HI TRANS

THE HIGHLANDS AND ISLANDS TRANSPORT PARTNERSHIP

Turbo Boost

Class 170 Refurbishment Scoping Project - Design Aspirations

ITLR/T29576/002/Rev3

Date: March 2013

Interfleet Technology

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Refurbishment Scoping Project
- Design Aspirations

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Turbo Boost - Scoping Class 170 Refurbishment

Introduction

Interfleet Technology's Industrial Design team has been commissioned to support the Highlands and Islands Transport Partnership (HITRANS) with the 'Turbo Boost' Class 170 refurbishment scoping project.

HITRANS are in a position to influence the scope of the Class 170 mid-life refurbishment programme which is planned to coincide with the release of the 170's from their current Edinburgh to Glasgow services following electrification post 2016 and the completion of the Highland Main Line Hourly service project.

The shortcomings of the existing ScotRail Class 170 fleet are well documented with regards to insufficient levels of passenger comfort, service provision and facilities for business travellers.

Project Objectives

The aim of this project is to explore the level of interior transformation possible within the known technical constraints of the Class 170 fleet and to establish a vision for the future main line services in the Highlands of Scotland.

A number of parameters were reviewed to establish the potential for improving the travelling experience on the Class 170 fleet and to identify a new range of facilities to serve the Highland and Island communities.

Passenger Service Enhancements	
• Wifi and Communication System Improvements	• Improved Cycle Storage
• On-board Catering Provision	• TSI-PRM Compliance to ensure post 2019 operation
• Business /Premium Leisure Class Provision	• Toilet Enhancements
• Seating/ Facilities Layout Optimisation	• Heating/Aircon System Improvements
• Increased Luggage Capacity	• Floor Coverings
• Lighting System Enhancements	• Internal Doors
• Fitment of Power Sockets	• Sound Proofing

Following the initial kick off meeting in Inverness, it became clear that the vehicles require significant flexibility improvements to facilitate the diverse requirements of the local Highlands communities, tourist industry and business users.

As such the key objective for this document is to act as a catalyst for further discussion and to obtain buy-in to improve the service provision of the Class 170 fleet to fully meet the needs of this unique and challenging environment.


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Existing Class 170 Services

ScotRail's Class 170 Express Pool forms the mainstay of the 170 fleet, the units are heavily utilised on the services between Edinburgh, Glasgow, Aberdeen, Inverness, Perth and Dundee.

The Class 170 fleet have a number of shortcomings with regards to passenger comfort, service provision, flexibility and facilities for business travellers.

The traditional 1/3 and 2/3 door configuration is suited to commuter and inter-urban services, which depend on efficient passenger access and egress, however, for longer journeys in the Highlands the wide open vestibules provide little protection for passengers against the elements. In winter, this is particularly noticeable as the heat build up in the saloon is rapidly lost through the vestibule doors, especially when high winds gust through the vehicles.

The overall comfort and facilities provision on the Class 170's is also insufficient for Highland services, with many journeys in excess of three hours. Basic seat pitch size and comfort of the seat cushions is pushed beyond the ideal parameters for long distance journeys. Trolley based catering services and limited toilet facilities also result in a less than ideal level of passenger facilities on board the Class 170's, when combined with the low level noise from the underslung engines and inherent interior vibration the Turbostar fleet offers a relatively poor level of passenger comfort and refinement.

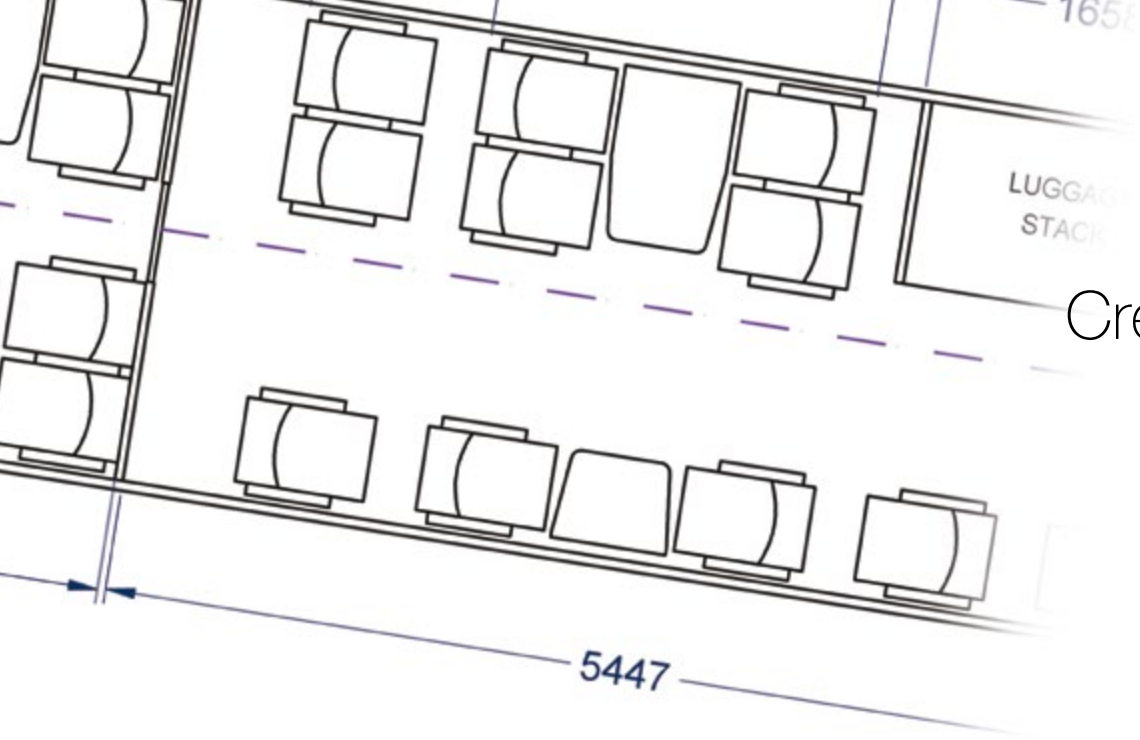
Transport Scotland's Brand Application

The Class 170 'Turbostar' fleet of 33 trains is currently undergoing a series of interior and exterior refreshments at RailCare Limited's depot in Springburn, Glasgow. The project, aimed at enhancing passenger comfort, is taking place during routine maintenance cycles and includes new interior materials as well as the application to the 'ScotRail, Scotland's Railway' unified livery.

The interior refresh includes:

- Fitment of new First Class compartments to previously only Standard Class trains
- New saloon carpets and toilet flooring
- Re-coated grab poles, table stands and coat hooks
- New seat moquette and anti-mocassars in First Class
- Heavy clean and polish of interior panels and glazing

ScotRail
Scotland's Railway



Space Utilisation

Creating a Flexible Interior Configuration

The train must be convenient and usable for all passengers: people with physical impairments, parents with prams or buggies, age range and people with varying levels of travelling experience.

The Highlands and Islands of Scotland attract large numbers of tourists, with a wide range of tourist attractions, from Whisky distillery tours, to walking/ hiking, mountain biking and skiing. Passengers will bring on board a large amount of luggage and equipment that needs to be safely stored.

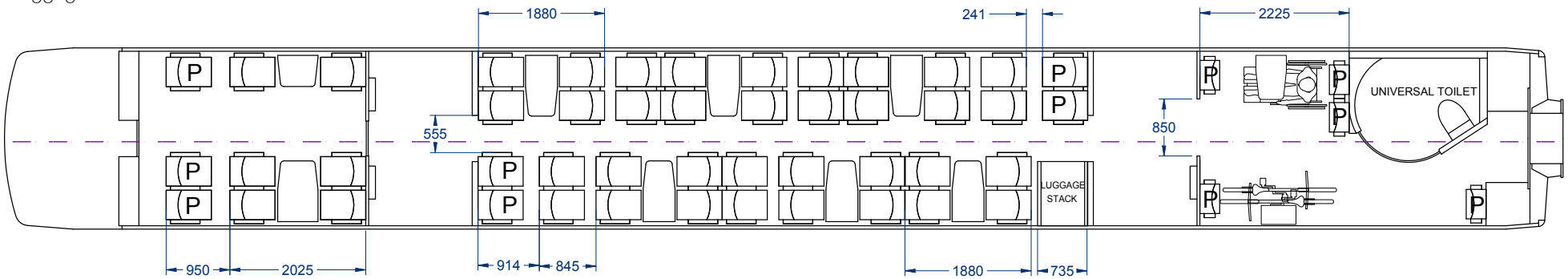
Creating interior flexibility and maximising space utilisation throughout the week/weekend and through the seasons will be key for the Class 170 fleet to provide an attractive and viable alternative to the motor car.

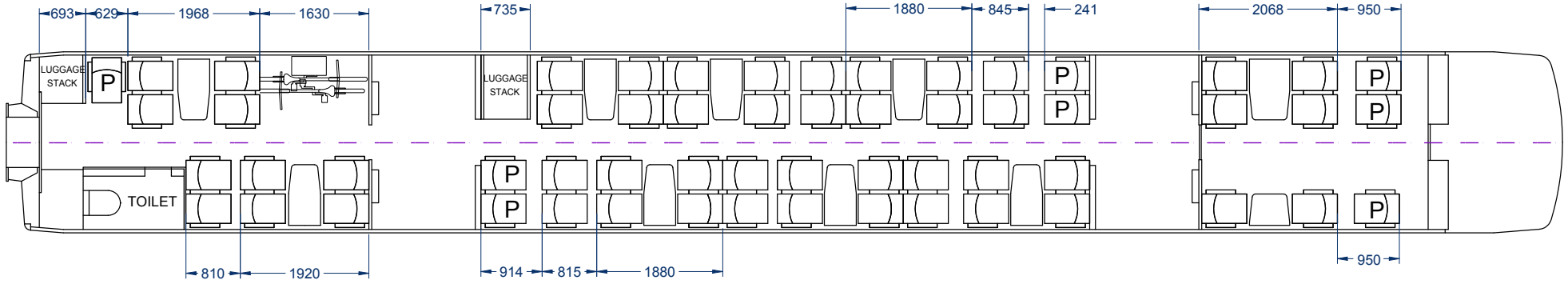
The following section explores a range of interior layout options aimed at providing a more suitable balance of on-board facilities.

Existing Class 170 3 Car Layout

DMSL (A) Vehicle Summary - Total 52 Seats

43 Standard Class Seats (including 9 Priority), 9 First Class Seats (including 3 Priority), 3 Tip-up Seats, Universal Toilet, 1 Wheelchair Position, Bike Storage Area (2 Bikes) &1 Luggage Stack



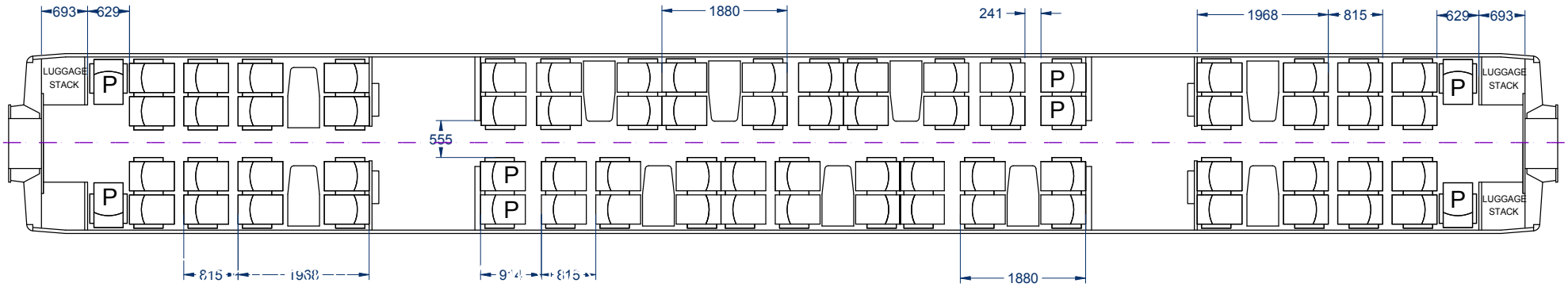


DMSL (B) Vehicle Summary - Total 58 Seats

49 Standard Class Seats (including 5 Priority), 9 First Class Seats (including 3 Priority), 4 Tip-up Seats, Standard Toilet, Bike Storage Area (2 Bikes) & 2 Luggage Stacks

MS Vehicle Summary - Total 76 Seats

76 Standard Class Seats (including 8 Priority), 4 Tip-up Seats & 3 Luggage Stacks



Existing Class 170 3 Car Layout

Total Seating = 186 (Including 28 Priority Seats (15.05%)

Comprising of:

168 Standard Class Seats, 18 First Class Seats &

11 Tip-up Seats

Notes:

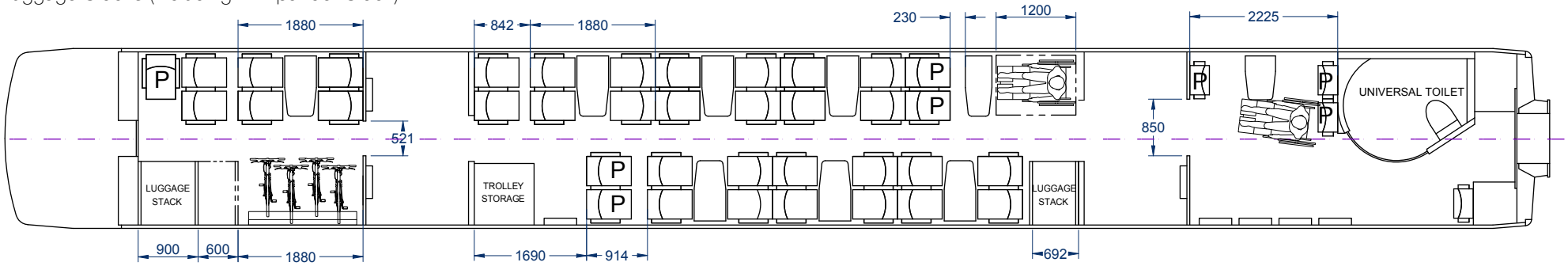
As it stands, the current Class 170 layout is noncompliant with RVAR. For a 3 car set, there should be 2 dedicated wheelchair positions.

