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## ***Document History***

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## **Technical Specification – Intercity Express Programme**

### **1 Definitions**

- TS1882 Designated Routes:  
Designated routes are those routes that IEP shall be required to operate on. The routes are defined within the Train Infrastructure Interface Specification (TIIS), which is included in the suite of ITT documentation.
- TS1959 Train:  
Defined as a train or other vehicles forming part of the Intercity Express service.
- TS1579 Multiple Working:  
Defined as having the ability to control a train, comprising more than one train, from a single cab at either end of the train consist, and having full control of all systems throughout the train such that that there is no difference in functionality between single and coupled trains.
- TS414 Furnishable space:  
Defined as the length of useable full body width available for use by either seating, wheelchair space, luggage, catering or toilet facilities (excluding vestibules and gangways)
- TS1883 Mean Distance Between Failures (MDBF):  
MDBF is defined as being the National Fleet Reliability Improvement Programme (NFRIP) definition MP5MD (Miles per five minute delay).
- TS1884 Standard Toilet:  
Standard toilet is defined as a toilet that is accessible by the user population, except wheelchair users.
- TS1885 Universal Toilet:  
Universal toilet is defined as a toilet that is accessible by the user population including all categories of Persons of Restricted Mobility (PRM).
- TS1887 Tare Condition:  
Train equipped with all the consumables and occupied by all the staff, which it requires in order to fulfil its function but empty of any payload.
- TS1888 Fully Seated Load :  
Train in tare condition plus a passenger load of all seats occupied.
- TS1889 Fully Laden Load :  
Train in tare condition plus a passenger load of all seats occupied, with further passenger load of 20 standees.
- TS1890 Crush Laden Load:



Train in tare condition plus a passenger load of all seats occupied with further standee passenger numbers equivalent to 4 passengers per m<sup>2</sup> of available standing space (in accordance with 'long distance' category of EN12663).

TS1891 Passenger Load:

Passenger mass shall be assumed to be 80kg (in accordance with 'long distance' category of EN12663). Note this mass includes a luggage allowance.

TS1584 Intercity Express Service Types:

Intercity Express trains are defined as 'long distance' against the requirements of EN12663. The following is the definitions for the range of operating service types that Intercity Express shall support;

i. Intercity Service

Service typically operating at high speed with a journey time of around 2-3 hours and stopping intervals of 30 minutes or more. High level of amenities and a normal intercity type standard class seat spacing.

ii. Interurban Service

Service typically operating at high speed with a customer journey time of around 1-2 hours, stops every 30 minutes and loadings higher than the Intercity Service but less peaked than the Commuter Service. Lower level of amenities than Intercity Service and higher density standard class seat spacing.

iii. Commuter Service

Service typically operating at high speed with a customer journey time of around 1 hour, stops every 30 minutes and loadings more peaked than the Interurban Service. Low level of amenities, lower proportion of first class and higher density standard class seat spacing.

TS1747 Basic Services:

Basic services is as a minimum defined as consisting of the emergency services defined in TS1945, TS1946 and TS1947 (section 3.18), all systems necessary to allow safe movement of the train and egress of passengers, together with saloon ventilation and PIS capability.

TS1948 Nominal Services:

Nominal services as a minimum is defined as the provision of all facilities but with limitations in the performance of heating ventilation and cooling systems such that the auxiliary power demand is 'capped' to 50% of the maximum. It is expected that this mode will in general maintain the saloon environment as required, with the limitation only having significant effect during extremes of external ambient temperature.

TS1949 Limited Movement:

Limited movement as a minimum is defined as train movement while on level track, with the capability to accelerate up to a minimum speed of 30mph within 5 minutes. The train shall have the capability to climb any gradient encountered on the route but it is accepted that 30mph may not be achieved whilst climbing gradients.

TS1950 ECML Track Data:

Representative track quality provided within the data room.

TS1951 MML Track Data:  
Representative track quality provided within the data room.

TS 1957 Maintenance:  
Routine planned activities that ensure IEP vehicles continue to operate with the required functionality, performance, availability and reliability as specified within this specification.

## 2 Introduction

TS306 The role of this Technical Specification is to define the technical requirements for the Intercity Express Programme (IEP) rolling stock. Requirements are expressed in outputs terms, necessary for the success of the IEP.

The document serves to define the technical output requirements of the Rolling Stock for the IEP. The requirements for the Invitation to Tender (ITT), obligations on the bidder are contained elsewhere within the suite of documents.

Information on the Infrastructure over which the IEP trains are planned to be operated over is provided within the Train Infrastructure Interface Specification (TIIS).

Annex A of this specification sets out detail requirements to be provided as part of the Invitation to Tender (ITT) submission in addition to the requirements laid out in the Concept Train Design Section of the ITT.

### 2.1 Requirements

TS307 The output requirements within this document are expressed in two distinct ways, these are categorised as follows;

- Essential Requirements: Requirements that have been deemed essential because the analysis that the DfT and its advisors have conducted indicates that these requirements are necessary to deliver a train that meets the DfT's key objectives and satisfies the DfT's business case.
- Desirable Requirements: Requirements that exceed the Essential Requirements, which shall be considered in the design of the vehicle to provide the best whole life value solution across the train and infrastructure. The extent to which achievement of these requirements strengthens the business case for IEP shall determine whether the desirable requirement is worth providing.

Requirements shall normally be expressed as follows;

"It is an [requirement category] requirement....."

Where there is ambiguity concerning whether a requirement is essential or desirable within this specification, that requirement shall be considered to be an essential requirement unless further clarification is obtained.

### 2.2 Standards

TS308 The IEP trains shall comply with the requirements of all applicable British and European Standards, and all European and UK legislation during the design, construction, delivery, testing and commissioning, maintenance and operation of the vehicles.

Attention is drawn to Technical Standards for Interoperability (TSI) that are currently in

draft form which are expected to be in force and therefore apply to the IEP vehicles.

Where not mandated by specific legislation or requirements the IEP train(s) shall use Euro Norm standards. Where a supplier wishes to propose an alternative standard full justification shall be provided as to the applicability and acceptability of these standards.

Where individual standards are considered appropriate the standard shall be stated in the relevant part of this specification. When a standard is declared, the standard shall be deemed mandatory and alternate standards shall not be considered.

The intent is that achievement of compatibility with the infrastructure should extend to a fully optimised system based on a whole life, whole system cost basis; in particular the imposition of low physical impacts on the infrastructure and train and low energy requirements.

Where compliance with standards or with the TSI requirements acts against the intent of infrastructure compatibility extending to a fully optimised system based on a whole life whole system cost basis, in particular the imposition of low physical impacts on the infrastructure and train and low energy requirements, then the standards should be challenged by the TSP.

## 2.3 Train Comparators

TS277 Where comparative requirements are specified, details and guidance are given with that requirement.

Where comparative measures have been used they refer to:

- Electric power train - Class 91 and 9 x MkIV coaches and DVT for the electric routes with a capacity of 500 seats
- Self power train - A 2+8 HST formation with MTU engined power cars and a capacity of 469 seats

TS278 Where more than one comparator is invoked, demonstration of compliance with the comparative requirement shall be with reference to the more onerous attribute of the comparators.

## 2.4 Infrastructure Compatibility

TS1789 It is an essential requirement that the IEP trains are technically compatible with the infrastructure over which they are planned to operate without any limitation. The information on the infrastructure at the time of service introduction is provided within the Train Infrastructure Interface Specification (TIIS).

# 3 Train Wide Functions

## 3.1 Train Operation, Types and Flexibility

### 3.1.1 Train Operation

TS1823 It is an essential requirement that IEP trains shall be able to operate on the designated routes at full line speeds

- TS1960 It is an essential requirement that IEP trains shall be able to take advantage of differential line speeds. They shall be able to operate at the highest speed allowed for either of the Comparator Trains or Class 220, including the case where HSTs are permitted to operate at Sprinter differential speeds.
- TS1824 It is an essential requirement that IEP trains shall maintain functionality while operating over the designated routes. Particular consideration shall be given to continued system functionality on canted track.
- TS1825 It is an essential requirement that IEP trains shall be capable of operating on the minimum horizontal and vertical track curvatures of the designated routes. Specifically the trains shall be capable of operating on the following minimum curvatures during mainline operation at the relevant maximum line speed:
- Single Horizontal Curve: 120 m
- Reverse Horizontal Curve: 140 m, 3 m straight between curves
- Vertical Curve: 500 m
- TS1826 It is an essential requirement that IEP trains shall be capable of negotiating the minimum horizontal and vertical track curvatures within depots and sidings. It is expected that these curvatures shall be less than the mainline minima defined in TS1825 (within this section).
- TS1827 It is an essential requirement that IEP trains shall be capable of operation on gradients of up to 1 in 37.
- TS1470 It is an essential requirement that all IEP trains are capable of operating over the following route types (it is accepted that the train performance requirements for electric or bi-mode trains will not be met if the route does not have 25kV electrification infrastructure):
- 25 kV AC overhead electrified routes
  - 750V DC third rail electrified routes
  - Non-electrified routes
- Routes including any combination of the above either together or separately.
- TS1961 It is an essential requirement that IEP trains shall be designed such that they are compatible with the operational requirements of the Rule Book (GE/RT8000).

### 3.1.2 Train Types

- TS1832 It is an essential requirement that the IEP vehicle design and architecture allows for the following train types;
- 25kV overhead electric powered train
  - self powered train
  - bi-mode train
- TS1576 It is an essential requirement that a bi-mode IEP train shall be capable of operating in any of the following modes;
- electric only mode
  - self power only mode
- TS1962 It is a desirable requirement that a bi-mode IEP train shall also be capable of operating in a

combined electric and self power mode where power is primarily taken from the self power source and any additional power is taken from the electrification supply.

- TS2000 It is a desirable requirement that a bi-mode IEP train shall also be capable of operating in a combined electric and self power mode where power is primarily taken from the electrification supply and any additional power is taken from the self power source.
- TS1963 It is an essential requirement that for the commissioning of the pre-series bi-mode trains, the mode identified in TS1962 shall be provided.
- TS1964 It is an essential requirement that the train allows the driver to select any of the modes (identified in TS1576 and TS1962) offered by the bi-mode train.
- TS1577 It is an essential requirement that a bi-mode IEP train shall be capable of switching between modes whilst at any speed from stationary up to line speed.

### 3.1.3 Flexibility

- TS1578 It is an essential requirement that IEP vehicle and train architecture shall be flexible to allow for train formation changes, changes of power source, redeployment or route upgrade throughout their life.
- The train architecture shall minimise the cost and timescales to effect these changes.
- TS1965 It is an essential requirement that the number of different vehicle types within the architecture of the various trains is minimised.
- TS1966 It is an essential requirement that a self power train can be readily modified to a bi-mode train at a future date.
- TS1967 It is an essential requirement that a self power train can be readily modified to an electric train at a future date.
- TS1968 It is an essential requirement that a bi-mode train can be readily modified to an electric train at a future date.
- TS1969 It is an essential requirement that the modifications identified in TS1966 TS1967 and TS1968 shall, after modification, have interiors which match the equivalent train specified in the November 2007 ITT for IEP.
- TS1970 It is an essential requirement that a self power train can be readily modified to utilise a different type of fuel and/or self power source.
- TS1971 It is an essential requirement that systems and any associated options which are specified in this specification but not fitted to the train on delivery can be fitted to the train at a later date.
- TS1972 It is an essential requirement that all train types can accommodate a change in interior finish, layout or fit out, including catering and toilets.
- TS1973 It is an essential requirement that all train types can accommodate a change in livery and brand identity.
- TS1834 It is a desirable requirement that all IEP vehicles within a train that contains a self power source shall be capable of being reused on that train following change of motive power source on a route e.g. introduction of 25kV electrification or new self-powered energy source.

### 3.2 Multiple working

- TS231 It is an essential requirement that all IEP trains shall be capable of full multiple working in normal passenger service with other IEP trains (of any type) within the following constraints;
- Up to a maximum of two trains
  - Up to a maximum total multiple length of 312m
- TS1837 It is an essential requirement that all IEP trains shall be capable of being coupled with other IEP trains (of any type) to allow rescue or for Empty Coaching Stock (ECS) movements within the following constraints;
- Up to a maximum of four trains
  - Up to a maximum total train length of 624m
- The multiple working capability for ECS movements shall have no operational or performance limitations.
- TS1974 It is an essential requirement that an IEP train can haul a similar length IEP train in normal operation, subject to the maximum overall service length criterion. In particular, it is expected that self power or bi-mode half length trains will haul half length electric trains on non electrified routes.
- TS1975 It is an essential requirement that an IEP train of any length can rescue a similar length IEP trains at a minimum speed of 30mph, subject to the availability of electrification power if the rescuing train is electric
- TS1695 It is an essential requirement that IEP trains shall be capable of coupling and uncoupling with passengers on board in a station environment, regardless of door status on the stationary train portion and with appropriate regard to risk of passenger injury.
- TS1696 It is an essential requirement that IEP trains be capable of coupling or uncoupling with each other in no more than 3 minutes.
- The coupling or uncoupling time shall be taken from original train being available to operate until the new formation train is available to operate. This shall exclude any traincrew walking time between cabs, but shall include all train borne system reconfiguration activities such as ERTMS, GSM-R, TMS, brake proving etc.
- TS1838 It is a desirable requirement that IEP trains be capable of coupling or uncoupling with each other in no more than 2 minutes.
- TS1839 It is an essential requirement that IEP trains shall be equipped at each end with an automatic centre buffer coupler in accordance with the requirements of TSI.
- TS1840 It is an essential requirement that IEP trains shall be able to couple or uncouple to another IEP train on all track geometry within the designated routes.
- TS1828 It is an essential requirement that IEP trains shall be ready to move under control from any cab, within 3 minutes of releasing control from any other cab of the train.
- This time excludes any traincrew walking time between cabs, but shall include all train borne system reconfiguration activities such as ERTMS, GSM-R, TMS etc.

