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National Rail

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Guidance Note: New Trains – A Good Practice Guide

Synopsis

This Guidance Note describes good practice that organisations should consider when they are specifying, contracting, procuring, design reviewing testing, commissioning and introducing New Trains.

Applicability

This Guidance Note has been prepared for passenger train operating companies. However, its content may also be of use to others.

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Issue record

This Guidance Note will be updated when necessary by distribution of a complete replacement.

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2.0	March 2020	Document updated in the light of comments received from industry consultation

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Part 1 About this document

1.1 Responsibilities

1.1.1 Copies of this Guidance Note should be distributed by RDG members to persons within their respective organisations and stakeholders for whom its content is relevant.

1.2 Explanatory note

1.2.1 This document has been produced in consultation with rail professionals and is to be disseminated within the railway industry.

1.2.2 RDG produces RDG Guidance Notes for the information of its members. RDG is not a regulatory body and compliance with RDG Guidance Notes is not mandatory. This publication is advisory only and must be evaluated and implemented as appropriate at the sole discretion and responsibility of the user.

1.2.3 Every user of this document is responsible for its own operation and carries full responsibility of ensuring the safety of its own systems of work.

1.2.4 RDG Guidance Notes are intended to reflect good practice. RDG members are recommended to evaluate the guidance against their own arrangements in a structured and systematic way. Some or all parts of the guidance may not be appropriate to their operations. It is recommended that this process of evaluation and any subsequent decision to adopt (or not to adopt) elements of the guidance should be documented and reviewed from time to time.

1.3 Guidance Note status

1.3.1 This document is not intended to create legally binding obligations between railway duty holders and should be binding in honour only.

1.4 Supply

1.4.1 Copies of this Guidance Note may be obtained from the RSSB or RDG members' web site.

Part 2 **Purpose and introduction**

2.1 Purpose

2.1.1 This Guidance Note describes good practice that organisations should consider when specifying, contracting, procuring, design reviewing, testing, commissioning and introducing New Trains.

2.1.2 This document attempts to identify 'good practice' in terms of how to both specify and contract for a New Train and it is the intention that it is used in combination with the existing Key Train Requirements (KTR) document, since the KTR specifies detailed requirements for the <u>train</u> only.

2.1.3 A successful New Train introduction project is very much wider than the train itself and this document is designed to cover these non-train specific aspects.

2.2 Introduction

2.2.1 There have recently been several high-profile instances where the industry has experienced difficulties introducing New Trains.

2.2.2 It is a fact that recent New Train projects have experienced difficulties meeting anticipated deadlines for fleet introduction. Unfortunately, there are numerous reasons for this and this document highlights the major issues that recent projects have experienced.

2.2.3 Some of the issues are as a result of the procurement process, both in terms of the content of (or omissions from) the relevant contract and the train specification itself.

2.2.4 Some of the issues are also a direct consequence of 'over optimism' during the Franchise Bidding stages.

2.2.5 Even when New Trains are introduced to service late, their reliability is often very poor. It can sometimes take years for a New Train to replicate the reliability performance of the 'old' trains that they are designed to replace. (It can therefore seem perverse to stakeholders that hundreds of £millions are being invested to apparently make the railway worse).

2.2.6 It is therefore in everyone's interests that industry accelerates the reliability performance improvement of New Trains. Manufacturers benefit by the fact that they will succeed in securing new orders as a consequence of demonstrating their ability to design and manufacture a reliable train and our passengers benefit by not being subjected to delays caused by untested and unreliable New Trains.

2.2.7 It is therefore also in everyone's interests to improve the processes surrounding obtaining the necessary 'approvals' to introduce the New Trains into service since long delays to projects do not present the industry in a good light with the national media.

2.2.8 The situation is further complicated by the increasing use of software control in recent designs of New Trains. The increased complexity of these systems has often resulted in New Trains being 'debugged in public' which significantly contributes to their unreliability. This bad situation is also exacerbated by the time needed to properly validate software 'fixes.'

2.2.9 Between 2017 and 2022 the industry has embarked on a programme to introduce approximately 7,900 new vehicles. This represents approximately half of the national fleet that already existed prior to this time.

2.2.10 In the light of this unprecedented volume of change and continuing problems with New Trains projects during 2018 several cross-industry workshops and an independent expert was commissioned[1] to undertake a review of the risks to service delivery and network performance that may arise from the high level of New Train introduction in Railway Control Period 6.

2.2.11 It is a fact that where previous New Train programmes e.g. Pendolino and the early builds of Electrostar have experienced significant difficulties, good progress has only been made once a more collaborative approach has been adopted by the affected parties working together to resolve the problems faced (as identified in the independent expert review[1]).

2.2.12 This Guidance Note attempts to distil the relevant points made during these two cross-industry events and capture the salient points contained in[1].

2.2.13 Where specific examples of good practice have been identified these are presented to illustrate the point.

2.2.14 Similarly, where specific examples of bad experience have been reported these are also presented to illustrate the point - in order to make future projects aware of the potential pitfalls.

[1] Risks to Network Performance from New Train Introduction. P. Hinde, RDG New Fleet Introduction Risk Manager 18/04/2018.

Part 3 Train Specification

3.1 Background

3.1.1 If the specification of the train you require is not correct, there is little chance of success – since it is highly unlikely to meet your requirements. Getting the specification of the train correct is therefore absolutely critical and whilst this takes significant effort and is difficult to get 100% right, it should be considered as time well spent - since it will inevitably save time and reduce problems in the long run.

3.1.2 Requirements should be objective and measurable and the means of demonstrating compliance should be clear.

The Benefit of Hindsight:	Too often, the question of 'What do you mean by that?' is asked at the wrong end of the programme.

3.1.3 A further consideration is that due to the fragmented nature of our industry, the organisation that specifies the train is typically not the organisation that will be taking delivery of the train and subsequently having to either operate and/or maintain it in service.

3.1.4 There can therefore be a significant disconnect between the specifiers and operators of the New Trains.

3.1.5 In addition, consultancies are typically employed to develop train specifications on behalf of train procurers and it is asserted that they often have 'template' train specifications that they use as their starting point.

3.1.6 As a consequence of all of this, since they are not necessarily aware of the experiences of operating the trains that they have specified (often many years previously) the 'train specification templates' are often not reviewed or updated in the light of experience and the same mistakes are therefore repeated for subsequent train procurements.

3.2 Learning the Lessons - KTR

3.2.1 In order to address the previously identified potential disconnect between the organisations and to capture (and therefore hopefully learn) the lessons from previous train designs, the wider industry has collaborated to produce the Key Train Requirements (KTR).

3.2.2 KTR is intended to assist rolling stock procurers, manufacturers and system suppliers to (amongst other things) compile train procurement specifications by drawing attention to experience that has emerged from historic rolling stock projects.

3.2.3 The current KTR is on its fifth iteration (v5.1) and can be accessed at the following link: https://www.raildeliverygroup.com/about-us/publications.html?task=file.download&id=469775901

3.2.4 It is the intention that a structured review of the KTR is used to inform which requirements are of particular relevance to the project train specification.

3.2.5 KTR was never intended to be used verbatim for procurement purposes.

3.3 Specifying for Safety

3.3.1 It is a fact that a train that has been designed to the relevant Technical Specifications for Interoperability (TSI), European and national standards (and has even been third party assured) is not necessarily safe to operate (see 3.9).

3.3.2 The reason for this is that this assurance process does not consider local technical and operational issues associated with the operation of the train including the infrastructure it is intended to operate over.

3.3.3 The Office of Rail and Road have stated that train designers should adopt the concept of 'health and safety by design.[2]'

3.3.4 Health and safety by design is to preferably eliminate, and if not eliminate to control, health and safety risks in rolling stock, equipment and processes by early consideration of potential risks and then dealing with those risks at the design stage.

3.3.5 Train specifications should therefore explicitly state that compliance with health and safety by design is a requirement.

3.3.6 In addition, the hazard identification process in accordance with the Common Safety Method for Risk Evaluation and Assessment[3] (CSM-RA) needs to be properly managed to ensure that local operational and technical constraints are covered and all of the hazards are being managed by the most appropriate party and that they have agreed and are therefore aware of any risk that they are expected to manage (see 5.4).

The Benefit of Hindsight:	Despite being fully compliant with all relevant braking standards there was an incident on a recent fleet of trains where despite the driver selecting a service brake, they did not apply for approximately 22 seconds. This risk had indeed been identified by the manufacturer, but it had not been communicated to the operator that they were managing this risk – through the use of the Emergency Stop button. The root cause of this is as a result of the absence of assigned safety criteria for the service brake in the TSIs.

[2] https://orr.gov.uk/__data/assets/pdf_file/0009/21402/strategic-chapter-12-health-and-safety-by-design.pdf
[3] Refer to RSSB and ORR Websites for the relevant guidance on the application of CSM-RA

3.3.7 Safe integration of the vehicles with operations and the Safety Management System is the responsibility of the Operator so it is therefore essential that the Operator is involved in the design process to ensure that the operational needs are appropriately addressed.

3.4 Specifying for Operational Resilience

3.4.1 It has been shown that stranded trains on the network increase the overall level of railway system risk.

3.4.2 As a consequence, it should be the aspiration that there should be no single point failure that results in the train becoming stranded and in need of rescue.

3.4.3 Practically, this is unlikely ever to be achieved. However, trains should be specified that minimise the number of single point failures.

3.4.4 Train designers should be requested to identify all potential single point failures related to their design that has the potential to result in a train becoming stranded on the network.

3.4.5 The objective is to ensure the manufacturer understands and is able to quantify the reliability risk of single point failures and to encourage them to amend their designs to mitigate single point failures where a cost-benefit analysis demonstrates that it is economic to do so e.g. incorporating multiple air compressors, pantographs etc.

3.4.6 In addition, trains should be specified with remote condition monitoring functionality that is capable of reporting when a maintenance intervention is required – prior to any adverse effect on service – and of equal importance with sufficient notice, so that management action can be taken to move the train to a suitable location for the maintenance to be actioned.

3.4.7 The impact on the passenger environment is often overlooked.

3.4.8 Functionality should be such that the impact on the passenger environment and amenities should be minimised in the event of a loss of external power supply for a specified period (dependent upon service type).

3.5 Specifying for Operational Functionality

3.5.1 The specifier should be very clear how the train will be operated and requirements should therefore be articulated in functional descriptions.

