14. New Train Introduction

How to buy a new train fleet to get the best "out-of-the-box" service performance, risks associated with whole fleet behaviour following Introduction

14 New Train Introduction

This handbook for reliability improvement will concentrate on how to buy a new train fleet to get the best out-of-the-box service performance. It is written primarily from the perspective of TOCs as key players in the procurement of new trains. They have the best knowledge of what they and their passengers need and want and will be first in the firing line if the product and reliability fall short. There are lessons learned based on recent procurement experience, but these are not comprehensive and are intended to raise awareness of issues which can inform future thinking. This section may be equally applicable to the installation of new train equipment.

Two powerful lessons learned to maximise reliability are:

- The effective deployment of significant train operator resources. This costs money but pays reliability and other long-term dividends; and
- adequate timescales and sufficient contractual rights to enable the TOC to demand that deliverables are right at each stage of the project (to avoid time or financial pressure from other stakeholders to accept an inferior product).

14.1 Pre-contract – product selection

14.1.1 Planning

It is worth investing serious time and energy in this phase of the project, hence the lengthy recommendations in the pre-contract and contract sections. Some are legal requirements (such as issuing an OJEU notice) but the focus is on practical steps to improve reliability based on positive and negative experiences.

Critical to efficient implementation of the eventual train service is the early and effective engagement of the TOC's operations and commercial functions, e.g. what the needs of the passengers on the route are, what the roles of on-train staff are, how other trains on that TOC work, etc. It is best if the TOC frees up some of its own staff who know how their railway operates, its constraints and opportunities, rather than hiring consultants (although long-term secondees can be valuable if integrated in the TOC team).

A one-team integrated approach should be adopted early on, bringing together operational staff, engineering and commercial aspects of the business, and be cross-organisational, preferably with knowledge and experience in fleet introduction. It can also be worthwhile to include representatives from Network Rail, front line staff and the driver body in cross-company workshops.

No matter how tightly the contracts are written, the TOC always has risks that cannot be fully passed back to other parties:

- Safety - the ultimate responsibility to run a safe train falls to the TOC
- Overall business risk - performance regimes with manufacturers to deal with poor performance are invariably capped and based on an estimate of possible TOC losses made years before the trains enter service.

In recognition of these risks a detailed train specification (setting out how the manufacturer will deliver a product compliant with the TOC's functional specification) should be agreed before any preferred supplier is nominated. The more time invested here, the more successful train implementation has been in terms of fewer (expensive) variations to the contract during the project; higher reliability out-of-the-box; lower risk of an overspent manufacturer being unwilling (or unable) to finish the job properly.

Further, there is a correlation between the time available for the whole project and successful implementation: heroic timescales are less likely to produce good trains. This gives the TOC the ability to say no (or even to credibly threaten to say no) at critical milestones in the development and delivery of the fleet, providing real leverage to ensure quality requirements are met.

14.1.2 **Specification development**

The process can be either prescriptive (by invitation to tender) or co-operative (by invitation to negotiate, as in the Eurostar example given below).

> Example: Eurostar's process of tendering for new fleet was unique in that it issued a tender to negotiate for a suitable high-speed TSI-compliant platform. They then worked with the supplier to build the specification around what was possible.
>
> Eurostar are fortunate in that their infrastructure is largely TSI-compliant so there was good knowledge in the supply chain of system requirements and products available that could be easily modified.

The core requirements should cover:

- Train technical issues, e.g. route-specific performance parameters such as top speed and kinematic envelope;
- Train passenger issues, e.g. passenger carrying capacity, ambience, facilities;
- Train depot issues, e.g. fuel, coolant, sander and toilet interfaces for servicing; and
- Train station issues, e.g. water filling, ability to use emergency coupler in platform road.