To rectify this, the current bike storage rack (calyx unit) adjacent to the universal access toilet would need to be permanently converted to a wheelchair position with table accessory rather than the bike loop.

3 Car Layout Proposal A

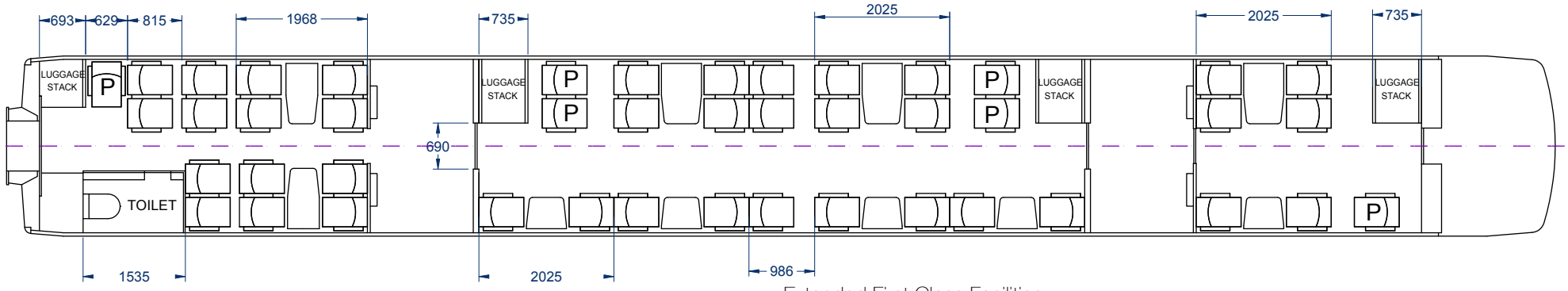
DMSL (A) Vehicle Summary - Total 41 Seats

41 Standard Class Seats (including 8 Priority), 8 Tip-up Seats, Universal Toilet, 2 Wheelchair Positions, Catering Trolley Storage/Micro Galley, Bike Storage Area (4 Bikes) & 2 Luggage Stacks (including 1 Expander Stack)



Flexible leisure zone

Catering trolley storage/ Micro galley



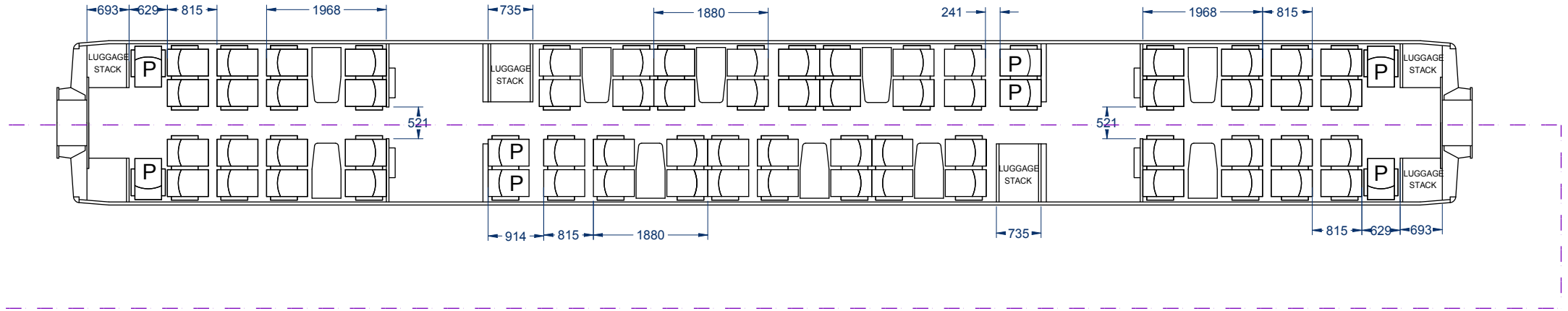
Extended First Class Facilities

DMSL (B) Vehicle Summary - Total 45 Seats

15 Standard Class Seats (including 1 Priority), 30 First Class Seats (including 5 Priority) , 4 Tip-up Seats, Standard Toilet & 4 Luggage Stacks

MS Vehicle Summary - Total 72 Seats

72 x Standard Class Seats (including 8 Priority), 4 Tip-up Seats & 5 Luggage Stacks



3 Car Layout Proposal A

Total Seating = 158 (Including 22 Priority Seats (13.92%)
Comprising of:
128 Standard Class Seats, 30 First Class Seats &
16 Tip-up Seats

Notes:

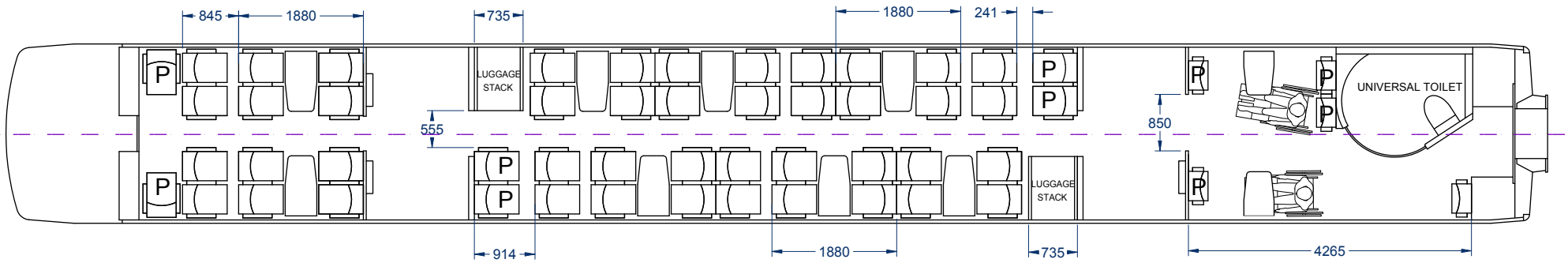
Layout proposal A focuses on creating a large dedicated First Class area on the DMSL (B) vehicle. The saloon area is shielded form the elements with internal doors, enabling a quiet and refined interior environment to be created.

Behind the cab on the DMSL (A) vehicle, the old First Class area has been converted into a flexible leisure zone aimed at providing a comfortable and reassuring environment for bikers/skiers that is secure and allows visibility of equipment etc.

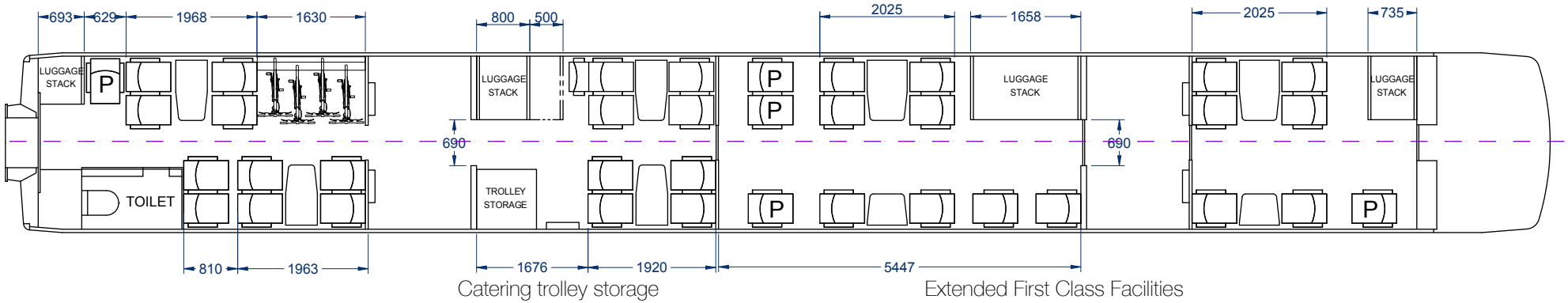
A catering trolley storage point/micro galley also provides a focal point and useful store for a greater range and quality of on board catering provision.

DMSL (A) Vehicle Summary - Total 55 Seats

55 Standard Class Seats (including 10 Priority), 3 Tip-up Seats, Universal Toilet, 2 x Wheelchair Positions & 2 Luggage Stacks



Vertical bike storage



Catering trolley storage

Extended First Class Facilities

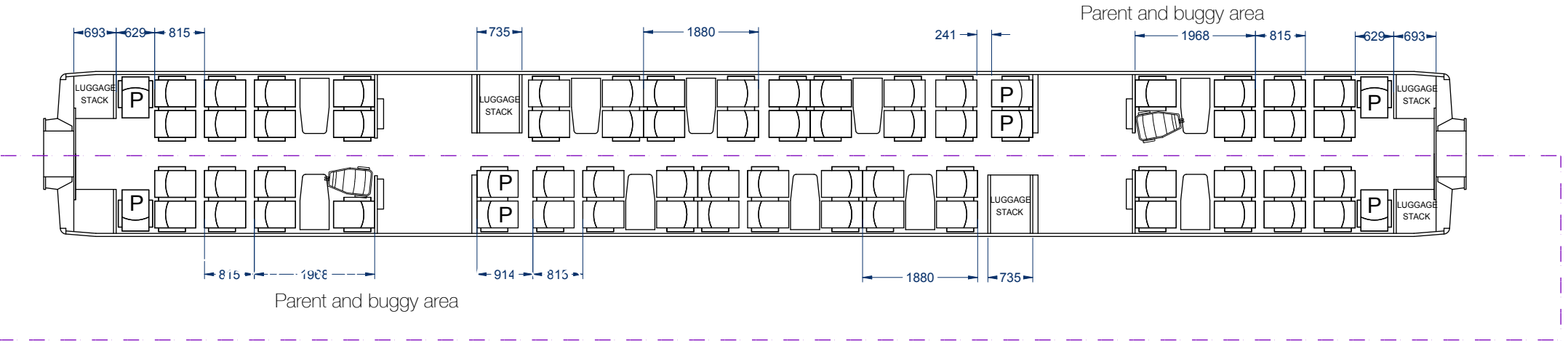
DMSL (B) Vehicle Summary - Total 38 Seats

20 Standard Class Seats (including 1 Priority), 18 First Class Seats (including 5 Priority) , 5 Tip-up Seats, Standard Toilet, Bike Storage Area (4 Bikes), Catering Trolley Store/Micro Galley & 4 Luggage Stacks (including 1 Expander Stack)

3 Car Layout Proposal B

MS Vehicle Summary - Total 70 Seats

70 Standard Class Seats (including 8 Priority), 4 Tip-up Seats, 5 Luggage Stacks & 2 Parent and Buggy Areas



3 Car Layout Proposal B

Total Seating = 163 (Including 23 Priority Seats (14.11%)

Comprising of:

145 Standard Class Seats, 18 First Class Seats &

11 Tip-up Seats

Notes:

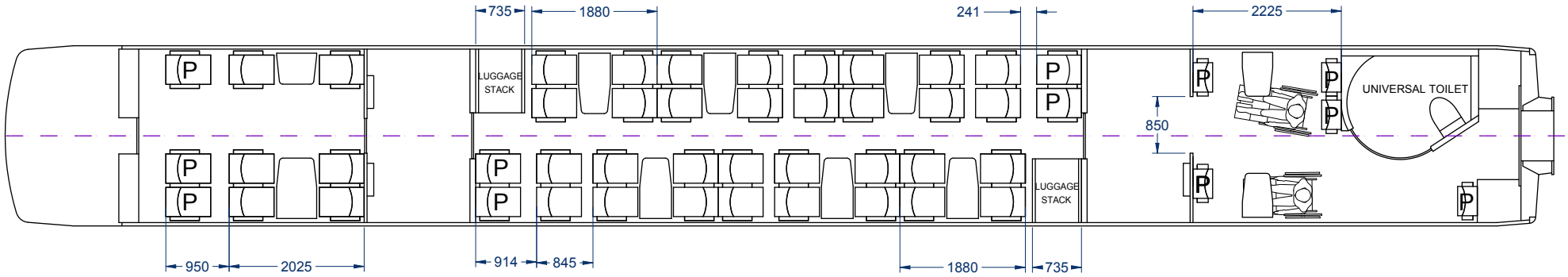
Layout proposal B consolidates both First Class areas into the DMSL (B) vehicle. The First Class saloon area is shielded form the elements with internal doors, enabling a quiet and relaxed interior environment to be created. The remainder of the DMSL (B) has been utilised for multi- function areas for luggage/bikes and catering trolley storage/service area.

