Marketing costs should also be forecast, subdivided into ongoing campaigns and one-off campaigns. Forecasts of the increases in ridership arising from marketing, benchmarked against experiences from similar HSIPR operators should be presented along with the process by which the effectiveness of marketing will be measured.

Train stabling and maintenance plan. This reflects the manufacturer’s specified inspection requirements and overhaul regime for the actual rolling stock which will be procured in conjunction with the simulation outputs which determine how trains will be allocated to operate the final passenger timetable.

The maintenance regime (frequency of inspections and the activities to be undertaken on each inspection) is likely to remain consistent with the final stage unless there is a fundamental change in technology used, for example, hybrid or fuel cells. The cost of materials both for specified component changes (such as brake discs and pads) and failures/damage (for example, windows, seats and tables) will now be firm. This is an area where costs can increase compared with final stage, particularly if suppliers other than the rolling stock manufacturer have not been fully investigated. The plan should clearly stage the levels of materials which will be held at depots and the critical spares such as traction motors, inter-vehicle couplers, wheels and

bogies held centrally or by the manufacturer. Labor requirements should not change significantly from final stage.

Cleaning requirements are driven by the number of trains in service each day and therefore will not be subject to large changes.

The size, number and location of maintenance and stabling facilities would not be expected to change from final stage unless major risk has been realized in the final design phase, for example, the required land at preferred site(s) has not been able to be acquired in a cost effective manner.

Railroad maintenance plan. This is the only major new plan expected at commercial closeout. It builds upon the railroad asset management plan and documents:

- **Examination regimes** - for example, weekly visual inspection, monthly electrical test and 6 monthly component change, for each asset type. The factors affecting the examination regime will be influenced by manufacturer guidelines; national safety standards; the performance regime the Infrastructure Manager has contracted with the train service operator (preventative maintenance effort is directly proportional to the level of reliability and availability required from infrastructure); the characteristics of the trains using the infrastructure (generally weight but also speed) and the number of services operating. In some projects, the design outputs will have been passed directly into the maintenance work allocation software and job sheets produced for all work being undertaken over a fixed period. It would not be reasonable to always expect to see this level of detail prior to contract award. However this will be the end product from the team responsible for managing infrastructure maintenance and it is reasonable to expect the building blocks of asset list, asset location, examination requirements to be available for review.
- **Method statements** - these step by step guides to completion of each type of examination will probably have been developed in “example” format for a number of key activities but not for all at this stage. Examples would be expected to be available for review at commercial closeout in order to allow cross-checking of resource and material requirements along with safety requirements specified by the operations plan.
- **Spare requirements** - the importance of each component to the overall performance of the rail system will be calculated during the detailed design and this compared with the availability and reliability specified for the infrastructure will dictate where component redundancy is required - as a minimum, telecommunications and power supplies are almost always provided with some form of redundancy. This same analysis will also identify locations where it is not possible or practical to have equipment redundancy, but where spare components should be centrally held to minimize disruption in the event of failure. Such spares are generally accounted for in the capital budget, but if not provided, generate a key risk to successfully managing operating cost.
- **Consumables** - the examination regime will identify which components require replacement as part of regular maintenance, i.e. they are changed before they fail to avoid a performance impact. The annual usage of such consumables should be calculated from the examination regimes and costs applied.
- **Estimates of reactive maintenance or work arising** - these arise from unplanned component failure or external factors such as train derailment, road vehicle encroachment onto railway or vandalism. The plan should clearly identify the areas of the network most vulnerable to such impacts and detail how they will be managed.

Railroad maintenance resource plan. This is considerably more detailed than at final stage and contain for each maintenance depot location:

- Detailed staff rosters showing how labor will be allocated to deliver the planned and reactive workload identified in the maintenance plan. The underpinning assumptions on travel time and reactive maintenance requirements should be clearly stated - if these are underestimated, then preventative maintenance suffers and the reliability and availability of the infrastructure is reduced. If they are overestimated, overstaffing will occur.
- Management, training and competency arrangements for staff - employees are working in a regulated, safety-critical environment, and a reasonable amount of annual effort is required in this area. The supervisory arrangements should be clearly shown in the rosters.
- Plant and machinery requirements - this will range from handheld tools such as digital multimeters to rail-based plant such as tampers and ballast cleaners. These are likely to have a mix of lease and capital repayment costs, as best matched to the size of the proposed operation.
- Operating and maintenance costs of plant and machinery - the management arrangements and costs for fuel and safety certification for vehicles, calibration for tools etc. should be clearly identified.
- Subcontract costs - elements requiring specialist (and generally infrequent) maintenance such as HV switchgear, elevators and escalators and telecommunications may be subcontracted rather than undertaken "in-house." The resource plan should clearly define the activities which will be undertaken by either party - for example, weekly visual inspections may be undertaken by in-house staff, but intrusive examinations undertaken by subcontractors.
- Technical management - a team of specialists will be required to define standards, monitor compliance, revise method statements, liaise with manufacturers and provide problem solving support to the general maintenance team.

Quantification of costs

The HSIPR operator must demonstrate its confidence that the HSIPR service can be operated for the costs specified in the commercial closeout submission. This will be expressed through few (if any) exclusions or caveats and extensive supporting detail derived from firm prices from suppliers and modeling outputs to quantify staff numbers and energy consumption. Compared to the final stage submission there are likely to be changes in costs to reflect:

- Final commercial negotiations with the suppliers of resources for the HSIPR operation (for example, rolling stock manufacturers and leasing entities, railroad and train maintenance contractors, plant and equipment suppliers, energy suppliers and third parties who sell tickets on behalf of the HSIPR);
- Changes to the train service specification or methodology of delivery of the service (to reflect final timetable submissions and the marketing plan);
- Final modeling outputs reflecting the actual performance rolling stock to be procured and its interface with the railroad. Where a new railroad is to be constructed, completion of design will allow energy consumption and rolling stock maintenance regimes to be estimated with high accuracy;
- Railroad operating and maintenance costs reflecting completed design, a final timetable and selection of rolling stock;
- Availability of labor to operate the service (is there sufficient skilled labor available in all locations, or will the workforce need to be attracted from existing employers, or is intensive training required for all most staff?); and
- A greater level of detail of forecasting general and administrative costs.

The delivery plans provide the underpinning data for development of the operating cost estimates. It is essential that there is evidence of consistency between the cost forecasts and the delivery plans and that all sources of cost identified in the plans are included in the estimates. The commercial closeout design work

provides improved granularity on the activities to be undertaken and allows staff roles and responsibilities to be more tightly defined. For example, the exact number of on-board train staff required on each service is now known, because it will have been a factor in determining the final rolling stock design. The skills they require are known because the equipment they need to operate has been defined. The same process applies for maintenance of rolling stock and the railroad: the components requiring inspection are now known, allowing detailed maintenance schedules to be prepared, each defining the time to do the job, and the tools and skills required.

