

**Rail Vehicle Accessibility:**  
**Exemption Application**  
London Trams

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## **Foreword**

The 24 Bombardier CR4000 trams entered service in 2000 at which time the Rail Vehicle Accessibility Regulations (RVAR) 1998 was in force, with the newer 12 Stadler Variobahn trams entering service in 2012, 2015 and 2016.

RVAR 2010 came into force on 6<sup>th</sup> April 2010. The following year Transport for London (TfL) commissioned a review of the Bombardier CR4000 fleet against the Requirements of RVAR 2010. Since the 2011 review several work streams have been carried out to make modifications to the trams to address the areas of non-compliance.

However due to the prioritisation of maintenance activities to ensure availability of the required number of trams to meet service each day and safety related works; all the necessary modifications to the trams have not taken place. Operating within tight budgetary constraints has also led to the de-scoping of works items, and often meant the non-availability of budget for works to take place.

A further review against the Requirements was performed in August 2019, during which several of the open items on the Bombardier CR4000 were closed, with a few remaining non-compliant. A few instances of non-compliance were also noted on the newer Stadler Trams.

Subsequently London Trams has compiled the following application for time limited and permanent exemptions against the remaining areas of non-compliance against the Requirements.

# Passenger Doorway Audible Warning Devices

## 1. Full name of applicant and address

London Trams  
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17 Addiscombe Road  
Croydon  
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## 2. London Trams rolling stock

Table 1: Vehicles for which the exemptions are to apply

Manufacturer	Class	Number	Quantity
Bombardier	CR4000	2530 – 2553	24
Stadler	Variobahn	2554 – 2565	12
<b>Total</b>			<b>36</b>

## 3. Circumstances in which exemptions are to apply

To apply at all times in passenger service.

## 4. Relevant requirements from which exemption is sought

### 4.1. For All Vehicles

#### Schedule 1, Part 1, 3

3(3) *Subject to sub-paragraph (4), each passenger doorway in the side of a rail vehicle must be fitted with an audible warning device which must emit warning sounds in accordance with sub-paragraph (5) inside and outside the vehicle in the proximity of each control device for the doorway or, if there is no such control device, adjacent to the doorway.*

3(5) *Subject to sub-paragraph (6), the audible warning device must—*

3(5)(b) *emit a different distinct sound to that required by paragraph (a) and, where applicable, paragraph 1 of Part 2 of this Schedule, commencing not less than 3 seconds before the door starts to close.*

### 4.2. For Bombardier CR4000 vehicles only

#### Schedule 1, Part 1, 3

3(5) *Subject to sub-paragraph (6), the audible warning device must—*

3(5)(a) *where the unlocking of all the passenger doors in the side of a rail vehicle is activated by a member of the operator's staff, emit a distinct sound for a period of not less than 3 seconds commencing when the doors become openable by passengers; and*

#### Schedule 1, Part 2, 1

1 *Where the opening of all the passenger doors in the side of a rail vehicle is activated by a member of the operator's staff, or activated automatically, the audible warning device required by paragraph 3(3) of Part 1 of this Schedule must emit a distinct*

sound for a period of not less than 3 seconds commencing when the doors begin to open.

## 5. Technical, economic and operational reasons why exemption is sought

London Trams is requesting time limited exemptions to the clauses detailed in Section 4 for each of the two fleets listed in Section 2.

The passenger door opening and closing procedure was checked on a sample set of trams, with the accompanying audible warning times recorded (see Table 2).

Table 2: Duration of door audible warnings

Vehicle	Duration of audible warning before doors start to close (seconds)	Duration of audible warning commencing when the doors begin to open (seconds)
Bombardier CR4000	2.2	1
Stadler Variobahn	2.2	5.2

On both fleets the duration of the audible warnings before the doors started to close was recorded as approximately 2.2 seconds, which is less than the 3 seconds required by RVAR 2010. On the Bombardier CR4000, the audible warning commencing as the doors start to open, was a single tone lasting for 1 second, which is less than the 3 seconds permitted by RVAR 2010.

It is technically feasible to change the length of the door audible warnings before the closing routine commences to a minimum of 3 seconds on both fleets, and to extend the audible warning duration for the opening procedure on the Bombardier CR4000. This will require the active participation of the vehicle manufacturers and suppliers to provide the necessary software packages for these changes to be implemented and for any necessary component changes to be made.