Subsequent steps:

- Understand what is available on the market. Aim for proven design rather than a trial stage of product development. For example, TPE based the Class 185 on Class 180 below the solebar and Class 360 above. Is there an opportunity to use an existing production line? This can save ramp-up time and costs.
- Determine the level of innovation. Southeastern's Javelin, for example, was considered very high performing but not very innovative as it used 1980s/90s traction technology. There is a line between innovation, such that your customers really see this as a new train, and out-of-the-box reliability. Understand best practice and industry codes of practice and do not be afraid to challenge outdated or irrelevant standards. Also allow time for necessary derogations.
- Understand the functional needs, e.g. how passengers, crew, maintenance staff and other stock will interface with the new train. Obtain input from operations colleagues within the TOC as well as engineers. For instance, take the train specification detail right down to the level of a driver or guard opening and closing doors (including SDO). Does this fit with station dwell times? How does the train's diagnostic system report faults to the driver? What does it tell them to do? How long will it take them to do it? Is the remote downloading capability sufficient? Every detail could cost money and compatibility with other stock may be critical.
- Specify no single point failures and consider the train as a whole. For example, Class 700 units introduced on Thameslink are 8/12 car fixed formation units, which meant that a single damaged window can take the unit out of service. Is there the ability to isolate or make safe such failures to allow the unit to complete its journey?
- Be clear on requirements for data management systems on the train, including data formats

and downloads.
- Ensure the right to participate in final design reviews. This will be an opportunity to clarify any grey areas left in the specification (*see 14.4 below*).

14.1.3 **Commercial strategy**

Recommendations from experience are:

- Start with 5 or more train suppliers and run with at least 2. Reach at least train specification and heads of terms agreements with both to facilitate a contract with either. This is to maintain competitive pressure and mitigate the risks of opting for a preferred bidder too early (it is more difficult to return to the non-preferred). Keep two suppliers in to have a credible alternative right up to the point of contract conclusion. Consider the manufacturer's order book– success can breed success but also stretch the supplier's resources.
- Decide whether to manage procurement in-house or outsource it. If outsourced, how much control should be retained? Is it viable to buy the trains and then apply for re-financing?
- If appropriate, approach 5 financiers and develop 2. Decide between different forms of relationship.

Examples: ROSCO and TOC speak with one voice to the supplier with a clearer focus on reliability and other essential requirements as a result.

In the South West Trains Desiro project, the TOC was contracted to manage ROSCO's interests in the procurement process. For the Southern Electrostar programme, a TOC/ROSCO team was formed where the ROSCO engineer was contractually designated the TOC engineer's assistant. Both arrangements require individuals to develop good working relationships and rely on clear and acceptable contracts.

14.1.4 **Maintenance strategy**

- Decide what the product is, e.g. train and spares only/train and specialist support/design-build-maintain/train-service-provider/availability contract
- Set targets for overhaul cycles and routine maintenance periodicities as these will be key drivers of both maintenance costs and train availability
- Be aware that a whole life maintenance plan may not be available at this stage and great care must be taken at later stages to ensure that subsequent development of the plan does not present additional risks
- If an aftersales division of the supplier is providing any of the services, what is their relationship with the manufacturing arm, and how committed is the latter to supporting the former? Is there an internal contract in place? What level of the supplier's management structure decides on cross- division support?

Example: Be wary of the split of responsibilities between operators and suppliers.

Siemens are responsible for all maintenance of the 700s at both Three Bridges and Hornsey. The existing arrangement at Hornsey had GTR drivers who managed the washing and moving of trains. Three Bridges copied this approach and had Siemens maintaining trains but was reliant on GTR for movements and the wash side. GTR had to recruit new drivers and a management team for Three Bridges.

This was a missed opportunity at the contracting stage. Both parties are working around the problems, but a strict contract makes it difficult. Handover from maintainers to drivers, for example, is very prescriptive.

14.1.5 **Procurement process**

- Develop a risk allocation matrix – who is responsible for what
- Plan support services –allocate enough resources with the right knowledge and incentives. The person who reviews the bids should be the person who lives with the product. This includes the operators, e.g. ensuring the driver manager and head of guards sign off the specification.