3.5.2 A good train specification will therefore be written in terms of ‘functional output specifications’ as opposed to input specifications. In other words, the train specification should specify the ‘what’ in order to leave the train designer to take care of the ‘how.’

3.5.3 In addition, functionality should be considered in terms of reliability since it has been suggested that the industry likes to specify new shiny things, but we don't adequately consider why we actually need them, nor potentially consider the implications on overall reliability. 'Keep it simple' should therefore be the mantra.

3.5.4 There have been numerous occasions where the deficient specification of operational functionality has created problems once the train is in operation. This is increasingly the case with the advent of 'fly by wire' train control systems where complex software control systems have been designed.

The Benefit of Hindsight:	A manufacturer of a recent fleet of multiple units did not appreciate that the operator intended to regularly 'split' and 'join' multiple unit formations in service. The manufacturer had assumed (wrongly) that splitting and joining would only be undertaken under controlled conditions in a depot environment Not surprisingly, this created reliability problems when the trains were introduced to service.

3.5.5 It is a truism that train designers are not train operators and train operators are not train designers therefore a mutual understanding of the needs and constraints of both sides will improve the specification and delivery.

3.5.6 It is therefore essential to specify the operational assumptions and requirements associated with any vehicles. This is often overlooked as the focus becomes predominantly about engineering requirements and the associated operational needs are addressed too late in the day and may result in costly redesign.

3.6 Specifying Diagnostic Functionality

3.6.1 More recent train designs typically include a Train Control and Management System (TCMS) that can monitor, control and report on the status of virtually all of the train systems.

3.6.2 Much unreliability witnessed with recent designs of trains has been caused by train diagnostic systems being relatively 'immature.' This is considered an aspect of train design that has frequently been neglected and is therefore worthy of increased focus by manufacturers.

3.6.3 A direct consequence of these these 'hypochondriac' diagnostic systems is that they bombard the driver with each and every event that the diagnostic has witnessed so that the driver is overloaded and therefore confused with respect of the course of action that should be taken.

Good Practice Example:	In order to prevent confusion and therefore unreliability in service, operators are very clear that messages and alarms appearing on driver interface screens should be concise, relevant and helpful in managing a situation.

3.6.4 As a consequence of this, the philosophy that should be specified in relation to the train diagnostic events that are reported to the driver should be that events should only be reported that need immediate action from the driver.

3.6.5 The additional philosophy that should be specified in relation to all events (including those reported to the driver) is that they should be remotely reported to maintenance control.

3.6.6 An aspect of diagnostics that is often overlooked is that the diagnostic data needs to be transformed into information that is able to support operations and to support the management of performance.

The Benefit of Hindsight:	Some existing designs of trains collect vast amounts of data but ultimately provide little useful information on which decisions can be made.

3.7 Specifying for Flexibility

3.7.1 We currently design trains to operate for typically 35 – 40 years. A lot can change in that time.

3.7.2 Train interiors should be specified to be much more flexible in terms of seating configuration since operators need to be much more flexible in terms of the business offering that they are able to make. It is also pertinent to highlight that trains are unlikely to stay on the routes that they were originally specified to operate for their whole life.

Good Practice Example:	Seats that are cantilevered from the vehicle body side are considered to be a design feature that contributes to the provision of a flexible train interior.

3.7.3 Ideally train interiors should therefore be configurable so that the use of the space is optimised ‘real time’ dependent upon the needs of the service being operated i.e. high-density capacity during the commuter peak and more spacious and comfortable ‘off peak’ for the leisure traveller.

3.7.4 The amount of luggage space is also something that should be carefully considered.

3.8 Specifying for ‘The Future’

3.8.1 The process of train procurement to delivery takes several years. A lot can change in that time and if you are not careful, your New Train design can be out of date before it has even been delivered.

3.8.2 Train specifications need to be cognisant of the following foreseen changes:

i) Climate change: More extreme temperatures and weather conditions are anticipated

The Benefit of Hindsight:	One fleet of diesel trains shut down as a result of their control system detecting a temperature of 40C ambient on a particularly hot day in 2019 – which was fully in accordance with how the system was designed. The train was designed to operate in accordance with the temperature ranges currently specified for the UK in existing standards – which 40C exceeds these specified limits.
Good Practice Example:	London Underground specify the maximum ambient temperature that trains are expected to operate as 55C.

ii) Political Change: The government has set the rail industry the challenge to decarbonise by 2040.

Good Practice Example:	Propulsion systems e.g. Diesel engine prime-movers (and associated fuel tanks) should be installed on the vehicle as part of a 'demountable' raft so that ready replacement with future 'clean' propulsion systems e.g. batteries, hydrogen fuel cells is made a simple as possible – once equivalent performance becomes available from these technologies.
Good Practice Example	Propulsion systems should be designed so that as much energy as possible can be 'harvested' e.g. during train braking for either future use by the onboard train systems or regenerated into a 'receptive' traction supply. The use of friction brake and rheostatic brake systems should therefore be minimised since these systems are wasteful of energy.

iii) Demographic Change: As a result of improvements in nutrition and other dietary changes people are getting bigger - that is both taller and wider. This has implications for the interior seating configurations of trains. Combined with this, due to advances in medical science, people are also living longer. This presents the potential for a future where an increasing percentage of the population will be older and therefore place higher demands on 'Accessibility' of our railway.

iv) Technological change: This continues apace and will continue to accelerate.

The Benefit of Hindsight:	The Global System for Mobile Communications – Railway (GSM-R) is technology based on 2G telecommunications technology. By the time the system was implemented on the national fleet the rest of the world i.e. the railway's neighbours were implementing 4G technology.

3.8.3 In order to be able to adapt train designs for this uncertain future, 'modularity' of systems that facilitate relatively simple changeout should be specified.

Good Practice Example:	A precursor to the roll-out of the European Train Control System is the fitment of the 'onboard' equipment to rolling stock. Trains should therefore be specified as 'ETCS' ready (in accordance with 5.3.2 of KTR v5.1) to facilitate fitment when required.
The Benefit of Hindsight	Experience has shown that there are significant differences in the size and power demand of ETCS equipment, so the provisions to make new trains really 'ETCS ready' is not straightforward.

The Benefit of Hindsight:	GSM-R was retrofitted to the national rolling stock fleet during the course of many years. As part of the initial design, there was no requirement to make the design modular in order to facilitate future system upgrade. As a consequence, the next system upgrade that is now about to be rolled out is considerably more expensive to implement than it would have been had 'modularity' been implemented as an initial design requirement. It has to be the aspiration that the relative simplicity of changing an automobile radio is achieved on the railway.
The Benefit of Hindsight:	The amount of technology on board trains is ever increasing. A consequence of this is that it is highly unlikely that the hardware and software systems that are currently operative will be supported through the life of the train. Such systems therefore need to be made modular to facilitate system changeout with 'new' updated versions that are able to provide equivalent functionality of the original components.

3.9 Specifying 'Standards'

3.9.1 It is simply insufficient to state in train specifications that the train must comply with all 'relevant standards.'

3.9.2 The reason for this is that manufacturers will therefore equate this statement to compliance with all 'mandatory' standards which, from a legal point of view include only:

i) Technical Specifications for Interoperability (TSIs)
ii) Any associated references to European Standards
iii) Notified National Technical Rules (typically contained in Railway Group Standards)

3.9.3 Legally, Great Britain has been prevented from making additional requirements 'over and above' those listed earlier in 3.9.2 - since it is argued that they represent a 'barrier to entry' to new users of our railway.

3.9.4 As a consequence, it is an unfortunate fact that requirements that have been identified in the light of our experience of operating our railway over the past 200 years cannot be legally enforced.

The Benefit of Hindsight:	Despite being fully compliant with all relevant braking standards there was an incident on a recent fleet of trains where despite the driver selecting a service brake, they did not apply for approximately 22 seconds. This risk had indeed been identified by the manufacturer, but it had not been communicated to the operator that they were managing this risk – through the use of the Emergency Stop button.
The Benefit of Hindsight	Despite being fully compliant with all glazing optical standards, the design of the windscreen of a recent train design created secondary images of signals at night time which caused a distraction to the drivers. In order to resolve the problem the original curved design of windscreen was replaced with one that was flatter.

3.9.5 Beyond the requirements in standards listed in 3.9.2, the law gives projects and entities a choice in deciding how to meet their legal obligations and business objectives.

3.9.6 Rail Industry Standards (RISs) are railway-specific standards that contain requirements, or they set out rules about how systems should be operated or managed.

3.9.7 RISs are managed on behalf of the industry by RSSB Committees and have been developed to be used by projects to define functional or technical requirements that are not covered by the standards listed earlier in 3.9.2 - where a common industry approach is considered beneficial.

3.9.8 In 2019, ORR made amendments to the Licence Conditions for both Network Rail and Operators with respect to expecting these organisations to comply with RISs[4]. With respect to train design there absolutely no reason why compliance with relevant RISs cannot be made a requirement of train specifications.

3.9.9 Indeed, compliance with RIS should be seen as helpful in that since they are developed by formal industry processes that reflect industry agreed good practice, they can effectively be considered as a 'code of practice' and therefore used by a train operator to demonstrate that the design of the train has been undertaken in line with the Common Safety Method for Risk Evaluation and Assessment.

3.9.10 Whilst it takes a significant amount of effort, it is considered good practice to comprehensively list all the legislation and standards (including versions) that the train should be compliant with in the train specification.

3.9.11 In order to assist train operators in relation to applicable European Legislation the Community of European Railways and Infrastructure Managers regularly updates a list of relevant legislation.

3.9.12 It must also be stressed that all standards are open to challenge and should specifiers consider that a standard contains 'onerous' or even 'obsolete' requirements they should be challenged for that very reason. This challenge should ideally be made at the earliest opportunity i.e. potentially at the specification or bidding stage.

Good Practice Example:	The challenge may be in the form of a request to revise the standard or for specific cases to request to deviate from the standard when the intent of the standard can be achieved by other means.

[4] https://orr.gov.uk/__data/assets/pdf_file/0011/40403/letter-to-licence-and-snrp-holders-re-rssb-and-rgs-conditions.pdf

3.9.13 Conversely, there is no restriction on specifying a higher level of performance than that required by standards where there is an operational need or benefit, since sometimes the outcome of the 'standardisation process' could be considered to result in the lowest common denominator, or only define minimum expectations.