In response to a series of incidents involving the passenger doors, a review was conducted in September 2019 of the door related incidents from January 2014 to August 2019. The review highlighted several incidents involving the door closing operation. This included passengers, possessions and other objects being hit by the closing doors and in some cases becoming trapped. In a few trapping cases the tram moved away before the object could be freed, resulting in a dragging incident. There was one incident recorded on a Bombardier CR4000 tram in relation to the opening of the passenger doors, in which a passenger became caught on the opening door, leading them to fall forward onto the platform.

Door audible warnings are required to ensure passengers have sufficient notice before the doors start to close. Audible warnings of a longer duration provide more notice to passengers. However, it is not possible to know the actual effect of increasing the duration of the audible warnings on the door related incidents recorded on the London Trams network. A time limited exemption would provide time for a detailed investigation to be undertaken into the impacts of changing the door audible warning timings on passenger accessibility.

**6. The effect which non-compliance would have on a disabled person's ability to use trams of the description to which the application relates**

Limited Impact – London Trams believe that the non-compliance to the clauses listed in Section 2, are likely to only have a limited effect on a disabled person's ability to use the trams.

**7. The measures proposed, if the application is granted, to enable a disabled person to use the rail vehicle**

London Trams does not believe there are any interim measures which could be applied to enable a disabled person to better use the rail vehicle, which are feasible or cost effective to implement, prior to the implementation of the measures described in Section 8.

**8. Any proposals for later modifications of rail vehicles to secure compliance with RVAR within a stated period**

A time limited extension for the clauses listed in Section 2, will allow for proposals to be developed and further study to be carried out to determine if an increase in duration of audible door warnings would deliver benefits to customers for the cost of modification. If this is the case, the solution would be implemented to increase the length of the door audible warnings before the passenger doors start to close on both fleets, and to increase the length of audible warnings when the passenger doors start to open on the Bombardier CR4000 fleet; to ensure compliance with RVAR 2010.

**9. Supplementary information for consideration**

For the Bombardier CR4000 fleet, London Trams (previously Croydon Tramlink) was granted an Exemption Order in 2000 covering Regulation 4(2) and 4(3)(b) of RVAR 1998. These Regulations have since been superseded by 3(3) and 3(5)(b) of RVAR 2010, of which the Bombardier CR4000 fleet is non-compliant.

The non-compliant door audible warnings were originally highlighted during an RVAR 2010 review undertaken in 2011 on the Bombardier CR4000 fleet, and subsequently identified on both fleets during the August 2019 RVAR 2010 review and as part of the door incident review conducted in September 2019.

A two year extension would ensure adequate time to undertake all the works associated with changing the door audible warning durations. The request for a two year extension has been based on several factors. It would allow for additional time to engage with suppliers in regards to the software packages required to change the door audible warning lengths and to design and purchase any necessary component changes. Within the extension, a trial would be conducted to better understand the impact of changing the door audible warning durations on safety, service reliability and customer behaviour. Trials have taken place on London Underground and the Docklands Light Railway which will be analysed in advance of the trial.

Based on the feedback from the trial, suppliers and customers, a decision would be made on the optimal audible warning timings to use on the London Trams system and for this to be implemented on both fleets. Implementation frequency on each tram would

be dictated by fleet resource and depot space availability. The changes to the door audible warning durations would also need to be factored into future budgets which will impact on when the works can commence.

**10. Unless permanent exemption is sought, the period during which exemption is to apply**

London Trams is requesting time limited exemptions for the clauses listed in Section 4 for all vehicles listed in Section 2.

London Trams, Bombardier CR4000 Stock, Vehicle Numbers 2530 – 2553  
Time limited exemption – until 1<sup>st</sup> January 2022

London Trams, Stadler Variobahn Stock, Vehicle Numbers 2554 – 2565  
Time limited exemption – until 1<sup>st</sup> January 2022

# Internal Passenger Information Displays

## 1. Full name of applicant and address

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17 Addiscombe Road  
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## 2. London Trams rolling stock

Table 3: Vehicles for which the exemptions are to apply

Manufacturer	Class	Number	Quantity
Bombardier	CR4000	2530 – 2539	23
		2541 – 2553	
Stadler	Variobahn	2554 – 2565	12
<b>Total</b>			<b>35</b>

## 3. Circumstances in which exemptions are to apply

To apply at all times while the tram is in passenger service.

