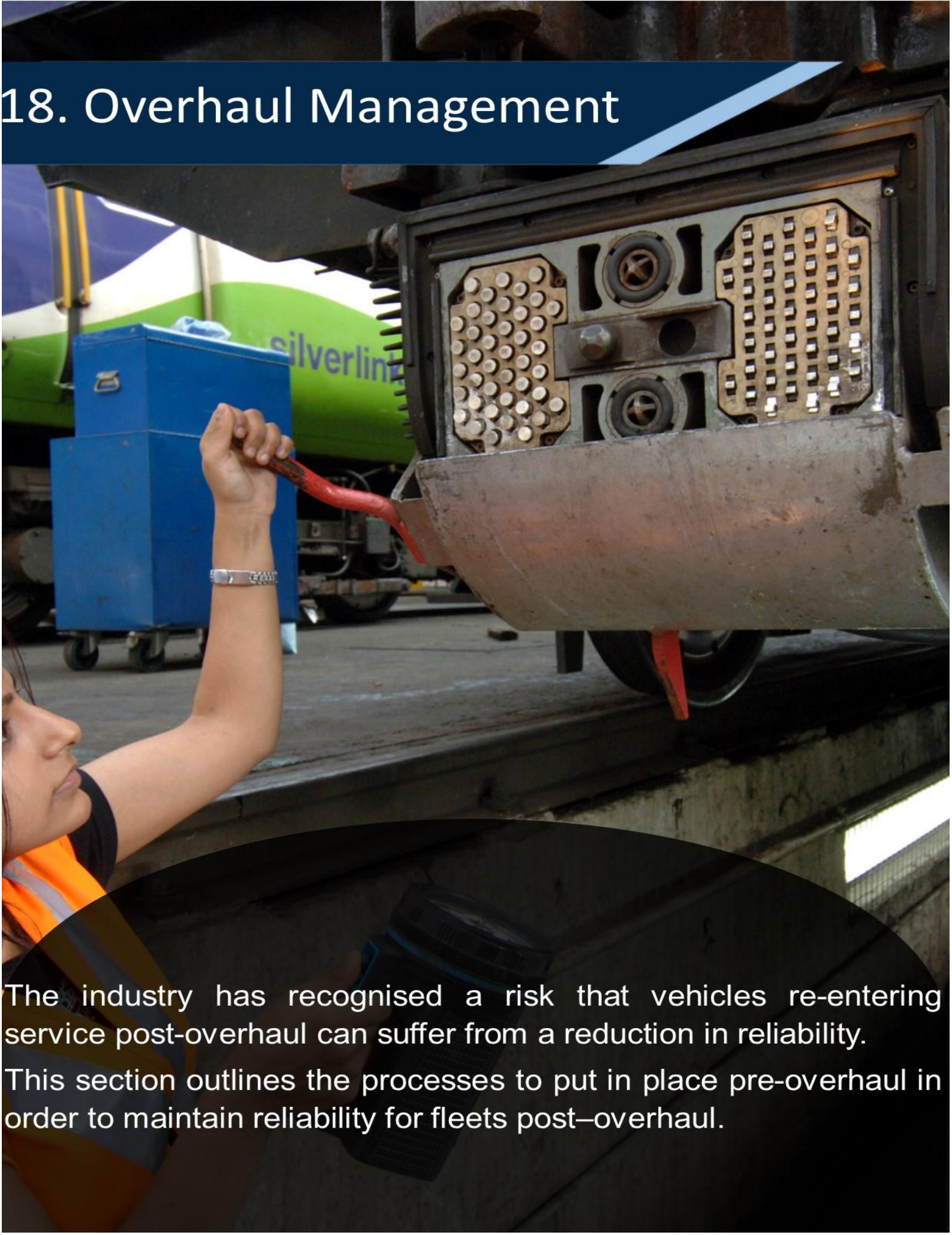
18. Overhaul Management



The industry has recognised a risk that vehicles re-entering service post-overhaul can suffer from a reduction in reliability.

This section outlines the processes to put in place pre-overhaul in order to maintain reliability for fleets post–overhaul.