Staffing levels for traincrew, stations, rolling stock maintenance and railroad maintenance must be recalculated on the basis of this information and optimized. This will be an iterative process to arrive at the best commercial trade-off between the capital cost of components and the operating cost of maintenance. For example, over a 30-year concession, the HSIPR operator decides if it is more advantageous to specify expensive “black box” type equipment, requiring little or no maintenance, but which needs to be thrown away and replaced when it fails, compared with less expensive, repairable equipment which requires regular inspection and therefore increases the operating cost because more staff is required.

The same resource allocation software used in the final stage will calculate the number of full-time equivalent staff to provide a specified workload per shift. The difference at commercial closeout is that the inputs and constraints such as the quantity of refresher training required to retain competencies, are defined more accurately.

The commercial closeout submission must provide a clear and detailed explanation on the variations from the final stage submission. A good quality submission will be presented in a manner which gives a reviewer confidence that all risks have been addressed and no other significant changes will emerge and compromise funding levels and sources. Where costs have changed by more than 10- 20%, the HSIPR operator should reasonably have forewarned the reviewing authority.

The commercial closeout costs will be presented to a similar level of detail to the final stage estimate - the key difference is the increased certainty in the unit rates and quantities used.

Traincrew

This will consist of similar calculations to those produced at final stage but updated to reflect revised staffing requirements output by the timetable, rolling stock and on-board train plans. Unit costs for staff and grading structures may change as a result of union negotiations. The commercial closeout checklist for traincrew is presented in Table 7-2.

TABLE 7-2. QUANTIFYING TRAINCREW COSTS AT COMMERCIAL CLOSEOUT

Cost Element	Description
Staff roles and responsibilities described	Any changes to the staff roles and responsibilities stated in the commercial closeout stage proposal must be described. Where additional responsibilities are required of a role, the proposal must provide evidence that all responsibilities are deliverable (and train operation and customer service will not be adversely affected).
Number of employees on each train	Changes to the number of on-board staff per train must be explained and a summary table provided which shows the number of traincrew employees in each role against the estimates of both the intermediate and final stage proposals.
Description of approach used to quantify numbers of traincrew	<p>Where revised rostering exercises have identified changes to the number of traincrew staff required, the proposal must state any changes in the input assumptions to the rostering exercise and assess whether there is an impact on train operation and customer service.</p> <p>Where the number of traincrew has changed, the proposal must present a table comparing the total number of staff in each role against the estimates of both the intermediate and final stage proposals, referencing the text to explain the changes.</p> <p>If the methodology to forecast the number of traincrew changes, the proposal must fully explain the reason for the change and explain the impact on the staff numbers.</p> <p>The proposal must forecast the number of trainee drivers and traincrew operations staff and the timescales of the training program which each will follow.</p> <p>The detailed rostering exercise should be sense checked to understand how contingency has been treated. A good indicator of contingency being applied on top of contingency is where daily staff numbers are rounded up, combined with assumed productivity of 60-80% and then a large deduction for training, holidays and illness over the course of a year.</p>
Salaries and overhead <ul style="list-style-type: none"> • Basic salaries stated • Overhead • Source specified • Risks identified 	<p>The process to recruit staff must be explained and evidence provided that salaries and training requirements are realistic for the areas staff will be based. Where staff salaries have changed compared to the final stage proposal, the reasons must be specified and a comparison table presented. Where staff salaries change significantly +/- 20% detailed explanations must be provided.</p> <p>It is likely that the level of employer overheads and terms and conditions of employment will have changed from the final stage proposal. A comparison table must be presented and the reasons for the changes explained.</p> <p>The rostering exercise must identify where staff will start and finish a shift away from their home location. In such cases, cost will be incurred in providing transportation or overnight accommodation and subsistence. Over the course of a year, this can amount to a considerable sum. The costs for this must be clearly presented.</p>
Changes in staff costs over time	While changes in staff costs over time are sometimes based on high-level assumptions at the final stage, at commercial closeout they must be based on detailed assessments of how resource levels will change. Evidence of this analysis must be provided.
Presentation of traincrew costs	This must be presented with consistent headings to those used at final stage and a comparison table provided to explain changes in each element.

Energy

This is an area where costs could change significantly from the final stage estimate. As previously discussed, completion of the route alignment and rolling stock design will permit accurate simulation of traction energy consumption. The sections of route where trains consume and regenerate power will be better understood, as will natural energy losses where overhead lines are used to provide electric power. Overall, the more accurate modeling could show a reduction in total power consumed, particularly if a broad assumption was used at final stage for levels of regenerative braking and energy losses.

However, this reduction may be offset by underestimates in the tariff which the HSIPR operator finally manages to negotiate with the electricity supply provider. Reasons for increases in the tariff could be lack of supply competition or the fact that the cost of providing supply infrastructure to more remote parts of the HSIPR route were more expensive than estimated.

Volatility of tariffs in the medium- and long-term remain the largest risk to energy costs and commercial closeout must detail how these are being treated and how the risk of change is being managed.

The commercial closeout checklist for energy costs is presented in Table 7-3.

Stations

Staffing requirements will be updated as a result of refinements to the fares and ticketing, retail distribution and timetable plans. Significant changes in numbers from the final stage will only be expected if there is a major change in these underpinning plans affecting, for example, station opening hours, means of train dispatch (for example, now being undertaken by traincrew rather than platform staff) or ticket retailing (for example, focus on internet, call center and self-service rather than booking office sales).

As with traincrew, staff grading and costs may increase through recruitment difficulties or union negotiations.

A step change in detail will be expected for estimates of station utility and maintenance costs, reflecting completion of all design and full specification of equipment such as elevators, information systems, ticketing machines and power supplies. Maintenance of specialist equipment such as this is often subcontracted and the costs underestimated at final stage. Evidence of firm prices from contractors should therefore support the cost at commercial closeout.

Completion of the design also allows utility consumption to be accurately estimated - as with traction energy, the key risk is fluctuations in the tariff rather than consumption. However, compared with traction energy, this cost risk is relatively small.

As the physical size of the station is unlikely to change, cleaning and light maintenance (such as changing light bulbs and broken windows) costs will be expected to be consistent with those estimated at final stage.

A useful check is to consider the responsibilities of the HSIPR operator external to the station such as maintenance of access roads, including snow clearance in winter, lighting and CCTV monitoring of parking lots and payment of property taxes. Inclusion and clear documentation of these will give confidence in the completeness of the estimate.

The commercial closeout checklist for energy costs is presented in Table 7-4.

TABLE 7-3. QUANTIFYING ENERGY COSTS AT COMMERCIAL CLOSEOUT

Cost Element	Description
Method of calculation	The method of calculation of energy costs would not expect to change from that at final stage. Where there has been a change, a detailed explanation of the reason for the change must be provided. A full description of the new method of calculation must also be provided, explaining why it is more appropriate for use.
Unit cost of energy	Where the cost of energy per unit has changed from earlier stages, the reasons must be explained. This may be a result of negotiations with suppliers of energy, in which case the terms of the supply price must be described in the proposal.
Energy consumption of rolling stock	Commercial closeout represents a point in the HSIPR proposal development when there is certainty in the design specification of the train and final (small) adjustments to the timetable will be made. The resulting changes to energy consumption must be explained, in terms of the aspects of the train specification which have affected energy consumption rates or the changes to the timetable.
Changes over time	The proposal must confirm forecasts of changes in the unit price of energy over time and evidence must be provided that these forecasts are based on a careful assessment of future energy markets. The proposal as a whole must provide evidence that the energy price risks identified in the final stage proposal have influenced the development of appropriate aspects of the proposal.