### 3.3 Train Formation and Length

- TS1829 It is an essential requirement that IEP trains shall be equipped with a driver's cab at each end and be capable of bi-directional operation.
- TS1833 It is an essential requirement that IEP train architecture shall allow any driving vehicle to be positioned at either end of any train.
- TS223 It is an essential requirement that IEP trains shall be capable of operating within the following length constraints:
- Maximum length – 312m (this is the maximum design length of an IEP train).
  - Minimum length (also known as “Half length”) – Approx 130m, where two minimum length trains coupled together are no longer than 260m.
- The initial deployment shall be “Half length” trains of 130m and “Full length” trains of 260m, with ‘Intermediate’ length trains specified for Cross Country.
- TS1587 It is an essential requirement that the length of IEP trains can be easily modified to allow for varying service requirements including future redeployment or route capacity requirement changes.
- TS1976 It is an essential requirement that intermediate vehicles can be added to a train up to the maximum length.
- TS1977 It is a desirable requirement that intermediate vehicles can be added to a train in any intermediate position.
- TS1978 It is an essential requirement that intermediate vehicles can be removed from a train down to the minimum length.
- TS1979 It is a desirable requirement that intermediate vehicles can be removed from a train from any intermediate position.
- TS1980 It is an essential requirement that the time to add or remove intermediate vehicles shall be minimised.
- TS1588 It is a desirable requirement that the time to add or remove intermediate vehicles shall be short enough to allow it to be done during the shortest scheduled maintenance period.
- TS1589 It is an essential requirement for IEP train reconfiguration that software and control systems shall reconfigure automatically.
- TS1660 It is a desirable requirement that all non cab end couplings and inter-vehicle connections shall be of the same type to ensure that vehicles can be placed in any orientation and at any position within the IEP train.

### 3.4 Driver Only Operation (DOO)

- TS1981 It is an essential requirement that the IEP trains shall be capable of DOO across the designated routes, on some sections of which DOO is currently in operation. The train dispatch methods that the IEP trains shall be compatible with for DOO operation are defined within the TIS.



### 3.5 Interior space & capacity

- TS1841 It is an essential requirement that the vehicle internal cross-section (height & width) is optimised to provide the maximum interior space.
- TS198 It is an essential requirement that the IEP trains shall maximise the furnishable space. As a minimum the furnishable space length per nominal 260m IEP train shall be 164m for the self powered train and 197m for the electric train.
- Alternative uses of the partial body width within the vehicle for defined interior elements (ref. section 6.1) shall be permitted. Where such solutions are proposed these shall be credited within the furnishable space evaluation.
- TS199 It is a desirable requirement that the furnishable space length is increased as much as possible above the essential requirement.
- TS1564 It is an essential requirement that structural intrusions or other permanent features within the furnishable space shall be minimised to ensure the maximum possible flexibility in terms of interior layouts.

### 3.6 Weight

- TS196 In pursuit of the objectives of better energy efficiency, reduced emissions, improved performance and whole life whole system cost savings it is an essential requirement that the nominal 260m length IEP trains shall be no heavier than 362 tonnes for an electric train, 392 tonnes for a self powered train and 385 tonnes for a Bi-mode train. These are masses with the train in the Tare Condition as defined in TS1887, except without fuel, toilet water or train crew.
- TS197 It is a desirable requirement that the nominal 260m length IEP trains shall achieve a target mass of 332 tonnes for an electric train, 368 tonnes for a self powered and 350 tonnes for a Bi-mode train.

### 3.7 Performance

- TS261 It is an essential requirement that IEP trains shall have a maximum service speed of at least 125mph across all designated routes as line speed limits allow.
- TS1982 It is a desirable requirement that IEP trains under electric power shall be capable of higher speeds than 125mph to allow for possible line speed upgrades or new lines with higher speed limits being available.
- TS206 It is an essential requirement that the IEP trains shall achieve journey times as defined in the ITT.
- TS2008 It is an essential requirement that the Bi-mode IEP trains make optimum use of the electricity supply on electrified lines whilst meeting the journey time criteria for both electrified and non-electrified lines, maximising flexibility of architecture and minimising train mass.
- TS1483 It is an essential requirement that electric and bi-mode (while running on 25kV electrified lines) IEP trains can be extended to the Maximum Length of 312m whilst still meeting the journey time requirements specified.

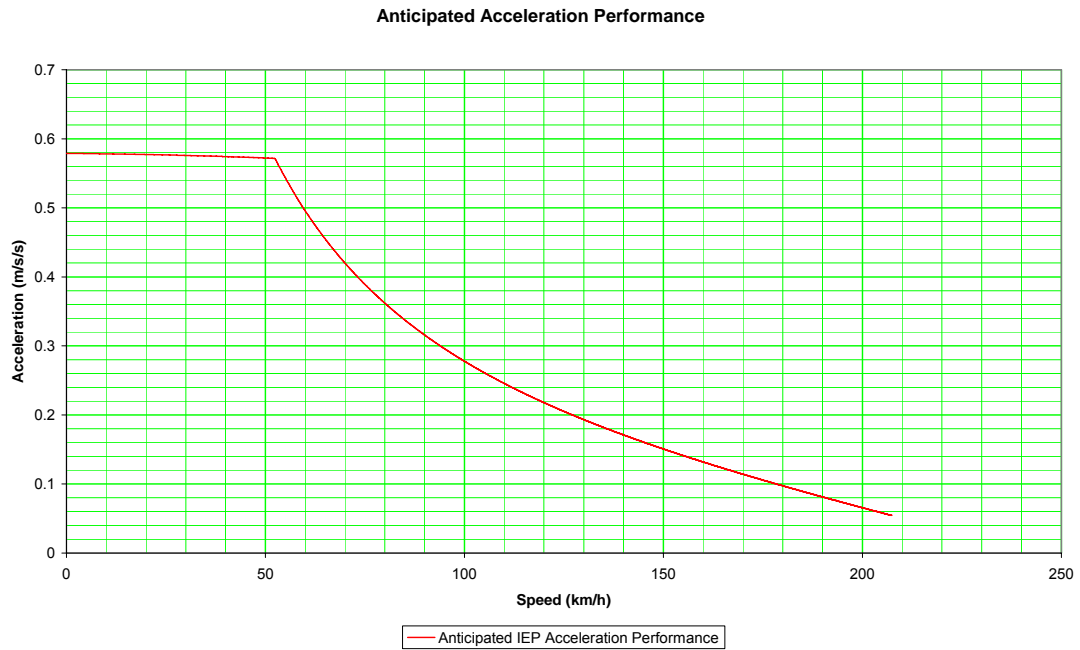


- TS1843 It is an essential requirement that any IEP train shall be able to haul or propel any other IEP train of similar or shorter length over any part of any route, irrespective of the loading condition of either train. In addition, such a train shall be able to start at any position on the route, including gradients of up to 1 in 37.
- TS2005 It is an essential requirement that IEP trains shall be able to operate as required by TS1843 for rescue purposes. Degraded performance is accepted in rescue situations.
- TS1998 It is an essential requirement that a self-power or bi-mode IEP train shall be capable of hauling a half length electric IEP train on non-electrified routes. There is no specific performance requirement in this mode. The performance is expected to be that achievable by a train design optimised to meet the other essential requirements of this specification.
- TS1999 The figure below is provided for reference as the basis for the generation of the specified journey times for electric, self power and bi-mode (when operating on electrified lines) trains.

The figure shows the minimum anticipated acceleration performance to be achieved by the following train formations:

- Half Length Electric
- Full Length Electric
- Maximum Length Electric
- Half Length Bi-mode in Self Power mode
- Half Length Bi-mode while operating on 25kV electrified lines
- Full Length Bi-mode while operating on 25kV electrified lines
- Maximum Length Bi-mode while operating on 25kV electrified lines
- Half Length Self Powered
- Full Length Self Powered

Figure 1 – Acceleration Performance



TS208 For guidance only, a limiting adhesion factor of circa 20% is considered appropriate for the IEP trains in the tare condition.

### 3.8 Efficiency & Environment

TS200 It is an essential requirement that IEP trains shall deliver improved energy efficiency, measured per seat km moved for the reference trains and designated routes on the East Coast Main Line (ECML) and Great Western Main Line (GWML), and taking account of auxiliary loads. The required improvement in energy efficiency over the reference trains (ref. TS277, section 2.3) shall be as follows:

Electric train (Intercity Service Type):	Essential 31%	Desirable 37%
Self-power train (Interurban Service Type):	Essential 17%	Desirable 33%

For the energy consumption calculation the IEP train interior shall be assumed to be configured for the Intercity service type for the Electric train and the Interurban service type for the Self-power train, both in the Fully Seated Condition.

The routes over which the calculation shall be performed shall be as follows;–

ECML for Electric Train: London to Newcastle, stopping at;

- Kings Cross
- Peterborough
- Doncaster
- York
- Darlington
- Newcastle

GWML for Self-power train: London to Bristol, stopping at;

- Paddington

- Reading
- Swindon
- Chippenham
- Bath Spa
- Bristol Temple Meads

TS1486 For guidance it is expected that in order to meet the desirable targets, the following would be required:

- Improvements in aerodynamic performance.
- Increased use of regenerative braking above the minimum requirement on the electric train.
- The provision of brake energy recovery on the self powered train (including self power element within a bi-mode train).
- Improvement in the efficiency of auxiliary systems.

TS204 It is an essential requirement that IEP vehicles minimise auxiliary energy consumption under all circumstances. In particular, it is considered that there is significant scope for energy savings when the train is not in service.

TS1601 It is a desirable requirement that auxiliary energy consumption is progressively reduced when IEP trains are at rest and it is also a desirable requirement that such progressive reduction is achieved automatically.

TS1851 It is a desirable requirement that IEP vehicle include functionality to automatically reduce auxiliary energy consumption based on passenger load when the train is in service. This might include the extinguishing of unnecessary lighting and more precise control of the HVAC system to better match passenger demands.

TS1602 It is an essential requirement that any measure designed to reduce auxiliary energy consumption shall not compromise the ability of the train to meet the required diagrams with required passenger conditions.

TS1603 It is an essential requirement that IEP trains are seen to be efficient by the general public, in particular with regard to the use of self power sources and lighting.

TS1927 It is an essential requirement that when IEP trains are not in service it shall be ensured that train interior lighting is not illuminated unless required in order for servicing or maintenance - no interior lighting shall be illuminated for a period greater than 15 minutes unless personnel are present on the train.

TS1928 It is an essential requirement that when IEP trains are not in service it shall be ensured that any self power sources which are not required to provide power are automatically shut down so as not to consume any fuel - unused self power sources shall be shut down within a settable time period of between 1 to 5 minutes of becoming unused (unless it can be demonstrated that doing so results in a net increase in energy consumption).

TS274 It is an essential requirement that the IEP trains shall be equipped with a system which will assist the driver in driving the train in the most energy efficient manner whilst still meeting the timetable.

The system shall be developed in co-operation with Network Rail and the train operators. It

is expected that the system will be capable of displaying the following to the driver:

- The timetable
- The performance of the train
- Recent energy consumption history of the train
- Whether the train is running late or early
- Recommended speed at time at next timing point, taking account of;
- the indications of any train protection systems (e.g. AWS, ETCS, etc.) fitted.
- Any requirements for specific levels of performance in particular areas (e.g. for high levels of performance to clear busy areas).
- Route data - Position of the train and associated route data; including permanent and temporary speed restrictions.
- Predicted conflicts at junctions or stations ahead which could cause the train make an unplanned stop.

TS276 It is an essential requirement that all IEP trains fitted with compression ignition engines shall meet Non-Road Mobile Machinery Directive (NRMM) requirements for stage IIIB emissions without loss of performance.

### 3.9 Operating Environment

TS344 It is an essential requirement that IEP vehicles and all their constituent parts shall meet the requirements of the High Speed TSI within the climatic zone of T1, as specified in EN50125-1:1999 'Railway Applications - Environmental conditions for equipment'.

TS1983 It is an essential requirement that the IEP trains shall be resistant to the affects of exposure to salt water spray and that such exposure shall not cause excessive corrosion or degradation of exposed surfaces, components and equipment.

TS1844 It is an essential requirement that the IEP trains shall continue to operate as intended, without detriment to any equipment, when running through floodwater up to a depth of 100mm above rail level; speed restrictions may be applied if necessary.

TS1845 It is an essential requirement that the IEP trains shall continue to operate as intended, without detriment to any equipment, when running through snow up to a depth of (above rail level):

- 200mm; continuous normal operation is required, however speed restrictions may be applied if necessary.
- 300mm; continuous operation is required at reduced speeds.

TS345 It is an essential requirement that the DEFRA climate change study, specifically the UKCIP02 'High Emissions' scenario, shall be considered and its potential affects upon the future operating climate assessed, such changes shall not impede or prevent the vehicles and their systems to operate as original intended.

TS346 It is an essential requirement that the IEP vehicle exterior when all doors and windows are closed shall prevent the ingress of snow and dust under all environmental conditions. In the vicinity of externally opening windows and doors; all controls, equipment and enclosures shall be designed to ensure continued operation due to the potential local ingress of water, dust and snow.

### 3.10 Range

TS263 It is an essential requirement that IEP trains shall be capable of operating on all designated routes for one complete day's service without replenishing fuel.

It is expected that this range shall cover a daily operation of 18 hours or 1500 miles (whichever is greater).

### 3.11 Station Interface & Dwell Time

TS271 It is an essential requirement that station dwell times are minimised, to ensure this IEP trains shall ensure the following total number of passengers may embark or disembark (in any combination) within one minute. The applicable dwell minute is defined as being from the point that the train stops at the station platform to when the train is ready to depart.

- Electric - nominal 130m length = 150 passengers
- Electric - nominal 260m length = 300 passengers
- Self power - nominal 130m length = 120 passengers
- Self power - nominal 260m length = 240 passengers
- Bi-mode - nominal 130m length = 135 passengers
- Bi-mode - nominal 260m length = 270 passengers

The dwell requirement shall apply to IEP trains whilst in any of the interior configurations required for the train service types; Intercity, Interurban or Commuter ref. TS 1584. Allowance shall be made for a representative mix of passengers in terms of mobility & luggage.