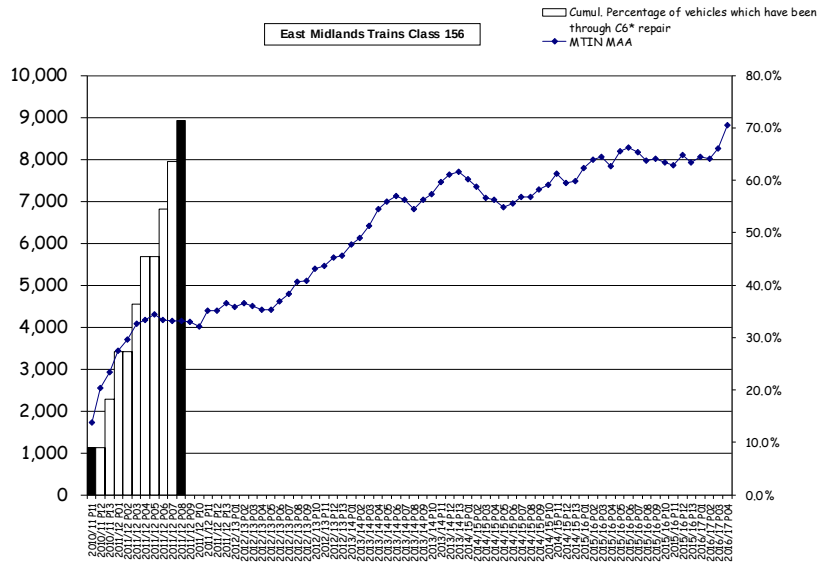
18 Overhaul Management

This chapter focuses on the overhaul of rolling stock and/or their components[1].

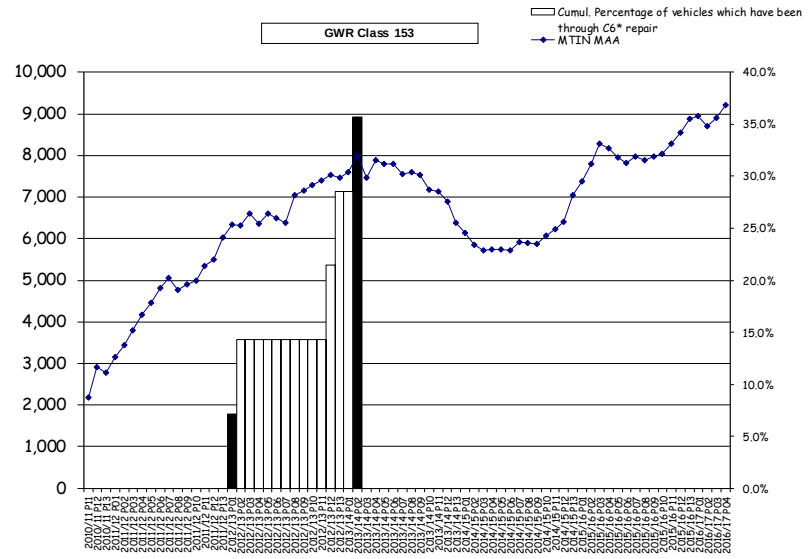
The industry has recognised that vehicles re-entering service post-overhaul can suffer from reduced reliability.

Analysis shows that reliability for fleets coming out of overhaul can vary widely, with there being no overall correlation between pre- and post-overhaul reliability.

Graph 1: An example of a fleet with improving reliability immediately post-overhaul



Graph 2: An example of a fleet with declining reliability immediately post-overhaul

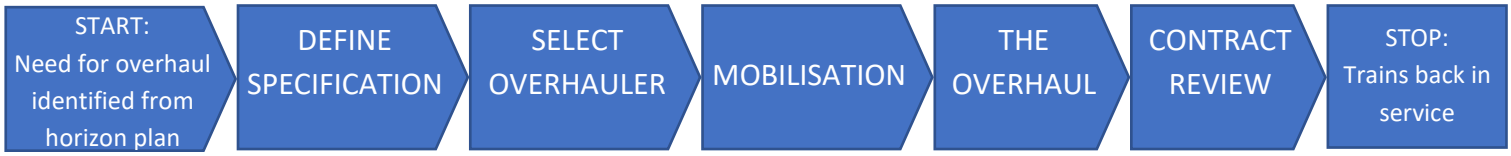


The good practice identified in this chapter aims to address the issues which cause fleets to have a post-overhaul reduction in reliability and to help RoSCos, TOCs, maintainers and overhaulers ensure that overhauls optimise fleet reliability.