TABLE 7-4. QUANTIFYING STATION COSTS AT COMMERCIAL CLOSEOUT

Cost element	Description
Station specification	<p>Any significant change from the final stage proposals must be clearly documented and justified. The design for each station must be demonstrated to be consistent with the ridership forecasts, working timetable and quality specified for the customer experience.</p> <p>All equipment will now be fully specified and the maintenance requirements presented.</p> <p>Minor changes will be expected to reflect the refinement of operating, timetable and fares and ticketing plans.</p> <p>Where retail facilities are to be provided, final draft tenancy agreements should be provided to identify the revenue generated.</p>
Staff roles and responsibilities	<p>Any significant changes from the final stage proposals must be clearly documented and justified.</p> <p>The managerial and supervision structure will be more refined than at final stage, but changes to front line staff requirements will only be driven through major changes to the operating, timetable or retail and ticketing plans.</p> <p>The location of costs for managing call center / internet ticket sales must be defined - to avoid confusion it is best to sit within general & administrative.</p>
Total staff numbers specified by Role	<p>The calculations undertaken at final stage will be re-run to reflect final plans.</p> <p>The detailed rostering exercise should be sense checked to understand how contingency has been treated. A good indicator of contingency being applied on top of contingency is where daily staff numbers are rounded up, combined with assumed productivity of 70-90% and then a large deduction for training, holidays and illness over the course of a year.</p>
Salaries and overhead <ul style="list-style-type: none"> • Basic salaries stated • Overhead • Source specified • Risks identified 	<p>The process to recruit staff must be explained and evidence provided that salaries and training requirements are realistic for the areas staff will be based. Where staff salaries have changed compared to the final stage proposal, the reasons must be specified and a comparison table presented. Where staff salaries change significantly by +/- 20%, detailed explanations must be provided.</p> <p>It is likely that the level of employer overheads and terms and conditions of employment will have changed from the final stage proposal. A comparison table must be presented and the reasons for the changes explained.</p>
Changes in staff costs over time	<p>While changes in staff costs over time are sometimes based on high-level assumptions at the final stage, in commercial closeout stage proposals they must be based on detailed assessments of how resource levels will change to reflect growth in the HSIPR operation. Evidence of this analysis must be provided.</p>
Fixed costs	<p>Sufficient information now exists through the design process to have full disaggregated costs for maintenance. Subcontracts should be in place for maintenance of specialist equipment such as elevators, customer information systems and ticketing machines.</p> <p>The approved design will allow utility costs to be estimated with greater accuracy than at final stage.</p> <p>The proposal should contain detail on HSIPR costs incurred with respect to the immediate station area, for example, maintaining access roads and parking lots and payment of property taxes.</p>
Presentation of station costs	<p>This must be presented with consistent headings to those used at final stage and a comparison table provided to explain changes in each element. Fixed cost is the area most likely to have been underestimated at final stage and therefore change may be expected.</p>

Trains (rolling stock)

The HSIPR operator will now be presenting information based on the actual trains it is procuring. Some assumptions may remain unvalidated at this stage, particularly if the train has not been manufactured and tested, for example, power consumption and acceleration rates. The contract between the HSIPR operator and manufacturer should clearly state the remedies available should the supplied train not comply with the contract specification.

Where the HSIPR operator has undertaken a due diligence review of the overall cost and revenue of the service, there may have been some last minute “cuts” to major cost areas. The consequences of reduction in the size of the train fleet or unit cost of trains must be clearly documented.

Train maintenance

The maintenance regime is unlikely to have changed significantly from final stage and sense checks should be undertaken to ensure the number of inspections planned is consistent with the annual miles operated with each train set.

Maintenance staff requirements can change at commercial closeout, particularly when the final arrival and departure times of trains at maintenance depots are calculated. This can result in insufficient time for a single team to undertake a full inspection and therefore additional staff is required. Requirements for other staff at the depot should also be fully defined at commercial closeout: the number drivers and switchmen to move trains around the depot will be determined by the number of trains at the depot and the interval between the arrival and departure times; office-based staff providing engineering, planning and management support will be determined by the number of trains and the split of work between the HSIPR operator and the manufacturer.

Most rolling stock maintenance is undertaken at night and on weekends - it is worth checking how effectively staff rosters balance this work, as it can be difficult to recruit and retain skilled staff who permanently work unsociable hours.

Material costs form the largest component of rolling stock maintenance costs. The commercial closeout cost should present estimated quantities for materials, including both scheduled component changes and estimates of failure and damage. Unit costs for each component should also be presented. It is common for unit costs to be significantly higher than anticipated at final stage, particularly when sources other than the rolling stock manufacturer have not been pursued by the HSIPR operator. Manufacturers markups on spares are often very high. Additionally, material requirements due to failure and damage (sometimes referred to as work arising) are also treated too optimistically at final stage.

Direct costs such as utilities, building, plant, equipment and railroad maintenance can now be estimated accurately based on the detailed design and final specification of the actual rolling stock.

Rolling stock maintenance is a first-order driver of total operating cost and significant variances can occur between final and commercial closeout, mainly through verification of actual material consumption and unit costs, but also through staff numbers required to undertake maintenance within the time constraints available. A good submission will have contained sufficient contingency at final stage to offset such cost increases.

The commercial closeout checklist for rolling stock is presented in Table 7-5.