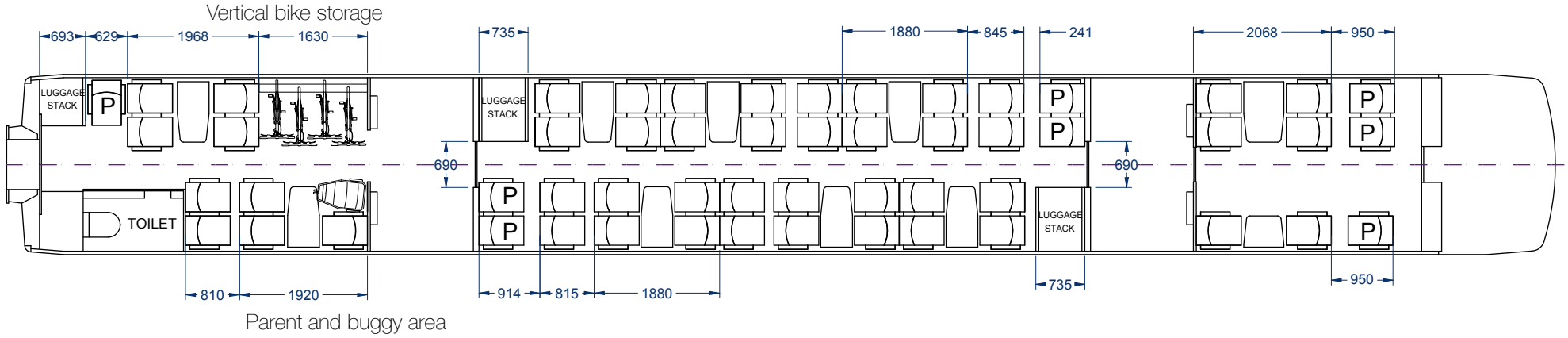
Both the DMSL (A) and MS vehicles focus on seated capacity to ensure a high vehicle capacity is retained.

3 Car Layout Proposal C

DMSL (A) Vehicle Summary - Total 50 Seats

41 Standard Class Seats (including 4 Priority), 9 First Class Seats (including 3 Priority), 3 Tip-up Seats, Universal Toilet, 2 Wheelchair Positions & 2 Luggage Stacks





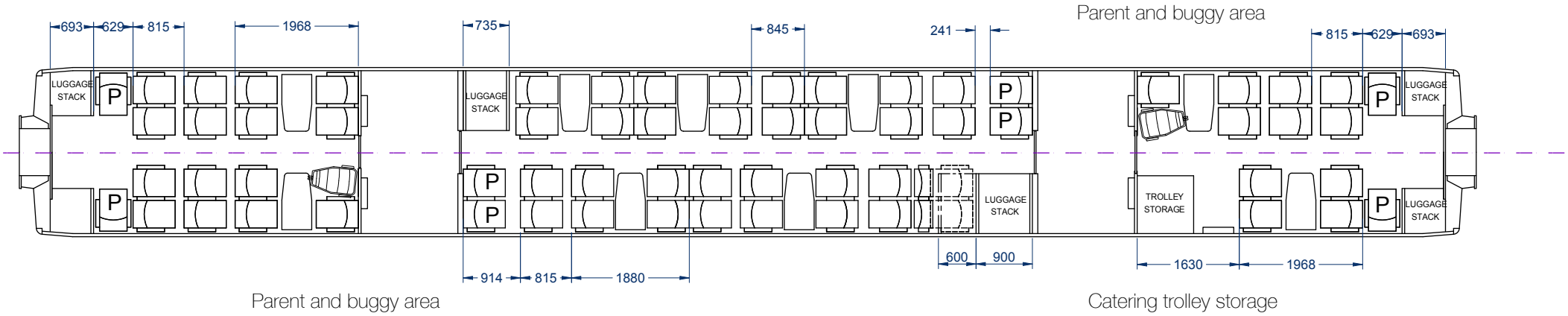
Parent and buggy area

DMSL (B) Vehicle Summary - Total 55 Seats

46 Standard Class Seats (including 5 Priority), 9 First Class Seats (including 3 Priority), 4 Tip-up Seats, Standard Toilet, Bike Storage Area (4 Bikes), Parent and buggy area & 3 Luggage Stacks

MS Vehicle Summary - Total 66 Seats

66 Standard Class Seats (including 8 Priority), 5 Tip-up Seats, Catering Trolley Store/Micro Galley, 2 Parent and buggy areas & 5 Luggage Stacks (including 1 x Expander stack)



3 Car Layout Proposal C

Total Seating = 171 (Including 28 Priority Seats (16.37%)
Comprising of:
153 Standard Class Seats, 18 First Class Seats &
11 Tip-up Seats

Notes:

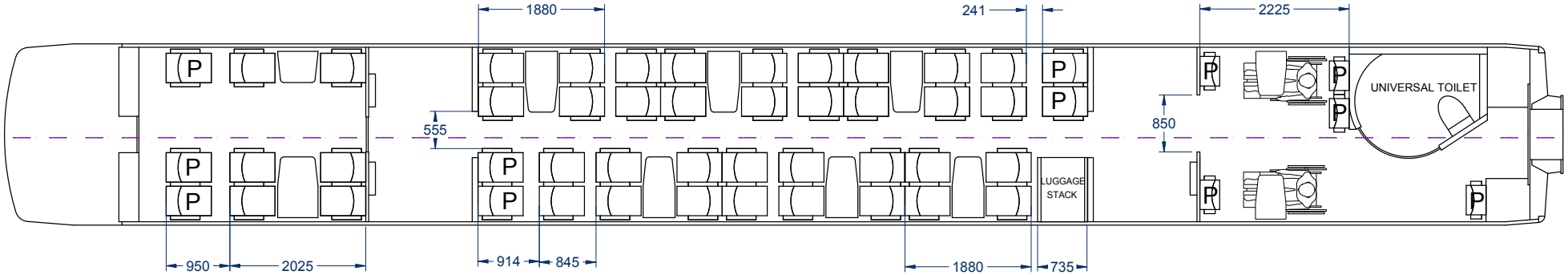
Layout proposal C retains First Class facilities at each end of the train, with the inclusion of discreet service enhancements throughout the entire train length.
Including; additional bike storage, expanding luggage stacks, parent and buggy areas and trolley storage/micro galley facilities.
One big transformation is the inclusion of internal doors to protect the saloon areas from the elements and to create a more cosy and relaxed travelling environment for the passengers.

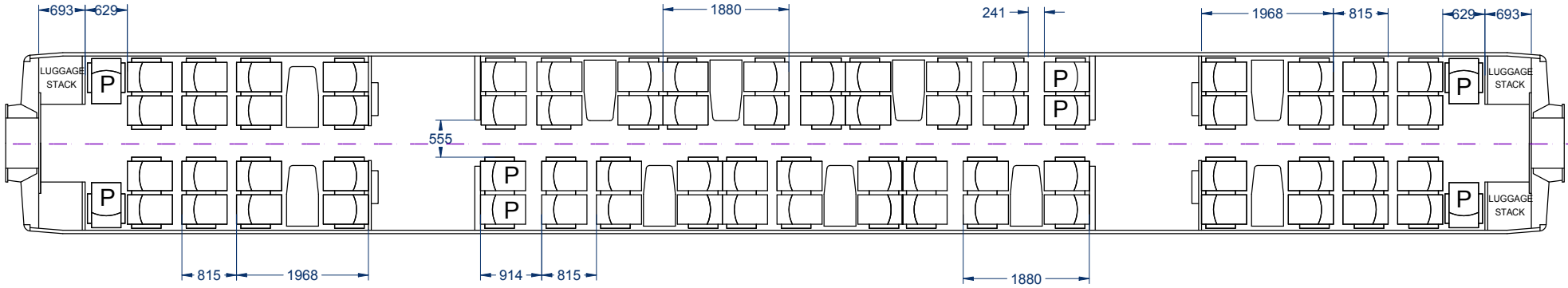
Revisions to the saloon ends, will allow a new and more modern interior ambience to be created.

4 Car Layout Proposal A

DMSL (A) Vehicle Summary - Total 52 Seats

43 Standard Class Seats (including 9 Priority), 9 First Class Seats (including 3 Priority), 3 Tip-up Seats, Universal Toilet, 2 Wheelchair Positions & 1 Luggage Stack





MS Vehicle Summary - Total 76 Seats

76 Standard Class Seats (including 8 Priority), 4 Tip-up Seats & 3 Luggage Stacks

Base 4 Car Layout

Total Seating = 262 (Including 36 Priority Seats (13.74%)
Comprising of:
244 Standard Class Seats, 18 First Class Seats &
15 Tip-up Seats

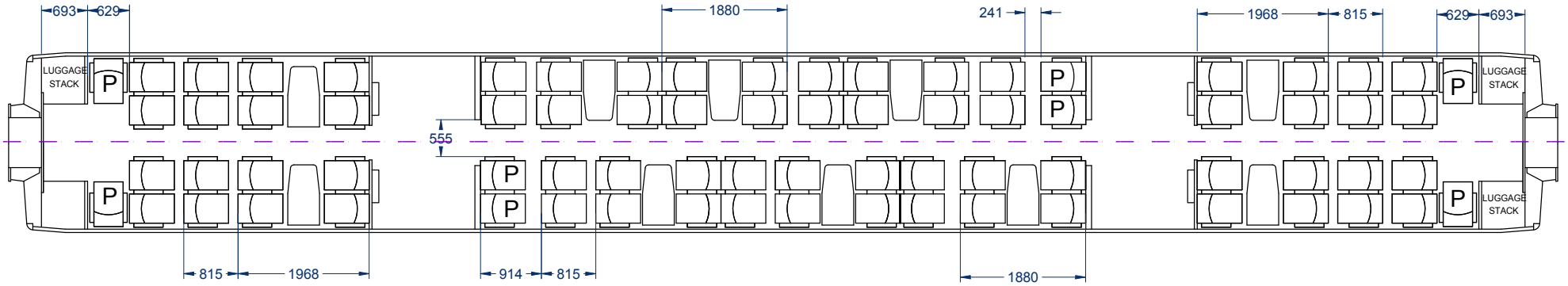
Notes:
This initial 4 car Class 170 rake, has been created to establish a baseline for comparison purposes. The existing MS vehicle has been duplicated to create a high capacity option.