TS273 It is a desirable requirement that IEP trains shall be capable of allowing the embarking/disembarking of 33% more passengers than the essential requirements within one dwell minute.

TS272 To reduce dwell times further it is a desirable requirement that IEP trains shall include measures that allow the external passenger doors to be prepared for opening prior to the IEP train stopping at a platform and the converse following departure from a platform.

TS1625 To assist the safe and efficient passage of passengers between station platforms and IEP vehicles, it is an essential requirement that the stepping distances between the train and platforms on the designated routes shall be minimised.

The IEP trains shall comply with the requirements of GI/RT7016 Issue 1 'Interface between Station Platforms, Track and Trains' also Section B6.3 of GM/RT2149, and of the ORR Railway Inspectorate.

TS1984 It is desirable requirement that IEP vehicle saloon interior floor height shall be less than 1150mm to facilitate a reduction in stepping distances and consequently dwell times.

### 3.12 Fire Safety & Evacuation

TS1468 Attention is drawn to the requirement for IEP train fleets to routinely operate through the Severn Tunnel which will result in the IEP train being classified as a Category B train with regards to the High Speed TSI.

### 3.13 Human Factors & Ergonomics

- TS422 It is an essential requirement that the IEP vehicles shall present a safe, secure and comfortable environment for their user population.
- TS423 It is an essential requirement that IEP vehicles are designed for the following human factors as a minimum;
- The range of variability in the user population (i.e. passengers, train crew and maintenance staff). It is expected that this will accommodate the 5%ile female and 95%ile male as a minimum.
  - All normal, degraded and emergency modes of operation of the train.
  - All climatic conditions which the user population may be exposed

The definition of user percentiles is given by the following publication;

'Adult data - The hand book of Adult Anthropometric and Strength Measurements: Data for Design Safety. Department of Trade and Industry, 2000'.

### 3.14 Ride

- TS425 The ride comfort of the IEP vehicles shall be assessed in accordance with DD ENV 12299:1999.
- It is an essential requirement that the following Simplified Comfort Indices shall be achieved at any point along the length of the passenger saloon when operating at maximum line speed in both the tare and fully seated conditions :
- |            |     |
|------------|-----|
| ECML Route | 1.6 |
| MML Route  | 1.9 |
- TS426 It is a desirable requirement that the following Simplified Comfort Indices shall be achieved at any point along the length of the passenger saloon when operating at maximum line speed in both the tare and fully seated conditions.
- |            |     |
|------------|-----|
| ECML Route | 1.4 |
| MML Route  | 1.7 |
- TS427 Track quality data representative of both the East Coast Main Line (ECML) and Midland Main Line (MML) will be provided to the Manufacturer for use in optimising the suspension design. This track data will be of sufficient length to fulfil the requirements of DD ENV 12299:1999
- TS1846 It is an essential requirement that passengers shall not be aware of significant longitudinal jerks during acceleration and braking. It is expected that the maximum longitudinal jerk value shall not exceed 0.5 m/s<sup>3</sup> in any circumstances.

### 3.15 Noise & Vibration

- TS192 It is an essential requirement that the interior noise levels within IEP vehicles (excluding vestibules) shall have a neutral character, with no strongly tonal or impulsive acoustic features. The un-weighted octave band spectrum of interior noise shall lie below the Noise Rating curve 55 (NR 55) when the vehicle is running at speed up to the maximum. In the

4kHz and 8kHz octave bands the interior noise shall be at least 2dB and 3dB lower respectively than the NR55 curve.

- TS2001 It is an essential requirement that the un-weighted octave band spectrum of interior noise within IEP vehicles (excluding vestibules) shall lie below the Noise Rating curve 45 (NR 45) when the vehicle is stationary.
- TS193 It is an essential requirement that the interior noise levels within IEP vehicles (excluding vestibules) shall be within the range 50 to 55 dB, described using the Preferred Speech Interference Level (PSIL) descriptor when the vehicle is running at speed up to the maximum.
- TS1985 It is an essential requirement that the interior noise level within the vestibules of IEP vehicles shall not exceed 70 dB, described using the Preferred Speech Interference Level (PSIL) descriptor when the vehicle is running at speed up to the maximum.
- TS1498 The assessment of vehicles against the interior noise requirements of this Specification shall be undertaken in accordance with the conditions described in EN ISO 3381:2005.
- TS336 It is a desirable requirement that the IEP trains shall be quieter than the external noise requirements of the HSTSI.

### 3.16 Aerodynamics & Pressure Effects

- TS361 It is an essential requirement that IEP trains shall ensure users do not experience discomfort due to internal pressure changes while operating over the designated routes. The IEP train design and construction shall take due account of operation throughout the vehicle life in single bore/track tunnels and two single IEP trains passing in twin track tunnels.
- Experience to date indicates that Internal pressure changes within trains should not exceed 4kPa over a 4 second period under any conditions.
- TS1994 It is an essential requirement that in addition to the TSI requirements IEP trains exert no more than 1.44kPa peak to peak pressure on a train on an adjacent track when the IEP train is travelling at all speeds on a windless day in open air on open track.
- TS1995 It is an essential requirement that the IEP trains shall meet the requirements of GM/RT2142 Resistance of Railway Vehicles to Roll Over in Gales. It is expected that the best whole life whole system cost solution (including infrastructure modification if appropriate) shall be adopted, as allowed for in the standard.

### 3.17 Reliability

- TS283 It is an essential requirement that the IEP trains are designed and capable of achieving the following Mean Distance Between Failure (MDBF) reliability requirements:

Train Type & Mode	Half Length (130m)	Full Length (160m)
Electric Powered Train	60,000 miles	60,000 miles
Self Powered Train	30,000 miles	40,000 miles

Bi-mode Train – Electric only mode	60,000 miles	60,000 miles
Bi-mode Train - Self-power only mode	30,000 miles	30,000 miles

### 3.18 Modes of Operation

TS237 It is an essential requirement that the IEP shall be able to operate in a number of modes as follows:

- a) “Standard” operating mode where the train meets all the requirements identified in this specification.
- b) “Multiple hauled” operating mode where an electric IEP train is operated in multiple with a self powered or Bi-mode IEP train but not on an electrified route, note that this is planned to be a regular timetabled operating mode.
- c) “Diversionary hauled” non-multiple operating mode where an electric IEP is operated together with another self powered vehicle / train (e.g. locomotive) but not on an electrified route.
- d) “Train unable to proceed under main power source” (due to either train or infrastructure failure).
- e) “Train requires assistance from another train” (i.e. the train is unable to proceed under its own main or auxiliary power sources or it is impractical to do so).
- f) “Real Emergency” operation, this includes incidents where damage to the train may have occurred (e.g. derailments). This may differ from the Emergency case defined in some mandatory standards.

The requirements for each mode are defined in the following sections.

#### 3.18.1 Standard Mode

TS1743 It is an essential requirement that for “Standard” mode, the train meets all parts of this specification.

#### 3.18.2 Multiple Hauled Mode

TS1744 It is an essential requirement that for “Multiple Hauled” mode, the train meets all parts of this specification (note that there is no journey time performance requirement for this train formation specified).

TS1745 It is an essential requirement that for “Multiple Hauled” mode the train shall be capable of operating in this mode for a period of at least [6] hours on each diagram.

TS1986 It is an essential requirement that for “Multiple Hauled” mode the train remains capable of falling back to “Train unable to proceed under main power source”, “Train requires assistance from another train” and / or “Real Emergency” modes if necessary.

#### 3.18.3 Diversionary Hauled Mode



- TS1746 It is an essential requirement that for “Diversionary Hauled” mode, the train meets all mandatory standards, there are no restrictions on the operation of the train (other than the duration / distance in this mode) and that the passenger environment meets all parts of this specification.
- TS1936 It is an essential requirement that for “Diversionary Hauled” mode the train shall be capable of operating in this mode for a period of at least [6] hours on each diagram.
- TS1937 It is an essential requirement that for “Diversionary Hauled” mode the train remains capable of falling back to “Train unable to proceed under main power source”, “Train requires assistance from another train” and / or “Real Emergency” modes if necessary.
- TS245 It is an essential requirement that for “Diversionary Hauled” mode the train is designed such that the whole train, both IEP and non-IEP parts together can be operated by a single driver.
- TS1987 It is an essential requirement that for “Diversionary Hauled” mode the train is designed such that all parts of the procedure necessary to couple and separate the IEP and non-IEP trains can be performed by train crew rather than other operational or maintenance staff.

### **3.18.4 Train Unable to Proceed Under Main Power Source Mode**

- TS1938 It is an essential requirement that for “Train unable to proceed under main power source” mode, "basic services" are provided to passengers for a minimum of three hours following failure of the main power source.
- TS1939 It is an essential requirement that for “Train unable to proceed under main power source” mode, the train shall be capable of "limited movement" while supplying "basic services" for a minimum of one hour following failure of the main power source.
- TS1940 It is a desirable requirement that for “Train unable to proceed under main power source” mode, the train shall be capable of "nominal services" following failure of the primary power source.
- TS1941 It is an essential requirement that for “Train unable to proceed under main power source” mode, the train shall remain capable of meeting the requirements of “Real Emergency” mode and shall fall back to that mode once the time periods specified have been exceeded.

### **3.18.5 Train Requires Assistance from Another Train Mode**

- TS1942 It is an essential requirement that for “Train requires assistance from another train” mode, the train shall so far as is possible meet the same requirements as in “Train unable to proceed under main power source” mode.
- TS1943 It is an essential requirement that for “Train requires assistance from another train” mode, the train shall remain capable of meeting the requirements of “Real Emergency” mode and shall fall back to that mode once the time period specified have been exceeded.
- TS1944 It is an essential requirement that for “Train requires assistance from another train” mode, the train formation can proceed in all of the following cases:
- i) Where the IEP train has an electrical supply to its auxiliary systems and with power available to its control systems.
  - ii) Where the IEP train is without an electrical supply to its auxiliary systems, but

with power available to its control systems.

iii) Where the IEP train is without any electrical supply to its auxiliary systems or power available to its control systems.

iv) Where the IEP train is with or without its own ability to provide braking functionality.

### **3.18.6 Real Emergency Mode**

TS1945 It is an essential requirement that for “Real Emergency” mode, the train shall provide interior emergency lighting.

TS1946 It is an essential requirement that for “Real Emergency” mode, the train PA system shall continue to function so far as is possible.

TS1947 It is an essential requirement that for “Real Emergency” mode, train operational communication systems (e.g. driver's radio(s)) shall continue to function so far as is possible.

### **3.19 Repairability**

TS286 It is an essential requirement that IEP vehicles shall be designed to allow for timely repair against (as minimum) the following scenarios;

- Level crossing collision with light road vehicle (family saloon) - up to 50mph.
- Low speed buffer stop impacts - up to 15mph.
- Minor derailments without vehicle collision - up to 15mph.
- Depot side swipes - where the corner of one vehicle contacts the side of another vehicle due to vehicles being left too close to points and crossings causing linear damage down the side of the non-moving vehicle at up to 15mph.
- Running over small obstacles on the track e.g. shopping trolleys - up to line speed. In this case the vehicle design should facilitate repairs being undertaken overnight.

### **3.20 Wheel Rail Interface**

#### **3.20.1 Contact Patch Energy**

TS1795 It is an Essential requirement that IEP trains shall generate minimum damage to the track, including surface damage such as Rolling Contact Fatigue (RCF) and wear to ensure that the tangential forces generated at the wheel/rail interface are minimised. An IEP train that reduces these forces will also provide benefit to the Train Service Provider (TSP) as surface damage to wheels will also be reduced. The amount of surface damage generated can be quantified using the contact patch energy ( $T_g$ ), which can be readily determined from vehicle dynamics simulations of wheel/rail interaction. The TIIS defines relationships between the contact patch energy and curve radius for tread and flange contact conditions at cant equilibrium and cant deficiency; and are upper limits to ensure that wheel and rail surface damage is minimised. The TIIS also describes the conditions under which the assessment of contact patch energy should be undertaken.

#### **3.20.2 Vehicle - Track Impact**

- TS1798 It is an Essential Requirement that the IEP trains are designed taking due account of the impact of the vehicle and bogie behaviour on the track using VTISM to optimise the train design to achieve the minimum overall railway system cost.

### 3.21 Current Collection

- TS1801 It is an essential requirement that the IEP trains design allows for flexibility of pantograph orientation and selection under driver control to allow for :
- The development of suitable solutions to allow operation in multiple up to 125mph.
  - The best whole life cost infrastructure/train solution to be developed when considering technical issues with respect to signals and both overhead line neutral sections and booster transformer overlaps.
- TS1864 The IEP trains shall be fitted with APC equipment in accordance with NR/GN/ELP/27010.

### 3.22 Signalling Compatibility

#### 3.22.1 Signal Sighting and Drivers Egress

- TS1809 It is an essential requirement that, in addition to the TSI requirements, the IEP trains comply with GM/RT2161, GE/RT8037 and NR/SP/SIG/10157.

#### 3.22.2 Nose Overhang

- TS1814 It is an essential requirement that, in addition to the TSI requirements, the IEP trains nose overhang shall comply with the requirements of GM/RT2149 and GK/RT0011.

#### 3.22.3 Train Detection Systems

- TS1816 It is an essential requirement that, in addition to the TSI requirements, the IEP trains comply with GK/RT0011 - Train Detection.
- TS1818 The IEP trains shall be designed to be compatible with the infrastructure in accordance with Track Circuits defined within the TIIS.

#### 3.22.4 Train Visibility

- TS1822 It is an essential requirement that the IEP trains comply with GM/RT2483 - Visibility Requirements for Trains.

#### 3.22.5 Train Location

- TS1997 It is an essential requirement that IEP trains shall have an onboard train location system for example by the use of Advanced Positioning (via satellite/GNSS/GPS), inertia measurement and track mapping. In the long term the use of advanced position will assist in the reduction of lineside train detection equipment which will decrease the cost of signalling fitment and maintenance and could potentially facilitate increases in signalling system reliability.

## 4 Base Systems

## 4.1 Bodysell & Structure

TS300 It is an essential requirement that there is minimal discernable ripple or distortion in the visible vehicle structure (excluding roof, underframe and bodyends).