## 4. Relevant requirements from which exemption is sought

Schedule 1, Part 1, 11

11(12) A letter or number used in a display inside a rail vehicle must—  
11(12)(b) in dimension, not have a height which is less than the minimum height ascertained in accordance with sub-paragraph (13)

11(13) The minimum height referred to in sub-paragraph (12) (b) is—  
11(13)(b) for a reading distance of more than 6 metres, 35 millimetres

## 5. Technical, economic and operational reasons why exemption is sought

There are four internal passenger information displays installed on each fleet. The displays are arranged such that two displays are mounted back to back. On the Bombardier CR4000 the displays are located in the centre of the A and B modules, and on the Stadler Variobahn in the centre of modules 2 and 6.

On both fleets, the distance between some passenger spaces (including standing and seating) and the nearest readable display, are over 6 metres. For viewing distances over 6 metres, RVAR 2010 requires the height of all characters on a display to be at least 35 millimetres. This is applicable to all character types.

On the Bombardier CR4000 the lowercase character types including those with descenders and ascenders, are less than 35 millimetres in height, whereas on the Stadler Variobahn the heights of all character types are below the minimum required height. Table 4 notes the characters heights (including pixel height) for each character type on the displays used on the fleets.



Table 4: Internal passenger information display character heights for each character type.

Character Type		Character Height (millimetres)	
		Bombardier CR4000	Stadler Variobahn
Lowercase	Standard	26 (5px)	20 (5px)
	With Ascender	32 (6px)	27 (7px)
	With Descender	32 (6px)	24 (6px)
Uppercase	Standard	43 (8px)	27 (7px)

Figures 1 and 2 show the measurements taken for the standard lowercase characters on the displays for each fleet.



Figure 1: Stadler Variobahn standard lowercase character

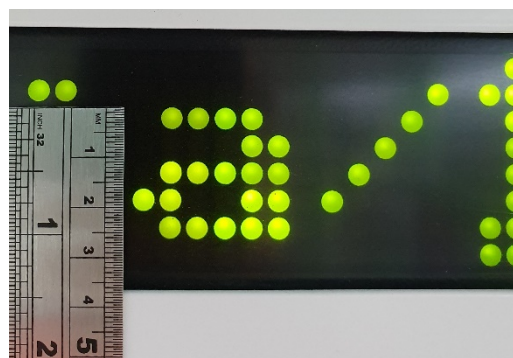


Figure 2: Bombardier CR4000 standard lowercase character

It is not possible to change the character heights on the current displays, as there are a limited number of vertical pixels available. Increasing the height of lowercase characters with ascenders and descenders will impact on the ratio of those character types compared to the uppercase characters, which is covered by requirement 4(2) in Part 2 (Additional Requirements) of RVAR 2010. The displays on both fleets will require replacing to ensure compliance with the requirements listed in Section 4.

## 6. The effect which non-compliance would have on a disabled person's ability to use trams of the description to which the application relates

*Limited or no impact* – People with a visual impairment would use the priority seats as these are closest to the doors. The closest readable displays from the priority seats and wheelchair spaces are close enough such that the required character heights of the current displays are within those specified in RVAR 2010.

Passengers positioned in passenger spaces that are over 6 metres from the nearest readable display may have difficulty reading the displays. However, other methods of passenger communication are compliant and indicate where the tram's destination is including; the external passenger information displays on the side and fronts of the trams; the internal passenger announcements; and platform displays.

No customer complaints were received between May 2017 and August 2019 concerning difficulty reading the internal passenger information displays.

## **7. The measures proposed, if the application is granted, to enable a disabled person to use the rail vehicle**

As described in section 8, London Trams proposes to change the current displays with displays that allow for character heights which are compliant with the requirements of RVAR 2010. The priority seating and wheelchair spaces are positioned such that the character heights of the nearest readable display, are greater than those specified by RVAR 2010 for the applicable distances. As such London Trams does not believe there are any measures in the short term, which could be taken to address the non-compliant clauses listed in Section 4 which are economic to carry out and provide value to a disabled person.

## **8. Any proposals for later modifications of rail vehicles to secure compliance with RVAR within a stated period**

For both fleets, proposals are underway to replace the displays with ones which are compliant with the RVAR 2010 requirements covering the internal passenger information displays.

## **9. Supplementary information for consideration**

For the Bombardier CR4000, London Trams (previously Croydon Tramlink) submitted exemption requests covering some of the clauses within section 13 (Passenger Information) of RVAR 1998.