[1] E.g. doors, bogies, gearboxes, engines, etc.

This chapter is structured around a generic high-level overhaul process (*Figure 1*) with good practice identified at each stage. Each overhaul will have its own complexities[2], so the guidance should be followed with consideration of the individual circumstances.

Figure 1: The high-level overhaul process



18.1 Need for overhaul identified from strategic plan

The publishing of strategic plans is good practice, particularly if they are reviewed and updated to incorporate recent developments. It enables the industry to form a more complete view of overhaul plans and timescales nationally. Conflicts of resources can be identified quickly and efforts made to smooth out demand. It also provides the supply chain with information to secure investment for future bids.

Example: Porterbrook openly publishes a six-year overhaul plan on its website. This gives visibility to work coming up for tender and enables suppliers to plan future bids.

18.2 Defining the specification

The purpose of defining the overhaul specification is to make clear to all parties what is expected from the overhaul process. If done well, it reduces the likelihood of:

- unacceptable performance delivery during the overhaul,
- undesirable reliability post-overhaul,
- additional/unforeseen costs to the overhaul,
- delays/late delivery and
- poor quality delivery,

all of which can bring reputational damage to the industry and have a negative impact on passengers.

This section will be split into four sub-sections for the good practice recommendations:

1. timescales for creating and agreeing the overhaul specification,
2. method for creating and agreeing the overhaul specification,
3. content to be included in the overhaul specification and
4. clarity over the intended outcome of the overhaul.

18.2.1 Overhaul specification timescales

The time required to create an overhaul specification will vary from project to project, based on factors including:

- the complexity of the overhaul,
- the number and experience of stakeholders involved,
- the initial scope and
- lessons to be learned from previous overhauls.

It is critical that the overhaul specification is developed prior to contract award in order to avoid late-notice contract variations which can result in additional costs and delays.

[2] E.g. C4 exams are historically more predictable than C6 exams (frequently a minefield presenting numerous potential additional challenges).

18.2.2 **Overhaul specification method**

A truly collaborative approach[3] to developing an overhaul specification should create an environment where all parties are properly engaged in the overhaul process and its outcomes.
RoSCos and TOCs should aim to learn from previous overhauls to ensure specifications are created in appropriate timeframes. This includes considering removing tasks which no longer add value[4].

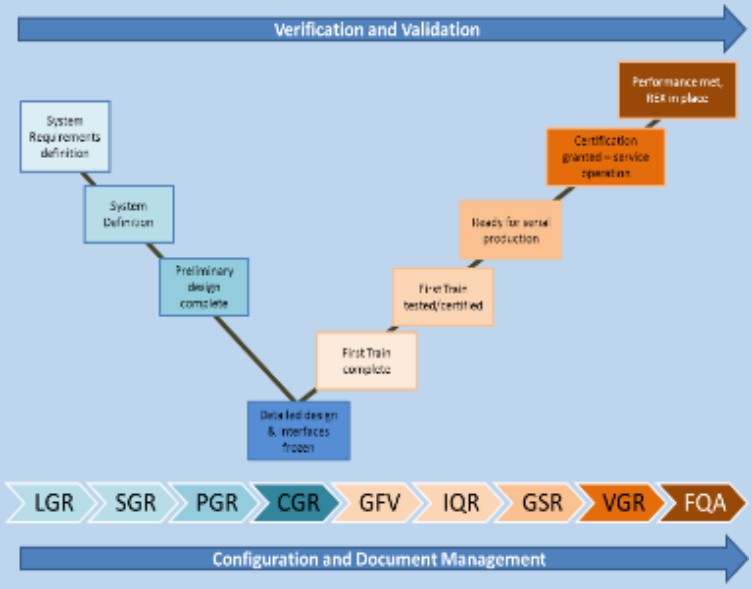
It is recommended that the overhaul specification should be jointly developed by overhaulers, OEMs, RoSCo(s) and TOCs/maintainers, setting the process on a collaborative footing. A horizon plan can help overhaulers create a case for investment in this process but framework agreements are also a good solution.