To meet this requirement, as a minimum the visible vehicle ripples or distortions shall be less than 2mm per metre length.

## 4.2 Windows

TS303 The bodyside window arrangement, including the dimensions of the windows, shall be optimised to ensure that the maximum number of seated passengers in the saloon and standing passengers in a vestibule can see out of an adjacent window. This optimisation shall be based upon the range of interior layouts that meet the scenarios defined for the Intercity, Interurban and Commuter service types.

TS1607 It is an essential requirement that the total change time for damaged or defective windows to allow an IEP vehicle to be returned to service shall be less than the shortest scheduled overnight maintenance period. This requirement applies to all bodyside windows and cab front windscreens.

TS1847 It is an essential requirement that all bodyside windows including external doors shall be laminated in accordance with Railway Safety & Standard Board (RSSB) report dated 31/07/07 on 'Passenger Containment'.

TS1848 It is an essential requirement that all bodyside windows including external doors shall allow the continued operation of the train at normal linespeeds following the breaking of the external pane of a window assembly.

## 4.3 Gangways

TS312 It is an essential requirement that the gangways fitted between IEP vehicles shall allow for the train configuration flexibility requirements to be able to move vehicles to any position within an IEP train.

TS1617 It is a desirable requirement that inter-vehicle gangways shall meet the following requirements;

- Gangways shall be of a size such that they allow unrestricted passage for the full range of users defined including when operating on the minimum mainline curves (ref. TS1825, section 3.1.1); additionally gangways shall, as a minimum, satisfy the minimum dimensional requirements for wheelchair accessibility specified in the TSI for People with Reduced Mobility (PRM).
- Gangways shall be designed to be as level as practicable to allow the free passage of both wheelchairs and catering trolleys..
- There shall be a clear unobstructed sightline through the gangway to suit the range of users defined.

## 4.4 Brakes

TS314 In addition to the TSI requirements for emergency braking, it is an essential requirement that

an IEP train's service brake shall comply with the requirements of GM/RT2044 Figure 3, Curve A3.

- TS1988 It is a desirable requirement that the IEP trains shall comply with the High Speed TSI 'Brake requirements for rescue purposes' following complete loss of all electric power within that train.
- TS1849 It is an essential requirement that IEP brake system shall not allow single point failures or likely combinations of failures that could lead to an unsafe event. As a minimum the events to be considered shall include the following;
- Significant loss of braking capability
  - Dragging brake
- TS1850 To facilitate efficient rescue of a failed unit it is a desirable requirement that IEP brake system brakes may be released at one position, following a train fault that has caused the application of the brakes.

#### **4.5 Motive Power**

- TS1750 It is an essential requirement that the traction system alone shall be capable of delivering at least the same level of deceleration during braking as is achieved during acceleration, at any speed greater than 20km/h and during the entire duration of a brake application bringing the train to a stand from maximum speed.
- TS1989 It is an essential requirement that where an IEP train is supplied from a 25kV overhead supply, all the energy recovered by the traction system during braking (less any electrical losses) shall, where the infrastructure permits, be returned to the supply (less any used beneficially onboard the train, e.g. in supplying auxiliaries).
- TS1751 It is desirable that the traction system makes a greater contribution to braking than the minimum specified above.
- TS1752 It is a desirable requirement that the Self Powered and Bi-mode IEP trains shall make optimum use of energy recovered during dynamic braking; this may include the use of this energy to power auxiliary systems and / or the provision of energy storage so as to allow its use for subsequent acceleration of the train.
- TS348 It is an essential requirement that if the IEP self power or Bi-mode train uses a compression ignition engine it shall be capable of using fuel with a sulphur content of 10 ppm or less. It is also essential that it is capable of using fuels where up to 20% of the fuel is bio derived.
- TS1611 It is a desirable requirement that IEP self power or Bi-mode trains shall be optimised for operation with fuel that is readily and commercially available.

#### **4.6 Auxiliaries**

- TS1506 It is an essential requirement that the auxiliary system distribution and power management shall be capable of accommodating the complete range of flexibility requirements defined in this specification (section 3.1.3).
- TS1507 It is an essential requirement that the auxiliary system shall be optimised to support the maximum operating auxiliary load requirement, taking account of diversity. In addition the auxiliary system shall be designed such that a further 5kW load can be added to the auxiliary

system on each IEP vehicle at a later date.

## 4.7 Doors

- TS1597 For information the requirements for external and internal doors are generally covered by the requirements for station interface & dwell time (TS271, 272, 273, 1625), train controls (TS255, 1567 to 1570) interiors (TS1925, 1598) & fire (TS1468) elsewhere within this specification.
- TS1599 It is an essential requirement that the local control arrangements for internal doors shall include the following functions;
- Allow train crew to activate the door open without using their hands.
  - Ensure that the doors do not close on passengers while walking through or standing in the aperture.
  - Allow train crew only to isolate the door in the open position in the event of failure.
- TS1921 It is an essential requirement that both external and internal doors fitted within the unit shall be designed for the safe evacuation of passengers following a major incident such as collision or derailment. Consideration shall be given for the range of positions and attitudes and states of the vehicles with the train following a major incident. Reference shall be made to RSSB report dated 31/07/07 on 'Passenger Containment' and earlier supporting work.

## 4.8 Heating Ventilation & Air Conditioning

- TS317 It is an essential requirement that the IEP vehicles are fitted with Heating Ventilation and Air Conditioning (HVAC) systems which conform to the operational and functional requirements of EN13129-1:2002, 'Air conditioning for main line rolling stock' and EN14813-1:2006, 'Air conditioning for driving cabs'.
- TS1619 In accordance with EN14813-1, 'Air conditioning for driving cabs', IEP shall be designated as a 'Category A' driving cab; all appropriate requirements shall be met.
- TS1620 The HVAC performance of the vehicle saloon shall be calculated on the basis of an interior layout in accordance with the Commuter Service Type interior scenario (ref.section 6.4), loaded to the Fully Laden Condition. Additionally the HVAC system shall ensure the safe carriage of passengers when loaded to the Crush Laden Condition.
- TS1621 It is an essential requirement that the saloon HVAC system shall not impede the interior flexibility requirements of the IEP vehicles, i.e. where vehicle configurations are changed through the removal of catering facilities or fitment/removal of toilets etc.

## 4.9 Passenger Information & Communications

### 4.9.1 Passenger Information & Announcement System

- TS290 It is an essential requirement that the Passenger Information System (PIS) / Passenger Announcement (PA) system shall have sufficient capacity to store enough messages for any one franchise deployment.
- TS481 It is an essential requirement that the PIS / PA system shall be capable of uploading new timetable/message database information for the IEP fleet of each individual franchise



deployment.

This upload capability shall allow that fleet at timetable change implementation to finish service one day with the previous data to then be loaded with the new timetable data from the Train Service Database (TSDB) for the following day's service.

Similarly any short term timetable changes for engineering work, special events etc shall be capable of being downloaded from the TSDB within one overnight period.

- TS482 In addition to the legislative requirements it is an essential requirement that the PIS/PA systems shall deliver the following functionality:
- It shall be possible for real-time messages to be generated by either the train crew or central control.
  - The PIS shall display journey information and coach identification letters/numbers inside each vehicle and outside close to entrance doors at all times whilst in passenger service.
  - The PIS/PA shall update journey information in real time throughout the journey.
  - The PIS system shall identify to passengers which vehicle they are in, and PIS/PA shall explain in the case of a service that divides en route which portion of the train each vehicle forms a part. The coach identification shall remain the same throughout the journey even after a division and the possible reversal of a train or a portion of a train.
  - The PIS/PA system shall advise passengers of any requirements to alight from specific vehicles or doors a station ahead of the affected station. This shall be fully integrated with the SDO system.
  - The voice PA shall be available to crew at all staff areas, door control points and catering areas. Its function shall be retained if the visual PIS fails and vice versa.
  - The PA system shall accommodate coded alarms or messages which shall be selectable by train crew.
  - The PIS/PA shall allow for different information to be provided in different parts of the train (e.g. between classes of accommodation)
- TS1931 It is a desirable requirement that the PIS system shall utilise the data from the passenger counting system to indicate to passengers the status of the occupancy of each vehicle within the train. This information shall be viewable from station platform and within each vehicle.

#### **4.9.2 Seat Reservation System**

- TS636 It is an essential requirement that IEP trains shall be fitted with an automatic seat reservation system.
- TS1990 It is a desirable requirement that the automatic seat reservation system is fully integrated with the PIS & PA system.
- TS637 It is an essential requirement that the seat reservation system shall be flexible, such that reservation displays shall be capable of being moved with the associated seat, to accommodate interior layout changes.
- TS638 It is an essential requirement that there shall be a manual method of displaying printed reservation tickets as a back-up to the automatic system.

- TS640 It is an essential requirement that the automatic seat reservation system shall deliver the following functionality;
- Interface directly with the national seat reservation system. The reservation system shall utilise this data to maintain the reservation database for each IEP train.
  - Automatic remote download of reservation data via a communications link immediately prior to start of a timetabled journey within a minimum time period, which allows sufficient time to allow passengers to board during the shortest turn-around times.
  - Allow on board train crew to load or update seat reservation data in real time.
  - Displays for each seat shall indicate whether that seat is free, reserved for part of or for the remainder of the journey. The method of display shall be easy for passengers to interpret quickly when boarding, and shall seek to convey an overall impression of the extent of reserved and unreserved seats within the saloon.
  - Displays shall be automatically updated throughout a journey to indicate the current reservation status for the remainder of the journey.

#### 4.10 Lighting

- TS550 It is an essential requirement that the lighting system conforms to the operational and functional requirements of EN13272:2001, 'Railway applications- Electrical lighting for rolling stock in public transport systems'. IEP trains shall be designated as main line rolling stock; all appropriate requirements shall be met. It will be a further requirement to provided lighting of a minimum of 20 Lux on emergency equipment and any cubicles within which they are stored.
- TS1662 It is an essential requirement that the lighting system shall comply with EN13272 under the differing interior layouts, designs and seating pitches. To meet this requirement for the full range of interior arrangements the lighting system will need to be flexible.
- TS1661 It is an essential requirement that IEP trains shall be fitted with a low level lighting system that shall continue to function following any event that causes the separation of any single vehicle from the remainder of a train rake, for up to 3 hours continuously.

#### 4.11 Radio & Data Transmission

- TS248 It is an essential requirement that IEP trains shall be fitted with radio equipment as required to operate on the designated routes (as a minimum this requirement includes GSM-R radio equipment).
- TS1922 It is a desirable requirement IEP trains shall have common aerial methodology for the transmission of data from and to systems fitted to IEP vehicles. This methodology shall maximise the effectiveness of the wireless connectivity while minimising the number of aerials that are fitted to vehicle exterior.

Consideration shall be given to the recommendations and output from RSSB Research Project T379 Train Roof Antennae Positioning Study, when published.

#### 4.12 Train Control

- TS255 Train Control systems shall be provided as dictated by standards and these systems should be



implemented in accordance with general UK practice in conformance to TSI requirements. Where general UK practice is not proposed, detailed justification and agreement shall be required prior to this being adopted.

The following examples should not be considered as a exhaustive list but are provided for guidance:

- Drivers Safety Device (DSD) – General UK Practice is to provide a pedal in the driver’s foot well.
- Traction/Brake Controls – General (modern) UK Practice is to provide a Combined Power Brake Controller (sometimes referred to as a Traction Brake Controller). Moving the controller away from the driver shall apply the brakes and moving the controller towards the driver shall apply traction.
- Door Controls – General UK practice is to provide two sets of control panels, with one for the left-side doors and one for the right-side doors. It is normal to provide two door-open buttons that are required to be operated simultaneously and one door-close button for each set of door controls.

- TS1567 It is an essential requirement that train controls are designed to allow either Driver Only Operation (DOO) or Driver Guard Operation (DGO).
- TS1568 It is an essential requirement that door controls shall be provided at each guard’s position, which shall as a minimum be at vehicle length intervals on each side of the train. These controls should allow for guard, opening, closing and selective re-closing of the passenger saloon doors as per general UK operating practice and rules.
- TS1569 It is an essential requirement that external door indicators are fitted to each side of each vehicle which serve the following functions;
- Indicate the status of the door interlock circuit per vehicle
  - Indicate the status of the guards control panel per vehicle
  - Visually distinguish between the above status types
- TS1570 It is a desirable requirement that a discrete indication shall be local to each door, visible from both inside and outside the train, showing when that door is not closed and locked.
- TS1571 It is an essential requirement that IEP train design takes account of the operational requirements that may lead to system isolations being necessary, and that the isolation devices (Electrical/Pneumatic/Mechanical) shall be positioned accordingly to allow isolation.
- TS1786 It is a desirable requirement that system isolation devices shall be contained within the cab and can be operated without the driver leaving his cab.
- TS1923 It is a desirable requirement that passenger facing system controls (e.g. HVAC, internet provision, seat power supply, lighting etc) shall be implemented so that all train crew can set or reset these system controls as required.
- TS1853 It is an essential requirement that IEP trains shall be fitted with train protection systems (AWS, TPWS) necessary to operate on the designated routes.
- TS1572 It is an essential requirement that IEP trains shall be fitted with European Train Control System (ETCS) Level 2 equipment.
- TS1867 It is an essential requirement that IEP trains comply with train infrastructure interface

requirements as specified in ERTMS/CAM/D138 issue 5 – Train-borne Functional Application Specification and is compatible with the UK application of the ETCS level 2 system currently being developed by NR.

- TS1573 It is an essential requirement that where IEP trains operate on routes currently fitted with the BR-ATP system the train shall be capable of operation with this system.
- TS1870 It is an essential requirement that an integrated approach is adopted for IEP trains capable of both ETCS and ATP operation to allow a simple migration strategy for ECTS to be realised and to provide a common interface to the driver.
- TS1991 It is a desirable requirement that the ATP functionality is implemented using a Specific Transmission Module (STM) in accordance with the TSI.
- TS2009 It is a desirable requirement that the AWS and TPWS functionality shall be integrated into a single driver's Man Machine Interface (MMI) using an STM.
- TS1872 It is an essential requirement that IEP trains shall contain a High Integrity Train Complete Function (a system that can guarantee that a train is complete for a known length train) that is made available to the ETCS system.
- TS1924 To reduce overall vehicle weight it is a desirable requirement that train controls are not hard wired.