TABLE 7-5. QUANTIFYING ROLLING STOCK COSTS (INCLUDING MAINTENANCE) AT COMMERCIAL CLOSEOUT

Cost element	Description
Method of procuring rolling stock	<p>A firm contract will be either in place or ready to execute with a manufacturer for the supply of rolling stock. This will define the specification, delivery timescales, commissioning and approval process. These should be checked to ensure consistency with the key delivery plans.</p> <p>The remedies available to the HSIPR operator in the event of delay or failure to meet the specification should be clearly explained. These should be back-to-back with any compensation the HSIPR operator will have to pay to the funder(s) in the event of late delivery or poor performance.</p> <p>The payment profile and services provided by the manufacturer should be clearly defined and consistent with requirements of the delivery plans.</p> <p>The HSIPR operators plans to accommodate future ridership growth must be presented, for example, this may be through fixed-price options to procure additional trains.</p>
Rolling stock fleet required	<p>The final requirements should be a refinement of the final stage calculation and consistent with the delivery plans. The detailed diagramming exercise should be presented.</p> <p>Any reduction in the rolling stock fleet size from final stage must be clearly explained and the mitigating actions to avoid impact on performance and service quality presented. Changes in the number of maintenance spares or trains available for strengthening peak services will impact the reliability and quality of the HSIPR offer and could reduce ridership and revenue.</p>
Rolling stock ownership or leasing costs	<p>The proposal must state the cost per train if they are to be procured. This price should be based upon a completed design and commercial agreement reached with the preferred supplier.</p> <p>Any significant change in the unit cost of each train from the final stage estimate must be documented. Cost increases may arise through difficulties in complying with national safety standards. Cost decreases generally only arise through reduction in the specification. The impacts of this on maintenance, performance and service quality must be clearly explained.</p> <p>The proposal must provide evidence as to how the risks identified at final stage have been managed. The submission must clearly confirm the selected rolling stock will clearly comply with all national standards and if any derogations to these standards are assumed, evidence must be provided that authorizing bodies are sympathetic and a plan presented for obtaining formal approval for the derogation.</p> <p>Where the rolling stock will be leased, the proposal must state the terms of the lease and whether the trains will be leased directly from the manufacturer or through a third party. If the lease is a different duration than the concession period for HSIPR operators, the proposal must state the HSIPR operator’s plan for ensuring proper rolling stock continues to be available throughout.</p>
Inclusion of rolling stock maintenance costs	<p>Rolling stock maintenance costs must be included as one or more line items in the operating cost forecasts.</p> <p>The proposal must describe the components of maintenance costs, with reference to different levels of maintenance (servicing, light and heavy) and comprising of the labor, materials and fixed cost elements. Materials will form the largest component of cost. Maintenance labor should be provided at terminal stations to undertake turnaround inspections and “running repairs”.</p>

Cost element	Description
Maintenance plan described	<p>If maintenance is to be undertaken by a third party, for example, the rolling stock manufacturer, the proposal must provide full details of the supply contract including payments, services to be provided, performance targets (such as reliability of trains expressed in number of miles per in service delay and the availability of trains - for example, 40 out of 44 trains are required for service at 06:00 every weekday and 35 at weekends.</p> <p>At commercial closeout, the maintenance plan will be now be unique to this HSIPR service, reflecting the specified rolling stock, timetable and route characteristics.</p> <p>The plan must not be generic and must include the following:</p> <ul style="list-style-type: none"> • How train equipment will be monitored and pre-emptive maintenance undertaken (including the trade-offs of the cost of this with better train performance/reduction in delays); • Assumptions regarding unplanned maintenance (e.g., for vandalism) must be explained, including how these are included in the quantification of maintenance activities and resources; • Description of the scope of each type of inspection and maintenance which will be undertaken (including those undertaken prior to every train trip and fleet overhauls/refurbishments); • Frequency of each type of inspection and maintenance (noting where these are statutory), both on a mileage basis and on a calendar basis (translated into the latter using the proposed HSR timetable); • Where each type of inspection and maintenance will be undertaken and who will be responsible for undertaking them; • Resources (labor, materials, equipment and plant) required to undertake each type of inspection and maintenance, including the provider of these resources; • Unit costs of each type of inspection and maintenance; • The number of inspections and maintenance activities required per day, week and year for the whole fleet; • How the location, size and facilities provided at each maintenance depot aligns with delivering the maintenance plan. This should include contingency plans for reacting to train breakdowns which occur away from depots or terminus stations; and • Staff numbers, skills and equipment required must be specified for each location. <p>The proposal must confirm that sufficient fleet is available to operate the HSIPR service when major overhauls are planned and trains are out of service for a period of time.</p>
Approach used to estimate train maintenance costs	<p>The proposal must describe how the costs of train maintenance are forecast, and this must be prepared on a bottom-up basis from the train maintenance plan described above.</p> <p>The different depot staff roles must be specified, including the associated responsibilities.</p> <p>The number of inspections undertaken each day, week and year should be used to estimate the quantity of resources required.</p> <p>A detailed rostering exercise must be undertaken to forecast the staffing requirements for each role; this must ensure that sufficient cover is provided for training, holidays and sickness.</p> <p>Salaries must be quoted for each role and these should have been tested with the labor market and unions. The promoter must explain reasons for salaries which are markedly different from peer groups in other industries and HSIPR operations.</p> <p>The estimate of employer overheads will be more detailed than at final stage, and should be consistent with the employment terms and conditions of staff.</p> <p>The sources of labor, the training required and plan for managing industrial relations with the unions must be explained in the proposal.</p> <p>As a sense check, the maintenance costs should be converted into an annual cost per train and a cost per train and vehicle-mile. If maintenance costs are not directly proportional to train miles or vehicle numbers, the proposal should clearly explain why.</p>

Cost element	Description
Fixed costs included	<p>The fixed costs for providing the depot facilities must be estimated on the basis of the completed rolling stock and depot design and planned workload at each location. The costs must be presented in a disaggregated manner covering utilities, property taxes, building, plant and equipment maintenance, subcontracts such as access road maintenance and waste uplifts.</p> <p>Evidence of the contracts which will be placed with suppliers must be provided to substantiate the cost estimates.</p> <p>The quantity of each type of maintenance equipment at each depot must be stated. This must be consistent with the maintenance plan (in particular the inspections and maintenance undertaken daily, monthly and annually. It must be clear that there is some spare capacity for unplanned maintenance.</p> <p>If the depot is not yet constructed, the proposal must provide details of the delivery plan and provide confidence the facility will be available when the first trains are delivered for commissioning and handover from the manufacturer. Custom plant and equipment such as train elevators and wheel lathes have very long delivery times from the point of contract award.</p>
Changes in rolling stock costs over time	<p>The proposal must state assumptions as to how rolling stock and maintenance costs will change over time. Where trains are leased or maintenance is subcontracted, this must include how inflation will affect annual payments to the supplier.</p> <p>Changes may arise from: timetable alterations affecting the number or frequency of services; longer trains required to increase passenger capacity; and inflationary pressure on salaries and materials. If maintenance is subcontracted, the change process must be clearly explained.</p> <p>If the HSIPR operator is tied to the manufacturer for the supply of materials, the process through which competitive rates will continue to be achieved in the medium-term without competition must be explained.</p> <p>For maintenance costs, the proposal must differentiate between changes in labor and materials/equipment costs over time.</p>
Presentation of rolling stock costs	<p>This must be presented with headings consistent with those used at final stage and a comparison table provided to explain changes in each element. Material and fixed costs are the areas most likely to have been underestimated at final stage and therefore changes may be expected.</p>

Railroad

Where the HSIPR operator is a tenant rather than landlord of a railroad the commercial closeout submission must include access agreements in final draft status, i.e. finalized and awaiting signature. These will define the timetable slots provided, the process by which these can be changes, the reliability and availability of the railroad to the HSIPR operator and the charges for providing the specified services.

The key requirement is consistency between the timetable and railroad operations plan: the timetable paths must be confirmed and they must provide the travel times, stopping patterns and first and last services upon which ridership forecasts and the costs of providing train service have been forecast.