From considering the primary roles of TOC, manufacturer and financier, the roles of other players can be inferred. Two key ones are listed below. (The TOC may arrange for other parties such as catering contractors to deliver aspects of their service.)

14.1.6 **Role of the franchising authority**

- If new train procurement is a requirement in a franchise, then enough time should be allowed prior to implementation to enable a robust procurement process to be set up and delivered.
- Core specification policy decisions should be timely to set the framework and key interfaces (using the criteria set out, e.g. extent of compatibility with other stock) to enable the TOC to undertake the detailed work (and negotiate with the franchisor on core requirements if they appear unduly costly).

Example: What is specified may be found at a later stage to be unfeasible or undeliverable.

Connected Driver Advisory System (C-DAS) was specified by the DfT for the Class 700 but did not include details. Siemens fitted a generic solution that 'should' marry up with the Hitachi traffic management at Three Bridges ROC but currently it is unknown if it will.

Both Greater Anglia and Northern found themselves in a similar situation with 'ETCS-Ready', which DfT had specified but not formally defined.

14.1.7 **Role of the infrastructure manager (commonly Network Rail)**

- Work with Network Rail and other operators on station design and platform lengths, etc. Siemens worked with Network Rail on station designs throughout the Thameslink core to ensure that dwell times could be met. This included signage to optimise flow from doors through barriers and onward.
- Thought should also be given to specifying and buying space or land for depots and stabling, etc. Is the land available? Might it be earmarked for other projects or public sale?
- Work with Network Rail on plans for electrification - how likely are these to remain on schedule and be delivered? This can greatly affect the choice of traction type, with bi-mode

offering security in the short term until electrification is complete.
- Specifications for overhead lines and 3rd rail parameters and interfaces with the train need to be considered as the actual infrastructure can deviate from Network Rail's drawings.

14.2 **The contract**

Delivery (what you get) and finance and train performance (how you pay for what you get and protect yourself from not getting it).

It is worth discussing some cultural differences at this juncture. A cultural disconnect between commercial and engineering departments in different countries can often be of benefit but there can also be a disconnect between project delivery teams and design teams in organisations set up with individual business units which must work together on new train introductions. This is a problem when technical experts are in a different country.

14.2.1 **Recommendations around acceptance and delivery**

- Delivery profile is crucial and TOCs should insist on delivery gateways. For instance:
    - if payment milestones are spread throughout the design and manufacturing phase, choose hard evidence gateways (e.g. first article inspections, submission of type test reports) rather than ethereal ones (e.g. the supplier's internal design freezes or assembly line build stages, which can be passed with issues outstanding)
    - treat hard deliverables (e.g. special tools, initial spares stocks) and soft deliverables (e.g. technical libraries) equally and specify when (how long in advance of train delivery) they should be provided to unlock train acceptance
    - use qualified acceptance to incentivise the supplier to close out acceptance issues. This should, ideally, be linked to price retention.
    - Mature software should be a milestone
- Detail is critical. If looking at a proven product, insist on the defined performance levels achieved on other railways. Be clear about when they are required and what happens if they are achieved (or not).
- Particularly if the rolling stock being procured is of a substantially new design, time should be allowed for evaluation of the first trains built before full fleet delivery takes place. For example, TPE gave drivers a pre-handover period (2 weeks) on the trains to test fault scenarios and see if they can break it, to enable design tweaks and process changes.
- Aim to have the external manufacturing arm treat the supplier's aftersales organisation as an internal customer alongside the TOC as external customer when setting up the acceptance process.

14.2.2 **Technical documentation and data**

- Be specific about technical and user documentation in the contract, e.g. what is meant by "all documents required to enable efficient and safe maintenance and operation". This might require an explanation of the elements of the maintenance plan, the limits on the periodicity of individual activities and the risks they were designed to mitigate.
- This would boost understanding of how to improve initial reliability and provide a robust basis for developing and refining the maintenance plan going forward. Ask for maintenance plan delivery on physical media such as a read only memory stick. Experience with web-based interactive manuals is often bitter and can conflict with the basic principles of document control.
- Be clear about how the information should be delivered. Does a bundle of A4 photocopies with suppliers' part numbers constitute a list of parts? What interfaces should be integrated with existing maintenance management systems? Similarly, request delivery of special tools, e.g. laptop-based diagnostic software at an appropriate milestone.
- Have the short- and long-term end users of the documentation agree the format. These may

be ROSCOs, TOCs and the supplier's aftersales division.