Upgrades to the existing DMSL (A) and DMSL (B) vehicles are as follows:

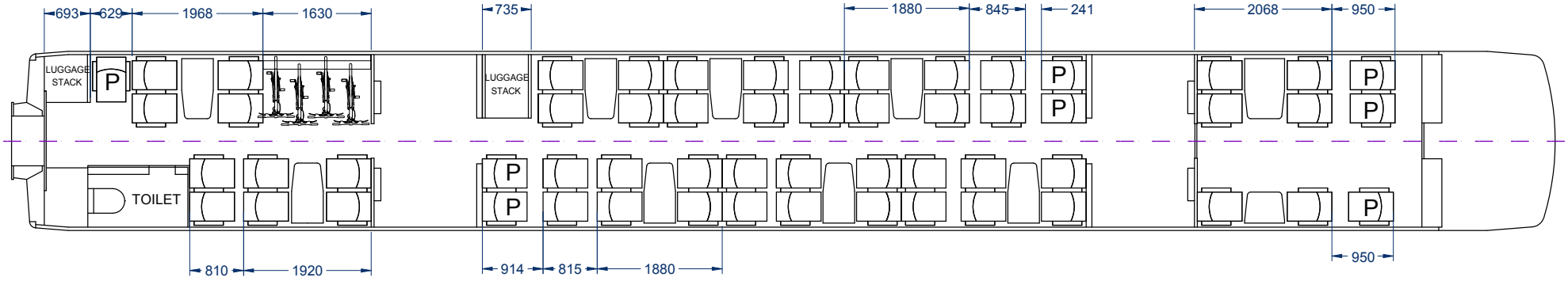
- Conversion of the DMSL (A) bike rack back to an RVAR compliant wheelchair position.
- Conversion of the bike storage area on the DMSL (B) to a vertical rack solution to compensate for the loss of storage space on the DMSL (A).

MS Vehicle Summary - Total 76 Seats

76 Standard Class Seats (including 8 Priority), 4 Tip-up Seats & 3 Luggage Stacks



Vertical bike storage



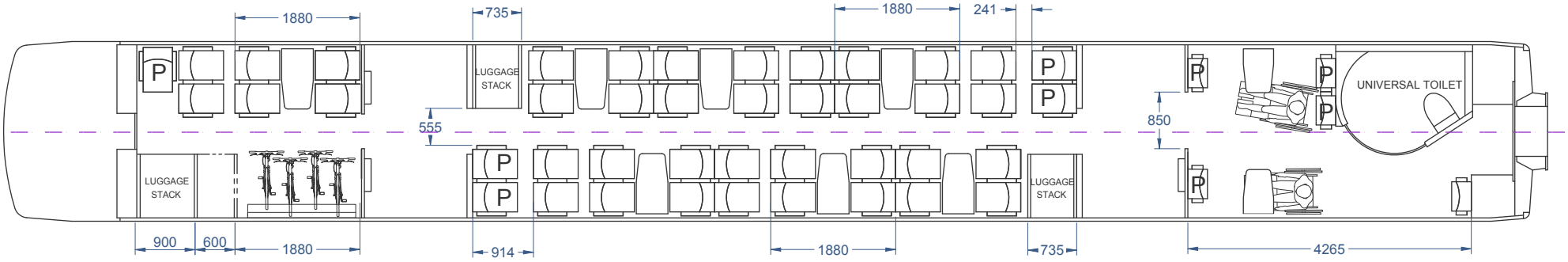
DMSL (B) Vehicle Summary - Total 58 Seats

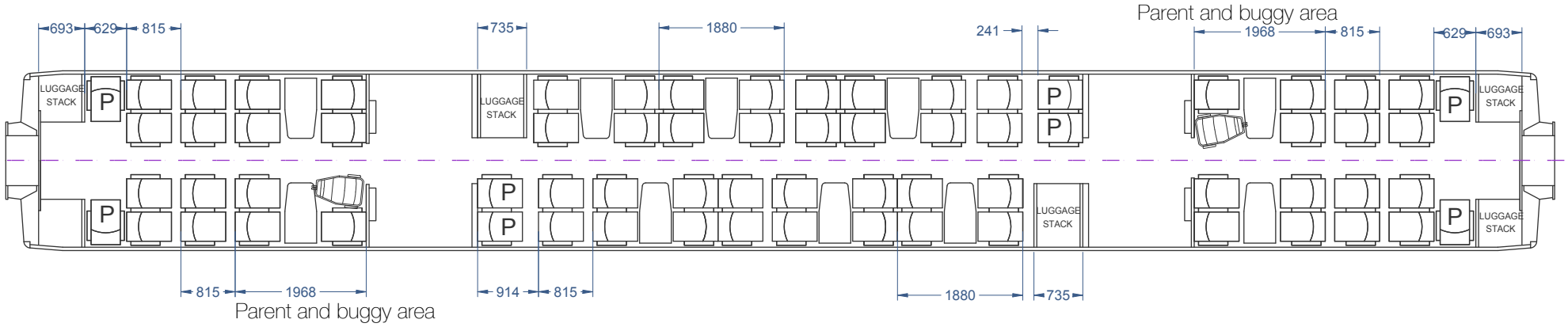
49 Standard Class Seats (including 5 Priority), 9 First Class Seats (including 3 Priority), 4 Tip-up Seats, Standard Toilet, Bike Storage Area (2 Bikes) & 2 Luggage Stacks

4 Car Layout Proposal B

DMSL (A) Vehicle Summary - Total 48 Seats

48 Standard Class Seats (including 9 Priority), 3 Tip-up Seats, Universal Toilet, 2 Wheelchair Positions, Bike Storage Area (4 Bikes) & 2 Luggage Stacks (including 1 Expander Stack)





MS Vehicle Summary - Total 70 Seats

70 Standard Class Seats (including 8 Priority), 4 Tip-up Seats, 5 Luggage Stacks & 2 Parent and Buggy Areas

4 Car Layout Proposal B

Total Seating = 226 (Including 30 Priority Seats (13.27%)
Comprising of:
210 Standard Class Seats, 18 First Class Seats &
15 Tip-up Seats

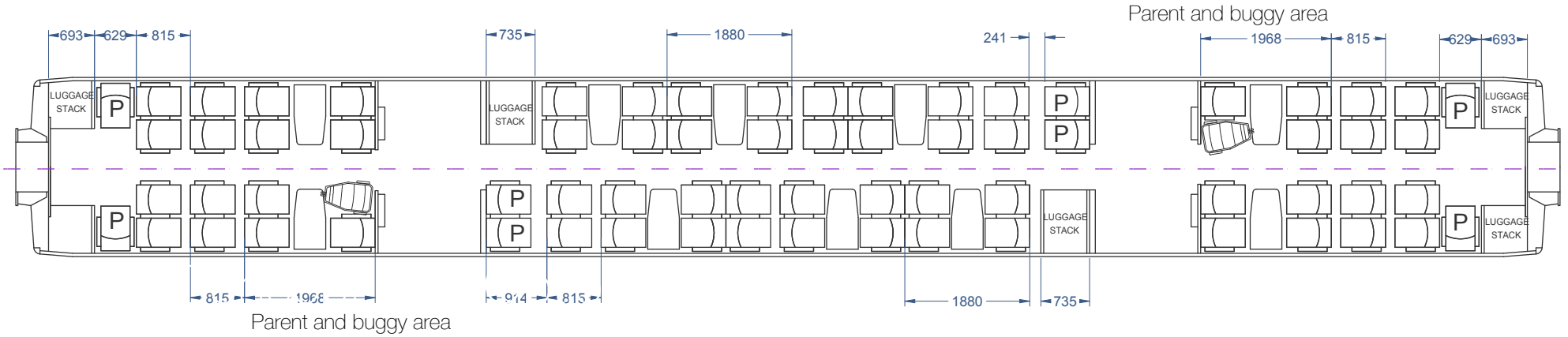
Notes:
This proposal features a selection of the improvement features seen in the 3 car options. Whilst the overall capacity is 40 seats lower than the base option (4 Car Layout A), this layout features the following key benefits that are appropriate to the Highland communities.

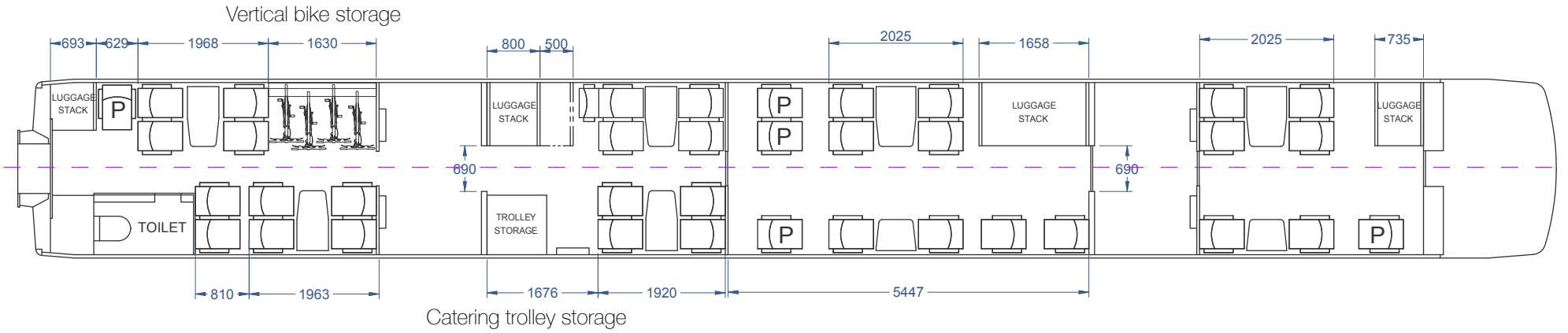
Features:

- Storage for 8 bikes
- 4 Family focussed areas
- Almost twice the quantity of luggage stacks (17)
- Catering trolley store/micro galley for improved onboard food and drinks provision.

MS Vehicle Summary - Total 70 Seats

70 Standard Class Seats (including 8 Priority), 4 Tip-up Seats, 5 Luggage Stacks & 2 Parent and Buggy Areas





DMSL (B) Vehicle Summary - Total 38 Seats

20 Standard Class Seats (including 1 Priority), 18 First Class Seats (including 4 Priority), 4 Tip-up Seats, Standard Toilet, Bike Storage Area (4 Bikes), Catering trolley storage area & 4 Luggage Stacks

Layout Comparison

Comparison of layout capacities and features:

	Existing Class 170 3 Car	3 Car Layout Proposal A	3 Car Layout Proposal B	3 Car Layout Proposal C		4 Car Layout Proposal A	4 Car Layout Proposal B
Total Seating Capacity	186	158	163	171		262	226
Priority Seats	28 (15.05%)	22 (13.92%)	23 (14.11%)	28 (16.37%)		36 (13.74%)	30 (13.27%)
Standard Class Seats	168	128	145	153		244	210
First Class Seats	18	30	18	18		18	18
Tip-up Seats	11	16	11	11		15	15
Luggage Stacks (Quantity)	6	11	11	10		9	17
Approx Luggage Capacity (m^3)	$6.98m^3$	$14.29m^3$	$15.46m^3$	$11.97m^3$		$10.47m^3$	$23.77m^3$
RVAR Wheelchair spaces	1	2	2	2		2	2
Bike Storage Capacity	4	4	4	4		4	8
Parent and Buggy Areas	0	0	2	3		0	4
Trolley Store/Micro Galley Facility	No	Yes	Yes	Yes		No	Yes

Observations:

- Introducing a additional MS car would provide the most cost option to create a 4 car set. On the positive side, the capacity for the rake increases by 70 seats. Unfortunately, the down side is that the toilet per passenger ration increase from 93 passenger per toilet to 131 passengers per toilet.
- Providing a greater range of facilities, such as additional bike/luggage storage, and flexible areas, reduces the total capacity of the set and could create reservation issues and passenger conflict.
- With the addition of a 4th car to the set, one vehicle (potentially coach A) could be left as unreserved to provide flexible 'turn-up' capacity.
- A balance will need to be struck between overall passenger capacity and facilities provision (especially if a 4th car is introduced) to form a solid business model for ScotRail and the vehicle owners Porterbrook.

Concept Development

As part of the scoping project, Interfleet's Industrial Design team have developed a number of concepts to enhance the passenger travel experience and to create flexible and practical enhancements.

The overall aim is to create the ideal vehicle platform to cater for the busy and diverse requirements of the Highland communities as well as the busy intercity services between Edinburgh, Glasgow, Aberdeen, Inverness, Perth and Dundee.