Where the HSIPR operator is the railroad landlord, consistency between the plans is still critical, but is subject to less external influence. Where a new railroad is being constructed, all design work for the construction will be complete and approved for construction by commercial closeout. Construction works may even be underway. A full list of railroad assets and components and their physical location on the railroad is now available and management plans should be developed specifying the maintenance regime and staff (including specialist skills), tools and plant required.

The plans should include provision for non scheduled maintenance work - damage is caused to the railroad by faulty rolling stock and also through trespass and vandalism.

Staff rosters for each depot location will be developed in an identical manner to those for traincrew and rolling stock maintenance. Most maintenance work will be undertaken at night and on weekends, and the HSIPR operator should specifically address how they will recruit and retain skilled staff if large numbers are required to permanently work unsociable hours.

As with rolling stock maintenance, materials from a large component of railroad costs and quantities and unit costs should be presented in detail. A wider supply base exists to provide railroad materials compared with rolling stock, and there is less risk of a step change in cost in this area compared with rolling stock.

The other major cost component is plant and equipment. Each railroad maintenance depot covers a large geographical area and large numbers of road and road/rail vehicles are required to permit rapid access to respond to equipment failures and also to undertake inspections of the way (and overhead line where fitted) in an efficient manner. Specialist equipment is required to access bridges, clean ballast and keep the way in the correct geometry. Some of this equipment will be purchased and some will be leased. This specific area may see a significant cost increase at commercial closeout due to underestimates at final stage.

As a first-order driver of total operating cost, any increase in railroad costs between final stage and commercial closeout will impact total costs. Due to the large geographical area, huge range of assets requiring maintenance and susceptibility to external influences such as flooding, landslides, road vehicles striking bridges and damage cause by rolling stock failure, railroad costs are a significant risk to the HSIPR operator. Costs therefore often increase between final and commercial closeout as a result of many small changes reflecting the HSIPR operator's changing perception of the potential size of this risk.

The railroad checklist for commercial closeout is presented in Table 7-6.

TABLE 7-6. QUANTIFYING RAILROAD COSTS AT COMMERCIAL CLOSEOUT

Cost element	Description
Railroad operations and maintenance costs included in operating costs	<p>Railroad operations and maintenance costs must be included as multiple line items in the operating cost forecasts, including labor, materials, subcontract and lease costs.</p> <p>Where the HSIPR service will operate as a tenant on a railroad, the costs may be presented as “railroad access costs” and these must also be presented as multiple line items, in accordance with how access costs are charged.</p>
Railroad landlord or tenant?	<p>If the HSIPR operator is a tenant to a railroad, the final access agreements must be presented to explain the services provided by the landlord and the remedies available to the HSIPR operator if these services are not provided and the costs of obtaining these services.</p> <p>Key areas of focus are:</p> <ul style="list-style-type: none"> • What rights does the landlord have to suspend the HSIPR services to undertake maintenance, how much notice do they require to give and what compensation is payable; • How will the landlord ensure sufficient capacity is retained for the HSIPR service for the duration of the concession; • What is the process by which the HSIPR can change their timetable; and • How will the landlord ensure the rights of the HSIPR operator are treated fairly and consistently in conjunction with other tenants, for example, what rights of appeal are there if proposed timetable changes are rejected by other operators?
Capacity of railroad	<p>The proposal must present the detailed working timetable and its verification by simulation. The services of other operators must be included in the simulation and the underpinning assumptions and the model outputs agreed upon with the operators (and railroad landlord if appropriate).</p> <p>The proposal must clearly demonstrate the proportion of railroad capacity unused along the route with particular focus on bottlenecks such as stations and junctions. The HSIPR operator should demonstrate in its proposal how the remaining capacity will be used, for example, to accommodate future growth or to sell access to other operators.</p>
Approach to estimating railroad operations costs described	<p>The proposal must describe how the railroad costs have been estimated and include assumptions (and their sources) for:</p> <ul style="list-style-type: none"> • The size, facilities and responsibility for each signaling and control center. The approved design must be consistent with the operations, timetable and rolling stock delivery plans; • The number of staff per signaling and control center will be verified through standard operating procedures developed from the final design. The staff skill and grades must be identified and the number quantified using a detailed rostering exercise. Management, supervisory and incident response staff must be identified; • Annual salaries and employers overheads for each role must be stated; and • The cost of maintaining the signaling and control centers and providing road vehicles for incident support staff included as fixed costs. <p>Unless there has been a radical change in the means of regulating the railroad, for example, through use of a different technology, commercial closeout costs should be expected to be consistent with those estimated at final stage. The underpinning detail will however provide greater confidence in the estimate.</p>
Approach to estimating railroad maintenance costs described	<p>The proposal will build upon the final stage estimate for railroad maintenance costs. This key difference is the outputs from the completed design allowing a full asset register to be compiled and from this a maintenance plan specific to the asset register and final train timetable can be developed. At commercial closeout, the maintenance plan must not be generic. The proposal must state:</p> <ul style="list-style-type: none"> • The agreed times when planned maintenance can take place and the railroad will be closed or access restricted to HSIPR services; • Maintenance activities which can take place when HSIPR services are running normally; • The frequency of preventative maintenance and servicing inspections of the railroad, the scope of these inspections and maintenance and the time taken for each; and • Labor, material, plant, equipment and sub-contract resources required to deliver the maintenance plan. <p>The proposal must present a maintenance program which shows the inspections taking place on each section of railroad during the year and the resources (labor, equipment and plant) required for each. The labor requirements must be disaggregated by skill type.</p> <p>The proposal must explain how reactive maintenance will be managed and resourced while at the same time ensuring that the rest of the railroad is maintained to enable safe operation of HSR services. It must identify “on-call” maintenance staff for such events.</p> <p>The unit costs of materials and equipment must be provided along with estimates of annual usage. The proposal must state whether significant elements of</p>

Cost element	Description
	<p>equipment will be purchased or leased, and the associated purchase or lease costs.</p> <p>The location, specification and facilities provided at railroad maintenance depots will have been fully designed. These should underpin the maintenance plan. The final stage detailed rostering exercise must be refreshed to reflect the greater knowledge available on staff roles and responsibilities and forecast workload.</p> <p>Salaries must be quoted for each role and these should have been tested with the labor market and unions. The promoter must explain reasons for salaries which are markedly different from peer groups in other industries and HSIPR operations.</p> <p>The estimate of employer overhead costs will be more detailed than at final stage, and should be consistent with the employment terms and conditions of staff.</p> <p>Fixed costs such as utilities, vehicle fuel, building maintenance, property taxes and plant and equipment leasing and maintenance should all be quantified either through estimates output from the design process or subcontracts.</p> <p>The sources of labor, the training required and plan for managing industrial relations with the unions must be explained in the proposal.</p> <p>As a sense check, the maintenance costs should be converted into an annual cost per route mile. If maintenance costs are not directly proportional to route distance or varies significantly from international benchmarks, the proposal should clearly explain why.</p> <p>Total annual resource costs must be presented for the full route as well as each depot.</p>
Changes in costs over time	<p>The proposal must state what assumptions have been made in terms of how costs will change over time. Of particular importance are the assumptions regarding how staff and material costs will be affected by inflation.</p>
Presentation of railroad costs	<p>This must be presented with consistent headings to those used at final stage and a comparison table provided to explain changes in each element. Material and fixed costs are the areas most likely to have been underestimated at final stage, and therefore changes may be expected.</p>

General and administrative

Table 7-7 presents the checklist for general and administrative costs at commercial closeout. Feedback to the HSIPR operator at intermediate and final stages on how to structure operating cost estimates should avoid this category becoming a “catch all” and restrict the content to head office type costs.