3.10 Specifying for Infrastructure Compatibility

3.10.1 Whilst it is possible to manufacture New Trains that are fully compliant with current standards and other legislation, it is a fact that the infrastructure that they will typically operate over (unless they are being procured to operate solely on a brand new line) is unlikely to be compliant with the relevant current infrastructure standards.

3.10.2 This is because standards do not apply retrospectively and continue to evolve so railway systems introduced before a particular standard was published are therefore likely to have been built to earlier standards. Additionally, there will always be legacy aspects of the GB mainline network that are not captured by requirements in any national standards due to lack of knowledge about those assets; inherent uncertainty and variability of performance; and/or lack of industry agreement on key design parameters.

3.10.3 This therefore presents a real challenge for manufacturers since it is the aspiration that the train must also be compatible with the physical assets of existing track, platforms, signals, power supplies, trackside structures, bridges, tunnels, depots, sidings and not to mention the human factors related to passengers, drivers, traincrew and maintainers.

3.10.4 The compatibility process to be followed is described in RSSB Rail Industry Standard RIS-8270-RST: Route Level Assessment of Technical Compatibility between Vehicles and Infrastructure[5] which sets out requirements and responsibilities for the assessment of technical compatibility at route level for vehicles and infrastructure.

The Benefit of Hindsight:	A class of train was designed to be compatible with the cab sightlines specified in current standards. Unfortunately, it was discovered that the positioning of a platform signal on legacy infrastructure was arranged so that the driver could not actually view the signal when stopped at the platform. Until the signal could be repositioned, in order to introduce the New Train into service, an additional person to the driver had to be provided in the cab. The lesson here is that legacy infrastructure is not necessarily compliant with current standards.

[5] https://catalogues.rssb.co.uk/rgs/standards/RIS-8270-RST%20Iss%201.pdf

3.10.5 It is therefore of prime importance to ensure that train specifications are very clear with respect to the specific routes and the associated technical characteristics of those routes for particular design parameters. This is especially true of areas/aspects where previous vehicles may have encountered issues during introduction or operation.

3.10.6 The specified routes should also be reviewed by the operator's planning team since apart from the routes the New Trains are intended to operate over, it is important to identify depot / stabling access routes, diversionary routes and routes to access a wheel lathe.

3.10.7 In addition, this review should also identify any locations requiring temporary access, particularly during the commissioning / acceptance phase where it is likely that there is insufficient capacity to stable both existing and new fleets during the transition.

3.10.8 A robust set of parameters and description of route constraints (or an activity to identify the route specific constraints and challenges) is essential in any procurement specification. This will ensure that the vehicles being procured can, at the very least, be compatible to operate over the legacy infrastructure of those routes or only have to modify the absolute minimum infrastructure where necessary.

3.10.9 Particular attention is therefore needed with respect to signal sighting, trains stopping positions and stepping distances since all legacy signals and platforms are not necessarily compliant with current standards.

The Benefit of Hindsight:	A class of train was designed to be compatible with existing wheelchair ramps. Unfortunately once the train was introduced to the network it was found that due to the location of the wheelchair accommodation being at the outer extremity of the trainset, due to the taper that was present at the platform end there was insufficient platform width available at the end of the wheelchair ramp for the wheelchair to safely use the ramp and therefore the stopping position had to be changed.

3.10.10 This compatibility is not only in relation to the fixed railway infrastructure, it must also be specified that the train must be compatible with the other trains already in operation over the routes. Factors to consider in this respect include Electromagnetic Compatibility; power demand; passing clearances; coupler compatibility etc.

The Benefit of Hindsight:	A class of train was initially tested on a route without problem. Once more trains of the same design were commissioned and in operation on the route it was only then that Electromagnetic Compatibility problems with lineside equipment became evident. In order to resolve the problem, there was a need to retrospectively modify the train by the addition of a line inductor and extensive infrastructure works.

3.10.11 Other local environmental factors also need to be considered e.g. the presence of sea spray or other potential contaminants.

The Benefit of Hindsight:	A class of train was found not to be compatible with the 'sea spray' that was present along the sea wall at Dawlish. The salty water created earth faults on roof mounted resistors that caused the static converters to trip and resulted in the trains becoming stranded. Until a technical solution could be found, these trains were blocked for many years from operating over the affected route during conditions where sea spray was present – causing significant unplanned disruption to passengers.

3.10.1 In terms of maximising residual value it might initially appear attractive to specify a train that is able to operate everywhere on the GB mainline network, but this train would therefore have to be compliant with all the known gauging 'pinch-points' on the network in terms of tight clearances and will therefore be sub-optimal for the proposed routes of operation. There is therefore a balance to be struck since a train specified for a single network is unlikely to secure the necessary funding whilst there are associated cost and time implications to demonstrating compatibility for 'all routes' and on the infrastructure side the entire network would have to be maintained to accommodate a train it might never see.

3.10.2 Another aspect to compatibility is to acknowledge the fact that the compatibility process that is currently employed in Great Britain differs from that undertaken in mainland Europe. It is therefore sometimes difficult for new entrants to the GB rail market to understand and navigate.

The Benefit of Hindsight:	Whilst it may be the case that it can be difficult for new entrants to understand GB's compatibility processes it has been commented that it is the attitude of the proposer to the demonstration of compatibility that has more of an effect on the measure of success than how established a company is in the GB marketplace.

3.10.3 It is hoped that the 'Key Interface Requirements' document that is under development (see 6.1.13) will assist with this.

3.11 Specifying Power Supply Requirements

3.11.1 There is currently a relatively circular problem in respect to traction power supply capability for electrically powered trains.

3.11.2 Traction power supply capability needs to incorporate all the other users of the network and not only those services that will be operated by the New Train fleets.

3.11.3 The amount of power drawn by a New Train fleet is therefore heavily dependent upon the timetable that is planned to be operated – as opposed to being something that can solely be attributed to the train design.

The Benefit of Hindsight:	Some New Train project introductions have been delayed by the fact that there was not enough electrical traction power available to operate the proposed timetable. This is something that was only discovered towards the end of the programme.

3.11.4 It is therefore important that the train specification includes a description of the routes (identified previously in 3.10.6), the infrastructure managers, train formations, stabling plans and the proposed timetable to be operated.

3.11.5 It is also considered crucial that this information is shared with the Infrastructure Manager at the earliest opportunity to confirm any power supply assumptions are correct.

3.12 Specifying for Maintainability

3.12.1 It is often claimed that the manufacturer is primarily focussed on building the train i.e. facilitating quick assembly and it is only a secondary consideration that the train should be maintainable.

3.12.2 The train should therefore be specified to be easily maintainable so that all maintenance activities are achievable within a specified timeframe.

Part 4 Contracts and Procurement

4.1 Background

4.1.1 There are no published guidelines in relation to train procurement and introduction.

4.1.2 The more comprehensive and explicit definition of contractual requirements reduces the risk of dubiety and therefore subsequent debate and argument with respect of commercial liabilities.

4.1.3 It has been suggested that it would assist the industry if a generic template for New Train procurement contract were developed. However, it needs to be stressed that each New Train project is unique and procurers need to ensure that their contract effectively caters for the specifics of their project.

4.1.4 Similar to the fact that it is crucially important to ensure the Train Specification is as good as you can make it, it is also essential that an equivalent amount of effort should be given to the train procurement contract.

4.1.5 It can be argued that, there has been a tendency in recent years to 'over bid' in Franchise Commitments in terms of the delivery of New Trains. Manufacturers are compelled to offer immediate product with short delivery timescales.

Good Practice Example:	The procurement timescales of the Class 395 'Javelin' provides an example of where the train procurement process went well, with the following milestones: • June 2005: Contract Signature • August 2007: First Train Delivered for Testing • December 2009: Full Fleet Service
Good Practice Example	Procurers should anticipate that it will take around three years for manufacturers to design, build and test a brand new design of train prior to service introduction.

4.1.6 Typically, what has happened more recently is that a manufacturer signs up to an 'optimistic' i.e. unrealistic programme to design and deliver a New Train. Not surprisingly, when problems are experienced in relation to the design (as they inevitably do) the original delivery timescales are not met and the relationships between the procurer and the manufacturer become strained. The added complication here is that if the delivery of the New Train is a Franchise Commitment this can place the Franchise holder 'in breach' and potentially lose the Franchise.

4.1.7 There have also been instances where there has been delay in closing contracts with a preferred bidder, but the end dates for delivery have not been adjusted accordingly to reflect this delay – further compressing production timescales.

4.1.8 It can therefore be argued that the root cause of all this 'angst' is therefore the Franchise Bidders setting (and manufacturers signing up to) unrealistic timescales.

4.1.9 Continuing this theme, it could further be argued, currently, that there is a need for the Department for Transport to improve their 'credibility and deliverability' review processes prior to Franchises being awarded.

4.1.10 This assertion is supported when it is considered that, in terms of product design and development looking at other industries it would appear that much less time is spent on this in rail – typically two years - than in either the automotive industry (3-5 years[6]) or aviation (10 years).

The Benefit of Hindsight:	Class 395 – June 2005 Contract Signature; August 2007 first train delivered for testing Boeing 787 – Jan 2003: Programme Announced; August 2011 type certificate obtained

4.1.11 In addition, the need for significant innovation can arise from numerous sources, e.g.:

- from the needs of the manufacturer to update their product platform to remain competitive
- from a client need for enhanced functionality
- from a government initiative or legislation[7]

4.1.12 Irrespective of where the need arises, if there is significant innovation then this also needs to be reflected in the associated contractual timescales.

4.1.13 The rail industry's very short development timescale is undoubtedly a factor in the poor reliability when New Trains are initially introduced to service. Effectively performance is poor as a result of designs that have been 'untested in the field.'

The Benefit of Hindsight:	Experience has shown that it will typically take two to three years from a New Train service introduction to achieve the contracted levels of reliability performance.

4.1.14 What follows are proposals that are considered to represent 'good contracting' practices that should implement the lessons learned from previous New Train projects.

4.1.15 It is also accepted that the typical 7-year franchise award period does not necessarily provide franchises with the incentive to follow the guidance contained in this section since the following franchisee takes the financial 'hit' of increased leasing costs etc.

[6] https://www.quora.com/Automobile-Design-How-long-does-it-take-to-develop-a-car-design-from-scratch
[7] There is a requirement in the LOC & PAS TSI that repeat orders of vehicles cannot claim type compliance after a period of seven years has elapsed.

4.2 Train Specification

4.2.1 Considering the time and effort invested in ensuring that the Train Specification is as correct as possible it should be a contractual requirement that the New Train is fully compliant with the Train Specification - which should form part of the Procurement Contract.