The tri-party approach to overhaul specification may also need to be extended to include other parties, particularly where a fleet is common to other TOCs and RoSCos. ACOP1006 provides a framework for multi-party engineering change and fleets should be standardised unless there is a valid business case to the contrary, e.g. duty cycles.

Development for quality is a good framework for an overhaul specification.

Example: Alstom uses a V model to plan their overhaul design and delivery. This development for quality (DfQ) process is used to verify project maturity and re-evaluate risks at pre-determined stages.

The process is a series of formal, checklist-based reviews, emphasising the importance of the project team identifying and making transparent any potential risks at each stage of the project. The DfQ model is illustrated as follows:



The overhaul specification should be jointly owned and periodically reviewed by the engineering teams within both RoSCos and TOCs/maintainers during the operation of the fleets to capture lessons learned and best practices. All changes in condition should be noted for the next overhaul. All good practice

[3] BS11000 is a collaboration standard.

[4] Subject to an appropriate risk assessment.

should be shared by RoSCos, e.g. updates to drawings or engineering change (EC) process details should be incorporated in future specifications.

18.2.3 **Overhaul specification content**

The expected train condition should be set out in the specification. Significant differences in asset condition can lead to delays while it is agreed how they will be accommodated. Therefore, condition assessment prior to overhaul is essential for specifying the overhaul regime. It must occur during or prior to tendering and again just prior to the actual overhaul, to have an up-to-date record. As a minimum, it may require a survey and audit of at least one or more vehicles.

It is good practice to involve TOC operations staff to ensure that opportunities to make improvements to the train from the users' perspective are taken into account.

A risk-based approach should be taken when planning for corrosion. Technology such as endoscopes are cheap and can be used to inspect hard-to-reach areas.

Former British Rail overhaul specifications may assume a level of competence which does not reflect modern maintenance practices and so additional instructions or changes to the overhaul specification may be required.

A good specification should consider how testing will be performed and what test equipment is required. This should include pre-testing of relevant systems by the overhauler in advance of component removal/overhaul. Testing should be done on the train at system level, prove functionality and involve components that were not directly overhauled but which form part of systems that were overhauled. Any issues identified in testing should be analysed for the root cause and used to review the overhaul specification to eradicate or minimise the issue. Consideration should be given to which components may/will be disturbed during testing and what might need to be removed. Best practice would be to test all disturbed components (pre- and post-overhaul) to ensure functionality. The specification should require data captured during overhaul and testing to be easy to manipulate and process. For example, spreadsheets and programmes such as Word or Excel are easier to analyse and manipulate than paperwork, scanned documents or PDFs.

The specification should also consider capturing images prior to and during overhaul so that the condition can be retrospectively reviewed.

18.2.4 **Overhaul specification outcomes**

It is very important that the TOC, RoSCo and overhauler have a clear and consistent understanding of desired outcomes.
Specifiers should focus efforts equally on:

- improving the reliability of the entire train as appropriate[5],
- restoring its condition back to that of a brand new vehicle as appropriate[6] and
- incorporating changes to ensure the vehicle is fit for purpose and easier to operate and maintain.

The performance of the fleet with respect to these points pre-- and post-overhaul should be measured.

In addition to reliability outcomes, the financial outcomes also need to be considered. These include:

- the cost of the overhaul itself,
- life-cycle costing and

[5] Taking into account the level of overhaul required and a scrutiny of the TOC fleet class reliability.

[6] This may not be practical for older vehicles which may require a level of accepted tolerance.

- future maintenance costs (including consideration for equipment/systems which do not currently have a maintenance plan but may require one).