Micro Catering Concept

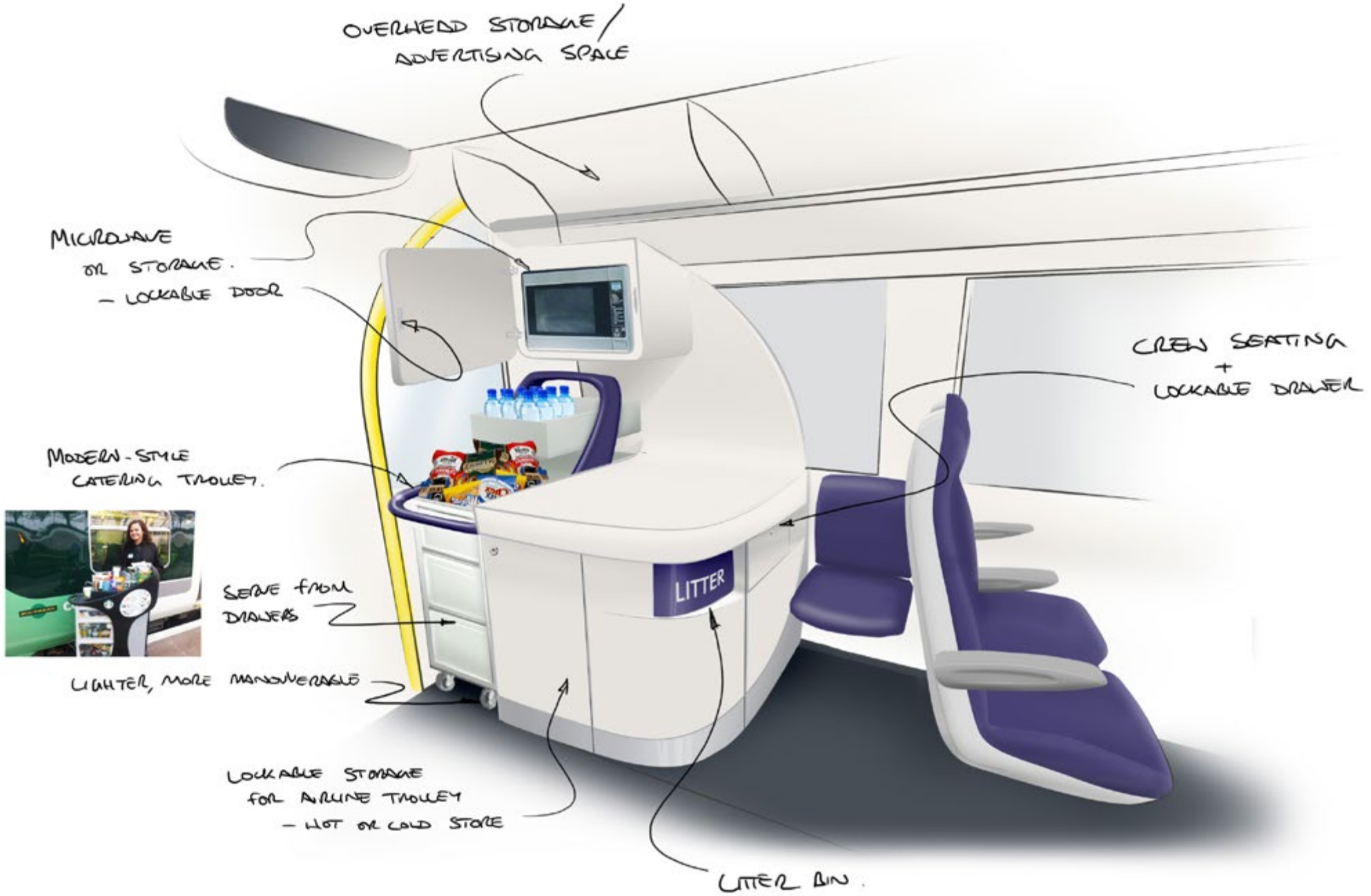
During the vehicle survey, it was observed that there is no defined location for the storage of the catering trolley. As such, a significant proportion of a vestibule is taken up by the trolley. This has the following detrimental effects:

- Catering supplies are subject to theft.
- Catering trolley creates clutter in the vestibule and could impede emergency egress.
- The catering trolley looks unsightly to passengers.

The micro catering concept, looks to provide a safe and secure catering hub for the service. The micro galley would be located adjacent to a vestibule to allow ease of access for the trolley and for stock replenishment and litter management.

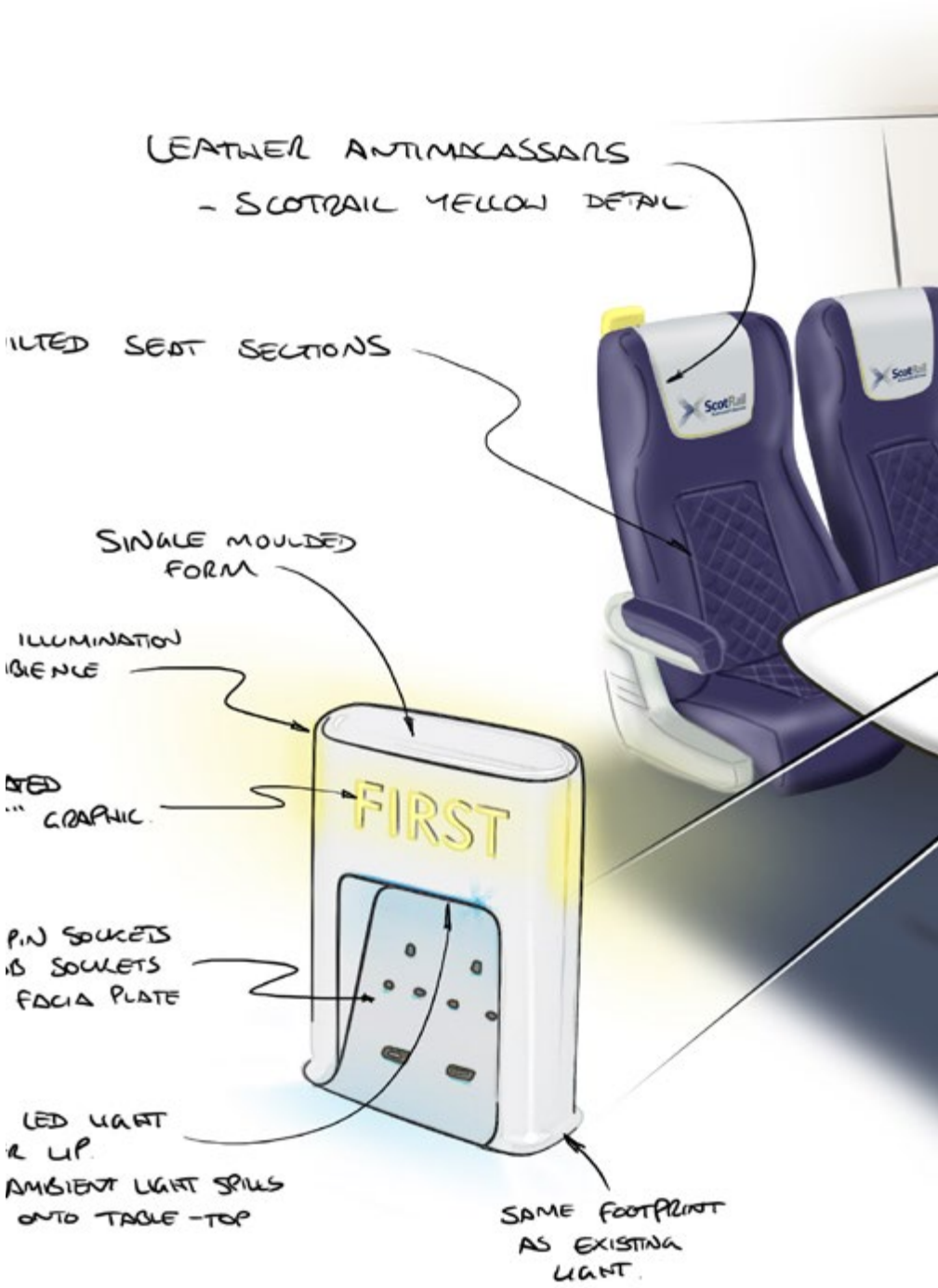
The concept provides the following service benefits:

- Secure trolley storage and potential for trolley power connection.
- Additional storage facilities for airline style hot/cold food store trolley, ambient storage locker, as well as litter bin.
- Secure store for alcohol after the watershed.
- Creates the opportunity for a much larger range and quantity of food to be provided on the longer routes, including seasonal variance, such as soup, hot sausage rolls in Winter and Chilled drinks and snacks in the summer.
- Micro galley could be operated as a mini shop or as a crew only facility to provide enhanced trolley services.


OVERHEAD STORAGE / ADVERTISING SPACE
MICROWAVE OR STORAGE. – LOCKABLE DOOR
CREW SEATING + LOCKABLE DRAWER
MODERN-STYLE CATERING TROLLEY.
SERVE FROM DRAWERS
LIGHTER, MORE MANOEUVRABLE
LOCKABLE STORAGE FOR AIRLINE TROLLEY – HOT OR COLD STORE
LITTER BIN.
LITTER

First Class facilities on the refurbished Class 158 fleet.

Existing First Class facilities on the Class 170 fleet.



First Class Service

It is well documented that the First Class facilities on the Class 170 fleet don't meet the requirements of the modern business users.

The First Class environment is aimed at both business users and leisure passenger seeking additional levels of comfort, space and luxury when travelling. Whilst the current service provision on the Class 170's and 158's offers more privacy and added features, there is no additional space or comfort provision.

This concept looks to enhance the levels of both real and percieved comfort by using deeper and more contoured seat cushions with luxury quilted panels.

The concept also includes a more subtle and advanced lamp unit with integrated mood lighting, 2 x electrical sockets and 2 x USB charging sockets.

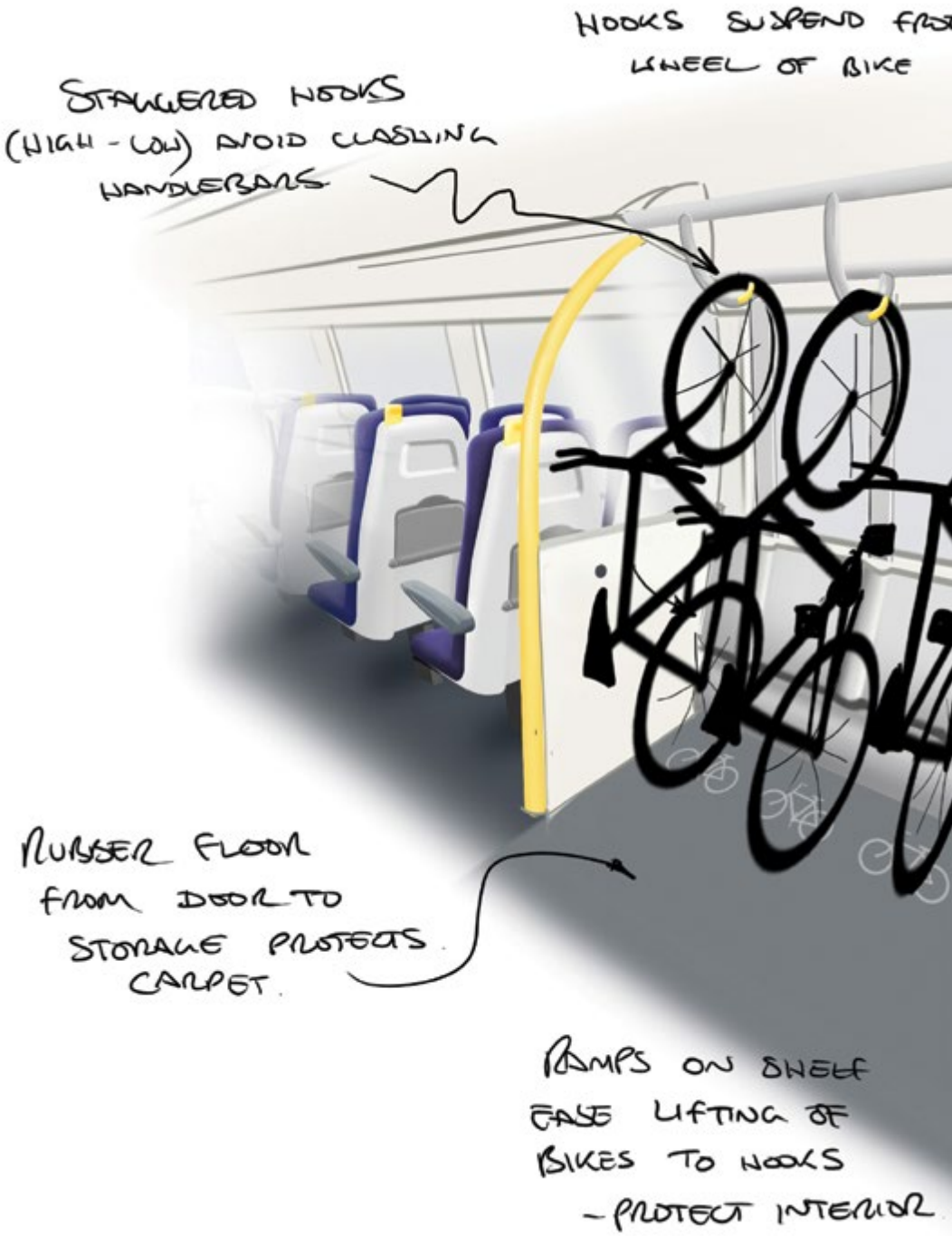
Creating a single dedicated First Class area will help to more exclusive and refined travelling environment that can be better managed and catered for by the on train team.