- Require safety critical components to be identified for approval as such in line with best practice, e.g. ATOC/ACOP/ EC01003 supplier accreditation (soon to be superseded by RIS 2750) and ATOC/ACOP/EC01007 management of safety critical components (which recommends, for example, that safety critical components are also entered on PADS).
- Either:
  - formally review and approve or
  - require sight of maintenance and overhaul instructions, particularly for components (as railway undertakings, TOCs need to know to ensure they are credible and compatible with the maintainer's facilities)
- Ensure access rights to all data within the train management system and all off-train software needed to analyse it (contracts have varied, even between TOCs buying the same train, and a lack of information can hinder reliability growth).

14.2.3 **Supply chain management**

Change control is particularly critical and should be guided by an assessment of fundamental risks and a standard engineering change process. There have been instances in long build contracts where inferior components have been substituted without asking the TOC. Of course, some changes are necessary and/or desirable as better products are developed or existing parts become obsolete. There should be a contractual clause to the effect that TOC agreement would not be unreasonably withheld. The TOC should also contractualise the right to audit supply without warning, but it should not be used to weaken the supplier's product responsibilities in the contract (or company processes).

14.2.4 **Obsolescence management**

As outlined in *Section 13.6* above, obsolescence risks should be identified for every train and a conscious decision taken about how to manage each one. This may include additional specific contractual requirements or responsibilities beyond the warranty phase, possibly into long-term management deals.

It is important to ask in the early stages if there is flexibility in the design. This is more of a concern for future franchises or the rolling stock owners as they may be restricted in later cascades or route changes if there is no future proofing, e.g. procuring a diesel fleet when electrification is a possibility in 10 years' time. Perhaps a bi-mode traction type will be better for future use, even if electrification does not transpire.

A design authority or similar support arrangement should be in place for each fleet to provide a point of reference for design information and knowledge and a base from which electronic systems and the vehicle in general can be developed throughout its life (proactive obsolescence management). It will certainly include some careful consideration of electronics and software, such as life time buys for some electronics and clear software escrow rights in general.

Electronics are not always expected to last the life of the train. This must be managed on the basis that the train needs to continue functioning. Obsolescence is also compounded by new trains being built from a kit of parts. Component drawings and design knowledge may be held at sub-supplier level and not in the public domain, making it harder to resolve future issues. Challenge existing designs where appropriate and insist on a new approach.

14.3 **Financial recommendations**

14.3.1 **Performance**

- Use standard industry measures (3-minute delays [MTINs], delay minutes) as indicators for the performance regime. Do not allow suppliers to quote their own measures, such as technical capability, which favour their statistics at the expense of passengers. Be wary of using older performance measures, i.e. DfT specified reliability for the Class 700 using MPC (miles per casualty).

- Ensure the supplier takes responsibility for problems caused by poor ergonomics and man/machine interface (e.g. misleading messages on the train's data management system).
- Include targets and incentives for reliability of passenger amenities (toilets, air conditioning, etc.).

Example: Depending on the manufacturer, synergies can be achieved between certain requirements and targets.

With the Class 700, the DfT had specified optimised maintainability and reliability and reduced energy consumption. In fact, the lighter the train was, the more they were paid. However, Siemens had to make sure that any savings in weight were not detrimental to maintainability or reliability (lighter yet solid). This is a benefit of train builder and maintainer being the same entity.