18.3 Select overhauler

The ITT should ensure suitable service level agreements to incentivise correct behaviour from all parties. This could include penalties to operators who fail to present a unit for overhaul on time and penalties for overhaulers who fail to return units to the customer on time and in a suitable condition.

An overhauler is recommended to respond to the procurer's questions using a compliance matrix.

Good practice shows that a number of different criteria[7] should be used to assess the quality of a bid. These can then be compared to the price to establish which bid presents the best value for money. Some options to consider are shown below.

- **Alignment of business models**
  Do the business values of potential overhaulers match the business values of the party concerned? If not, could this cause problems in the future as and when issues need to be resolved?

- **Capability**
  How capable is the potential overhauler of doing the work? Will specialist skills be required? How is the potential overhauler planning to cover them (in-house or sub-contract)? It is important to be confident that a potential overhauler can reliably undertake the work.

- **Capacity**
  Can the bidder adequately demonstrate ability to take on additional work? While it is important to a supplier to maximise the use of its facility, it is likewise important that this does not impact on deliverability.

- **Deliverability**
  Is there confidence in the potential overhauler's ability to deliver on time? Late delivery can cause operational and therefore reputational damage to TOCs. Bidders should submit an overhaul programme which demonstrates how experience will be gained (either through learning from the first unit, having a 'glass case' train or utilising pilot runs as relevant) prior to increasing production.

- **Quality and standards**
  How will potential overhaulers guarantee an acceptable quality standard?[8] Will accredited suppliers be used? Is quality process management an embedded part of the operation?

- **Cost of overhaul and impact on whole life cost**
  How does the cost of the overhaul impact on the whole life cost of maintaining the fleet? It may be tempting to choose the overhauler offering the lowest price, but it may turn out to be a false economy. Elements such as warranty and impact on maintenance costs need to be factored in.

- **Location of overhauler's facility relative to fleet's base depot**
  Is the potential overhauler close to the fleet's base depot? It can be difficult and expensive to

[7] These should be requested in the ITT.

[8] This should be defined in the overhaul specification.

transport fleet around the country, so it is important to consider how it will be done and what impact any fluctuations in the overhaul schedule will have on the ability to move fleet.

It is also good practice to involve a number of stakeholders in evaluation of the proposal. When an overhauler is rejected, they should be clearly informed why their bid was unsuccessful and what they would have needed to be successful.

18.4 Mobilisation

Good practice is for mobilisation[9] to commence at least a year in advance of a major overhaul. The specification should also be defined within the same timeframe.

Example: Alstom uses 12 months to plan between H exams and builds on previous experience.

This time is required to:

- create a robust overhaul plan,
- ensure there are enough staff with the correct competencies and
- ensure that the facility, materials, documentation and tooling are ready.

18.4.1 Creating a robust overhaul plan

Overhauls can be very complicated and have a number of constraints, not all constraints of which can be easily removed. These include (but are not limited to):

- learning from previous overhauls,
- programme risks,
- interdependencies with other projects,
- critical path,
- critical resources,
- impacts of long lead times,
- human resourcing,
- site layout and
- the need for specialist work to be undertaken off-site.

A robust delivery plan is key to the successful delivery of an overhaul programme. Critical chain project management is a useful tool to ensure a plan is deliverable.

As many overhaul activities as possible should be co-located to minimise transportation times. Where necessary, customers should perform a 'make versus buy' analysis to decide where and why to outsource overhaul activities. This also applies to third-party suppliers.

Transporting trains to an overhaul location by rail barrier wagons/translators is a logistical problem as there are only seven pairs on the GB rail network. Good practice is to avoid the use of these wherever possible.

Example: Southeastern utilises the Rail Operations Group to move their Class 375 units for overhaul to Derby. The need for barrier wagons is negated by using a modified Class 37 locomotive with Dellner couplers.

Overhaulers will aim to reach the steady throughput rate[10] as early as possible to reduce the total

[9] i.e. the time between agreeing the contract and receiving the first unit.

[10] i.e. the time taken to overhaul most assets.

overhaul time and minimise the time assets are out of service.