4.2.2 It should be a contractual requirement that the procurer (and operator) work together on the design of the New Train.

4.2.3 It should be a contractual requirement for the manufacturer and procurer to agree both which diagnostic events and the actual text that is reported to the driver on the Train Management System – as described earlier in 3.6.4

4.3 Mock Ups

4.3.1 For brand new, or significantly different variants of an established design, it is considered good practice to include as a contractual requirement the production of a full size mock up of the driving vehicle.

4.3.2 The mock up would typically (at least) consist of:
- the full driving cab that includes a fully functional cab door and cab access steps
- a half-length section of the passenger saloon that includes a pair of fully functioning passenger doors and footsteps.

4.3.3 There are numerous purposes that such a mock-up could be used. These include:
- to facilitate the traincrew consultation exercise by physically demonstrating the proposed arrangement of the cab to the traincrew representatives in order to involve them at the outset.
- to undertake a public consultation exercise on the arrangement of the interior e.g. that includes options for different seats or seating layouts.

4.3.4 It should be a contractual requirement that the manufacturer will work with the procurer (and operator) in order to ensure a successful consultation exercise with the relevant industry traincrew representatives in relation to the design of the cab prior to the construction of the first trains.

The Benefit of Hindsight:	Whilst train manufacturers have a ‘product platform’ for their train design they sometimes have different designs for cabs on the same platform. One operator discovered that their cab was materially different in design to that which had been previously approved by the relevant train crew representatives and therefore that approval could not simply be ‘read over.’

4.3.5 In order to assist their representatives, the Associated Society of Locomotive Engineers and Firemen (ASLEF) have produced a 'Train Cab Design Guide for Negotiators and Members.' The document can be accessed at: https://www.aslef.org.uk/visageimages/Publications/General/asleftraincabdesignhandbook.pdf This is considered a useful reference document whilst undertaking this process.

4.3.6 Whilst physical mock-ups are considered the optimal approach, virtual mock-ups could also be considered since they have advantage in terms of improved agility in terms of design and significantly reduce production timescales.

4.4 Prototyping

4.4.1 If you are procuring a brand-new design of train it is strongly recommended that your contract contains a requirement for the manufacturer to produce at least two prototypes (this is especially the case if they will be expected to operate in multiple formations).

4.4.2 Prototypes allow the manufacturer to understand how they will assemble the train – without the added complication of immediately having full production line logistics to manage. In theory, they can therefore take more time to ensure that all problems are identified at the manufacturing stage and therefore subsequently implemented during the production run.

4.4.3 The prototypes (after the necessary testing and validation activities) should be operated in service for a significant period of time (typically 12 months) so that all the issues identified during operational shake down are addressed and also implemented during the subsequent production run.

4.4.4 Another benefit of having a distinct prototype phase is that it provides a manufacturer with increased flexibility in terms of being able to iterate aspects of the design without having to be subject to a 'full blown' formal Engineering Change Process (as outlined in 4.18).

Good Practice Example:	When Connex procured the Adtranz Class 375 'Electrostar' they specified in their contract that the manufacturer should construct four prototype units that should run a combined mileage of 200,000 miles before the manufacturer was expected to manufacture the subsequent units. The manufacturer was also contractually obliged to implement the modifications on the production units that had been identified as needed during the construction and operation of the prototype units.
The Benefit of Hindsight:	More recently, a class of train went straight from the drawing board into the production run. There were so many reliability problems that the relevant fleet manager commented that they sometimes felt that "they have a fleet of prototypes!" In addition, the manufacturer was forced to deploy a technical rider on each and every train in service in order to provide an 'adequate' level of reliability performance.

4.4.5 It cannot be stressed enough how beneficial the early interaction between the New Train and the general public is in order to 'flush out' issues at the earliest opportunity. This is equally applicable to the interaction of operational and maintenance staff with the New Train.

4.4.6 Undesirable functionality often only reveals itself in service.

The Benefit of Hindsight:	On one recent design of train the Passenger Information System functionality was only discovered to be not what the TOC wanted until it was already in operation e.g. who wants to see an overview of London Underground Tube information as they head off towards the coast?
The Benefit of Hindsight:	On one recent design of train, despite the bodyside door system being designed to current standards, once the train was introduced to service it was found that it was possible for members of the public to damage the door mechanism by simply obstructing the door on closure.

4.4.7 Once the period of prototype running is completed the manufacturer can then commence building the production series with increased confidence and can undertake the necessary retrospective modifications on the prototypes. An added benefit of this is the reduction in retrofit work necessary to implement any modifications on the subsequent fleet which therefore reduces the overall costs to the industry.

4.4.8 It should be a contractual requirement for the prototype units to be retrofitted by the manufacturer to be subsequently redelivered to production status.

4.4.9 Another advantage of prototype running is that the operator is able to build up a small core of expertise on the New Train in terms of operational, technical and maintenance personnel that can be used as 'super-users' or 'ambassadors' once the production trains start to be delivered.

4.4.10 There should be no need to include a contractual requirement for a prototype if the train you are procuring is an 'established design' that comes with a 'proven pedigree' of acceptable performance. However, procurers should be wary of manufacturers changing their sub-system suppliers for subsequent orders of supposedly the same 'Class' of train.

Good Practice Example:	Procurers of 'tried and tested' product platforms e.g. Class 387 Units that were the final incarnation of the 'Electrostar' product platform were buying a proven product.

4.4.11 The need for prototyping therefore depends upon the degree of deviation from the mature design. A simple re-configuration of a well-established train design with many units successfully in service should not need a prototype as such, but significant new systems added (or significantly different control software) for upgraded communications systems to the base design may require prototypes to be produced.

4.5 Contracting - Payment Milestones

4.5.1 Historically, contract payment milestones have been based upon the manufacturer building hardware e.g. a watertight bodyshell with bogies.

4.5.2 It is important that incentive or penalty regimes are properly though through since as a result of unintended consequences they can often lead to 'perverse' behaviours from organisations.

4.5.3 It is recommended that there should be a contract payment milestone related to the receipt of a Network Rail Summary of Compatibility for the train that is (ideally) without restriction, but at the very least is acceptable to the vehicle procurer.

4.5.4 There should also be contract payment milestones based on the New Train demonstrating adherence to an agreed reliability growth plan i.e. staged payments based upon increasing reliability performance of both an individual train and the fleet as a whole.

4.5.5 It is also recommended that a benefits 'share' mechanism should be included in order to incentivise the manufacturer to work with the operator to accelerate the reliability performance of their New Train.

Good Practice Example:	A typical example of this could be a payment that is made once the reliability of the fleet of New Trains has exceeded the reliability of the trains that they have replaced.
Good Practice Example:	Another approach that is often adopted is the 'Performance Bond' approach. This is where payments are made by the procurer into an escrow account and the subsequent payment is made to the manufacturer once the reliability has reached an agreed level.

4.5.6 It is recommended that reliability performance should be measured in terms of impact to the fare paying customer and the recently adopted 'Miles per 701D' (where 701D is the relevant TRUST[8] cause code) is considered an appropriate independent measure of this.

4.5.7 The final contract payment milestones should only be made once the contracted reliability performance has been delivered for a consistent period and that all 'service affecting software bugs' have been eradicated through software updates.

4.6 Contracting – Liquidated Damages

4.6.1 Historically, penalties or 'Liquidated Damages' (LDs) are included in contracts that are designed to protect the procurer against non-delivery and therefore incentivise the manufacturer to meet committed delivery dates.

[8] TRUST (Train Running Under System TOPS) is a Network Rail computer system used for monitoring the progress of trains and tracking delays on Great Britain's rail network

4.6.2 However, these LD's are typically capped, since excessively severe penalty clauses serve no purpose if this causes the manufacturer to file for bankruptcy.

The Benefit of Hindsight:	Recent experience has demonstrated that whatever LDs are currently written into contracts they haven't prevented late deliveries of New Trains. As a consequence whether LDs as currently defined in contracts are therefore 'fit for purpose' has to be called into question.

4.7 Contracting – Human Factors

4.7.1 It is important that procurers (and operators) ensure that that they are aware of all the manufacturers assumptions about how the train will be operated.

The Benefit of Hindsight:	On one recent design of train the manufacturer specified operator responsibilities that could not be complied with e.g. following an air conditioning trip, the crew were expected to open a locked cupboard and reset a circuit breaker that was behind a cover that only maintenance personnel had access to.

4.7.2 It should be a contractual requirement that manufacturers state all assumptions in relation to how the train will be operated, for subsequent review and agreement by the procurer (and operator).

4.8 Contracting - Safety Strategy

4.8.1 It is important to recognise that if the designer's hazard identification and risk assessment processes are not sophisticated enough to identify gaps, a train which meets the TSI may not be fully safe to operate under specific constraints or freedoms e.g. which are local in nature and operationally or geographically driven – as highlighted earlier in section 3.9.

4.8.2 It should therefore be a contractual requirement that the manufacturer should identify and fully document those residual risks that they are proposing to transfer to the operator/asset owner.

4.8.3 It is also important that the manufacturer ensures that the operator/asset owner is fully aware and accepts those risks that the designer is proposing to transfer, which should also be a contractual requirement.

4.8.4 Similarly, the train operator needs to conduct a thorough risk assessment at a sufficiently early stage of how the train will operate in the real world, taking into account, and if necessary, challenging any risks identified and documented by the designer proposed to be transferred to the operator/asset owner and also taking into account the conditions and restrictions with which they are familiar but the manufacturer is not.

4.8.5 It is a legal requirement[9] that the Common Safety Method for Risk Evaluation and Assessment is undertaken jointly by the manufacturer and operator to ensure that both the operator and manufacturer are very clear in relation to the allocation of the risks associated with the operation of the New Train and that any operational requirements related to route specific issues are identified and agreed.

4.8.6 For absolute clarity, it is the responsibility of the Operator to demonstrate 'Safe Integration' of the New Train and therefore will require the manufacturer to be engaged to ensure that this happens in practice. This will help to clarify whether safety risks are addressed by the design, operating practices or a combination of the two.

4.8.7 In an ideal world, there should be no single point failure or set of external circumstances that will result in a train becoming a safety hazard. Pragmatically, it is unlikely that a manufacturer will be able to comply with this requirement.

4.8.8 It should be a contractual requirement that manufacturers state all failure modes or external circumstances that will result in their train becoming a safety hazard, for subsequent review and agreement by the procurer.