A large increase in general and administrative costs at commercial closeout should at one level be viewed positively as earlier omissions are being captured, however this does indicate earlier estimates were of poor quality.

A full head office organizational structure must now exist and costs must be based on as many salary bands as necessary to properly reflect the variety of technical, professional, management and clerical skills required to support an HSIPR operation.

Firm costs will exist for subcontracts such as call center and internet ticket sales, however, other consultancy-type support, such as legal support, is more reactive and budgets should be based on an estimated number of person-days of support for each category. Support is typically required for legal, commercial, ridership and revenue analysis and technical (standards, timetable development and rolling stock / railroad performance).

Risk assessment

At commercial closeout, the HSIPR operator is prepared to enter into a contractual commitment and take an agreed level of commercial risk. The cost estimate must therefore be developed entirely from detailed plans with supporting job descriptions, rosters, staff salary ranges, train diagrams and maintenance activities.

At this stage, the cost estimate should be accompanied by a list of factors which the HSIPR operator is unwilling or not best placed to take commercial risk on, such as: annual inflation rates; the performance impacts on ridership of the regional and national economy; and future government policy impacts on standards.

The operating cost estimate will therefore have no exclusions or caveats and instead be supported by clear attribution of each identified risk area to the HSIPR operator and the funder(s). Completion of design and modeling work means most if not all assumptions will have been verified with supplier contracts defining the redress available to the HSIPR operator should elements which have yet to be supplied (such as the rolling stock and railroad) fail to meet the contract specification.

A reviewer must consider the cost of managing such risks, irrespective of the party it is allocated to. A true picture of the cost of operating the new/enhanced rail system is only obtained when the costs of all parties are collated. The total costs presented must therefore include the operating costs not only of the HSIPR operator, but also those being borne by the other parties whose support will be required to deliver a successful rail service.

The risk register and quantified risk assessment (QRA) undertaken at final stage will have been updated to reflect the increasing knowledge base as design is completed and approved and supply contracts established with subcontractors. The assumptions register would be expected to now be restricted to how external events such as inflation rates are being treated.

TABLE 7-7. QUANTIFYING GENERAL AND ADMINISTRATIVE COSTS AT COMMERCIAL CLOSEOUT

Cost element	Description
Inclusion of general and administrative costs	Forecasts of general and administrative costs must be included as multiple line items in the operating cost forecasts and they must be forecast on a bottom-up basis.
Staff roles and responsibilities	<p>Assuming traincrew, maintenance, station and railroad staff have all been accounted for in the separate cost categories described earlier, staff in the general and administrative function must include:</p> <ul style="list-style-type: none"> • Directors and senior management; • Specialist support such as technical standards, procurement and contract management; • General support such as administration, marketing, human resources, training and finance; and • Operations - control center for day-to-day management and separate strategic planning. <p>Each role must be identified and the responsibilities outlined.</p> <p>The proposed head office team must be presented in the form of an organogram, to confirm that all functions have been covered and there is no double-counting. Where head office functions will be covered by a parent company, the proposal should clearly state how these costs are included in the HSIPR operating cost forecasts.</p>
Total staff numbers specified by role	<p>The proposal must specify the total number of staff in each role in the categories described above. The number of staff by role and grade must also be specified, since “other staff” costs are relatively high due to the higher than average salaries which are paid to employees in these roles.</p> <p>Most of these functions are Monday to Friday only but where support is provided on a 24/7 basis (such as the control center), the number of staff must be estimated based on a rostering exercise to ensure that there is sufficient cover for training, holidays and sickness.</p>
Salaries and overhead <ul style="list-style-type: none"> • Basic salaries stated • Overhead • Source specified • Risks identified 	<p>Salaries must be quoted for each role and at commercial closeout, these should have been tested with the labor market and unions. The promoter must explain reasons for salaries which are markedly different from peer groups in other industries and HSIPR operations.</p> <p>The estimate of employer overhead costs will be more detailed than at final stage, and should be consistent with the employment terms and conditions of staff.</p> <p>The sources of labor, the training required and plan for managing industrial relations with the unions must be explained in the proposal.</p>
Non-staff costs	<p>Non-staff costs will account for the majority of general and administrative costs. Robust cost forecasts can only be prepared if the promoter is clear how the HSIPR business will be supported day-to-day and to cover periodic issues.</p> <p>Cost forecasts must be prepared on a bottom-up basis, reflect initial negotiations with suppliers and include:</p> <ul style="list-style-type: none"> • IT equipment and maintenance/renewals; • Insurance; • Marketing and advertising; • Office supplies including stationery, postage and printing of HSR customer information (e.g., timetables); • Telephone services; • Professional services such as legal and engineering advice and insurance; • Commissions to third parties who sell HSR tickets (including other train operators, travel agents and airlines); • Internet and telephone ticket sales; • Utilities (water, gas, electricity) and waste disposal; • Catering, parking management and maintenance and station security staff, where these are subcontracted; • Employees’ uniforms;

	<ul style="list-style-type: none"> • Employees' expenses (e.g., to cover travel and subsistence for traincrew staff who finish their shift at a remote location); • Employees' bonuses (the proposal must propose how a bonus system would work); • Air/bus costs (where train or railroad failures mean passengers need to be conveyed by an alternative means); and • Facilities management costs such as utilities, building maintenance and property taxes (the facilities costs for stations and depots must be discretely presented in the respective stations and train maintenance sections of the cost forecasts). <p>The proposal must include a description of each of these items, an estimate of the number of units required and the frequency of incidence (e.g., the number of computers and staff uniforms required and how frequently they will be replaced/updated) and the unit cost of each.</p> <p>The proposal must give a particularly thorough explanation of marketing and advertising costs and the costs of ticket sales, as these are often poorly scoped and they are critical to achieving the ridership forecasts and the passenger revenue.</p>
Changes in costs over time	<p>The proposal must consider and make assumptions with respect to how staff costs will increase over time.</p> <p>This must include planned variations in staff numbers for each function with any proposed change in train service level, passenger volumes or changes in train formation.</p> <p>The rationale behind the assumptions adopted must be explained.</p> <p>Inflationary assumptions which grow the non-staff costs over time should be clearly explained.</p>
Presentation of general and administrative costs	<p>This must be presented with consistent headings to those used at final stage and a comparison table provided to explain changes in each element. Material and fixed costs are the areas most likely to have been underestimated at final stage, and therefore changes may be expected.</p>

Given the QRA and clear definition of which costs the HSIPR operator will be taking risk on, the contingency required for unknown risk should be very low - certainly less than 10% and potentially 0% if responsibility for managing risks is shared between the HSIPR operator and the funder(s).