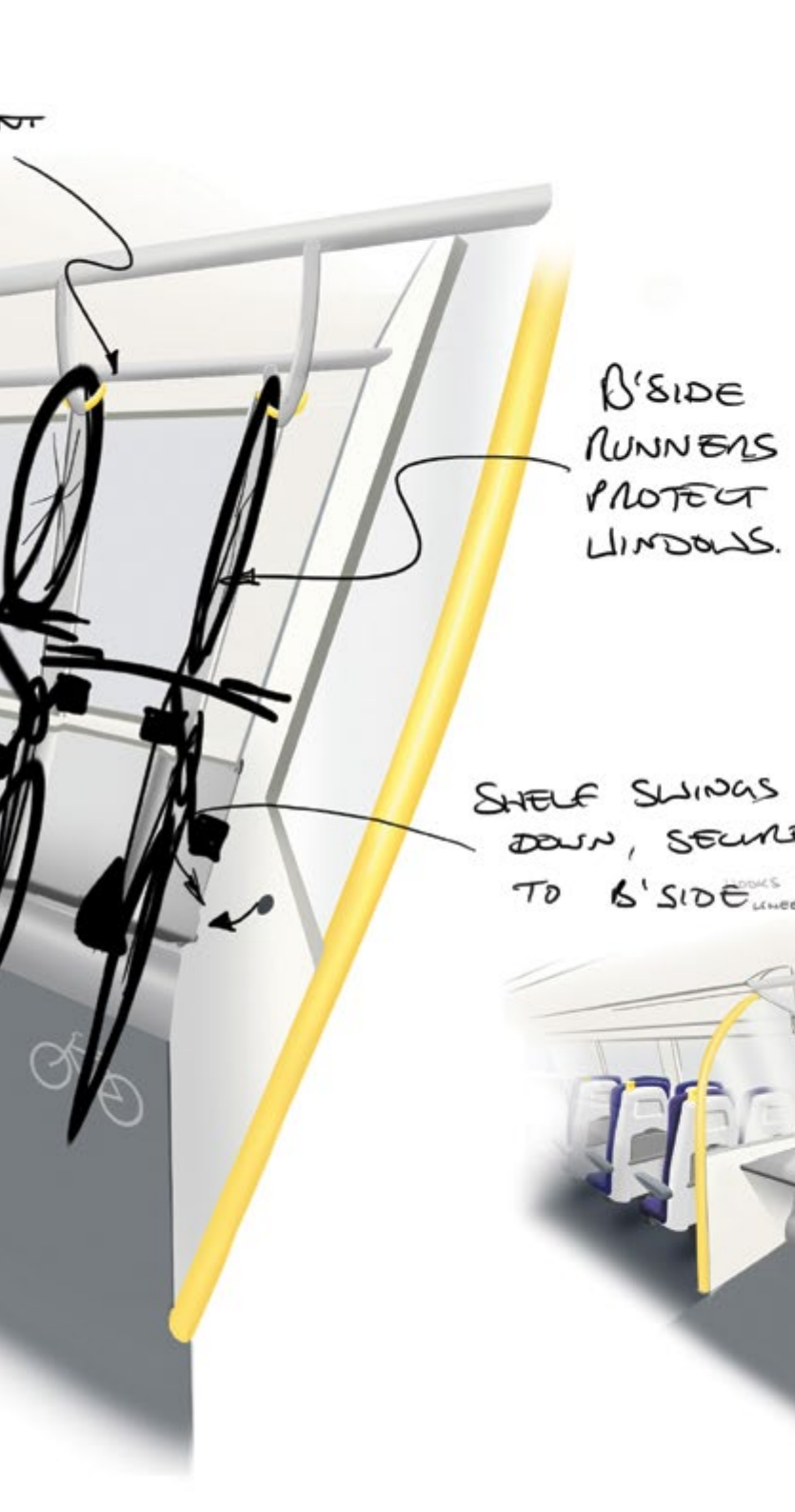
Adaptable Bike Storage

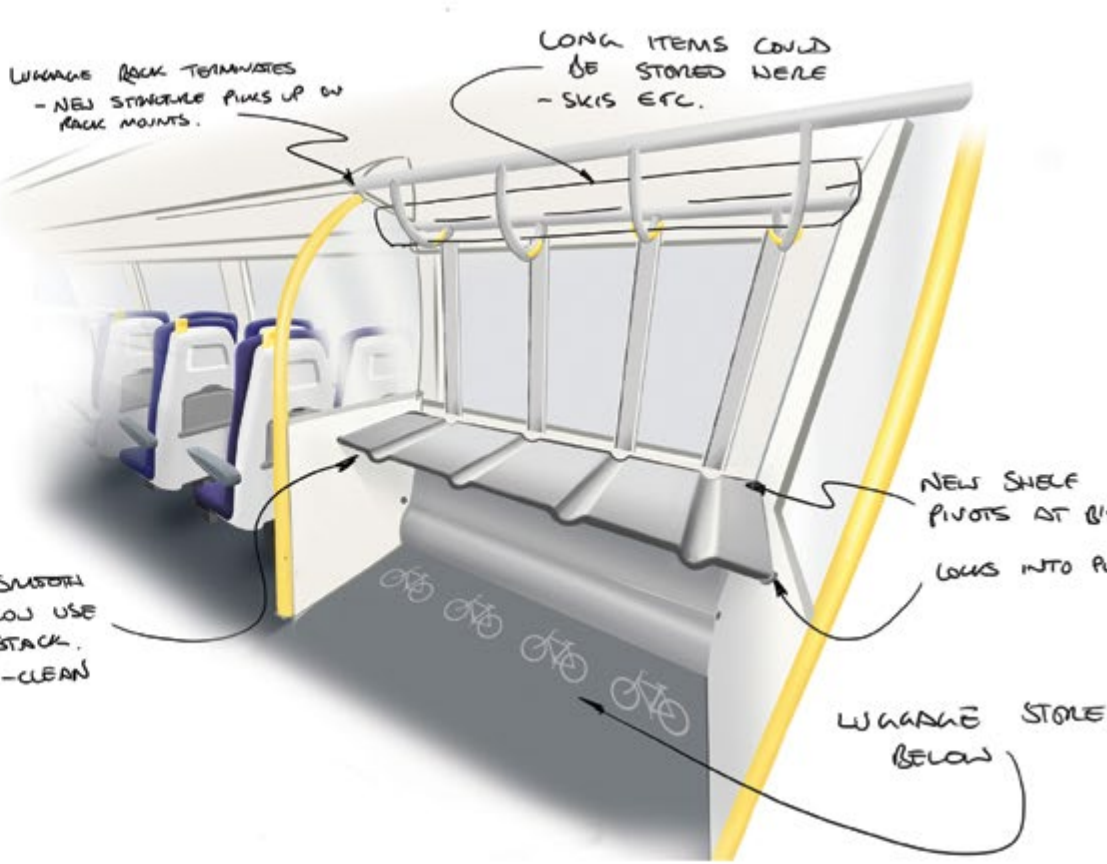
The Highlands of Scotland provide a beautiful and rugged landscape that attracts visitors all year round, walking, hiking and mountain biking holidays and day trips are extremely popular as well as Skiing in the Caingorms in the winter.
Outdoor activities are an essential part of the Scottish tourist industry. At the moment, these are poorly supported by the configuration of rail vehicles serving the Highland routes.

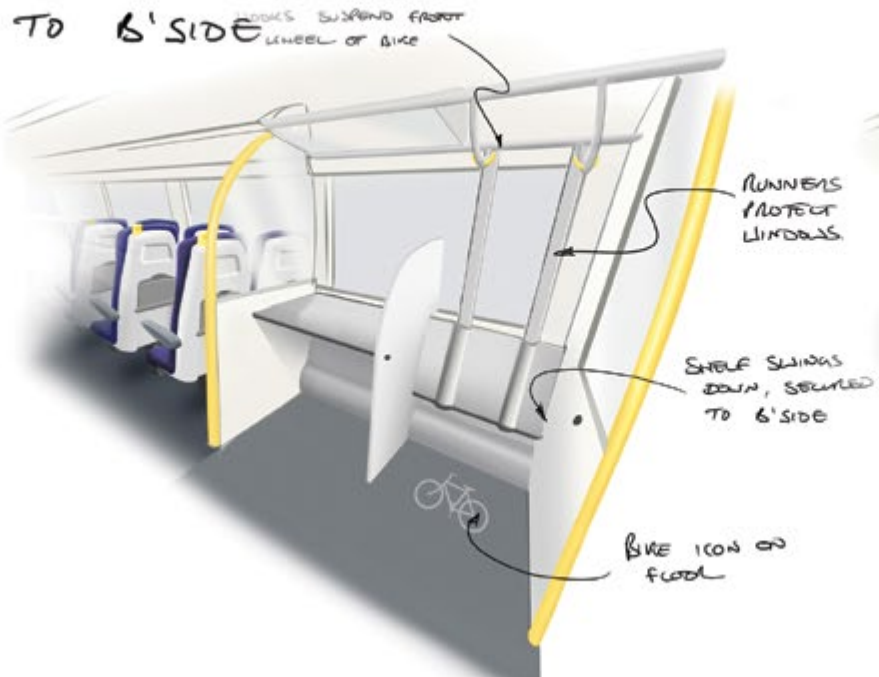
Creating a dedicated and flexible storage area with adjacent passenger seating will allow outdoor sports enthusiasts to travel in groups whilst staying in close proximity to their equipment. This concept provides flexible storage options to cater for a wide range of seasonal activities including hiking, mountain biking and skiing/snowboarding.

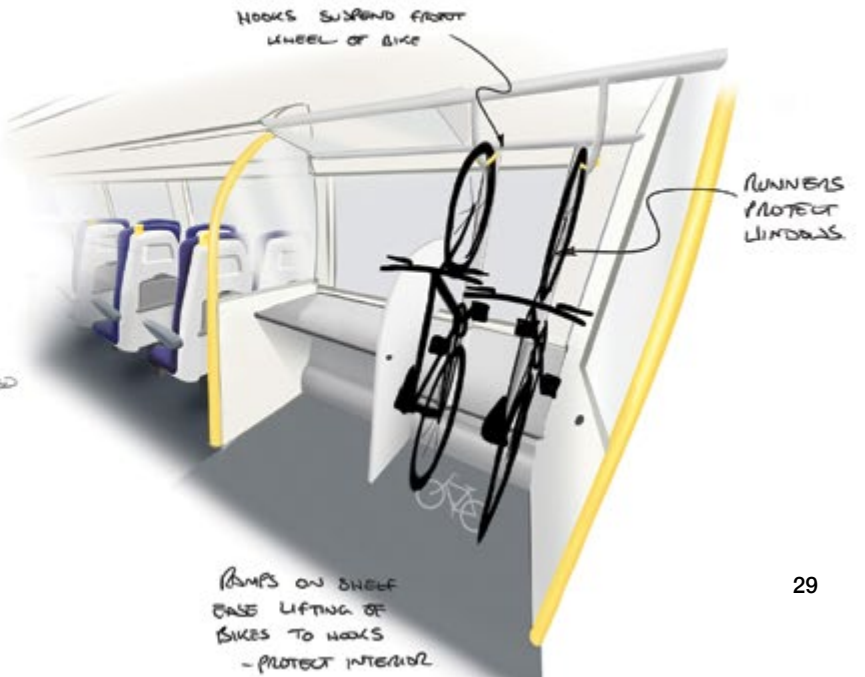
Variants of this concept could be explored for full width stack shelves or split shelves to facilitate both luggage and bike combinations - to alleviate potential passenger conflict issues.