#### 4.13 Selective Door Operation

- TS296 It is an essential requirement that IEP trains are fitted with an Automatic Selective Door Operation (ASDO) system to allow for longer trains operating in single or multiple formation to stop at short platforms. Train position detection will be facilitated by the infrastructure and is defined within the TIIS.

#### 4.14 Energy Metering

- TS297 It is an essential requirement that IEP trains shall be fitted with on-board metering which measures the total energy consumed for electric, self-powered and dual-powered trains. The system shall ensure that the data is logged on board and be of a sufficient quality to meet electricity supply industry requirements for billing purposes.
- TS1854 It is an essential requirement that the IEP trains comply with prEN50463 (Energy Measurement on Board Trains). The metering used shall be capable of determining:
- The total energy consumed.
  - The total energy returned to the network under regenerative braking.
  - The total energy consumed while operating on specific areas of the infrastructure such as depots and sidings and at specific times.
- TS1855 It is an essential requirement that IEP trains shall be capable of the remote download of the energy data logged, as and when required. The download method shall ensure that the data will be auditable to ensure that it has not been affected by the transmission from the meter to the remote site
- TS1856 It is a desirable requirement that the data from the energy metering system shall allow optimal energy efficient driving styles to be identified and actual driving techniques

monitored. To achieve this the system should be capable of making recordings at a maximum of 1 minute intervals and should have a GPS input.

#### 4.15 Train Management System

TS298 It is an essential requirement that the IEP trains are fitted with a Train Management System (TMS) that is capable of generating and receiving information on the train status and location, providing ‘in service’ fault information, identifying repair work required, and storage of Vehicle data. The system shall provide easy access to users to enable performance indicators to be compiled, identify safety critical components and processes to be monitored. The system shall be operated by various levels of user, e.g. Train Drivers, service controllers, Train maintainers or system specialist.

The TMS shall, as a minimum, be capable of the following:

- Automatically reconfiguring when IEP trains are split or joined together
- Monitoring status and fault data from the train’s intelligent subsystems, safety systems and service critical systems (e.g. motive power, HVAC, braking etc...)
- Generating status and fault messages from monitored data and provide the relevant alerts to Train Drivers, Train Maintainers and Control Centre. The messages should advise what action to take and apply any necessary constraints on the subsequent operation of the train.
- Displaying status and fault information in the driving cab and any other relevant Train Crew area.
- There shall be a number of internal and one external download points per IEP train, which shall allow download at either end or midpoint of the train. Each download point shall be capable of download all of a train’s messages, including all OTMR data.
- Receiving and displaying real time information from the Control Centre

TS1718 It is a desirable requirement that all messages, including all OTMR data, shall be accessible remotely and/or in real time from the Control Centre and Operating depot.

TS1932 It is a desirable requirement that the TMS system shall provide a single integrated interface across train sub-systems.

TS1992 It is a desirable requirement that the TMS shall provide a single communications channel for operation and maintenance data from train to ground.

#### 4.16 Passenger Counting System

TS299 It is an essential requirement that each IEP vehicle is installed with a system that automatically, reliably and accurately records the number of passengers boarding and alighting the train at each station. The system shall record the individual journey, time and date for which this information applies.

TS1993 It is an essential requirement that the passenger counting systems shall in addition to the requirements of TS299 automatically, reliably and accurately record the number of passengers moving between vehicles to facilitate the calculation of the number of passengers per vehicle.

- TS1857 It is an essential requirement that the system is capable of recording the passenger numbers to a minimum accuracy of 96% for each station stop.
- TS1859 It is an essential requirement that recorded data for the entire train can be downloaded via the TMS .
- TS1860 It is a desirable requirement that all passenger count data shall be accessible remotely and/or in real time from a Control Centre and Operating depot.

#### 4.17 Infrastructure Monitoring Systems

- TS2002 It is an essential requirement that IEP trains shall monitor the railway infrastructure, and interfaces between the IEP train and railway infrastructure, on a continuous basis during the time trains are in service operation. The data that is recorded shall be collected, stored and provided to Network Rail at least every 24 hours.

The system(s) provided shall enable each item of infrastructure equipment, being monitored/recorded, to be identified. The recorded data shall include:

- unique identities for each IEP train,
- the journey/diagram
- IEP train position in real time
- the route(s) travelled over including position and direction
- date, and timestamp data to the nearest second

##### 4.17.1 Intelligent Monitoring System

- TS2003 It is an essential requirement that each IEP train shall have an Intelligent Monitoring System, that shall monitor, record, analyse, store and transmit data on the health and condition of the following systems as specified below;

i. AWS

The onboard AWS system shall be monitored in real time.

The strength and polarities of magnetic fields created by the AWS equipment over which IEP trains pass.

ii. TPWS

The onboard TPWS system shall be monitored in real time.

The frequency and signal strength being transmitted from the TSS and OSS loops fitted in the track shall also be monitored.

iii. ETCS

The health and condition of Eurobalises shall be monitored.

It shall be possible to:

- identify latent problems that have not yet resulted in a failure to read a Eurobalise.
- identify failed Eurobalises

IEP trains shall be capable of providing diagnostics of any failure of the European Vital Computer (EVC) in the event of an ETCS onboard failure

## iv. GSM-R

IEP trains shall have onboard equipment capable of collating information on GSM-R quality of service issues.

#### 4.17.2 Forward Facing CCTV (FFCCTV)

TS1907 To support incident management it is an essential requirement that each IEP train is fitted with Forward Facing CCTV that is optimised to identify track, signals and any approaching features of interest on the track.

TS1911 It is an essential requirement that the FFCCTV system shall be capable of:

- Operation during loss of the main source of motive power.
- Recording images under all lighting conditions including night time when the light source will be IEP train headlights
- Record images with a minimum resolution of 3 mega pixels
- Record images with a minimum frequency of 12fps (frames per second).
- Recording up to a minimum of 72 hours of data.
- Provide drivers with a pushbutton that allows them to flag a feature worth noting for further investigation.
- Provide an automatic means of reporting when a driver notices an incident.
- Provide simple data download capability to a laptop pc without the need for specialist software.

#### 4.17.3 Automatic Vehicle Identification (AVI)

TS2004 It is an essential requirement that an AVI system shall be fitted to all IEP trains. This will consist of two tags per IEP train (one on either side) and be based on Radio Frequency Identification (RFID) technology. The system shall be compatible with Network Rails requirements.

#### 4.17.4 Unattended Track Geometry Measurement Systems (UGMS)

TS1899 It is an essential requirement that sufficient IEP trains are fitted with an operational UGMS so that the required track geometry data is provided to Network Rail, for each route, at least twice weekly.

TS1903 It is an essential requirement that the IEP trains UGMS system shall require no operator intervention and shall monitor and record the following track data geometry parameters:

Parameter	Repeatability of geometry signal	Repeatability of statistical data (1/8 <sup>th</sup> mile Standard Deviation)
35m top (left and right rail)	+/- 1mm	0.1mm
70m top (mean)	+/- 1mm	0.1mm
35m alignment	+/- 2mm	0.2mm
70m alignment	+/- 2mm	0.2mm
Gauge	+/- 0.5mm	0.1mm

3m twist	+/- 1.5mm	0.15mm
Curvature (versine from a 20m chord)	+/- 1mm	0.1mm
Cross level	+/- 1.5mm	0.15mm
Cyclic top	TBD	TBD
Dip angles	TBD	TBD
Train Speed	+/- 2mph	TBD
Differential Global Positioning System (DGPS)	TBD	TBD

TS2006 It is an essential requirement that the UGMS system shall be capable of delivering the data to the accuracy defined in TS1903.

In addition to this the location of the geometry signals shall be repeatable to 1m (run-on-run) with absolute location of the network being determined to within 3m in terms of miles and yardage. All data must be attributed with the correct Engineers Line Reference ELR / Track ID (TRID).

The accuracy and repeatability of the UGMS outputs shall be determined as follows;

- by comparison to Network Rails fleet of calibrated infrastructure monitoring trains.
- by run-on-run UGMS comparison
- for a range of vehicle speeds to demonstrate the UGMS outputs are invariant with speed and vehicle orientation.

TS1900 It is an essential requirement that the data acquisition rate of the UGMS system shall allow the NR reconstructed track geometry to show data at intervals of at least every 0.2m along the track being monitored.

TS1902 It is an essential requirement that the IEP trains shall be capable of transmission of the captured data to remote sites. The data gathered shall be automatically down loaded to ground based receivers provided by the TSP. These will be located at depots and stabling points and other defined locations. The data shall be passed on to Network Rail's Engineering Support Centre (ESC) in a format compatible with Network Rails analysis tools.

#### 4.17.5 Unattended Overhead Line Measurement System (UOMS)

TS1914 It is an essential requirement that sufficient IEP trains are fitted with an operational UOMS so that Overhead Line (OHL) condition data is provided to Network Rail, for each route, at least twice weekly.

TS1917 It is an essential requirement that the IEP trains UOMS system shall require no operator intervention and shall monitor and record the following overhead line parameters:

Parameter	Repeatability of signal (at same speed and similar environmental conditions)
Overhead Line Height	+/- 10mm
Overhead Line Stagger (uncompensated for vehicle roll)	+/- 10mm

Pantograph Contact Force (max within 0.2m sample)	+/- 5N
Pantograph Vertical Acceleration (max within 0.2m sample)	+/- 2g
Pantograph Longitudinal acceleration (max within 0.2m sample)	+/- 1g
Train Speed	+/- 2mph
DGPS	TBD

TS2007 It is an essential requirement that the UOMS system shall be capable of delivering data to the level of accuracy defined in TS1917 (subject to vehicle dynamics and environmental conditions).

In addition to this the location of the signals must be repeatable to 1m (run-on-run) with absolute location of the network being determined to within 3m in terms of miles and yardage. All data must be attributed with the correct Engineers Line Reference ELR / Track ID (TRID).

The accuracy and repeatability of the UOMS outputs shall be determined as follows:

- by comparison to Network Rails fleet of calibrated infrastructure monitoring trains.
- by run-on-run UOMS comparison

TS1915 It is an essential requirement that the data acquisition rate of the UOMS system shall allow the NR reconstructed OHL parameters to show data at intervals of at least every 0.2m along the route being monitored.

TS1916 It is an essential requirement that the IEP trains shall be capable of transmission of the captured data to remote sites. The data gathered shall be automatically down loaded to ground based receivers to be provided by the TSP. These will be located at depot and stabling and other defined locations. The data shall be passed on to Network Rail's Engineering Support Centre (ESC) in a format compatible with Network Rails analysis tools.

## 5 Custom Systems

### 5.1 Saloon Closed Circuit Television

TS604 It is an essential requirement that IEP vehicles are fitted with a Saloon Closed Circuit Television (CCTV) Monitoring System.

TS605 It is an essential requirement that the Saloon CCTV system shall incorporate the following functionality:

- Each vehicle shall contain sufficient CCTV cameras to view all public accessible areas (excepting inside toilets) and to minimise blind spots. The passenger areas to be covered shall include vehicle saloons, doorways, vestibules, gangways, catering areas and other public spaces.
- Cameras fitted shall be tamper proof and vandal resistant
- The CCTV system shall record, without overwriting, for a minimum of 1 months IEP train service operation
- Recorded picture quality shall be in colour and shall be of sufficient clarity to enable



the identification of individuals within the vehicle.

- Recorded images may require to be used as evidence in a prosecution. To facilitate this the system shall be capable of supporting a clear evidential trail so as to allow the integrity of the recording to be demonstrated.
- The CCTV picture capture frame rate shall be sufficient to allow the actions of person within all public accessible areas to be identifiable. Consideration shall be given to increasing this frame rate after an 'emergency event' trigger, such as an passenger alarm handle being actuated.
- The CCTV recordings, from all saloons, shall be capable of being viewed in real time in a secure train crew area.

## 5.2 Mobile Device Communications Interface System

- TS1475 It is an essential requirement that IEP trains shall allow mobile device communications connection within the all vehicles.
- TS1691 It is an essential requirement that the IEP trains shall allow wireless internet access at all seat positions via personal computers or equivalent. This facility shall be capable of being configured so that the service is chargeable or not as the operator requires.
- TS1693 It is an essential requirement that the IEP trains allow for a choice of internet service providers. Due to possible variations of equipment/service types, it is permissible that the IEP trains shall be fitted with internet transmission equipment to an interface point, where a choice of alternative suppliers' equipment may be easily fitted to allow the internet service to operate.

## 5.3 Livery

- TS324 It is an essential requirement that IEP trains shall be capable of being customised to reflect a range of external livery and marketing requirements for each franchise deployment.
- TS1861 It is an essential requirement that the external livery of IEP trains shall reduce thermal load on the interior of the vehicles due to solar gain.

# 6 Passenger Environment

## 6.1 Train Interior and Elements

- TS1508 It is an essential requirement that the train interior design shall contain the elements as defined in the following section. The elements will allow choice in seating layout and the provision of amenities such as toilets and refreshments. The selection of an appropriate combination of these elements for each deployment shall be established. This approach requires a 'building block' principle to be applied to the design of the main interior features.
- TS1552 Further elements or an alternative 'building block' structure may be proposed, provided that the minimum requirements defined below are accommodated.
- Entrance areas
  - Litter collection
  - Seated areas



- Toilets
- Luggage storage
- Catering
- Interior partition doors
- Interior Information and Advert System
- Crew office

TS1553 It is an essential requirement that the interior elements shall follow a common neutral style which when combined as an interior layout shall present a cohesive overall interior style, collectively making for a pleasant and stress-free journey.

The inter-city and inter-urban/commuter service may have different styles reflecting their characteristics and requirements.

TS1554 It is an essential requirement that a range of features that complement the overall ambience of the interior shall be proposed. The following feature shall be included, additional items may be proposed to form part of the interior design solutions.