In order to achieve the steady throughput rate, it is a good idea to perform a pilot run[11] prior to receiving the first asset from the TOC. It is also a good way of exposing staff to overhaul tasks pre-overhaul which will support their personal development and familiarise them with the process, tasks and materials.

Example: Wabtec has bought a spare mark 3 coach in order to trial fit new exterior powered sliding doors supplied by Vapor Stone Rail Systems prior to the arrival of coaches from GWR for modification at Wabtec, Doncaster to the latest 'Persons of Reduced Mobility (PRM)' standard. This is enabling Wabtec to gain confidence in the fit and performance of the doors without using rolling stock required for passenger service.

Where it is not possible to perform a pilot prior to overhaul it is still worth trying to simulate as much as possible to identify any issues. Production bottlenecks should be reduced/eliminated to ensure maximum throughput and lean techniques can be used to improve throughput. *See Appendix J for more detail*.

Example: Wabtec, Doncaster, have invested in a new paint shop as this stage of overhaul was creating a bottleneck for production. Their new Class 321 facility has also been built to allow vehicles to be lifted over each other to remove bottlenecks within the facility.

Example: Alstom's Longsight depot is set up around a pit-stop strategy, where all materials are located close by where they will be required. This is due to the depot overhauling specifically Class 390 units. Wabtec, Doncaster, however, is capable of overhauling a wide variety of rail vehicles and therefore a strong planning process should ensure that, if a similar strategy is to be implemented, plenty of time is assigned for planning where materials will be located.

It is recommended that overhaulers implement a longer-term continuous improvement plan to build on the learning from successive overhauls.

18.4.2 Human resourcing and competency

When planning an overhaul, the timing of staff recruitment is important, as is identification of the skills and competency they require. A RACI[12] can help set out clear roles and responsibilities for staff.

It is good practice to ensure skilled project managers are one of the first additions to any overhaul team. When considering the standard of project managers, a date should be set around specific qualifications (e.g. APMP) and they should have experience of lean techniques.

For all staff recruitment, it is good practice not to rely on CVs and interviews to assess competence (although these things are important) but to also use testing procedures involving genuine examples of overhaul work to score candidates' capabilities and identify training and development needs.

KPIs can also be developed based on these competency assessments if they are revisited periodically.

Example: Alstom requires all new contractors joining the overhaul team to undergo a competence

[11] A pilot run is a preliminary study conducted to evaluate feasibility, time and adverse events in an attempt to improve upon the process design prior to commencement of a full-scale programme of works.

[12] A matrix which identifies who is responsible, accountable, consulted and informed for the activities undertaken.

assessment to verify that their skills match their CVs. A record is kept of the skills each new contractor possesses and is used to form a framework to match required skills for each task to those available and enables the reporting of shortages as a KPI.

BR-built units are usually hand-built and therefore there are differences between units. Staff should be granted additional pre-series exposure to become familiar with the variances in vehicle manufacture prior to undertaking overhaul. Training should also be provided on the use of key pieces of overhaul equipment[13].

Where contracting staff are used, it is good practice to consider providing incentives towards the end of the contract to retain the essential skills required for completion.

Example: Alstom utilises a tool retention bonus to ensure that no tools are lost. In short, the fewer tools are lost, the greater the bonus. Tool stores are therefore checked twice daily.

Where the overhauler's workload may fluctuate over time, it is beneficial to try to retain key staff during downtimes, as this will help to ensure consistency and minimise skills loss.

Mobilisation should plan for quality checks throughout the overhaul process from component arrival to final testing and unit return. Good practice is to use peer reviews so each team owns responsibility for passing on quality work.