The Benefit of Hindsight:	There have been recent incidents related to propulsion package traction capacitors exploding. Historical traction equipment had pressure switches installed in the capacitors to mitigate this risk, but more recent equipment designs have not included this design feature.

4.8.9 The Safety Strategy is further complicated by the need to nominate the Entity in Charge of Maintenance (ECM), which dictates the level of influence of that the Train Operator has over the Maintenance Regime (see section 4.11)

4.8.10 An additional consideration is that with the implementation of the 'Fourth Railway Package' in Great Britain in June 2020, there is a need for manufacturers to identify 'Safety Critical Components' to the ECM.

[9] Refer to clause 1.2.1 of COMMISSION IMPLEMENTING REGULATION (EU) No 402/2013 on the common safety method for risk evaluation and assessment

4.8.11 It should therefore be specified in procurement contracts that the manufacturer should advise the procurer and ECM of the details of all Safety Critical Components, provide an explanation why those components are critical and specify what needs to be undertaken to keep them safe to the procurer and ECM.

4.9 Contracting – Resilience Strategy

4.9.1 As previously identified (in 3.4), stranded trains increase the level of rail industry system risk and are therefore to be avoided if possible.

4.9.2 In an ideal world, it should be a contractual requirement that there is no single point failure or set of external circumstances that will result in a train becoming stranded and in need of rescue, but pragmatically, it is unlikely that a manufacturer will be able to comply with this requirement.

4.9.3 However, it should be a contractual requirement that manufacturers state all failure modes or external circumstances that will result in their train design becoming stranded and in need of rescue, for subsequent review and agreement by the procurer (and operator).

4.9.4 It should also be a contractual requirement that the manufacturer documents the rescue and recovery procedures for subsequent review and agreement by the procurer (and operator).

4.10 Contracting – Testing Strategy

4.10.1 For projects that have not had the benefit of running prototypes in service it is important to ensure that the testing programme is appropriate.

4.10.2 It should be a contractual requirement that the manufacturer and procurer agree an appropriate testing plan. This plan also needs to include arrangements for software testing.

4.10.3 Whilst recognising the benefits to be gained through introduction to passenger service as soon as practicable, the testing plan should incorporate:

- Software testing incorporating the whole development life-cycle

Good Practice Example:	It is recommended that software development should proceed in accordance with the following: • Functional modelling (to minimise the lines of code to be developed) • Software integration testing with other connected software systems that will be on the New Train • Combined testing including ‘aerospace Iron Bird’ concept which incorporates representative cabling and connectors

- Maximising the use of non-mainline infrastructure where appropriate. (This recognises the need that access to the network can be difficult.) However, it is also helpful if the test location can replicate as much of the mainline characteristics as far as possible.
- Realistic tests reflecting the anticipated duty cycle foreseen and passenger misuse and abuse tests.
- Stress testing of the train systems in abnormal situations to identify any potentially dormant issues that the train might encounter during its life.

4.10.4 There should be no barrier to the manufacturer demonstrating the provenance of subsystems already used on other designs that obviates the need for tests, but this needs to be documented and agreed with the procurer.

4.11 Contracting - Maintenance Strategy

4.11.1 With the implementation of the 'Fourth Railway Package' in Great Britain in June 2020, there is a need for a 'Certificated Entity in Charge of Maintenance' (C-ECM) for each fleet of trains.

4.11.2 Some recent train procurements have nominated the manufacturer as the ECM, whereas others have the Train Operator nominated as the ECM.

4.11.3 However, there are important implications of this decision, since if the manufacturer is nominated as the ECM, the Train Operator has no influence over the content of the maintenance and overhaul documents.

4.11.4 Train procurement contracts should therefore clearly state the arrangements in terms of C-ECM for New Train fleets.

4.11.5 The initial maintenance plan is only ever an 'educated best guess' of the manufacturer and sub-system suppliers in terms of anticipated maintenance requirements for the life of the rolling stock.

4.11.6 It is also the case that maintenance requirements are often 'over prescriptive' in terms of protecting manufacturers and sub-system suppliers 'warranties.'

4.11.7 In any event, the actual maintenance requirements are heavily dependent upon the duty cycle of the rolling stock and are therefore typically optimised over a period of years.

4.11.8 Components that are overmaintained are wasteful of resource, especially where resource could be better employed maintaining components that might have been overlooked in terms of the maintenance plan and therefore impact on fleet reliability.

4.11.9 It is also a matter of fact that there are components installed in rolling stock that will not last for the life of the vehicle that are also not included in the initial maintenance plan. Examples of this are electrolytic capacitors, battery 'back ups' on printed circuit boards, relays etc. only have a finite life – sometimes in the order of 5-8 years and will therefore undoubtedly need to be replaced at a point in the future.

4.11.10 It should therefore be a contractual requirement that manufacturers identify all such components and provide an indicative life for their replacement.

4.11.11 It is therefore suggested that a 'benefits share' mechanism is established between procurer and maintainer in order to facilitate the maintenance optimisation process

4.11.12 This mechanism provides a real incentive for all parties to establish an optimised maintenance regime which both optimises fleet reliability performance and represents real value for money – for which all parties are beneficiaries.

4.11.13 Another aspect of maintenance that is often overlooked is the provision of 'special tools' or maintenance diagnostic software applications necessary to maintain the New Train. It should therefore be a contractual requirement that the manufacturer identifies all such 'special tools' or software applications.

4.11.14 It should be a further contractual requirement that the manufacturer provides the relevant maintenance diagnostic software in a form that enables its use by depot staff.

4.12 Contracting – Depot, Stabling and Berthing Strategy

4.12.1 In an ideal world, New Trains should be procured with a new depot specifically designed for their maintenance.

Good Practice Example:	A useful source of information in terms of depot design is GIGN7621: Guidance Note for the Development and Design Considerations of Passenger Rolling Stock Depots.[10]

4.12.2 However, the realities of life typically get in the way in that new fleets of trains are expected to replace existing fleets and therefore be maintained at an existing depot.

4.12.3 It should therefore be a contractual requirement that a joint assessment (by the manufacturer, maintainer and the procurer) is undertaken of the existing depot facilities for the manufacturer to identify what modifications are required to existing depot facilities in order to maintain the new fleet of trains.

[10] https://catalogues.rssb.co.uk/rgs/standards/GIGN7621%20Iss%201.pdf

4.12.4 The review should encompass: inspection pits; sidings; headshunts and wheel lathes; carriage washing machines; Controlled Emission Toilet (CET) aprons and other servicing locations; etc.

4.12.5 This is especially pertinent if the length of the New Train set differs significantly from the existing fleets being serviced and maintained and have e.g. engines and water tanks in different positions.

The Benefit of Hindsight:	Changes in stock formations can have a significant adverse impact on depot, stabling and berthing capacity e.g. 5-car sets that replace 4-car sets dictate that only one set can be accommodated in an 8-car siding (that could previously accommodate 2x 4-cars).

4.12.6 It should be a contractual requirement that the electrical shore supplies required for the New Trains are compatible with the supplies already in use at the depot unless there is a clear benefit to making changes to the depot equipment e.g. for safety reasons. This compatibility assessment should also include the assessment and confirmation that there is sufficient power available to service the needs of the New Train fleet at the depot.

4.12.7 It should be a contractual requirement that the connections for the replenishment of consumables e.g. fuel, water, potable water, sand, Controlled Emission Toilet (CET), AdBlue, coolant, windscreen wash are compatible with the systems already in use at the depot unless there is a clear benefit to making changes to the depot equipment e.g. for safety reasons.

Good Practice Example:	Physical tests to verify the operation of the depot systems with the New Train should be undertaken to confirm suitability.

4.12.8 It should also be a contractual requirement that any depot modifications are completed prior to the delivery of the first production deliveries. If the New Trains programme is subject to the running of prototypes, this provides the necessary 'window' to complete the necessary works.

Good Practice Example:	A useful source of information in terms of depot design is GIGN7621: Guidance Note for the Development and Design Considerations of Passenger Rolling Stock Depots. [4]
The Benefit of Hindsight:	The introduction of a new fleet is probably one of the most stressful times for a depot. Not only have the existing fleet to be maintained, but there are the new build vehicle deliveries to accommodate and therefore space, not only at the depot but at stabling and berthing facilities across the network is at a premium. If your depot facilities are also being rebuilt at the same time to accommodate the new fleet then the situation can rapidly become untenable.

4.12.9 It should therefore be a contractual requirement that a joint assessment (by the manufacturer, maintainer and procurer (and operator)) is undertaken of the plans for stabling and berthing of the new fleet. This plan should be reviewed periodically as the New Train deliveries progress and the existing fleets are cascaded elsewhere.

4.12.10 It should be a contractual requirement that sufficient time is given to training the maintenance, control and technical teams on the New Trains and the requisite number of trains should be delivered in order to support this training. This will be made considerably easier if the new fleet of trains have been subject to the running of prototypes (as per section 4.4)

4.12.11 As a result of late New Train deliveries, the time available for staff familiarisation and training is typically an aspect that comes under significant pressure to compress timescales in order to have trains in service. This must be resisted as far as possible as doing so is often a false economy since the introduction of New Trains into service when the people tasked with operating, maintaining and providing technical support are not really ready simply generates more problems than it solves.

4.13 Contracting – Documentation Strategy

4.13.1 Notwithstanding the ECM arrangements outlined earlier in section 4.11, there is often a perceived reluctance from manufacturers to produce sufficient documentation that will support the operation and maintenance of the train for the whole of its life. This inhibits the operators, technical teams and maintainers from really understanding how the train is designed to work and often makes subsequent fault finding almost impossible.

4.13.2 As a minimum it should be a contractual requirement that the manufacturer and procurer (and operator) jointly develop the following documentation:

i) Train operating manual
ii) Technical information manual
iii) Illustrated list of components
iv) Fault finding guides - including the use of diagnostic software applications
v) Electrical schematics
vi) Software schematics
vii) Vehicle Maintenance Manual that includes:
   - Vehicle maintenance schedule
   - Vehicle maintenance instructions
   - Vehicle maintenance procedures
   - Vehicle overhaul instructions
   - Component overhaul instructions

Good Practice Example:	A ‘cloud storage’ solution assists the collaboration process, storage and version control of these documents.