- Carpets / Floor Covering appropriate to interior area
- Magazine/newspaper racks

## 6.2 Interior Element Requirements

TS1555 The specific requirements for each interior element are detailed in the following sections.

### 6.2.1 Entrance Area

TS1556 The area between entrance doorways and seating shall provide as direct a transition as possible as a contribution to minimising platform dwell time. It shall be able to act as a buffer area where passengers may gather whilst they wait for the opportunity to alight or move to seats.

TS1557 The area may also be used as a waiting or conversation area. The provision of seats within an entrance area is not preferred. Its ambience shall be welcoming and not utilitarian, but shall take account of the high traffic level through it and consequent potential for high wear and tear.

TS1558 The area shall have a facility for the display of such items as maps, notices and tariffs to the choice of the individual franchise deployment. This provision is in addition to statutory and functional signage.

### 6.2.2 Litter Collection

TS1559 It is an essential requirement that the collection of litter within the vehicle interior shall be considered in the interior design. IEP vehicle shall include a range of litter bin solutions, which shall meet the following requirements;

- Litter bins shall not be located such that they reduce the luggage stowage capability of the saloon interior.
- Litter bins shall be fitted in entrance areas.
- The litter bins shall be as large as possible and ensure their contents are securely

contained, preventing escape of odours into the surrounding areas.

- The design of each litter bin shall take due account of security considerations. It shall be possible to remove the bin liner and its contents easily without use of any more than a key.

### 6.2.3 Seated Areas

TS1560 It is an essential requirement that a range of solutions are provided for seating areas, which will provide a style and density of seating to suit the intercity and inter-urban service types for both Standard and First class. Each solution shall allow for applications where passenger saloon space may vary in length depending on the other amenities selected for each vehicle.

TS1509 It is an essential requirement that the seat arrangements shall accommodate the range of anthropometric dimensions used for the human factors analysis throughout the train design.

The following factors shall be considered for the seat arrangements;

- Seat spacing - the distance between the base of the seat back and the front of the knees (the “knee space”).
- Seat pitch - the distance between the same points on successive seats - is a combination of seat spacing and the dimensions and configuration of the seat itself.
- Seat width.
- Seat access/egress.

TS1511 It is an essential requirement that at each seat position, the following features shall be accommodated. Each of these features shall be capable of being incorporated or not as required for each IEP deployment;

- support of passenger arms when seated
- use and support of laptop etc.
- use and support of cups, meal plates and utensils
- sufficient lighting level to be allow reading when seated
- coat hooks
- sun shading

TS1512 A means of providing power to passenger’s low power electrical devices (laptops & mobile phones) shall be provided. As a minimum a power point should be provided for each seat row and at each side.

### 6.2.4 Luggage Stowage

TS1265 It is an essential requirement that IEP vehicles incorporate a range of luggage stowage solutions. Each solution shall ensure that the luggage is securely and safely stowed under all vehicle movements. The solution design shall facilitate the ease of loading and unloading the luggage for the user population.

TS1664 It is an essential requirement that luggage stowage solutions shall maximise the ability of passengers to view their luggage while seated, to address their concerns about the security of their luggage.

TS1665 It is an essential requirement that luggage stowage solutions shall ensure that items cannot be

concealed and that their presence can be easily identified by train crew.

- TS1666 It is an essential requirement that luggage stowage solutions and their application shall ensure that the following additional factors are achieved;
- minimise the use of interior space and hence maximise the available seating capacity.
  - maximise the available luggage stowage capacity within the available interior space.
  - minimise station dwell times through suitable design and location.
  - shall not obstruct the movement of passengers or train crew during normal or emergency service conditions

- TS1667 It is an essential requirement that the range of luggage stowage solutions shall accommodate the following luggage types;

<b>Luggage Type</b>	<b>Size &amp; Definition</b>
Small Bag	420x400x300 mm
Large Bag	800x570x300 mm
Bicycle	Full size 'road' bicycle with 25inch frame
Pushchair	Full size single foldable pushchair 1100x500x350mm (folded)

- TS1668 It is a desirable requirement that the range of luggage stowage solutions shall accommodate the following luggage types;

<b>Luggage/Item Type</b>	<b>Size &amp; Definition</b>
Excess luggage / packages	Up to 4m <sup>3</sup>
Powered Disabled Scooter	1400x730x1300 mm. Maximum mass of 160kg, capable of carrying 200kg person.

## 6.2.5 Toilets

- TS1282 It is an essential requirement that the IEP passenger carrying vehicles shall be capable of accepting both, standard and universal type toilet systems in the following configurations:
- Intermediate vehicles shall be capable of accepting one universal, or one standard, or two standard toilets
  - Driving vehicles shall be capable of accepting one universal, or one standard toilet.
- TS1671 It is an essential requirement that all toilet modules, irrespective of quantity or type, operate as intended throughout the IEP trains entire daily duty cycle. The vehicle and toilet design, whilst in service, shall ensure that the toilet consumables are available for passenger use at all times and that the waste storage capacity adequately considers the delivery capacities held. Designs shall consider and conserve the use and misuse of consumables without impeding the performance of the system.
- TS1672 It is an essential requirement that both, standard and universal toilets are compliant with the 'Persons with Reduced Mobility' TSI (PRM TSI). However it is an essential requirement that the following additional requirements be met;
- The passageway and doorways between the wheelchair space and the Universal Toilet shall be not less than 850 millimetres wide at any point and provide a space adjacent to that toilet for the disabled person in the reference wheelchair to turn the wheelchair around through one

hundred and eighty degrees.

Where one or more vehicles within an IEP train are provided for a different class of passenger accommodation from another vehicle in that train there shall be not less than one wheelchair space and in each class of passenger accommodation in that train.

- TS1673 It is an essential requirement that both standard and universal toilets include hand washing and drying facilities, mirror, means of retaining personal possessions (e.g. coat, handbag etc) while using the toilet. The hand washing facility shall utilise hot water. These facilities shall be positioned at appropriate heights and locations specific to standard and universal designs; with respect to the range of users and persons with reduced mobility.
- TS1862 It is a desirable requirement that further facilities to suit a range of other user amenities be included in the toilet solutions.
- TS1674 In the case of an emergency, it is an essential requirement that the toilet's access door, for both standard and universal toilet modules, may be overridden and opened by train crew when in its 'locked' state, this shall still be possible with an incapacitated passenger behind the door. The overriding device shall be tamper proof and/or be hidden from passenger sight.
- TS1675 It is an essential requirement that the toilet system shall limit the presence of odours within the toilet cubicle and prevent their escape into surrounding passenger areas including vestibules; the passenger saloon shall be free from toilet odours at all times.
- TS1676 It is an essential requirement that a toilet module shall be capable of being removed and replaced by seating, or other interior features, without the need for major structural changes. Likewise the installation of an additional toilet shall be possible following the same rationale.
- TS1863 It is a desirable requirement that toilet waste retention tanks be sited in the underframe area of the vehicle, to facilitate ease of cleaning if required.

### 6.2.6 Catering

- TS1630 It is an essential requirement that IEP trains shall be capable of providing a range of catering services. It is expected that catering solutions shall be provided that are capable of providing catering at four levels:
- Level 1 - Full restaurant service or at seat first class service with meals cooked on board
  - Level 2 - Re-generated meals served at-seat
  - Level 3 - Hot and cold snacks and drinks through a 'Café-Bar' style outlet.
  - Level 4 - A trolley service.
- TS1631 It is an essential requirement that for any one application of IEP trains it shall be possible to select any of these catering solutions. The range of potential combinations (A to J) of IEP catering services for any one IEP train are described in table 1 below:

<i>Catering Facility combinations</i>	<i>Level 1</i>	<i>Level 2</i>	<i>Level 3</i>	<i>Level 4</i>
<i>A</i>	✓		✓	✓
<i>B</i>		✓	✓	✓
<i>C</i>	✓		✓	
<i>D</i>		✓	✓	
<i>E</i>	✓			✓
<i>F</i>		✓		✓
<i>G</i>			✓	✓
<i>H</i>			✓	
<i>J</i>				✓

- TS1632 It is an essential requirement that catering solutions shall allow catering areas to be adapted to meet changing services and demand. To meet this requirement the following is required; an incremental and flexible arrangement for the accommodation of cooking equipment, power and water services, environment control, food preparation, refrigerated and ambient storage, and waste handling.
- TS1633 It is an essential requirement that the catering solutions shall be capable of servicing the following minimum capacity of services. Note that the actual installed capacities shall depend on the number of seats served;
- On-board kitchen to be equipped to deliver 100 full cooked breakfasts and a further 70 lighter breakfasts, or 100 luncheons or dinners within a two-hour journey time. (Examples: Mk4 Mallard, Virgin Pendolino.)
  - The regeneration capacity shall be able to deliver a similar number of re-heated lunches or dinners as the on-board kitchen. (Example: Eurostar)
  - Café-Bar capacity shall permit storage, preparation and sale of goods to a scale typical of a two and a half hour journey time. The facility shall be equipped to deliver up to 250 hot and cold snacks and for the replenishment of trolleys when combined together.
  - Trolley capacity shall permit the storage of saleable goods and the ability to vend cold snacks and hot and cold drinks as required. The overall capacity shall allow up to 100 separate sales/transactions to be performed; the service shall be capable of making a single pass through the vehicles/service without the need to replenish its stock
- TS1634 It is an essential requirement that catering facilities will minimise the use of furnishable space, without compromising safety or functionality, and will be compatible with the building block principle for the selection of interior layouts appropriate to each franchise operation.
- TS1635 It is an essential requirement that the construction of the catering facilities should use durable, stain resistant and approved materials that are easily cleaned and maintained to food hygiene standards.
- TS1636 It is an essential requirement that suitable security measures shall be provided to ensure safety of the staff, takings, stock, equipment and prevent unauthorised access into catering areas.
- TS1637 It is an essential requirement that the design of catering trolleys and vehicle interiors shall be co-ordinated to ensure damage to interior components is avoided while using the trolley.

### **6.2.7 Interior Partition Doors**

TS1598 It is an essential requirement that IEP vehicles shall allow the fitting of interior partition doors within the vehicle interior at a range of positions to allow for different interior layouts.

### **6.2.8 Interior Information and Advert System**

TS1934 It is an essential requirement that IEP vehicles shall allow the fitting of an interior information system within the vehicle interior to allow for a range of operator requirements. This system shall allow additional display equipment to be fitted as required for the display of general information such as network maps, information, advertisements.

### **6.2.9 Crew Office**

TS1781 It is an essential requirement that IEP vehicles shall allow the fitting of crew office for carrying out customer liaison tasks if required. This facility shall have access to all functions as specified in TS1563 (section 7.2), together with storage for printed items. Provision shall be made to allow the fitment of such an office to any vehicle as part of the selection of interior elements. The office shall be sized to allow a minimum of one train crew to be accommodated.

## **6.3 Interior Customisable Areas**

TS1536 It is an essential requirement that IEP vehicles shall allow for a menu of customisation measures, for application at franchise change or redeployment. These measures are separate from the main building block interior elements, although the configuration of the latter may influence the scope and nature of customisation.

TS1537 It is an essential requirement that IEP vehicles shall allow the following minimum customisation following franchise or redeployment changes:

- Interior colours (including handrails, for contrast).
- Trim materials.
- Soft furnishings.
- Seat types, quantities and pitch.

TS1538 It is an essential requirement that IEP vehicles shall allow the following minimum additional customisation following redeployment changes:

- Toilet/Passenger Ratio.
- First Class/Standard Class Ratio.
- Luggage Capacity/Ratio.
- Replace a catering area with another of the other catering options.
- Replace a catering area with seating.

TS1539 It is an essential requirement that the above customisation shall be possible without alteration to load bearing structures and shall not dictate the need for bodyshell variations apart from minor areas.

It is not considered that under such IEP train redeployments, which generate the need for such conversions, that the level of catering provision shall increase.

## 6.4 Interior Scenario Definition

TS1038 It is an essential requirement that IEP shall be able to support a range of service requirements.

To assist with defining the required capability of IEP interior scenarios have been assumed that support three IEP service types; Intercity, Interurban and Commuter. These scenarios are defined below in table 2.

The definitions for each scenario purely aim to differentiate between each service type, while ensuring that they do not inhibit innovation in the interior design solutions.

TS1583 It is an essential requirement that the interior scenario definitions (ref TS1038) shall not constrain the ability of the vehicle and interior design to provide a flexible solution that allows different parameters to be used against individual franchise deployments.

Table 2 - Interior Scenarios, Key Parameters per Service Type

Train Type	Definitions	Intercity Service Type		Interurban Service Type		Commuter Service Type	
		First Class	Standard Class	First Class	Standard Class	First Class	Standard Class
Class Seat %	% Range	25 - 30%	75 - 70%	20 - 25%	80 - 75%	12 - 15%	88 - 85%
Bay / Uni. Seat %	Approx % Ratio	90 / 10%	50 / 50%	90 / 10%	35 / 65%	90 / 10%	35 / 65%
Seat Arrangement	Seat lateral grouping	2+1	2+2	2+1	2+2	2+1	2+2
Uni-directional Seat Pitch	Uni-direct. Leg room: Horizontal distance, at knee level, from the passenger contacting surface of the seat back to the rearmost section of the seat in front, at knee position.	≥950mm	≥800mm	≥950mm	≥750mm	≥950mm	≥750mm
Bay Seating Pitch	Bay Leg room: Half the horizontal distance, at knee level, from the passenger contacting surface of the seat back to the corresponding position on the facing seat.	≥750mm	≥750mm	≥750mm	≥700mm	≥750mm	≥700mm
Toilet ratio	Ratio	≥ 1 per 45 passengers	≥ 1 per 55 passengers	≥ 1 per 45 passengers	≥ 1 per 60 passengers	≥ 1 per 45 passengers	≥ 1 per 95 passengers
Toilet distribution	Maximum distance from seat to toilet	22m	22m	22m	22m	22m	22m
Small Luggage Storage	Small luggage storage allowance within defined distance  [Small luggage 420x400x300mm]	1 per 1 passenger within 1.5m	1 per 1 passenger within 1.5m	1 per 1 passenger within 1.5m	1 per 1 passenger within 1.5m	1 per 1 passenger within 1.5m	1 per 1 passenger within 1.5m
Large Luggage Storage	Large luggage storage allowance within defined distance  [Large luggage 800x570x300mm]	1 per 3 passengers within 9.5m	1 per 3 - 4 passengers within 9.5m	1 per 3 passengers within 9.5m	1 per 4 - 5 passengers within 9.5m	1 per 3 passengers within 9.5m	1 per 5 - 6 passengers within 9.5m
Catering	Combination & level defined within TS1630 & TS1631	Catering Combination 'A' * Kitchen/buffet required to separate classes Level 1 - Full restaurant service    Level 3 & 4 - Trolley service & buffet access		Catering Combination 'G' Level 3 & 4 - Trolley service & buffet access    Level 3 & 4 - Trolley service & buffet access		Catering Combination 'J' * Replenishing points required for trolley service Level 4 - Trolley Service    Level 4 - Trolley Service	

## 6.5 Signage

TS1374 It is an essential requirement that IEP vehicle data shall be displayed in accordance with GM/RT2459, 'Data to be displayed on rail vehicles'.