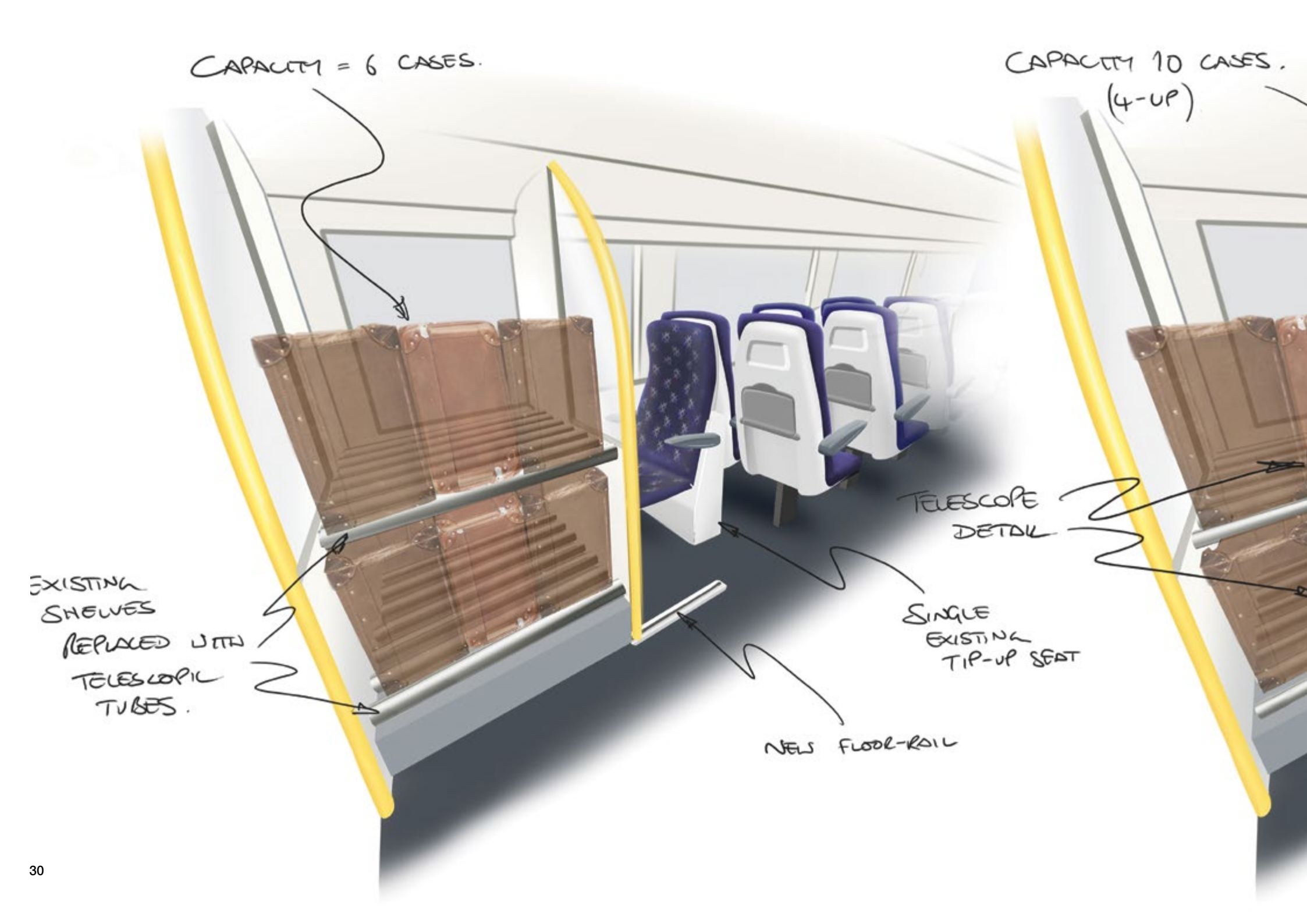


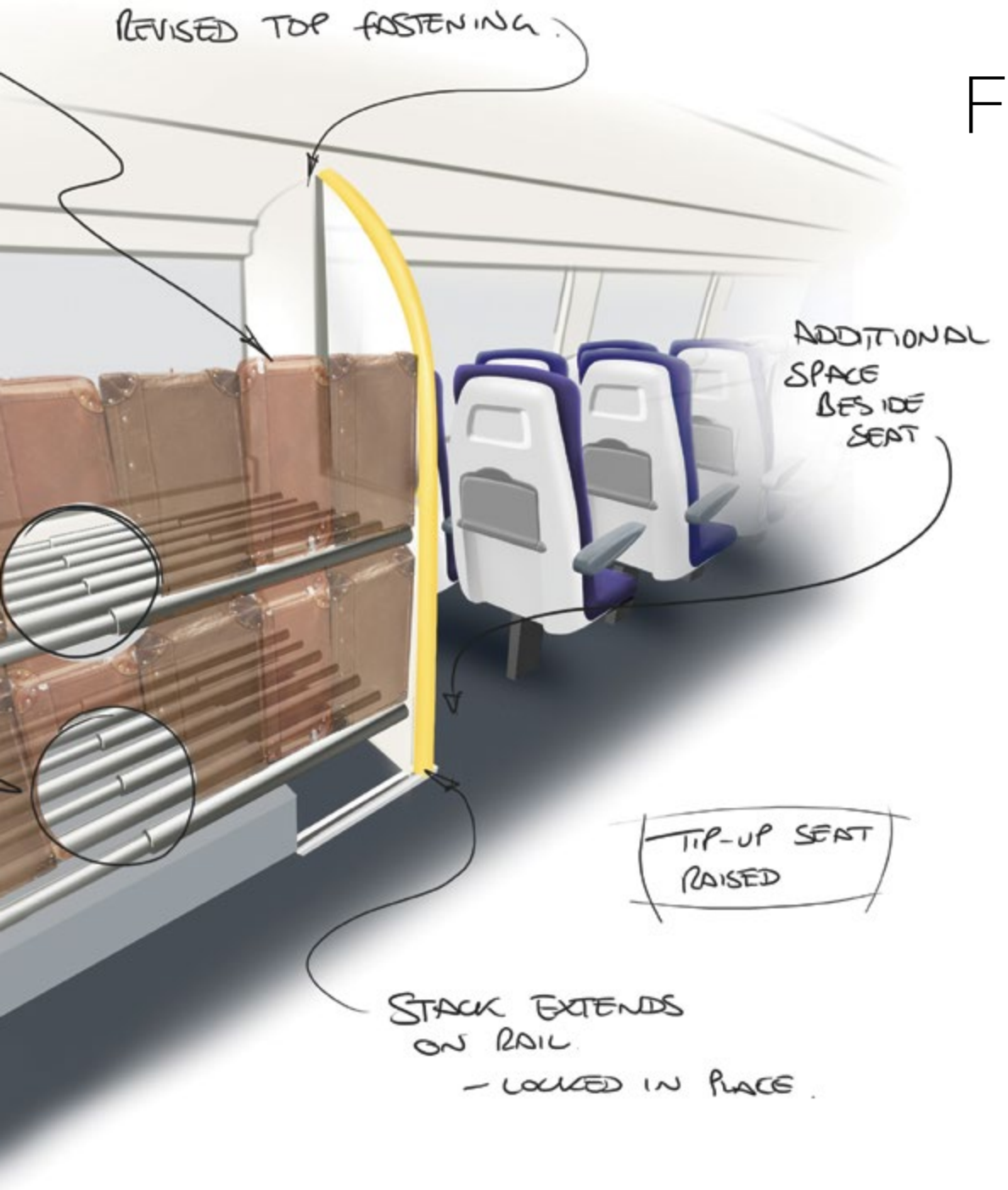

B'SIDE RUNNERS PROTECT WINDOWS.
SHELF SWINGS DOWN, SECURED TO B'SIDE


LUGGAGE RACK TERMINATES - NEW STANCHION PICKS UP ON RACK MOUNTS.
LONG ITEMS COULD BE STORED HERE - SKIS ETC.
RAMPS SMOOTH TO ALLOW USE AS STACK. - EASY-CLEAN
NEW SHELF PIVOTS AT B
LOCKS INTO P
LUGGAGE STORE BELOW


HOOKS SUSPEND FRONT WHEEL OF BIKE
RUNNERS PROTECT WINDOWS.
SHELF SWINGS DOWN, SECURED TO B'SIDE
BIKE ICON ON FLOOR


HOOKS SUSPEND FRONT WHEEL OF BIKE
RUNNERS PROTECT WINDOWS.
RAMPS ON SHELF RAISE LIFTING OF BIKES TO HOOKS - PROTECT INTERIOR


CAPACITY = 6 CASES.
CAPACITY 10 CASES.
(4-UP)
TELESCOPE DETAIL
EXISTING SHELVES REPLACED WITH TELESCOPIC TUBES.
SINGLE EXISTING TIP-UP SEAT
NEW FLOOR-RAIL



Flexible Luggage Capacity

Incorporating flexible luggage stacks into the Class 170 will allow for seasonal variations in passenger loading to be managed. For example at bank holiday weekends and at the start of the summer holidays, the luggage stacks could be extended to provide additional luggage capacity.

The expanding stack concept utilises the same seat design as presently utilised in the disabled area. By stowing the seat, and unlocking the stack, it can simply be extended along floor mounted rail, creating approximately 30% more luggage capacity.

When not required the stack can be collapsed and an additional seat place can be created.

For example, if the expander luggage stack in the DMSL (3 Car Layout Proposal A) were introduced:, the following luggage capacity increases are likely:

	Space Saver Mode	Fully Expanded Mode
Luggage Stack Shelf Area (m^2)	1.55	2.69
Luggage Stack Volume (m^3)	1.36	2.35

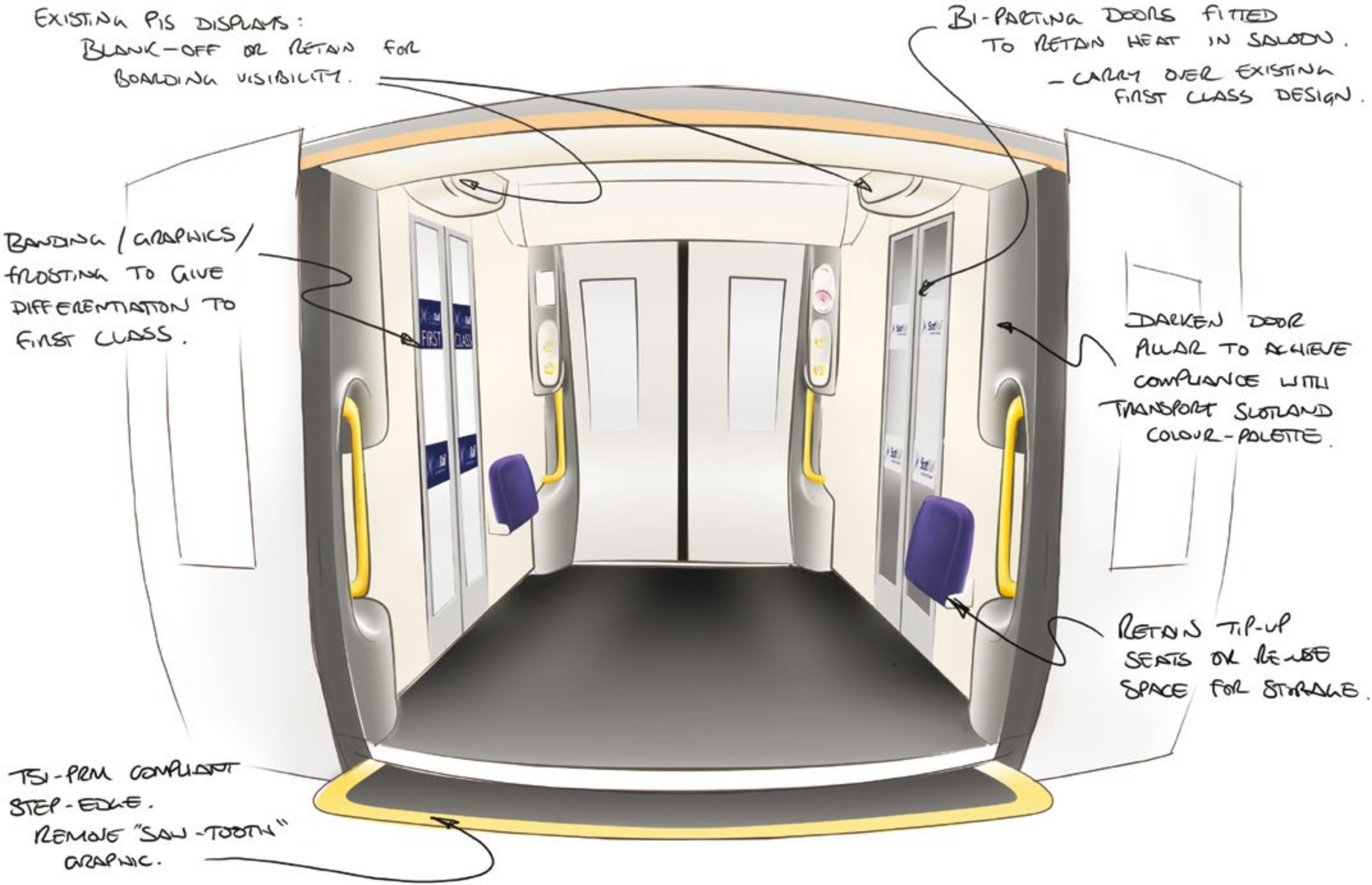
Vestibule Doors

Additional bi-parting saloon end doors could be installed to provide additional protection from the weather, creating a more comfortable saloon environment. The concept show is extremely simple and utilises the internal door solution already fitted to the Class 170 fleet to segregate the First Class compartments.