- Ensure that warranties and financial incentives are clear. Set realistic and enforceable delivery targets, e.g. achieve half the eventual reliability performance on day 1 otherwise the first train will not be bought; unless MTIN of x achieved by day y otherwise there will be no purchase or purchase at a lower price (i.e. link performance to price). Do not rely on the service organisation to get back to the manufacturer on a 'with maintenance' deal. Service organisations will always cap out their warranties on performance; retain a performance warranty with the manufacturer in addition.
- Set out the following warranty terms: what you get; what the supplier does; what you do. There should also be a strong endemic defect clause such that if you reasonably believe the product is defective, you can choose to stop buying until the issue is resolved, without having to reach a threshold of failures first.
- Set up a retention bond available to put right a major system failure should it happen, even after purchase (beyond warranty and for issues yet unknown). This risk decreases with a proven product.
- Seek timed and priced options for flexibility, e.g. to cope with future growth (inserting extra vehicles in a rake) or possible changes in future usage.

14.3.2 **Payment profile**

The ROSCO has a significant role in the payment profile and this can have a significant impact on long-term reliability. Bear in mind the risk of conflict between TOC and ROSCO requirements: the ROSCO wants a train that is leased and will be leasable throughout its life, whereas the TOC wants a reliable train that meets its franchise requirements. This demonstrates the need for a good relationship with the ROSCO, backed up by aligning interests contractually as far as possible:

- Ensure there are robust incentives on the manufacturer to close out all the technical issues – bonds and retentions are much more powerful than warranty agreements.
- Consider how qualified acceptance could work to incentivise the supplier and financier. If the financier withholds a proportion of payment until qualifications are removed from an acceptance certificate, then lease payments should likewise be reduced.
- Require unrestricted access to manufacturing as part of a robust acceptance process to ensure that each acceptance gateway has been achieved and the project (and payment) can proceed.

It is also good to link payments to the formal approvals milestones, i.e. work closely with your Notified Body (NoBo) to define and link these. It is less desirable to link to the manufacturer's design process because this is not directly linked to milestones.

- Require pricing transparency on any variation order from the supplier to check it is fair and accurate (e.g. over-stating the number of units required to be modified and double-counting for overheads – both in the artisan rate and added separately; including the original base design costs in addition to the costs of the actual variation). In some cases, errors have doubled the quoted cost.

ROSCO choice may be affected by attitude to variations after contract, e.g. their treatment of TOC-led reliability improvement changes such as making the doors work better (which are relevant to the whole life of the train). Other factors include willingness to allocate an agreed lump sum up front for getting things right (i.e. to help make beneficial changes). Capital sums for these and other things (e.g. depot improvement) should be available at a reasonable rate.

14.4 **The design – how the product works**

This begins with the functional specification drawn up by the TOC at the invitation to tender stage.

14.4.1 **Functional specification**

This should identify issues that are important to operation and which might not otherwise be recognised, such as:

- Reliable quantification of splitting, joining and moving away within x minutes;
- Times for door opening and closing sequences; time to shut down, change ends and open the desk; driver prep time (affects trade union agreements as well as train timing)
- Coping with short platforms (selective door opening requirements) and driver only operation;
- Any safety/compatibility management requirements that might be passed to the TOC by the supplier, e.g. daily checks for electrical interference monitors or other safety systems. This can require technical personnel at locations such as stabling sidings where they would not normally be present, adding cost and stretching resources;
- Maintenance constraints and opportunities to be included in the train design (e.g. no train components should require planned maintenance intervention between the maintenance intervals for diagrams);
- Easy re-start of electric trains after a 3rd rail or overhead contact line supply outage;
- Easy access to equipment for in-service diagnostics and fault mitigation (e.g. not putting re-settable or diagnostic devices a long way from the driver or adjacent to high voltages);
- Mechanical and electrical compatibility with existing fleets that the TOC will continue to operate.

This is crucial for successful operation in the real railway and effective mitigation of defects in service. The TOC must translate train operations expertise into design requirements. Never assume that the supplier has operational knowledge of products.

There needs to be early involvement of Associated Society of Locomotive Engineers and Firemen (ASLEF) and driver representatives in cab design. Use ASLEF's good practice guide and RDG's Key Train Requirement (KTR) Guidance Note for further assistance.