4.14 Contracting - Power Supply Strategy

4.14.1 For electric trains, it should be a contractual requirement that the manufacturer will work with the procurer (and operator) to obtain confirmation from the Infrastructure Manager that there is sufficient electrical traction power available to run the proposed timetable of the New Train fleet.

4.14.2 It should also be a contractual requirement that the manufacturer will work with the procurer (and operator) to obtain confirmation from the Infrastructure Manager that there is sufficient electrical traction power available at all stabling / berthing locations.

4.14.3 In the event that there is not sufficient power supply available, it should be a contractual requirement that the manufacturer should review their train design with the aim of reducing power consumption.

4.14.4 It is accepted that there is a practical limit to what a manufacturer can potentially achieve with this.

4.14.5 If it is ultimately determined that there is indeed insufficient power available, alternative strategies such as reduced timetable demand or power supply upgrades need to be considered.

4.15 Contracting – Simulator Strategy

4.15.1 It is considered good practice for driving simulators to also be procured – since this will significantly reduce the amount of time needed to train the necessary drivers.

4.15.2 It should be a contractual requirement that manufacturers also provide the necessary details to support the software on the simulators in order to ensure that updates to the functionality of the trains in service is simultaneously replicated on the simulators and that therefore the simulator software is kept up to date.

4.16 Contracting – Commissioning Strategy

4.16.1 The Operator will only ever be able to commission a specific number of trains at a time dependent upon their available resource.

The Benefit of Hindsight:	As a result of delays to the delivery of New Train fleets from different manufacturers the Operator found that the number of New Trains they had to commission was becoming unmanageable.

The Benefit of Hindsight	As a result of the delivery profile of New Trains exceeding those that the operator could use in service, a large proportion of a recent build of new trains had to go directly from the factory into storage. The trains could not be used by the operator since they had yet to be fully approved for passenger use and they also needed significant rework prior to the units being commissioned.

4.16.2 It is therefore considered good practice for there to be a contractual requirement for procurers (and Operators) to agree with the manufacturer the number of New Trains that can be commissioned at any one time – so that the expectations are clearly laid out at the outset.

4.16.3 The New Train commissioning plan should facilitate the New Trains operating a specified number of miles for 'fault free running' on the mainline before the next New Train can be offered by the manufacturer for commissioning.

4.16.4 It is considered good practice that the commissioning has two phases, with phase one in 'non-passenger shadow running' to ensure that all of the train systems are correctly functioning without passengers on board, whereas phase two will involve the trains operating in passenger service.

4.16.5 The precise number of 'fault free miles' will have to be determined based on the operational diagrams that are possible to ensure that the overall commissioning plan is achievable.

Good Practice Example	In the late 1980's, the much later batches of the Class 321 fleet manufactured by BREL York were introduced directly to passenger service from the production line.

4.16.6 It is accepted that, compared to legacy fleets the number of on-train systems that need to be tested and commissioned has increased rapidly and therefore commissioning a more modern design of train could be considered more complex. However, this is counteracted by the fact that increased levels of diagnostics are installed that can be used as a guide as to whether systems are functioning correctly.

The Benefit of Hindsight:	There have been instances where contractual 'fault free' running has amounted to only 500 miles. This has led to the fleet of trains replicating this unacceptably low reliability performance level once introduced to service.
The Benefit of Hindsight	There have been other instances where 'mileage accumulation' has been undertaken for suburban passenger stock where the commissioning did not test the passenger doors. As a consequence, once the trains were introduced to passenger service the door reliability was very poor.
The Benefit of Hindsight	Once New Train deliveries start there is often 'acceptance pressure' placed on operators to take trains that are 'sub-standard' so that manufacturers can receive payment or to fill a looming shortfall of existing vehicles that are no longer available to the operator since they are approaching the end of their lease.

4.16.7 There will also need to be some contingency factored in to reflect the fact that 'shakedown' faults will occur and therefore the 'fault free' clock will have to be reset on occasion.

4.16.8 It is also essential that high standards of fault reporting are required when things go wrong so that problems can be identified quickly and followed up. A small pool of test drivers (potentially supported by test engineers) for the initial 'shakedown' commissioning runs would be able to provide more detailed fault reports.

4.16.9 It is a fact that problems are bound to occur. It is therefore how agile organisations are at responding to these problems that will dictate how long it takes to expedite the necessary solutions.

4.16.10 The later stages of the commissioning phase are also very useful for dovetailing in with the driver training programme so that drivers are exposed as soon as possible to the operation of the train under controlled conditions on trains that have demonstrated a level of reliability performance.

The Benefit of Hindsight:	Initial reliability performance of New Trains fleets is often poor as a result of 'staff unfamiliarity' with the New Train systems (otherwise known as 'finger trouble') and utilising the driver training programme for commissioning is a way to improve drivers' understanding of the train systems.
The Benefit of Hindsight:	Whilst priority is typically given by operators to the training of drivers, the training needs of on-board staff are of equal importance in order to reduce incidents in service e.g. in relation to the operation of new door control panels.

4.17 Contracting – Driver (and on-board staff) Training Strategy

4.17.1 Ensuring the correct number of drivers (and on-board staff) are fully trained when the New Trains are ready to enter service is often a major headache for operators.

4.17.2 It should be a contractual requirement that sufficient time is given to training drivers (and on-board staff) on the New Trains and the requisite number of trains should be delivered in order to support this training.

4.18 Contracting – Engineering Change Strategy

4.18.1 Often, due to their large number, it is often difficult for procurers (and operators) to ensure proper scrutiny of proposed changes that the manufacturer is making to the train design.

4.18.2 In order to ensure that a robust Engineering Change Management process is established at the outset it should be a contractual requirement that the procurer and manufacturer (and operator) agree a specific date for 'design freeze' of the design of the New Train.

4.18.3 Any changes to the design of the train that are made by the manufacturer following this date would therefore be the subject of a formal Engineering Change from the manufacturer to the procurer (and operator).

4.18.4 It is therefore very important that an efficient process is established between all the parties to ensure that the agreement of Engineering Change does not become a bottleneck.

4.18.5 It is therefore important to establish a clear set of ground rules for the definition of significant changes i.e. those that need to be communicated and agreed as opposed to minor changes that support manufacturing or correct non-functional errors that genuinely do not need to be the subject of the Engineering Change Process.

4.18.6 It is equally important that the procurer (and operator) have sufficient resource available to deal effectively with the amount of documentation that Engineering Change can generate.

4.18.7 In order to assist Train Operators to understand good practice in terms of Engineering Change, in 2015 ATOC produced ATOC/ACOP/EC/01006: Approved Code of Practice – Management of Rail Vehicle Engineering Change which describes an approach for the effective management of engineering change to rail vehicles together with aspects of inter-company cooperation requirements.

4.18.8 In order to assist the wider industry implement the effective verification of conformity of engineering change, RSSB has published RIS-2700-RST: Rail Industry Standard for Verification of Conformity of Engineering Change to Rail Vehicles.

Part 5 Aspects of Train Design

5.1 Background

5.1.1 A train manufacturer does not (typically) understand how their train will be operated. A train operator does not (typically) understand how the train is designed to operate. A train owner needs to maintain the integrity of the train throughout its full life cycle. Therefore, each party has a unique perspective and therefore something to offer in relation to ensuring an effective introduction to service.

5.1.2 Operators should not therefore leave manufacturers to ‘get on with it’ during the design phase and good relationships need to be established at the outset with a cooperative balance being struck.

5.1.3 The irregular cycle of ‘famine and feast’ in terms of train procurement has potentially led manufacturers to wait until New Train orders are received in order to fund the development of their next ‘product platforms.’

5.1.4 A consequence of this is that there is a conflict here between manufacturers wanting to develop radically new designs i.e. from a blank sheet of paper, whereas operators would prefer designs that have evolved from previous designs e.g. evolution and not revolution.

5.1.5 An effective Design Review process therefore relies on transparency and openness from all involved. What follows is considered to be ‘good practice’ in terms of the Design process and the associated process of Design Scrutiny.

5.2 Learning the Lessons - KTR

5.2.1 In order to learn the lessons from previous train designs the wider industry has collaborated to produce the Key Train Requirements (KTR). KTR is intended to assist rolling stock procurers, manufacturers and system suppliers to (amongst other things) review designs by drawing attention to experience that has emerged from historic rolling stock projects.

5.2.2 The current KTR is on its fifth iteration (v5.1) and can be accessed at the following link: https://www.raildeliverygroup.com/about-us/publications.html?task=file.download&id=469775901

5.2.3 It is the intention that KTR is used as a ‘Design Review Checklist’ to ensure that aspects that are of particular importance to each specific project are considered at the Design Review stage.

5.3 Design Review

5.3.1 Manufacturers (both Original Equipment Manufacturers (Tier 1) and sub-system suppliers (Tiers 2 and 3)) should be much more open to the procurer (and operator) playing a much more active role in the design review process in order to improve the outcome of the design scrutiny process. Whilst this takes considerable effort to undertake effectively, both the manufacturer and operator will benefit from the output, resulting in an improved design.

5.3.2 Design review meetings should be constructive, objective and focus on assessing the suitability of the design to achieve the agreed requirements. They must also respect the contractual design timescales.

The Benefit of Hindsight:	The Design Review process is only effective if parties not only listen to concerns, but also react. There have been examples where concerns that have been raised on project mock-ups have not been addressed in the final product.
The Benefit of Hindsight	Design Reviews that are convened purely as a result of the need to satisfy contractual obligations often become meaningless or become ‘competitions’ to demonstrate who knows the most about the product.

5.4 Design - Hazard Identification

5.4.1 The Hazard Identification process needs to be properly managed as previously identified in 3.3.6.

5.4.2 There is a need to look beyond the legal and commercial obligations since these cannot be relied upon alone to assure safe operation.

5.4.3 As previously identified in 3.3, it is important to recognise that if the designer's risk assessment processes are not sophisticated enough to identify gaps, a train which meets the TSI (or even any other agreed set of requirements) may not be fully safe to operate under specific constraints or freedoms e.g. which are local in nature and operationally or geographically driven.

5.4.4 It is also important that the manufacturer ensures that the operator/asset owner is fully aware and accepts those risks that the designer is proposing to transfer.

5.4.5 Similarly, the train operator needs to conduct a thorough risk assessment at a sufficiently early stage of how the train will operate in the real world, taking into account, and if necessary, challenging any risks identified and documented by the designer proposed to be transferred to the operator/asset owner and also taking into account the conditions and restrictions with which they are familiar but the manufacturer is not'

5.4.6 It is therefore considered good practice for the Common Safety Method for Risk Evaluation and Assessment should be undertaken jointly by the manufacturer and operator to ensure that both the operator and manufacturer are very clear in relation to the allocation of the risks associated with the operation of the New Train (as highlighted earlier in 4.8.5).