As progression beyond commercial closeout will result in contractual commitments, the HSIPR operator should seek to retain some contingency to cover unknown risks. This may not be presented directly as contingency and instead is discretely built into key cost areas such as train miles and staffing requirements. This may not be achieved by inflating these elements from the final stage submission but rather efficiencies identified during the development work leading to commercial closeout. For example, at final stage, the HSIPR operator estimates it will require 200 drivers at an annual cost of \$100k each to operate the service. During the final timetabling and staff rostering exercises, a need for only 190 drivers is identified, and negotiations with unions result in an average cost of \$95k per driver. The HSIPR operator may choose to retain the cost of the 10 drivers which has been saved (only a theoretical saving because they are not recruited yet) and present at commercial closeout a cost of 200 drivers at \$95k each, with the purpose of the “saved” \$950k being to provide some contingency. This is prudent practice if applied appropriately as there will inevitably be errors in some elements of the overall estimate, even at commercial closeout. It is a useful exercise for a reviewer to try and find where elements of contingency have been “hidden” to try and quantify how much contingency above any declared amount lies within the total cost presented. This is not a straightforward process, and can be time consuming as it involves a fairly forensic examination of the presented costs, delivery plans and supporting detail to identify inconsistencies between them.

As discussed earlier in the section, an area of more concern is where contingency is applied on top of contingency, particularly in the process of scaling up the staff required to operate a train service or station per shift into annual full-time equivalent numbers. This is less desirable than the example discussed above, where a conscious management choice is made not to include all identified efficiencies in costs presented at commercial closeout. In this case, the HSIPR operator has less (and sometimes no) understanding of the size of contingency being carried in the estimate. The “rounding up” of resources can be undertaken by those who will have technical or line management responsibility in the operational railway as a means of providing themselves some contingency and an uninformed management team can be unsuspecting on this. This obviously leads to risk being double-counted and a less attractive commercial offer overall. The scale of this practice can really only be quantified through a reviewer repeating the resource calculations, particularly in the areas identified in the checklists.

Common shortcuts leading to poor quality estimates

At commercial closeout, the HSIPR operator will have developed its estimate of operating cost to a level of detail sufficient for its governing board to permit entry into a commercial contract to provide the service.

All areas of potential cost should have been identified at final stage, with the largest pitfall being optimism on the key metrics driving the cost and/or the unit rates applied. Completion of design and further simulation work will result in the correct metrics such as annual train miles and hours being calculated. Engagement with the labor market and supply chains will provide more accurate unit cost data.

This means the estimate for a base year should be well defined and accurate within narrow tolerances. The pitfalls and shortcuts leading to poor quality estimates discussed at final stage will substantially be addressed by commercial closeout. A substantial increase in the estimate of operating cost between final stage and commercial closeout is a good indicator that shortcuts were taken in the earlier stages.

Pitfalls can arise from the fact that an HSIPR service is a complex system with many interdependencies between its components. If the delivery plans underpinning the estimate are not completely integrated, errors in estimation will occur. For example, the team responsible for calculating the rolling stock

maintenance requirements may not be working from exactly the same data as the timetabling team, which can result in slightly different assumptions as to the exact times trains will be available at depots for maintenance. By commercial closeout, a reviewer will have built up an impression of the HSIPR operator's management style and areas of focus. If systems integration and control of data is seen as a potential weakness, it is suggested that time is invested to ensure the delivery plans and underpinning data in each are completely consistent.

However the main pitfall in commercial closeout estimates is where the HSIPR operator focuses on a developing a "perfect" base year cost estimate rather than considering how costs will change over a concession period of 20 or 30 years.

Estimates over a concession period

It is essential to ensure a common understanding and interpretation of the contract specification between the funder(s) and the HSIPR operator. This is particularly the case if state or national funding is used to offset some of the construction or operating cost of the HSIPR system in expectation of specific communities receiving a minimum level of service or benefit from introduction of the HSIPR service. The service introduced may not be consistent with information provided by elected representatives to local (and sometimes national) constituents. A commercial entity such as an HSIPR operator will interpret a specification more rigidly than a funder or politician - the quotation to provide the service is based on a specific service offer and anything else will be a contract change or variation. It is therefore important that the contract is designed in a manner which accepts there will need to be specification changes over a long concession period, and these can be introduced as efficiently as possible.

At commercial closeout, it is suggested that review effort is spent checking for differences between the parties in their interpretation of the specification, and in particular considering the HSIPR operator's potential response to external events.

During commercial discussions prior to concession award, the HSIPR operator of the service will present an optimistic view. However, following contract award, the actions which will be taken by the HSIPR operator if its forecast profit margins are not met should be considered. This situation can arise from the forecast ridership not materializing due to optimistic forecasts or external events such as a wider economic downturn or a competitive response from alternate transport modes. Alternatively the cost base can increase through inflation affecting staff costs or international events affecting energy or material costs. It is essential to consider the HSIPR operators contingency plans for such events and form a clear understanding how and by whom these risks will be managed.

Without constraints being applied, when faced with decreasing margins, the HSIPR operator will seek to increase revenue and decrease costs. Operating costs can really only be reduced by running fewer train miles and train hours to reduce energy and staff costs respectively. Train stopping patterns are particularly sensitive issues - it costs an HSIPR service to stop in terms of energy used, station staffing and maintenance and increased travel time, which can require additional rolling stock and staff. During a period of economic downturn, an intermediate station could see its service frequency reduced from (say) a train every hour to one or two per day. Economically, the reduction in connectivity could worsen opportunities for the populations and businesses served by this station. However, this does not impact the HSIPR operator directly, as it experiences a small loss in farebox revenue, but a proportionally larger reduction in cost and therefore benefit from its actions.

The purpose of this example is to illustrate how behavior will change when the HSIPR operator is placed under commercial pressure and illustrate the need to agree on how such periods will be managed as they will inevitably arise over a concession period of any reasonable length.

APPENDIX

A

RELEVANT ACADEMIC RESEARCH PAPERS

A1 A REVIEW OF HSR EXPERIENCES AROUND THE WORLD, FUNDACION BBVA, DECEMBER 2008

This study draws on an International Union of Railways (UIC) held database comprising all existing HSR projects around the world at the start of 2006. The database includes technical characteristics and building cost of each project plus detailed information on the operating and maintenance costs for services and infrastructure of lines already in operation.

The database has information on 166 projects in 20 countries of which 40 (24%) were in operation, 41 were under construction and 85 in the planning stage as of 2006.

The report has a specific chapter comparing the operating costs of different rail systems. It clearly defines the two separate cost components of operating and maintaining train services, and that of operating and maintaining the infrastructure. The report is clear in stating that where infrastructure is separately managed, access charges represent an additional cost for the train service operator but merely represent a transfer of funds when considered from the perspective of the HSR system as a whole.