14.4.2 **Design review**

- Check the comprehensive technical specification from the manufacturer against functional requirements; seek first-hand experience of existing products that are being touted as proven and talk to the people who are using, operating and maintaining them. Get to know the design and request a document that describes how the door control system works.

- Do not take on design responsibility. Document scrupulously exactly what has been agreed (e.g. that option A appeared better than option B. This does NOT absolve the supplier of responsibility with respect to option A and does not alter contractual reliability requirements).
- Design freeze and standards freeze – be clear about what and when this should be to ensure mutual understanding of change flexibility before (and rigidity afterwards).
- Standards conformance – be clear whether any non-conformity or derogation from mandatory standards is required, who is responsible for it and determining what is acceptable as an alternative.
- Change control –agree all changes in writing and keep all correspondence. Do not absolve the supplier from their obligation to provide a compliant product that is fit for purpose.
- Concentrate on interfaces – with the infrastructure, traincrew, passengers, maintainers, other trains. Focus on software functionality.
- Focus on the biggest risks to reliability and incorporate them in the design of the train management system and its interfaces to drivers and maintainers. Look at the top 10 existing and other comparable fleets and demand all available train data. For example, doors: emphasise requirements for door functional information capture, identifying incipient failures and diagnosing root causes of faults, especially intermittent ones.
- Build in redundancy for particularly critical systems where it will bring worthwhile reliability benefits (e.g. compressors).
- Design risk can be offset at performance level but a train purchase with in-house maintenance may be affected by design changes during the build that could have significant downstream costs for the maintainer (e.g. a fleet with a mixture of different reparable components under the same part number may require different maintenance specifications. This could have been avoided if there was a clear requirement not to make any design changes, even at low level not affecting the functional specification, without client approval). One TOC found that employing 2-3 people to monitor this proved worthwhile in terms of preventing downstream costs.

14.5 Manufacturing

14.5.1 Theory – desktop information

The TOC should: follow through from type approval to ensure that production roll-out is robust, seeking specific information to review as part of assurance that work is progressing (and tied into payment and progress gateways); have access to all drawings and build data and be able to review assembly processes; have access to all stages of manufacture (critical system OEMs as well as the main supplier, where relevant); and see the consistency of production and manufacturing standards.

Use first article inspections, a formal method of providing a reported measurement for a given manufacturing process, to create more direct lines of communication, especially in the case of in-house maintenance.

The TOC should likewise ensure that the supplier specifies engineering standards and has a robust staff training and competency management system. Other relevant supplier systems include goods inwards inspection and configuration database.

14.5.2 Practical - on-site presence

With clear responsibility for production, it is advisable to have a customer presence in the supplier's factory.

Example: Southern found that having 2 TOC engineers in Bombardier's factory and 1 at their commissioning depot was worthwhile in terms of identifying and resolving issues which could have caused problems in 10 years' time.

TOC engineers on site in supplier (and, where appropriate, sub-supplier) factories have often facilitated communications on the latest issues. This minimises the number of vehicles built with a defect once it has been identified in service, hence saving rectification work and benefiting all parties.

Example: Train builders can be tempted to overlook manufacturing problems during construction as they believe the TOC will not see or be aware of problems that might only come to light years later during overhaul or when exchange components do not fit. Reported cases include anti-corrosion treatments, paint quality and dimensional build tolerances.

Mistakes are costlier if not addressed early. Although they cannot be planned for, risk analysis should be conducted to identify potential failures and delays to the plan.

Example: SWT (who were also explicitly acting for Angel) found that assembly line audits were useful for residual value issues associated with passenger environment and paint quality.

Working with the supplier's service organisation can also help improve build quality. Many TOCs undertake factory gate commissioning, requiring TOC acceptance before vehicles leave the factory in addition to commissioning on-site in the nominated UK maintenance depot.

14.6 The acceptance process

This section does not cover the safety-focused approvals process (with Notified Bodies, etc.), only customer acceptance, which focuses on reliability performance.