5.4.7 The hazard identification process is also a very good tool to identify failure modes that are generated from unexpected operational scenarios.

5.5 Design for Human Factors

5.5.1 As stated previously, train designers are not (typically) train operators and train operators are (typically) not train designers.

5.5.2 Operators therefore need to work with the manufacturers to understand the assumptions that the manufacturer has made.

5.5.3 With the advent of ever increasing software control this has magnified the extent of the problems that can occur.

5.5.4 Problems with software functionality therefore typically arise due to the software designer not being aware of how the system will be operated in practice and, as a consequence making incorrect assumptions.

5.5.5 It could be further argued that the root cause of this is a ‘systems integration issue’ as opposed to being purely a ‘software issue'

Good Practice Example:	A train operator provided a dedicated resource to work with the manufacturers’ train control software development team to review any assumptions made by the software developer in terms of how the train would be operated.
The Benefit of Hindsight:	A software developer assumed that a driver would not be able to change ends of a six-car multiple unit in less than 10 seconds. The multiple unit had two pantographs. Unfortunately, the software developer had not considered that another driver might be waiting on the platform to ‘hop aboard’ the rear cab at a terminal station and therefore it was indeed possible to change ends within this timescale. This implicit assumption, led to physical damage to the train as a result of the rear pantograph being lowered in an energised state in close proximity to the vehicle roof.

5.5.6 Aspects that therefore need to be reviewed in terms of Human Factors control functionality include:

i) What happens if the process is undertaken too quickly?
ii) What happens if the process is undertaken too slowly?
iii) What happens if the process is undertaken in an incorrect order?
iv) What are the critical processes? i.e. those that potentially need to be analysed in specific detail e.g. train despatch
v) What is the operational functionality of the process under degraded conditions?
vi) Is it physically possible to undertake the process?

The Benefit of Hindsight:	A manufacturer assumed that following an air conditioning trip that the traincrew would reset the relevant circuit breaker. The circuit breaker was not accessible to the traincrew since the manufacturer had it positioned in a locked in a High Voltage cupboard.

5.6 Design for Operational Resilience

5.6.1 Unless a defect generates a high safety risk condition, there should be no failure mode that can result in a train becoming stranded due to a 'protective shutdown.' Effectively, systems should be designed to reset if the circumstances that initiated the protective shutdown have changed - as opposed to becoming permanently 'locked out.'

The Benefit of Hindsight:	A design of train went into 'protective shutdown' as a result of the 25kV Traction supply frequency momentarily dipping below limits. Once the traction supply was restored the trains were stranded as a result of the design of the software control causing the train to permanently 'lock out'. The only way to reset the affected trains (in the order of 27 around the affected network) was for a technician to attend the train in person with a laptop.

5.7 Design for Software Resilience

5.7.1 For obvious reasons Safety Critical Software requires more rigorous testing and validation than less critical systems – which takes considerably more time.

5.7.2 Communications networks used by software controlling safety critical train systems should therefore be kept separate from networks used by software controlling non-safety critical train systems.

5.7.3 There are several advantages of this architecture:

i. There is no possibility of changes to non-safety critical software interfering with the software controlling safety critical functions.
ii. Non-safety critical software changes can be rolled out more quickly – since the required validation and testing is less onerous.
iii. Due to cyber-security considerations, ideally, the connectivity to the safety critical network should not be made wireless.
iv. The connectivity of the non-safety critical network could be made wireless e.g. Bluetooth / WiFi in order to speed up the process of upload / download for time critical data.

Part 6 Interfaces to the Train

6.1 Background – The Demonstration of Compatibility

6.1.1 The train is only one part of the wider railway system and unfortunately compatibility problems during test runs of New Train designs are not unknown.

6.1.2 Unless you are fortunate enough to be introducing a New Train to brand new infrastructure that has been specifically designed to be compatible with the New Train it is highly likely that the New Train will be introduced onto to existing legacy infrastructure.

6.1.3 The industry has described and agreed the process that should be followed in RIS-8270-RST: Route Level Assessment of Technical Compatibility between Vehicles and Infrastructure which sets out requirements and responsibilities for the assessment of technical compatibility at route level for vehicles and infrastructure.

6.1.4 Whilst train procurers often make the manufacturer contractually responsible for successfully negotiating the compatibility process, it remains the operator's responsibility.

Good Practice Example	One New Train project identified the need for and funded a specific role for a member of Network Rail staff to act as the project single point of contact with NR. It was identified that a lot of time can be spent trying to identify the relevant contact within NR and it was found that it's easier for projects to have 'someone on the inside.' It was reported that the role paid for itself in that it facilitated the joining up the relevant NR Teams.
The Benefit of Hindsight:	NR report that train operators need to be more 'pro-actively' involved with the compatibility process, since it is their experience that train operators only seem to take an interest and really get involved when the manufacturer is having significant difficulties and timescales are under pressure.

6.1.5 This process takes time and therefore early engagement with the Network Rail Compatibility Team is strongly recommended. The following link https://cdn.networkrail.co.uk/wp-content/uploads/2017/09/Introducing-new-vehicles-or-changes-to-vehicles-August-2017.pdf provides a useful guide in relation to what is needed and also identifies who should be contacted in the first instance.

6.1.6 There are benefits to agreeing 'up front' testing requirements with the infrastructure manager and collaborating to maximise the relevance of test-track environments to the actual routes that the New Trains are anticipated to operate over.

Good Practice Example	There is the opportunity to work with Network Rail to install representative infrastructure at their Rail Innovation and Development Centres (RIDC) in support of tests required to demonstrate compatibility.

The Benefit of Hindsight:	A project did not engage with Network Rail prior to undertaking tests at the RIDC. This resulted in last minute problems and delays to the project testing programme.

6.1.7 It needs to be stressed that it is for the vehicle introducer to satisfy themselves that they have demonstrated compatibility to the legacy infrastructure and trains already in operation over the routes to be operated. The Infrastructure Manager has duty of co-operation with respect to facilitating this process.

6.1.8 Whilst the vehicle introducer is not seeking 'permission' from the Infrastructure Manager for the New Train to operate, the duty of co-operation applies both ways in that any legitimate concerns expressed by the Infrastructure Manager should be satisfactorily addressed by the vehicle introducer prior to operation.

6.1.9 It is a common misconception of vehicle introducers that Network Rail is responsible for the production of compatibility statements. This is patently not the case. The vehicle operator should produce the 'Statement of Compatibility' once they are satisfied that compatibility with the infrastructure has been demonstrated.

6.1.10 One common mistake is for operators to neglect to include all of the routes that they intend to operate the New Trains, so it is crucial that this aspect is ensured correct. (See 3.10.6 and 3.10.7 for further guidance on this aspect).

6.1.11 Network Rail then uses this Statement of Compatibility (and supporting evidence) to produce a 'Summary of Compatibility' for their own processes and to advise the Rolling Stock Library (R2) that the process has been followed and to communicate and record operational restrictions that apply to the train.

6.1.12 However, the demonstration of compatibility has been a problem that has afflicted many New Train projects over the years since there is not a list of clear 'pass/fail' criteria readily available that is able to fully describe what is necessary.

The Benefit of Hindsight:	A New Train had a novel design of pantograph head. The relevant 'route' infrastructure manager outlined some tests that they believed were required to demonstrate compatibility. When that individual moved to another 'Route' their replacement outlined some different tests that they stated were now required, but the original tests were no longer needed.

6.1.13 The direct consequence of these often opaque requirements is that the compatibility demonstration process is time consuming, uncertain and therefore expensive. In recent years the industry has recognised this problem and some progress has been made by the development of a several parts of the 'Key Interface Requirements' document – which can be accessed here [Link to be inserted when available]

6.1.14 When complete, the KIR will contain guidance on the following interface parameters:

- Gauge
- Pantograph/Overhead Contact System Compatibility
- Electromagnetic Compatibility
- Electrical Power
  - Mutli-mode changeover procedures and signage
- Loading
- European Train Control System
- Signalling
  - Signal sighting
  - Signal overlaps
- Telecoms
- Wheel/Rail Interface
- Track
  - Buffer stop assessments
- Tunnels
- Environment
- Platforms
  - Stopping positions / stop car marks
  - Stepping distances
  - Deployment of wheelchair ramps
  - Platform lengths / Use of selective door operation
  - Despatch arrangements
- Level Crossings
- Attainable Speed
  - Use of differential speeds

6.1.15 Whilst the KIR is not complete, the industry has committed to a plan to add further chapters as they are developed and it is suggested that New Train projects should use the list above as a checklist to ensure that they have plans in place determine how they intend to address each of these parameters.

The Benefit of Hindsight:	One New Train project, in order to provide more capacity increased the train length by several metres. This resulted in additional complexity in terms of compatibility with existing infrastructure that was not initially appreciated.

6.1.16 Compatibility of the New Trains with depot and operator processes is addressed by the operators demonstrating 'Safe Integration' (see 4.8.6).

6.2 Compatibility with Legacy Infrastructure

6.2.1 Accurate information with respect to existing infrastructure is essential to ensure compatibility of the New Train.

6.2.2 The infrastructure manager is duty-bound to provide the necessary information to projects in respect to their infrastructure assets.

6.2.3 The infrastructure manager should also be requested to provide information of specific assets that they are aware of on the proposed routes for operation that do not comply with the current 'suite' of standards (as listed in 3.9.2) since this will identify at the outset the areas where demonstrating compatibility could be challenging for a project.

6.2.4 The demonstration of compatibility of recent designs of pantograph with legacy Overhead Line Electrification has proved problematic in recent years since these more recent designs of pantograph have different performance characteristics than the pantographs fitted to existing fleets in operation.

The Benefit of Hindsight:	More recent designs of pantographs have 'open horn' and 'floating head' arrangements in order to provide the superior dynamic response that is necessary for operating coupled multiple units at higher speeds. These pantographs therefore had design features and behaviours that did not exist when the legacy infrastructure was established and were therefore difficult to assess and demonstrate compatibility.

6.2.5 New Trains project teams are advised to engage with the Network Rail Routes at the earliest opportunity, not just by formal channels but by contact with the infrastructure asset managers that are familiar with the condition and constraints of the local infrastructure.