Infrastructure maintenance

Infrastructure maintenance costs are presented for four European HSR networks. The analysis concludes:

- Labor accounts for:
 - 55% of cost for maintenance of electrification equipment (overhead catenary and electrical distribution systems providing traction power);
 - 45% of cost for maintenance of the permanent way; and
 - 50% of the cost of maintaining equipment.
- As a proportion of overall maintenance cost:
 - Permanent way and supporting structures account for 40-67%;
 - Signaling and telecommunications account for 10-35%; and
 - Electrification equipment accounts for 8-19%.
- Adjusted to 2009 prices, the annual cost of maintaining a high-speed railway is \$90,000 to \$102,000 per single track mile.

Rolling stock and train operating cost

The cost areas are summarized as:

- Shunting and train operations - mainly labor costs;
- Maintenance of rolling stock and equipment;
- Energy; and
- Sales and administration.

Sales and administration varies across rail operators depending upon the expected traffic level, as it principally includes staff costs for ticket sales and providing information at stations. An indication is given that this can cost as much as 10% of overall farebox revenue. The other three cost components vary widely across projects because they are dependent upon the specific technologies used.

Rolling stock acquisition costs are presented for a number of countries and range between \$46,000 and \$92,000 per passenger seat. Rolling stock operating and maintenance costs are presented for four European countries in terms of per train, per seat and per seat-km for the life of the train. The average operating and maintenance cost per seat is \$75,000, but there is a wide range of values and little which can be concluded in terms of trends.

However, the maintenance cost falls in the range of 8-14% of the operating cost over the life of the train. This clearly demonstrates the impact of staffing and energy on the overall costs.

Energy consumption per passenger is stated to increase rapidly when speeds increase above 187 mph. An interesting point is made that energy consumption of HSR in France is 5% lower than Germany, not only because the unit cost is cheaper (primarily nuclear generation), but also because it is directly acquired by the rail operator rather than purchased from the infrastructure manager. This gives the conclusion that when the rail operator can negotiate its own energy contracts, it finds more incentive to reduce consumption or is more adept at commercial negotiations with the electricity supplier.

A2 TRANSPORT RESEARCH CENTER, OCTOBER 2008

This paper considers the benefits which arise from HSR projects with a particular focus on intermodal effects and pricing rather than costs. However the paper clearly identifies operation of HSR services involves two types of costs: infrastructure maintenance and operating costs; and those related to the provision of transportation services using the infrastructure.

Infrastructure

Include the costs of labor, energy and other material consumed by the maintenance and operations of the tracks, terminals, stations, energy supplying and signaling systems, as well as traffic management and safety systems. It clarifies some of these costs are fixed, and depend on operations routinely performed in accordance to technical and safety standards. In other cases, as in the maintenance of tracks, the cost is affected by the traffic intensity; similarly, the cost of maintaining electric traction installations and the catenary depends on the number of trains running on the infrastructure.

The study reports infrastructure maintenance costs per mile of single track are, on average, equal to \$90 to \$102k per year (adjusted to 2009 prices). This is based on data from five European countries (Belgium, France, Italy, The Netherlands and Spain). The review team has identified from separate research, the UK equivalent cost as \$204k per year.

Train service

The study categorizes operating costs of HSR services as train operations, maintenance of rolling stock and equipment, energy, sales and administration. These vary across rail operators depending on the specific technology used by trains and traffic volumes. The study clarifies that in Europe, almost each country has developed its own technological specificities; each train has different technical characteristics in terms of length, composition, seats, weight, power, traction, tilting features, etc, all of which influence operating cost. The study estimates the purchase cost of HSR rolling stock to fall within the range \$46k to \$91k per passenger seat.

Train operating costs per seat range from \$58k to \$101k and rolling stock maintenance from \$4.2k to \$11.3k, over the life of the assumed 20-year life of the rolling stock. HSR trains operate between 185,000 to 310,000 miles per year, and have 330 to 630 seats per train. Given the size of these ranges, a cost per seat-km ratio for one country can be twice that of another. Accordingly, use of this ratio as a KPI should be treated with caution.

Worked out example

The study paper contains an interesting worked out example, which attempts to demonstrate how difficult it is for HSR operating cost to outweigh revenue without some level of government subsidy.

A3 THE FULL COST OF HSR: AN ENGINEERING APPROACH, ANNALS OF REGIONAL SCIENCE, DECEMBER 1996

This paper examines infrastructure and rolling stock capital and operating costs of a high-speed rail system proposed for a corridor connecting Los Angeles and San Francisco. The paper concludes HSR is more expensive than expanding the existing air service and should serve shorter-distance markets in which it competes with automobile travel.

The cost of operating the train service is divided into categories of:

- **Sales and administration** - include labor costs for ticket sales, providing customer information at stations and automated ticket vending. These are estimated as 10% of the farebox revenue;
- **Shunting / track switching** - depend on the distance between the depot and station as well as the average time trains stay in the depot. These can be approximated on a per train basis and staff costs account for 80% of the total shunting/track switching cost;
- **Train operations** - consist of train servicing, driving, operating and safety and consist entirely of labor costs;
- **Infrastructure maintenance** - this is proportional to the number of trains running and is labor intensive, with 45% of track maintenance, 55% of electric traction installations and 50% of equipment comprising of staff costs; and
- **Energy** - is estimated from the average consumption per km for each type of train operating. Energy consumption per passenger increases significantly at speeds above 187 mph. Figures quoted from France range between 16-32 KWhr/mile per train or 6-11 KWhr/passenger/100 miles.

The table below summarizes the costs estimated for the Los Angeles - San Francisco corridor.

Cost component	Units	Unit cost	Total cost (\$m)	
Sales & admin	Passengers	\$5.00	\$52.775m	19%
Shunting	Train	\$87.80	\$3.429m	1%
Train servicing	Train-hour	\$92.20	\$11.112m	4%
Driving	Train-hour	\$81.80	\$9.760m	3%
Operations	Train-mile	\$0.03	\$1.315	1%
Energy	Train-mile	\$1.50 (\$0.10 per KHhr)	\$69.135	25%
Infrastructure maintenance	Train-mile	\$3.00	\$132.691	47%
			\$280.217m	100%

The study assumes the capital cost of a 350-seat capacity high-speed train of \$17.9m, and 5% spares for maintenance (2 sets) is added to the number calculated as being required to operate the timetable.

CONTROL SHEET

Project/Proposal Name Best practices in HSIPR study
Document Title Operating Costs Estimation
Client Contract/Project No.
SDG Project/Proposal No. 22249901

ISSUE HISTORY

Issue No.	Date	Details
1_0	17/1/11	Completely revised submission for client review
2_0	28/2/11	Update following client feedback.
3_0	31/03/11	Draft Final
4.0	30/5/11	Commercial closeout added

REVIEW

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DISTRIBUTION

Client: Office of Inspector General
Steer Davies Gleave: File; Project team