The gateways TOCs should set are:

- **Preliminary acceptance** at factory gate (i.e. before each vehicle leaves the factory, after 1000 miles of fault-free test track running after leaving the factory but before the TOC accepts the train).
- **Commissioning:** both static and dynamic tests to guarantee trains can run on Network Rail-managed infrastructure, accumulating mileage and proving experience. This phase enables the ambience to be assessed (e.g. noise, ride and comfort, in addition to finish and décor). The examination work associated with commissioning should be regarded as the "zero miles" exam in the maintenance plan. It is vital to subsequent safety and performance that it:
    - Contains every task required to permit the vehicles to run to the next scheduled examination and hence to the longest scheduled maintenance interval in accordance with the safety certificate.
    - Is performed only by people with demonstrable competence in applying maintenance plan tasks.
- **Provisional acceptance**, after which trains are fit to run in passenger service under the TOC's safety certificate (this is usually a static test after 15k miles trial running on Network Rail-managed infrastructure, supported by an engineer on the first day in passenger service). This 'shakedown' testing should look to mimic future operations and diagrams on home routes, i.e. frequency of stopping, door opening, turn-around times, etc. At this stage, the trains are technically procured (i.e. ownership transfers from the manufacturer to the financier) but the

project is not yet complete.
- **Final acceptance** 2 or 3 years on, when each unit has had all the latest modifications retrofitted and software versions upgraded; plus 20k miles of fault-free running and 3k miles of no system faults; plus, all correspondence between TOC and supplier has been closed out.

To facilitate acceptance, the TOC should have unfettered access to finished units. This should be clarified in terms of site facilities and what arrangements are made for TOC personnel on-site.

Implementing an Engineering Change (EC) before type approval risks deviating from scope, i.e. the operator has less control but also less work to process additional ECs. A protocol must result from final design review regarding type approval and commissioning to ensure that the product has adhered to what was initially promised.

Note on test tracks: they are invaluable for developing the technical safety case for a new train and validating later changes to the design. Pre-delivery endurance running on test tracks is useful as a sophisticated build quality check but a true indication of reliability only emerges from experience on real infrastructure, which tends to draw out many more issues. It would, however, facilitate acceptance if Network Rail would more readily agree to testing on a particular track between particular times rather than having to set up a signal protection zone.

UK test tracks are in high demand and thus often unavailable. It is possible to test abroad but is difficult to replicate UK trackside to a sufficient standard (mainly due to inconsistencies between implementations).

There are two types of introduction:

- Phased fleet introduction - one strategy is to gradually replace old trains with new, perhaps even while improving old rolling stock, such as Eurostar introducing the new e320 while overhauling the e300s to match. This is particularly common with partial fleet renewals.
- Full fleet introduction – often the case under franchise commitments to replace the TOC's entire fleet with new trains within a set time, such as Greater Anglia's complete fleet renewal by 2019.

14.7 Service introduction

Some initial points of note:

- *Be sensible with unit introductions: use low mileage return to depot diagrams. Siemens were forced into GTR's existing diagrams and timetable rather than optimising a diagram for testing, etc. They were running 800 – 2000 miles and 2-3 days before returning to depot. Aim for less than a day in service before returning to depot, such as post-morning peak, etc.*
- *Have strong contingency plans: Defective On-Train Equipment (DOTE) policy should stay with the TOC as the supplier cannot influence the 'cut and run' policy.*

14.7.1 Interface with operations

The challenge here is to integrate the new train into the Railway Undertaking's safety certificate. There is significant and often underestimated work in this regard, e.g. training additional drivers (TOCs need more drivers to free some up for training and for driving the test runs on the new trains). This could be a 5 or 10% increase in drivers for a period prior to full service introduction.

There can be a disconnect between a project's delivery team and the next project's commissioning team as lessons do not always carry across and there is no feedback into the build line.

Operators should be realistic about the rate of change and communicate with the rest of the company. This could take the form of continuous readiness updates and briefings through the business change.