18.4.3 Non-human resources: the facility, components, tools and documentation

The facility should be set up to ensure the overhaul process flow is designed according to lean principles (*see Appendix J*) to maximise flow and reduce process-based errors.
It is important to consider the impact an overhaul could have on small, commonly shared component floats as it could negatively affect (other) operators. Therefore, the float of components required for overhaul should be bolstered to ensure that the level is sufficient to cover the overhaul cycle and continue supporting normal operation.
To ensure that good-quality components are procured and used for the overhaul, all suppliers should be approved within the customer's procurement system. This applies for RoSCos, TOCs/maintainers[14] and overhaulers. Approvals should cover change management.
Components used in overhaul should be of a sufficient quality to fulfil their purpose. This should be included in the specification and suppliers should be made aware of the consequences of quality issues with their materials. The supplier should likewise actively engage with the customer(s) to identify quality issues.
Components should have a warranty appropriate to the overhaul specification and, where practicable, for the period between overhaul cycles (e.g. C4 to C4).
Where obsolescence materialises during overhaul it should be managed as set out in *Section 13.6*.
Each workstation should be equipped with tools appropriate for the activity and compliant with the relevant standards. Staff should have the correct training to use the tools provided. For smaller tools liable to be lost/damaged, shadow boards should be used to reduce loss/damage.
It is good practice to ensure that all documentation available to shop floor staff and supervisors (e.g. work instructions, designs, drawings, checklists, etc.) fully back up the overhaul specification, are up-to-date, change-controlled and easily available.

[13] Some equipment requires training & certification.

[14] Maintainers are classified as organisations undertaking the day-to-day maintenance of rolling stock on behalf of a TOC.

18.5 The overhaul

This stage considers delivery of the plan created during mobilisation to the standard defined in the specification. Each time an overhauler goes through this process it provides an opportunity to make improvements, also for future overhauls, using lean techniques.

In order to identify where efficiencies may be made (without negatively impacting on quality), overhaulers need collect relevant data.

Example: Knorr-Bremse has a 5-year industrialisation plan to improve the efficiency and quality of overhaul work being undertaken at its Wolverton facility.

In order to provide clarity around the good practice recommendations, this section has been split into four areas:

1. receiving the train
2. working on the train: a lean process
3. working on the train: the culture
4. evaluating the results

18.5.1 Receiving the train

Transportation of the vehicles to and from overhaul facilities is a critical element of the overhaul. It is important that the mobilisation specifies this element early and it is managed carefully as alterations can result in repercussions for all other plans, including missing vehicle movement slots; often the next available slot is not for another week.

When trains or train components arrive for overhaul, they will be tested to check that their condition meets expectations as part of the acceptance process. A status of conformity should be agreed between the overhauler and the provider. This extends to parts and materials which should be thoroughly inspected to ensure no faulty goods are accepted. A risk-based approach is best as it is impossible to check all materials and components. Goods inwards should arrive with a certificate of conformity.

If the asset condition is not as described prior to the provider releasing to the overhauler, the asset provider should consider:

- starting discussions with the overhauler about the asset condition at the earliest opportunity in order to minimise delays; or
- releasing a different asset which meets the specified condition, allowing the provider and overhauler time to agree a plan for the non-conforming asset (without affecting the critical path for overhaul delivery)

18.5.2 Working on the train: a lean process

The overhaul plan will typically allow more time for the first few assets going through the process in order for staff to gain confidence and identify any issues without creating delays in the overall programme of works. This is a good opportunity to monitor the effectiveness of the process, especially if a pilot run was not possible. Lean techniques can be employed to identify and correct process problems.

Example: London Underground treats the first two units to pass through an overhaul programme as ‘glass case’ examples. The purpose is to trial, fine-tune and finalise implementation techniques and processes. It also allows additional time and resources to be allocated to check that assumptions about fleet condition and the overhaul plan are correct and ensures that the plan is achievable for future units.

Where there is confidence in the overhaul tasks, the process can be made more efficient. The

overhauler should analyse all activities (including waiting or downtime) and seek to minimise those which do not directly improve the asset as per the overhaul specification.

18.5.3 **Working on the trains: the culture**

It is good practice to utilise the knowledge and experience of staff when trying to identify and implement process improvements. Staff should perform the same task in the same way. If a member of staff identifies an improvement to the way a task is undertaken, there should be a clear process to implement the change. This will ensure that everyone benefits from improvements and learning is standardised and embedded.