Fitting saloon end doors throughout the train would create a completely different journey experience. Care must be taken to ensure enough power is available to operate the doors, a full heating and ventilation system review would also be required to ensure that all saloon areas are adequately and evenly heated and ventilated.

A number of visual modifications could be incorporated to align the vestibule colour scheme to the latest Transport Scotland Branding.

Graphical elements could be utilised to provide clear differentiation between First Class and Standard class saloon environments.


EXISTING PIS DISPLAYS:
BLANK-OFF OR RETAIN FOR BOARDING VISIBILITY.
BI-PARTING DOORS FITTED TO RETAIN HEAT IN SALOON.
- CARRY OVER EXISTING FIRST CLASS DESIGN.
BANDING / GRAPHICS / FROSTING TO GIVE DIFFERENTIATION TO FIRST CLASS.
DARKEN DOOR PILLAR TO ACHIEVE COMPLIANCE WITH TRANSPORT SCOTLAND COLOUR-PALETTE.
RETAIN TIP-UP SEATS OR REUSE SPACE FOR STORAGE.
TSI-PRM COMPLIANT STEP-EDGE.
REMOVE "SAW-TOOTH" GRAPHIC.

Engineering Assessment
Overview

In parallel to the conceptual design process, the design team have worked with Interfleet's wider group of engineering specialists to undertake high level reviews of the following engineering constraints:

• Passenger Information Systems	££
• WiFi and Communication System Improvements	££
• Potential additional loads on the existing power supply system	£ - ££
• Heating and Air Conditioning system enhancements	££ - £££
• Installation of internal doors	£££
• TSI-PRM Compliance	£
• Lighting System Enhancements	£ - ££

The aim of the reviews is to establish the relative technical complexity of each proposed upgrade and to evaluate its incorporation into future refurbishment specification.

It is envisaged that a more detailed engineering study is undertaken, including a detailed electrical loading analysis to establish available capacity on a subclass basis.

It is clear that there are a number of key areas that could limit the potential for service enhancements on the Class 170 fleet, the challenge will be to effectively manage these technical parameters.

Passenger Information Systems

Interfleet's Communications expert, Stephen Radford was responsible as Engineering Director at Whiteley Electronics for the original design of Class 170 Passenger Information System (PIS) as used on all 170 fleets. In 2006, for the First ScotRail franchise, Stephen produced specifications for upgrades to Class 170 and development of systems for Class 158.

The First ScotRail Class 170's are close to the present day Class 172 (LUL Overground) system functionality.

The Class 170 PIS is fully compliant with the requirements of the Rail Vehicle Accessibility Regulations (RVAR), as such this is deemed compliant with the TSI-PRM.

PIS system can offer more added value than the basic Destination/Next Station requirements outlined in RVAR/TSI-PRM. If it is possible for users of smart-phones to use real time information, then why can't this be displayed in real time on the train.

It is possible to replace the existing dot matrix screen with wide aspect Thin film transistor liquid crystal display (TFT-LCD). It is then possible to show large, fully compliant text as required by RVAR/TSI-PRM or graphics, presentations and videos in support of richer real time information. This could be utilised to enhance passenger information provision for local tourist attractions, onward journey planning or business/news updates. It is worth bearing in mind that this is likely to require additional loads from the existing power supply system

At a basic level, the LED displays are long in the tooth, at a minimal cost the plug-in LED tiles could be replaced to ensure a bright and uniform display.

Wi-Fi & Communications Systems

During the summer of 2012, ScotRail commissioned the trial installation of wi-fi equipment on four Class 170's. During the trial, the units operated on all ScotRail routes to establish network availability and performance. Following positive customer feedback (77% of users were satisfied with the speed and performance of the wi-fi, with personal and business use found to be 72% and 28% respectively).

The trial involved the installation of an Ethernet 'backbone' fitted to each class 170 train, using inter-vehicle 'jumpers' to allow passengers to access the internet from all three carriages. The router is mounted in the roof space in the middle vehicle close to the external antennae.

The system connects to the major phone networks simultaneously and splits the available bandwidth across the networks at any given moment. The quality of the mobile signal strength along the rail network varies depending on a number of factors. While wi-fi will undoubtedly improve internet access, there are still remote areas where there is limited or no access is available.

Route availability data will allow the Scottish Government and ScotRail to work with OfCom to address the problem of 'not-spots'. It is therefore likely that there will be considerable investment to provide an ADSL service to these remote locations (thus improving WiFi Availability), but this will be focussed on communities rather than transportation routes.

In January 2013, it was announced that Icomera had been awarded a contract to provide their onboard internet system onto the entire Class 170 fleet, with a programme scheduled for completion by the end of 2013.

Additional Electrical Loading

All Diesel Multiple Units (DMU's) have limited spare electrical capacity, the electrical design is optimised around the specified equipment list at the build stage. Unfortunately the Class 170's are no exception.

It is recommended that a detailed electrical study should be undertaken to establish the following:

- What equipment is fitted to the ScotRail Class 170 fleet and variations between the Express, Suburban and ex Hull trains Buffet pool.

- Determine how much capacity is being used, and if there is adequate capacity for any new equipment.

Following the electrical capacity review, a number of optimisation options may be employed to free up capacity and allow for the managed implementation of additional systems:

- Introduce interlocking to ensure certain electrical items can only operate if another is turned off. However options may be limited.

- Undertake system replacements with newer and more efficient systems, for example:
  - On train lighting - Led lighting systems can save up to 30% power compared to traditional fluorescent tubes, inverters and Halogen spot lights.
  - Toilet systems - 'Fast air' hand dryers in the toilets can significantly reduce consumption compared to traditional dryers.
  - At seat power - 5V USB Charging plugs for cameras/phones/GPS systems are likely to become the standard rather than traditional 240V AC three pin sockets.

Heating & Air Conditioning System Enhancements

A top level engineering review was undertaken of the Class 170 Heating, Ventilation and Air Conditioning (HVAC) system. Both in design and capacity terms the system has remained relatively static throughout the Class 170 Turbostar and 377 Electrostar build programmes, the same basic HVAC configuration is the same on the new Class 172 London Overground sets.

System improvements are possible, however major capacity increases or duct configuration changes would be complex and therefore very costly.

Management of 'Heat loss' is a more appropriate strategy, through the use of selective door opening and minimising the auto close sequences. RVAR and TSI-PRM regulations stipulate precise functionality and door open/close sequences timings (approximately 3 seconds per sequence). Through the Train management system it is possible to modify or apply seasonal variations to the door sequencing to better manage heat loss.

Re-design of the vestibule partitions could also provide better through-draught protection and natural saloon heat retention.

Installation of Full Partitions and Internal Sliding doors

Fitment of additional electrically activated pneumatic sliding internal doors is technically quite simple, with a proven design currently utilised to segregate 1st Class areas. This same modification has recently been implemented as part of the RailCare refurbishment programme undertaken at RailCare's depot in Springburn, Glasgow. As such a kit of parts will be available.

The benefits of installing full partitions and sliding doors will provide significantly improved weather protection for the saloon environment, creating a more cosy and comfortable saloon environment.

With regards to technical complexity, the installation of full partitions and new internal sliding doors would require:

- Minor structural modifications.
- Additional loading on electrical system is minor.
- PIS and CCTV system will to be re-configured to ensure adequate visibility of displays (90+% visibility required) and CCTV coverage/ angles etc. This could result in additional displays being required or the splitting of existing dual units with new single direction housings.
- Air system upgrades may be required to drive the additional sliding door units
- A detailed study on the impact on HVAC system air flow and heat management would be required to ensure that vehicle air flow is not significantly effected, creating localised hot and cold spots.

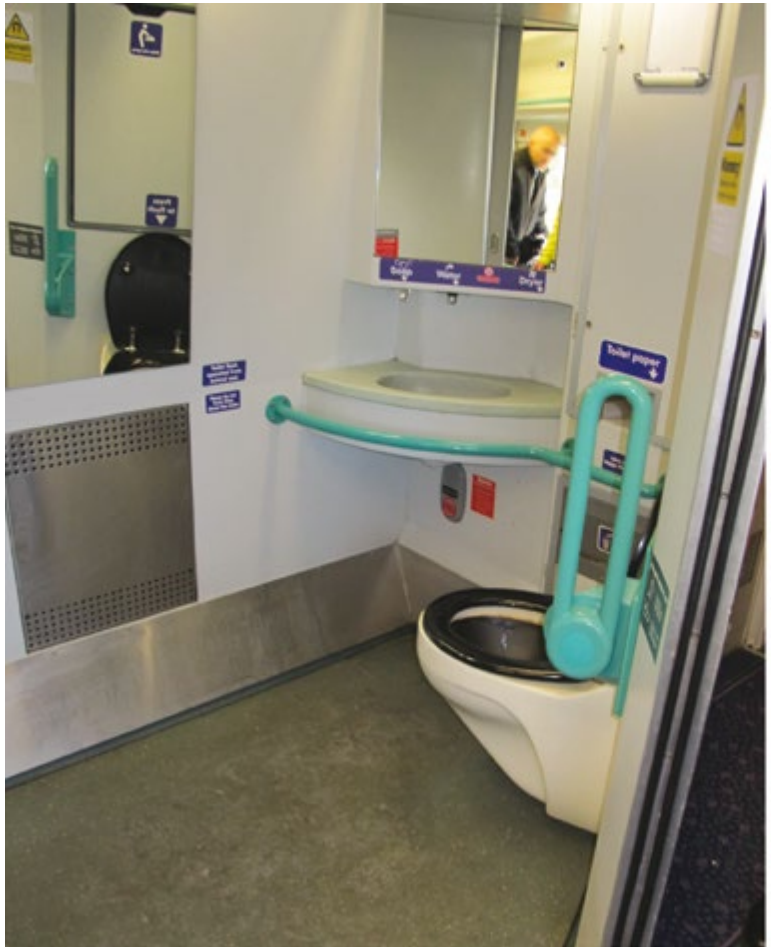
TSI-PRM Compliance

The Department for Transport is developing balanced proposals for reconciling domestic accessibility legislation and commitments with forthcoming interoperability requirements (PRM TSI). Subject to Ministerial approval and public consultation in due course, these are likely to include provisions disapplying RVAR from heavy rail vehicles (thereby avoiding the creation of duplicate regulatory regimes) whilst placing a continuing obligation on the operators of vehicles currently regulated under RVAR to maintain and operate them to the standard to which they were built.

All heavy rail vehicles will be required to comply with the PRM TSI by the End Date, which can be no later than 1 January 2020, unless they already comply with RVAR.

The ScotRail Class 170 fleets are fully compliant with the requirements of the RVAR and as such will be granted deemed compliance to TSI-PRM.

It must be noted that it is the operators obligation to ensure that the vehicles are maintained to the original 'as built' standard, therefore and degredation to this standard must be rectified.



Lighting System Enhancements

Although the Turbostar fleets could be considered as a modern DMU fleet, lighting technology has made huge advancements since the fleets introduction in 1999.

LED lighting solutions can provide a bright even lighting solution in a range of colour temperatures including cool white, natural and warm white. As well as mood lighting solutions using RGB controller technology.

The benefits of converting from the existing fluorescent lighting tubes and Halogen Spotlights to a full LED lighting system are:

- Significant reliability improvements with reliability up to 100,000 hours
- Significant energy savings - up to 40% compared to traditional inverters and fluorescent tubes.
- Very low maintenance required, especially with sealed unit products.

Ambient light responsive control systems can also provide significant energy savings, the Lumen output of the system is responsive to Ambient lighting levels. As ambient light levels increases, the Lumen output of the lighting system decreases, creating a balance between natural and artificial light.

Developed by Interfleet Technology for the Highlands and Islands Transport Partnership (HITRANS)

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www.interfleet-technology.com

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