14.7.2 **Interface with manufacturer**

This is particularly critical if the TOC is taking over the maintenance of the trains, as responsibility shifts.

> Example: Do not jeopardise warranties, e.g. by altering usage of door release anti-tamper catches, effectively requiring components to deliver more than their designed capacity.

Consider the length of time the supplier's support will be available. If they are contracted to perform maintenance for at least the first few years, they will have a vested interest in correct maintenance documentation.

Depending on the precise contractual arrangements, issues such as spares provision and management should be followed through and there should be regular contract meetings around all emergent issues and their resolution.

> Example: TOC should aim to ensure all emerging issues are openly discussed and solutions identified by the parties before expiry of the relevant warranty period.

Gone are the days of a commissioning team of 3-4 people who know all the ins and outs of the train. Operators should have teams or even departments of people who specialise in each sub-system and its scope. This means that very few people from the manufacturer see the bigger picture. When there is a technical problem manifesting across several systems, the diagnosis and corrective action could take much longer. Ask for 24/7 on-call groups of specialists knowledgeable about the trains and the systems during introduction.

> Example: Avoid training that is delivered from a sub-systems OEM point of view as this does not give maintainers the bigger picture of how systems can work together and influence behaviour.
>
> Siemens took this approach with the Class 700 and introduced a 'wiki' resource for maintenance staff to act as a repository of knowledge, including common faults encountered, previous fixes and how systems work. Staff are incentivised to contribute by securing additions to the staff entertainment fund

14.7.3 **Interface with Network Rail**

Key to minimising the pain of service introduction is to ensure that Network Rail appoints a project manager to meet with the TOC once a week to work round any emerging problems, e.g. booking test slots. TOCs should ensure that they establish compatibility on all route sections and tracks they might wish to run a train on, either as a timetabled or exceptional move, and that statements of compatibility are published for all possible moves.

14.8 **Reliability growth – delivery to the passenger**

Many of the issues highlighted here are cited as best practice for existing fleets in other parts of the 20PP. However, it may be worth drawing attention to the particularly critical nature of some issues at this stage of a train's life.

14.8.1 **Design for maintenance early on**

Different systems can require updates at differing intervals based on supplier development, different laptops or maintenance tools and different skill sets for fault-finding and general maintenance. Eurostar's e320 still has many train wires hard-wired to the train management system (TMS) rather than using a data bus. Equally, hard-wired solutions can limit the scope for future expansion.

Software can present unique issues. There is often little understanding of why it fails, how to fix it, or the impact it might have.

Suppliers can be tempted to pass blame on to other interfaces and sub-systems, which focuses attention on the common problem of fixing the fault and not the root cause.

The operator or manufacturer needs a robust test regime after implementation of the fix to monitor success. Software updates (previous and current version) should be held in ESCROW until updates are proven successful to protect against suppliers leaving the market.

14.8.2 **Measure everything – and follow it through**

TOCs should not underestimate the resources needed to monitor what is happening effectively enough to identify and resolve root causes of unreliability. Effort is also required to develop efficient mitigations to reduce the impact of faults while root-cause solutions are being developed and implemented. There should be close collaboration with traincrew as the first to see problems and build confidence by providing feedback on how problems are being tackled.

There should be engineering support for the maintenance and operations controllers, e.g. a technician from the train manufacturer in the control room.

Exploit data from train systems and ensure it is made fully and freely available. Avoid being charged by the supplier for collecting or processing information and use the opportunity to overcome any difficulties with downloading, transmitting or formatting data.

> Example: Ensure access to RCM data even if the manufacturer oversees maintenance.
>
> On some older trains, Greater Anglia have integrated their RCM with operations and engineering which allows them to monitor the systems and look at events from both points of view. This is very useful and enables joint investigations, etc. With new trains, they will not necessarily have access to the RCM data, making this sort of activity impossible or more complicated (i.e. if the different departments use different systems to monitor what is going on)

Again, ensure that passenger amenities such as toilets, information systems, wi-fi and air-conditioning are given sufficient attention at this stage of the project.