It is good practice to ensure that there is accountability at all stages of the process and that defects/quality issues are identified, recorded and rectified as early as possible, but without creating a blame culture. Using ad-hoc peer checks (or peer mentoring) to inspect work at each stage can be beneficial to both new and experienced staff. A fresh pair of eyes helps combat work blindness, whereby flaws may not be evident to the worker but they are to a third party.

Example: Wabtec utilises coloured overalls to easily identify the competence levels of staff. Where more senior technicians identify staff, who may require assistance/advice, they have a useful visual indicator to understand which skill level they are addressing.

Documentation is vital to record accountability and increase ownership of work. Names signed next to records of work or the use of swipe cards will ensure traceability. Sign-offs should be managed so as to not delay the overhaul process or encourage blame simply because a defect can be traced to an individual. Documentation should be produced in a format which is easy to analyse (e.g. .CSV file, not free text format).

Ensure service affecting failures (SAFs) are constructively fed back to staff and included in the process of eradication. Consistent bad news can reduce morale and should be balanced with good news stories.

Example: Alstom provides a plasticised booklet to all staff indicating previous SAFs/mistakes. These provide an ‘incorrect vs correct’ point of view to provide a positive message to staff and hopefully eliminate these issues.

It is also good practice to sign off all consumables (where appropriate).

Example: Alstom requires all staff to sign off the use of Loctite, including type and expiry date, to combat the use of out-of-life consumables.

Implementing formal handovers at each stage provides the opportunity for defects to be identified before more work is undertaken (thereby reducing the impact of any re-work). Using a formal handover checklist is ideal, as it will help to ensure clarity and consistency.

18.5.4 **Evaluating the results**

At the end of the overhaul, all trains are tested in preparation for return to passenger service. It is good practice to involve the TOC in this process. The following points should be considered:

- Quality: this is the final opportunity for the overhauler to identify any quality issues and correct them prior to returning the train to service. A systems approach to this final check is critical. If issues are discovered after the train has been returned to service, it is much more difficult and costly to investigate and fix them.
- Time: is the train being returned on time? If it is late, it is important to identify why. The overhauler and TOC need to be realistic about whether these issues can be improved upon or whether the end-to-end time for overhauling a train needs to be revised. An honest and

evidence-based approach needs to be taken when revising the plan for future trains.

- Documentation: the overhauler should provide the TOC with the engineering measures and results for the overhauled train, along with details of any deferred work (as per the overhaul specification). While it is convenient for all parties to provide these results in electronic format, it is worthwhile both parties reviewing them jointly.

18.6 **Contract review**

The contract review provides an opportunity for all parties to make a joint and structured assessment of the entire overhaul programme.

The review should look at whether intended outcomes were achieved and if not, why not. It is important that feedback is balanced and fair. If there were a number of problems, the review should not be overly negative as this will discourage open assessment. Overhaulers should supply a number of metrics which can be used to evaluate the success of their programme in terms of quality, time and cost. The review should assess what went well so that good practice can be embedded.

The review should also seek to assess whether the tri-party relationship worked as intended or whether it could be improved. It is a good idea for all parties to provide feedback on the contractual incentive/penalty conditions and how they were managed. It is important to ascertain what impact, if any, they had on the overhaul outcomes. It may be worthwhile asking an independent party to facilitate this discussion.

Lastly, the review should look at the overhaul specification to understand how it might be improved. Test results should be fed back into the overhaul specification, providing an enhanced outline of work based on experience from both completed units and initial condition assessments.

18.7 **Trains back in service**

This is the point at which the overhaul programme is effectively over. The post-overhaul review between the RoSCo, TOC/maintainer and overhauler will have been completed and normal fleet management processes will have resumed for the whole fleet.

This is a good opportunity for individual stakeholders to conduct an internal review of the overhaul and identify good practice/learning for the future.

TOCs/maintainers can use the opportunity to review their standard fleet maintenance processes to ensure that they remain fit for purpose for the overhauled fleet.

It is also good practice for TOC performance teams to check whether the overhauled fleet is delivering the projected performance and reliability improvements agreed as part of the performance improvement process.

The data used during the overhaul can also be used to shape future maintenance, fault-finding and engineering change.