TS1678 It is an essential requirement that safety and emergency signage shall have priority over all other bespoke signs i.e. posters, advertisements, promotions etc. Bespoke signage shall not interfere with, distract from, or contradict safety and emergency signage and shall be secured in a manner that allows its successful removal without specialised techniques, significant effort, or damaging the attachment surface(s).

TS1679 It is an essential requirement that all signage shall be, as far as practicable, resistant to forced removal and deliberate defacing activities.

TS1865 It is an essential requirement that a range of additional signs shall be capable of being applied as agreed with the relevant TOC.

TS1866 It is an essential requirement that signs shall be capable of being removed if required without damaging the substrate, using a method specified by the TSP.



## **6.6 Security & Resistance to Vandalism**

TS1377 It is an essential requirement that IEP vehicles shall be secure, resistant to vandalism and misuse. The following sections 6.6.1, 6.6.2 & 6.6.3 shall be complied with to achieve this essential requirement.

### **6.6.1 Vehicle Security**

TS1640 The vehicle doors shall be capable of being locked out of use to secure against unauthorised entry, suitable tamperproof designs and mechanisms shall be incorporated. Particular attention shall be paid to the catering car security and stock storage areas.

TS1641 The vehicle systems shall be protected from unauthorised access or tampering; suitable tamperproof designs and mechanisms shall be incorporated.

TS1642 As far as practicable all fasteners in passenger areas shall be concealed. Any visible fasteners inside the vehicles shall require special tooling.

TS1643 All equipment cupboards, cubicles or lockers shall be protected with suitable tamperproof locking mechanisms.

### **6.6.2 Vandalism and Misuse**

TS1644 The vehicle interior fittings shall be sufficiently robust to minimise damage from foreseeable vandalism and misuse.

TS1645 The vehicle interior fittings, panels and surfaces shall be sufficiently robust to minimise scuffing or abrasion damage from contact with wheelchairs, passenger luggage or other foreseeable items.

TS1646 Interior finishes shall meet fire safety requirements and additionally, be reasonably resistant to damage caused by cigarettes or other smoking materials.

TS1647 The vehicle interior shall be free from gaps and crevices where litter, sharp objects such as needles or cigarette ends or any other items could be concealed or lodged.

TS1648 Any soft furnishings shall be resistant to damage and be economical and easy to replace when necessary.

TS1649 The interior bodyside windows and glazed surfaces shall incorporate a means to deter vandalism by etching or scratching. This method shall be demonstrated to be effective.

### **6.6.3 Graffiti Removal**

TS1650 Internal and external finishes shall facilitate the removal of graffiti and not readily degrade as a result of the removal process. Where practicable, commonly affected components shall be designed to be economical and easy to replace when deemed necessary.

## **6.7 Cleanability**

TS1388 It is an essential requirement that IEP vehicles shall facilitate ease of cleaning. The following sections 6.7.1 & 6.7.2 shall be complied with to meet this essential requirement.



### 6.7.1 Interior Cleaning

- TS1652 The interior design and styling shall enable effective and efficient cleaning using normal railway and industrial cleaning methods and equipment. In particular flooring areas, shall avoid crevices, abrupt changes of section and intrusive internal features to avoid the accumulation of dirt and debris and to aid the cleaning process.
- TS1653 Panelling and other surfaces shall be durable, smooth, stain resistant and easy to wipe clean after normal soiling.
- TS1654 Panelling, floor covering (entrance mats & carpets) and seating items (cushions, covers and squabs) shall be capable of been easily replaced when heavily soiled or deemed necessary.
- TS1655 Ventilation and extraction ducts/grills, and other such features, shall be accessible and readily cleaned using standard cleaning equipment.
- TS1656 The interior finishes shall be capable of withstanding the effect of detergents and abrasive materials used in the cleaning process and shall not degrade as a result of the persistent use of such cleaning method. This shall include no loss or change in texture or colour of the interior finishes.
- TS1868 All areas of the vehicle shall be capable of being cleaned.

### 6.7.2 Exterior Cleaning

- TS1657 The vehicle overall exterior length, width and body styling shall allow effective automatic cleaning or washing.
- TS1658 The vehicle exterior shall as far as practicable not contain crevices or abrupt changes of section, to avoid the accumulation of dirt.
- TS1659 The vehicle exterior finish shall be capable of withstanding the affects of any detergents used in the cleaning process by both manual or automated application and the mechanical effects of the washing method. Particular attention shall be paid to vehicle roof design, which may be automatically cleaned thus requiring roof fittings to be suitably robust.

## 7 Crew Environment

### 7.1 Cab

- TS1405 It is an essential requirement that the driver's cab shall incorporate the following functionality over and above the mandatory TSI requirements;
- The second persons seat inside the cab shall be positioned so that it is possible for a second person to adequately monitor the drivers performance in particularly allowing adequate sighting of signals/signage and vital cab desk instruments (speedo, power/brake controller). Details on the monitoring of driver performance are contained within GO/RT3251.
  - It shall be possible for the second person to be able to operate an emergency brake control while seated.

## 7.2 Crew Areas

- TS1562 It is an essential requirement that IEP trains shall accommodate the operational equipment and personal effects for the train crew appropriate to the service.
- TS1563 It is an essential requirement that interfaces with PA/PIS, CCTV, seat reservations, the TMS and mobile comms. shall all be available together at a designated area secure from passengers.

## 7.3 Driver Egress

- TS1996 To facilitate driver egress it is an essential requirement that the IEP train design takes cognisance of walkways provided for existing Network Rail line side equipment such as signal post telephones and plungers that require driver interaction. Details can be found in GC/RT5203 “Infrastructure Requirements for Personal Safety in Respect of Clearances and Access” for further details. It is expected that a whole life whole system cost approach shall be taken when arriving at a solution, considering changes to the infrastructure as a possibility.

## 7.4 Emergency Equipment

- TS335 It is an essential requirement that IEP vehicles carry all necessary emergency equipment required for the service route and operation. The exact scope of this equipment shall be established in conjunction with the relevant Train Operating Company (TOC).
- TS1685 It is expected that this scope shall include all ‘mandatory’ and ‘optional’ emergency equipment, in accordance with Railway Group Standard GM/RT2177, ‘Emergency and safety equipment and signs on rail vehicles’, 1995. In addition the following items have been identified as potentially being required;
- Refreshments - Water, tea, coffee and energy bars, snacks. Quantities based upon 65% of passenger capacity against interior scenario definitions.
  - Foil blankets and Hand warmers - quantities equal to 65% of passenger capacity against interior scenario definitions (may be seasonal if required i.e. October through to March)
  - Emergency Clothing - High visibility clothing, leather gloves and safety glasses; five of each item; pairs where applicable.
  - Independent light sources - Torches/hand lamps and ‘light sticks’. Five torches/hand lamps and a minimum of two light sticks per vehicle.
  - Mobile Door barriers - Ability to open doors and maintain passenger safety e.g. vehicle and HVAC failure in hot weather. Ability to cordon-off eight external doors.
  - Emergency ladder - Mandated but shall have the ability to store two or more.
  - Bio hazard kit - To assist emergency service in fatalities. Ability to store 8 kits
  - Enhanced first aid kits - Ability to store larger more comprehensive kits, e.g. Defibrillators.
  - Enhanced first aid kits - Ability to store larger more comprehensive kits, e.g. defibrillators. Required storage space of 400x400x250mm; available at two locations.

- Emergency forms and lists - For issuing information and traceability of passengers and crew. Required storage space of 400x350x150mm; at a single location.
- TS1873 It is an essential requirement that all necessary coupler adaptors, hoses and associated equipment are fitted within the IEP driving vehicles. Necessary coupler adaptors, hose and associated equipment are defined as those required for diversionary operation or rescue purposes across the designated routes.
- TS1686 It is an essential requirement that IEP vehicles shall incorporate the secure storage of all emergency equipment. The following be considered in the design of emergency equipment stowage;
- where applicable, emergency equipment and supplies shall be located in a common stowage facility that affords sufficient capacity to store the items securely and safely.
  - the main storage facilities shall be accessed by the train crew only and incorporate a tamper/proof marking system to ensure their contents can not disturbed without this being apparent to train crew.
  - the main storage facilities shall be in close proximity to the cabs. Emergency equipment deemed accessible and useable by passengers will be appropriately situated throughout the train.

## **Annex A – ITT Submission Requirements**

The following detailed information shall be provided as part of the Concept Train Design to be provided in response to the ITT, Section 7.1.3.

### ***Train Operation, Types and Flexibility***

The bidder shall submit details of the vehicle and train architecture proposed to meet the train type, formation and flexibility requirements.

The bidder shall submit details including a method statement and timings for altering the length of a train. The base details that should be provided are:

- the addition of each different single intermediate vehicle to any IEP train.
- the change of a each different Driving car for an alternative in any IEP train.

The bidder shall submit details of how the vehicle and train architecture shall be able to adapt to possible changes to self-power energy source, or changes where lines are electrified and self-power trains need conversion to electric trains.

Particular details shall be provided of how the self-power source vehicles shall be modified to allow continued use.

### ***Multiple working***

The bidder shall provide details of how the coupling and uncoupling timing requirement shall be met together with a break down of the times into logical steps.

Particular details shall be provided of how the reconfiguration of all train borne systems shall be included within the time requirements.

### ***Train Formation and Length***

The bidder shall provide details of the full range of train formation lengths.

### ***Driver Only Operation***

The bidder shall provide details shall be provided on the method for ensuring that trains can operate under Driver Only Operation and train dispatch methods as identified within the TIS.

### ***Performance***

The bidder shall provide full simulations for the routes defined in the ITT to achieve journey times and energy consumption calculations, the following assumptions shall be detailed as used specifically within the simulation.

Train Composition - Details of each vehicle, including the seat numbers and whether they are trailer or motor cars.

- Tractive Effort Curve - This should include details of a power law or polynomial representation, and any defined speeds when the characteristics change.

- Train Mass - The tare weight and passenger loading for each vehicle, including the number of seated and standing passengers. (The static mass is used for this.)
- Braking Curve - This should include details of a power law or polynomial representation, and any defined speeds when the characteristics change. The braking rates of the train at different speeds as a percentage of g should also be provided.
- Power (kN)
  - Installed Power
  - Auxiliary Power
  - Losses and Efficiency
- Train Resistance - Details of the train resistance curves for plain track and tunnels should be specified and any other specific curves. This is normally a polynomial representation.
- Curve Resistance - This is optional and is normally only used for light rail systems or tramways, where there are significant curves.
- Driving Technique – The driving technique used in the simulation shall take full advantage of the line speed of the route simulated with the example by providing full acceleration, maintaining line speed however providing a 6% g brake.
- Adhesion – The adhesion used shall be detailed and justified as acceptable under typical conditions.
- Ambient Temperature – 15 degrees centigrade.
- Relative Humidity – 85%
- Fuel Type – Define fuel type and range, and effects on train performance

The Bidder shall advise the available performance (ref. TS1998) of half length self-power or bi-mode IEP trains hauling a half length electric IEP train, over a reference route from Doncaster to Hull.

The bidder shall provide a full technical justification to support the adhesion assumptions used in their train performance modelling, taking due regard of the range of railhead conditions likely to be encountered in the UK.

The bidder shall provide details of how the train performance for the range of configurations and power types shall be optimised. Details of assumptions used and the logic behind how the train performance has been optimised shall be provided.

### ***Efficiency & Environment***

In order to demonstrate and measure energy consumption and to validate any calculated reductions, It shall be a requirement that the energy consumption of the IEP auxiliary systems is quantified in several predetermined scenarios.

Bidders are required to submit energy consumption calculations for the auxiliary systems based upon

the below scenario combinations i.e. for each vehicle type, using the ‘Summer’ climatic condition and in each passenger loading case (6 individual calculations/scenarios). These reference calculations shall assume normal running conditions. The calculated values shall be expressed in kWh; litres of fuel used per minute will also be required for the self powered IEP.

<b>IEP Vehicle Type</b>	<b>Climatic Condition ‘Summer’</b>
Self Power Set, 260m nominal length Seating capacity : Interior Layout for Interurban Service Type	Temperature: 27° C Relative Humidity: 85% Solar Gain: 600W/m <sup>2</sup>
Bi-mode Set, 130m nominal length Seating capacity : Interior Layout for Commuter Service Type	
Electric Power Set, 260m nominal length Seating capacity : Interior Layout for Intercity Service Type	
<b>Assumed Passenger Loadings - To be applied individually</b>	
100% Seats occupied, 10% Seats occupied & No passengers	

**Table 1. Energy Consumption Scenarios**

For the purposes of accounting for passenger loadings, calculations should assume the ‘heat emitted by a seated person’ as detailed in, Annex D of BS EN13129-1:2002, ‘Air Conditioning for Main Line Rolling Stock’, using the ‘total heat’ data. It shall be assumed that the internal ambient temperature of the vehicles is required to be 22 ° C during normal running.