The Benefit of Hindsight:	A recent design of New Train experienced significant problems with train detection in areas with low voltage dc track circuits. The problem only became apparent as autumn conditions begun to bite in late October, despite them operating without problem since June that year. Despite the trains being fitted with Track Circuit Assistors they still failed to operate this design of track circuit. The New Trains had disk brakes installed whereas the stock that they replaced had tread brakes or scrubber blocks. It is this key difference that is believed to be contributory to the problem - since this allowed leaf contamination to build up on the surface of the wheel therefore affecting the ability of the New Train to operate the track circuit.

6.3 Compatibility with existing trains on the route

6.3.1 In addition to ensuring compatibility with existing legacy infrastructure it is also necessary to demonstrate compatibility with existing trains already in operation on the route.

6.3.2 Unfortunately, it is often the case that it is unclear who owns the relevant data (and therefore responsible for keeping it accurate) and as a consequence information with respect to existing trains is often out of date.

Good Practice Example:	The R2 industry computer system can be used to manage and therefore share the necessary train data with the wider industry.

6.4 Compatibility with 'Neighbouring Systems'

6.4.1 In addition to the railway system there is also a need to ensure that the introduction of a New Train will not affect the operation of any of the railway system 'neighbours.' Neighbours include other transport system operators e.g. London Underground; Light Rail / Tram systems etc.

6.4.2 There is therefore the need for a consultation exercise to be undertaken to ensure that any 'affected parties' are alerted and have the opportunity to discuss any concerns that they may have.

6.4.3 Experience has demonstrated that this can be a time-consuming process and should not be left until the last minute. One of the key problems is that it is not immediately clear who the point of contact should be with respect to the consultation and how it is best to contact them.

Part 7 **Authorisation**

7.1 Overview

7.1.1 The ORR authorises new vehicles and they aim to engage with designers, manufacturers and operators as early as possible in the process for them to assure themselves that hazards have been designed out at an early stage.

7.1.2 However, their involvement has no legal basis until an application for authorisation is made, which is typically at the end of the manufacturing process. This can represent a very small window of opportunity and is effectively too late in the process if there are issues identified.

7.1.3 It is therefore recommended that New Train projects engage with the ORR much earlier.

The Benefit of Hindsight:	According to ORR: Some New Train fleets are reaching too late a stage in their development before safety problems are identified. This means that resolving issues is unduly challenging. The associated risks are (i) delaying introduction to service, or (ii) the need for additional operational control measures that could have been avoided with better application of the principles of health and safety by design.
The Benefit of Hindsight:	ORR has identified the following safety issues with recent New Train designs: • Large stepping distances from platform to train • Cables between carriages which make it possible for trespassers to climb onto the roof and coming into contact with 25,000V a.c. overhead wires • Curved windscreens causing reflections which limit the driver's vision • Software inhibiting application of the service brake

7.1.4 In order to assist Train Operators to understand and navigate the Authorisation process in 2014 ATOC produced ATOC/EC/GN/002: Guidance Note – The ATOC Guide to Vehicle Change which sets out the vehicle change related requirements of the Railways (Interoperability) Regulations (2011) and the Railways and Other Guided Transport Systems (Safety) Regulations (2011) as they apply to mainline Railway Undertakings. It also takes account of the EC guidance for Member States on interpretation of the Directives that lay behind these regulations.

Part 8 Operational Readiness

8.1 Overview

8.1.1 New Trains are often used by Operators as a mechanism for business transformation e.g. new methods of operation and therefore the New Train itself, whilst very important, is only one key aspect.

8.2 People

8.2.1 It is therefore fundamental that everyone involved in supporting the operation of the New Train needs to be trained on the aspects relevant to their role be it drivers, controllers, maintainers, despatch staff, on board traincrew etc.

The Benefit of Hindsight:	It has been commented by TOCs on more than one occasion that the Operational aspects are often more difficult to get to grips with than the Engineering.

8.2.2 It is therefore very important that TOCs develop a robust plan for all these 'business transformation' activities.

8.2.3 It is also absolutely key that this plan is reviewed regularly in line with any changes to the delivery profile of the New Trains or any delays to the delivery of necessary infrastructure upgrades.

8.2.4 There is also the possibility that new skills will be required in the light of the new technology that the New Trains bring. This is especially the case with respect to computer software control of on-train systems (See Part 9).

8.2.5 This needs to be factored into Operator's plans in terms of the need to develop existing staff or where that is not possible to actively recruit new staff with the necessary skills.

8.2.6 It cannot be stressed how important it is for the Trades Unions to be consulted with respect to proposed changes to operation e.g. a move to Driver Controlled Operation.

8.3 Resourcing

8.3.1 Adequate resourcing of projects teams is also essential for a successful outcome.

The Benefit of Hindsight	Some suppliers and project teams have openly expressed the need for 'more boots on the ground.' This has stretched resources down the line and has sometimes resulted in basic issues becoming 'last minute panics' that have threatened deadlines.

8.4 Operational Impact

8.4.1 There are numerous potential impacts to the 'day to day' operation of the railway as a consequence of New Train introduction.

8.4.2 Operators should therefore consider the following when developing their 'Operational Readiness' plans:

- Is there a need to marshal the New Trains in a different way due to changes in unit and train length e.g. 1x 5-car berthed in an 8-car siding needing to be coupled prior to departure to another 1x 5-car similarly berthed
- Is there a need for increased shunting and fleet moves to get sets to CET etc roads where new units with toilets are introduced vice non-toilet fitted trains impacting on depot operations and mainline ECS moves with consequences for infrastructure maintenance times
- Is there any need to increase in on-network berthing and its acceptability to the NR infrastructure maintainer
- Do the New Trains need an increased duration for train preparation requiring shorter isolations to protect times of first movements with an impact on infrastructure maintenance durations
- Are there any implications with respect to necessary changes to the level and location of "bolt holes" which are not used in the Working Time Table berthing plan but provide the flexibility to enable Short Term Planning and Very Short Term Planning maintenance possessions to be taken
- Are there any changes needed in early/late Empty Coaching Stock (ECS) movements due to new depot locations impacting on infrastructure maintenance
- Is there an impact on other operators who use shared berthing locations where the host's aspirations make previously provided accommodation to such third parties no longer on offer
- Is there an impact on route knowledge requirements and retention opportunities from revised ECS requirements to/from berthing locations
- What are the arrangements for rescue and recovery of failed New Trains? How will the recovery be undertaken and with what? Whose responsibility will it be to recover the failed New Train? Who will attend failed New Trains?

8.5 Infrastructure Readiness

8.5.1 Some New Train Projects have been delayed by new infrastructure not being ready for the new fleet service introduction.

8.5.2 Projects also therefore need to maintain a watching brief with respect to any such infrastructure projects and revise their implementation plans as required.

The Benefit of Hindsight	One new electric train fleet was dependent upon the Infrastructure Manager completing an electrification project. The electrification ran late, but was completed just in time for the new timetable. The problem was that due to the delays there was insufficient time available for route proving and driver familiarisation which resulted in insufficient drivers trained over the new route and therefore the proposed timetable could not be operated.

Part 9 Software Management

9.1 Background

9.1.1 Train control architecture is getting ever more complex. Recent designs of trains are 'fly by wire' control and when compared to historical designs of train control e.g. relay logic, software control would appear to be emerging as the default situation and it is for this reason that this small chapter has been included in this document.

9.1.2 Software presents the industry with a real challenge in terms of 'upskilling' since there is currently a dearth of industry knowledge in this area.

9.1.3 Control systems are therefore becoming ever more integrated and engineers will therefore need to have a systems engineering approach to the integration and functional understanding of these systems and software.

9.1.4 This is further compounded by train designers integrating software from multiple sub-suppliers' equipment that do not interact in the way that was intended. It can therefore be very difficult to identify the 'root cause' of problems.

9.1.5 An added complication is that sub-suppliers often sub-contract the 'coding' of the software to specialist software companies and therefore even the train manufacturer's detailed knowledge of the software design is also very limited.

The Benefit of Hindsight	One GB train manufacturer subcontracted the coding of their train control software to a company based in China. The Chinese company subsequently further subcontracted the software development to a company back in Europe.

9.2 Skills

9.2.1 As previously identified, there is a need to 'upskill' our workforce and the industry therefore should prioritise the improvement of software skills throughout the industry.

9.2.2 As a minimum these skills need to encompass knowledge of:

- Software development processes
- Software validation and integration processes.
- Software upload (and download)
- Configuration control processes.
- Cyber-security awareness and mitigation
- Software lifecycle management

9.3 Stability and Reliability

9.3.1 Software should only be rolled out across the fleet of trains once it is proven.

9.3.2 All too often, typically as a result of commercial pressures, or as a result of changes that are made to fix known deficiencies, manufacturers produce and install updated software that contains ‘bugs’ which generate unexpected faults in service.

9.3.3 There have been instances in the past where trains have needed to be ‘reverted’ to a previous software version – provided that this is even possible.

The Benefit of Hindsight:	Testing of software on a real train is an important step – since laboratory testing does not replicate the ‘real life’ environment and there are numerous examples where potential problems have not been identified prior to installation on service trains.

9.3.4 It cannot therefore be stressed enough that the roll-out of new versions of software should not be rushed.

Good Practice Example:	A new software version should initially be installed on one train, that is closely monitored for a period. Subject to this trial not identifying any concerns, the new software version should then be rolled out across a sub-set of the fleet, again closely monitored. Subject to this wider trial not identifying any problems, gradual roll-out to the full fleet can commence with a level of confidence.

9.3.5 There might also be a need to inform traincrew of significant differences in terms of software functionality e.g. as a result of different functionality on the Train Control Management system.

Good Practice Example:	A prominent sticker displayed in the cab in relation to the software version installed provides an immediate alert to any traincrew.

9.4 Configuration

9.4.1 Due to its nature, software configuration control is far from straightforward.

9.4.2 Electronic hardware is typically loaded with both ‘firmware’ and ‘software’. Therefore, the following need to be accurately recorded in order to maintain effective configuration control across fleets

- vehicle number
- hardware position (if more than one position on the train is possible)
- hardware version
- hardware serial number
- firmware version
- software version

9.4.3 There are further complexities to manage where rolling stock variants have different installed versions of hardware, firmware and software – especially if these versions are not compatible with each other and need to be kept separated in service.

Good Practice Example:	Ideally software should be compatible with old and new hardware and firmware.