Bidders are required to identify auxiliary systems for energy consumption reduction; this shall be based upon a progressive scale approach, i.e. energy reduction/consumption as a function of time at rest. The following time periods are proposed:

<b>Service Condition</b>	<b>Time Periods (Time at Rest)</b>			
	<b>0 to 15 minutes</b>	<b>15 minutes to 1 Hour</b>	<b>1 Hour to 4 hours</b>	<b>4 Hours to 8 Hours</b>
<i>In Service 100% Seats Occupied</i>	S/P	S/P	N/A	N/A
<i>In Service 10% Seats Occupied</i>	S/P	S/P	N/A	N/A
<i>In Service No Passengers</i>	S/P	S/P	N/A	N/A
<i>Not in Service</i>	S/P	S/P	S/P	S/P

**Table 2. Energy Submission Matrix –Time Periods/Time at Rest vs. Service Condition**  
(Note S/P refers to Submit Proposals for Energy Consumption Reductions)

Bidders shall indicate the energy consumption of the auxiliary systems under each of the above service conditions, these shall be presented and cross-matched against each of the time periods; a progressive approach to energy reduction is expected. The values shall be expressed in kWh; litres of fuel used per minute will also be required for the self powered IEP.

Bidders shall detail:

- Which auxiliary systems have been considered, targeted and why.
- How the energy reduction functionality will be implemented within the chosen systems and activated with respect to the time period(s)/time at rest.
- How the normal running/system conditions will be re-activated when required.
- The time for each system to re-achieve normal running/passenger conditions within each service condition and time period classification.

Particular attention should be paid towards limiting engine idling, reducing the number of running engines and complete engine shut-down, where possible, on the self-powered IEP.

Bidders shall also demonstrate that the following has been considered and/or achieved:

- Establish the balance between a progressively degrading system performance, allowing energy reduction, whilst ensuring acceptable train readiness times and preventing departure delays.
- Deliver the maximum possible energy reductions without compromising the performance of the train with respect to normal running, passenger comfort levels and safety issues.
- Ensure that the vehicles are safe throughout all of the stages of system degradation whilst considering the needs of passengers, train crew, cleaning and maintenance teams alike.
- Deliver the maximum possible energy reductions without introducing unnecessary complexity, increase in mass or structural changes.
- Ensure that the costs of introduction and maintenance do not outweigh the reduced energy consumption savings throughout the life of the assets.
- Energy reductions through load shedding, use of shore or overhead electrification supplies, the use of energy storage technology, etc.
- Deliver 'visible' energy reductions e.g. reducing lighting levels when possible, thereby promoting the IEP vehicles as proactive in their approach to energy saving/reduction.

Bidders should also consider normal running conditions and indicate whether any of the reduced auxiliary system functionality may be invoked during normal running conditions to realise further energy reductions/efficiencies.

Bidders shall identify the method of operation of the driver advice system and how the driver interfaces shall be managed.

Bidders shall submit details on how their strategy shall meet the emission requirements. Particular attention is drawn to the current NRMM requirements for class IIIb emissions and the requirement that pre-series IEP trains shall have the same self power unit that is fitted to series build trains.

The bidder shall provide details on how they intend to maintain compliance with the emission requirements of IEP vehicles throughout the asset life.

### ***Operating Environment***

The bidder shall submit details on how the IEP vehicle shall meet the climatic condition requirements including provision for UKCIP02 'high emissions' scenario, in addition they shall also submit details

on how they intend to demonstrate compliance with these requirements.

### ***Station Interface & Dwell Time***

The bidders shall submit details of the expected stepping distances between IEP vehicles and the full range of station platforms on the designated routes. Details of any particular systems proposed to minimise these stepping distance requirements shall be included in this submission.

Bidders shall provide details on how the PRM TSI requirements for stepping distance shall be achieved.

The bidder shall submit dwell time simulations and identify within the simulations the times associated with each logical step of a station stop, for each interior configuration for against the train service types (Intercity, Interurban & Commuter) and each train type as defined in the TTS. As a minimum the train logical steps shall be:

- Train stops
- Doors Enabled
- Steps Deploy (if fitted)
- Doors Open
- Passengers disembark (refer to train specification for passenger numbers)
- Passengers embark (refer to train specification for passenger numbers)
- Doors Close (Driver Only and Driver Guard Operation)
- Steps Retract (if fitted)
- Trains Starts

### ***Fire Safety & Evacuation***

The bidder shall submit a fire strategy to demonstrate the proposed method of complying with the fire safety requirements.

### ***Human Factors & Ergonomics***

The bidder shall submit a Human Factors Integration Plan (HFIP) to identify, plan and manage the required human factors activities within the IEP.

The HFIP should describe the ergonomic principles to be applied in the design of the IEP and these should include, but not be limited to the following: anthropometry, reach envelopes, visual requirements, grouping of controls and displays and use of colour.

The contents of the plan should include, but not be limited to the following information:

- Scope of the project
- Strategy for integrating HF, cross-disciplinary working, communication within the project and with contractor
- Position of the HFIP within the overall project plan
- How uncertainties and disagreements will be resolved
- Human factors-related risks, assumptions, decisions, dependencies and constraints, issues and risks and their control and allocation with the project
- Human factors roles and responsibilities, and how these will be managed



- Test and evaluation criteria in uses and for user trials
- Applicable legislation and standards
- Integration priorities
- Co-ordination with other disciplines within the project team
- Project phases with reference made to project schedule of timetables
- Hold points where reviews and checks take place
- Extent of human factors studies that will be required and analysis methods
- Ownership of particular aspects of the work
- Treatment of results of human factors assessment
- Reporting methods
- Progress monitoring activities.

The HFIP shall pay particular attention to how systems that perform the same function over different routes take account of the route variation. The HFIP shall demonstrate how train dispatch issues are addressed by the train design, taking account of the dispatch requirements set-out in the TIIS. If the train design requires the driver is required to review CCTV images, the findings of RSSB research project T535 ‘Assessing the impact of increased numbers of CCTV images on driver only operation of trains’ shall be taken into account when carrying out the study.

### ***Noise & Vibration***

The bidder shall submit details of the proposed method of achieving compliance with the internal noise requirements. This should include but not be limited to;

- Reduction of noise sources
- Reduction of noise transmission
- Compartmentation within Saloon/Vestibule interior (Internal door arrangements)
- Reduction of HVAC air flow noise
- Reduction of air movement fan noise

The bidder shall provide details of how the external noise requirements shall be achieved, including details of development analysis and verification testing proposed.

### ***Aerodynamics & Pressure Effects***

The bidder shall submit details of how the design of the vehicle mitigates internal pressure effects, including details of proposed verification analysis and testing.

The bidders shall declare what rate of change of internal pressure IEP trains will be designed to, so that passengers and train crew will not experience discomfort. They shall describe what design figures they believe to be appropriate and why with quantified justification, they shall also explain how this will be achieved in terms of design, build and over the asset life. Bidders shall confirm how compliance can be demonstrated in measurable way and state how as a minimum the following operational conditions are considered.

Operation in Single Bore/Track tunnels

Operation in Twin Track Tunnels (with and without other trains passing in the tunnel at the same time)

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The bidder shall submit details of how it is intended to meet the requirements of GM/RT2142.

### ***Modes of Operation***

The bidder shall provide details of how the 'modes of operation' requirements shall be met. Particular details shall be provided on how the bidder intends to meet the requirements for 'Diversionary hauled mode' and the various failure and rescue modes detailed within the TTS.

Operational assumptions for each train mode shall be provided.

### ***Wheel-Rail Interface***

The bidder shall provide T-gamma predictions of their proposed solutions, taken from the leading wheel on the high rail of the curve. The T-gamma values should be presented as the average over at least 250m of continuous running over each curve radius for each of the cant deficiency conditions. Separate results should be supplied for the motor and trailer bogies with heaviest axle loads. The calculations shall use the following modelling assumptions:

- Wheel-rail friction coefficient of 0.45
- New (design) wheel profiles
- CEN60E1 (design) rail profiles.

### ***VTISM calculations***

The requirements for VTISM modelling are contained within the ITT.

### ***Kinematic Envelope***

The bidder shall demonstrate how the derivation of the KE for the proposed vehicles (including all physical features such as underframe equipment, footsteps, bogies, door light indicators, buttons, plates, and stowed pantograph) and all movements (except curve overthrow) and behaviours (including operation in all degraded conditions) can be accommodated completely within it.

### ***Repairability***

For each repair scenario defined in the technical specification the bidder shall advise how the likely effects shall be mitigated.

This mitigation shall consider the likely effects on the vehicle structure and systems and the implications for downtime before the vehicle and/or train can be returned to service. In particular the implications of measures taken to comply with crashworthiness requirements shall be considered with respect to reparability as these are designed deformation features.

As a minimum the bidder shall detail the proposed repair method against each scenario, including expected repair times and predicted availability of the vehicle to return to service.

The bidder shall detail its proposal for providing strategic crash spares defined within the ITT.

### ***Bodyshell & Structure***

The bidder shall propose levels of finish to be achieved, and the method of meeting the bodyside flatness requirement.

### ***Windows***

The bidder shall detail the methodology employed to fix bodyside windows and typical change times

given including any curing times as appropriate. The window change methodology shall consider replacement of damaged windows.

The bidder shall demonstrate how window viewing optimisation is achieved against the range of interior layouts required for the train service types (intercity, interurban & commuter)

### **Gangways**

The bidder shall submit details of their proposed gangway arrangement, including gangway performance on all curves. This shall identify the gangway throughway on a range of track geometry.

### **Brakes**

The bidder shall provide details of how the brake and traction system shall minimise wheel tread damage and extension in stopping distance under low rail adhesion conditions. Details of the following should be provided;

- The level of integration to achieve the control of wheel slide under conditions of both friction-only braking and combined friction and dynamic braking.
- The proposed system integration exercises at the design stage to fully identify the interactions and interdependencies of the friction brake control and the dynamic brake control, and this shall be used to develop the control strategy and ultimately confirm an optimised system control.
- Simulation test rig testing proposed.
- Track type testing proposal.

The bidder shall provide details on how the overall braking capability of the train has been optimised. Particular details shall be provided of the dynamic braking capability proposed, how this has been optimised to provide maximised capability while considering any weight disbenefits.

The bidder shall provide details of the adhesion modifier system, details of the following shall be given;

- Level of integration with the traction & braking system.
- Control logic
- Storage capacity for the required operation giving due regard of the expected level of sanding encountered in service.
- Method of filling reservoirs.

### **Motive Power**

The bidder shall provide details of how the self-power and bi-mode trains shall meet the emissions requirements, particularly the strategy to meet stage IIIb requirements.

The bidder shall provide details of the fuel assumed to be used on the self power IEP train.

The bidder shall provide details of the affect on train performance when using alternative fuel types.

### **Doors**

Bidders shall submit details of their internal door proposals, including the level of provision for fitting

interior doors as an interior building block element at differing positions within the saloon. Door cycling times and actuation methods shall be detailed.

### ***Heating Ventilation & Air Conditioning***

The bidder shall submit the following information relating to the cab and saloon HVAC systems;

- detail and define the expected consequences of any situation, environmental or other, where a degraded HVAC performance may be expected.
- all HVAC System performance specifics, such as pre-cooling rates, pre-heating rates and interior regulation curves.
- details on how the HVAC requirements shall be met throughout the entire service life of the vehicles. Particular attention shall be paid to maintainability, reliability, obsolescence, etc.
- details of methods to reduce energy consumption caused by HVAC operation
- details of how the HVAC system shall accommodate the range of interior layouts while meeting the comfort performance requirements. Particular details of how it shall accommodate possible changes to interior layout during the asset life, such as fit/removal of toilet or catering facilities.

### ***Passenger Information & Communications***

The following information shall be provided by the bidder as part of their submission;

- Bidders should indicate what capacity the systems would require taking due cognisance of the anticipated deployment and flexibility requirements.
- Identify how a TOC is able to add, remove or modify real time messages.
- Identify how the data format employed is to be agreed and allow upload by the operator.
- The level of display equipment that has been provided for.
- The level of integration and communication between all passenger information and communication systems (PIS, PA & Seat Reservation)
- Detail how the seat reservation system shall adapt to the range of interior layouts, and interior changes throughout the asset life

### ***Radio & Data Transmission***

The bidder shall provide details of the proposed fitment of radio systems to IEP trains. Attention is drawn to the following;

- the UK's installation programme for GSM-R (refer to TIIS) and the withdrawal of existing radio systems, if required by the delivery/test programme,
- responsibility for the necessary arrangements in providing equipment to ensure that the trains can operate prior to the availability of GSM-R on Network Rail Infrastructure.
- additional equipment (installed on the test/pre-series trains) that may be necessary to allow operation in this period shall not affect the cab ergonomics/aesthetics when compared to a series train.

### ***Saloon Closed Circuit Television***

The bidder shall provide details of how the Saloon CCTV requirements shall be met for the full range of interior layouts required against the train service types. Particular attention shall be given to how all areas of the vehicle interior shall be covered by the CCTV system.

### ***Livery***

The bidder shall propose a solution to meet the range of external livery and marketing requirements. The details provided should indicate whether extensive use of vinyl on top of a base coat is proposed, or alternative methods. As a minimum this should include provision for the following range of variation;

- Base finish - 1 to 2 colours
- Detail finish - between 1 and 6 different colours/finishes
- Type train/logo finish - between 1 and 4 features

### ***Interior Element Requirements***

The bidder shall provide details of the proposed solution for each Interior Element as defined within the TTS. These details shall identify the flexibility of application of each element within an interior design, along with any constraints associated with their application or removal.

The following additional specific areas shall be addressed and details provided

- To provide IEP with tangible improvement in appointment bidders should make proposals which recognise the ergonomic requirements of tasks typically undertaken during journeys, and which give better use of interior vehicle volume for the stowage of effects.
- The bidders shall provide details concerning the operation of the toilet module, including sizing issues relating to delivery and waste capacities.

### ***Emergency Equipment***

The bidder shall submit their proposals for the emergency equipment to be fitted to IEP vehicles and the intended storage positions and designs for evaluation.