In Statutory Instrument 2000 No. 6, exemptions were granted for Regulation 13(5)(a) and (8), and the remaining provisions of Regulation 13, but only so far as they relate to a public address system for visual announcements inside the passenger saloon of an exempted vehicle or to a public address system for audible announcements other than any such announcements required by Regulation 13(5)(b), (c) and (d).

This was later revoked and replaced by Statutory Instrument 2001 No. 3952, in which an exemption was granted for Regulation 13(5)(a).

The Bombardier CR4000 is now compliant with the Requirements under section 13 (Passenger Information) of RVAR 1998. These Regulations have now been superseded by the Requirements under Section 11 (Passenger Information) of RVAR 2010, of which both fleets are compliant except with Regulations 11(12) and 11(13). As detailed in Section 5, the internal passenger information displays do not meet the minimum character height requirements for the viewing distances from some passenger spaces to the nearest readable display.

On the Bombardier CR4000, work was previously undertaken to replace the internal displays and to install an additional two at either end of the vehicle. A trial replacement of the displays on tram 2540 was completed. The heights of all the character types on the new displays on this vehicle are greater than the required minimum of 35 millimetres. (The displays are still installed on 2540; hence it is not included in this exemption request). A full fleet roll-out was cancelled in favour of a future iTram installation. However the display replacement was eventually de-scoped from the iTram project works with no replacement strategy in place.

A two year extension would ensure adequate time to undertake all the works associated with the replacement of the internal displays on both fleets. The request for a two year

extension has been based on several factors. Changing the displays will be a time consuming piece of work, which will need to take place alongside standard fleet maintenance activities, with tram availability potentially impacting on the frequency of a fitment programme. Fleet resource will also need to be planned in for the works, with availability dependant on other works taking place. Time will be required to liaise with the vehicle manufacturers and suppliers, to procure the displays and other components necessary for the works. The display replacement will need to be factored into future budgets which will impact on when a future display replacement programme can commence.

**10. Unless permanent exemption is sought, the period during which exemption is to apply**

London Trams is requesting time limited exemptions for the clauses listed in Section 4 for all vehicles listed in Section 2.

London Trams, Bombardier CR4000 Stock, Vehicle Numbers 2530 – 2539, 2541 – 2553  
Time limited exemption – until 1st January 2022

London Trams, Stadler Variobahn Stock, Vehicle Numbers 2554 – 2565  
Time limited exemption – until 1st January 2022

# Handrail Clearances, Door Lighting, Floor Obstruction

## 1. Full name of applicant and address

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## 2. London Trams rolling stock

*Table 5: Vehicles for which the exemptions are to apply*

Manufacturer	Class	Number	Quantity
Bombardier	CR4000	2530 – 2553	24
Stadler	Variobahn	2554 – 2565	12
<b>Total</b>			36

## 3. Circumstances in which exemptions are to apply

To apply at all times in passenger service.

## 4. Relevant requirements from which exemption is sought

### 4.1. For All Vehicles

Schedule 1, Part 1, 10

10(4) *Subject to sub-paragraph (5) and (6), any passenger handrail fitted in or to a rail vehicle must comply with the following requirements –*

10(4)(b) *there must not be less than 45 millimetres clearance for a passenger's hand between any part of the handrail and any other part of the rail vehicle, excluding the mountings of the handrail to the vehicle;*

### 4.2. For Bombardier CR4000 Vehicles Only

Schedule 1, Part 1, 19

19 *There must be no obstruction to prevent, or cause unreasonable difficulty to, a reference wheelchair being manoeuvred in a rail vehicle to, from, into or out of any—*

19(b) *wheelchair space; or*

Schedule 1, Part 2, 3

3 *At a passenger doorway in the side of a rail vehicle the edge of the floor along the entrance must be illuminated by a light placed within or immediately adjacent to that edge.*

## 5. Technical, economic and operational reasons why exemption is sought

### 5.1. All Vehicles

Schedule 1, Part 1, 10(4)(b) – Distance between handrails and other parts of vehicle

On each fleet, there are two instances where the handrails to vehicle body clearances do not currently comply with the minimum specified distance of 45 millimetres.

### **Bombardier CR4000**

The handrails attached to both sides of the single priority seat (see Figures 3), have a minimum clearance of 40 millimetres between the seat cushion and handrails (variable depending on cushion wear).



*Figure 3: Priority Seat Handrails*

It would be possible to relatively easily remove the handrails from these priority seats. However, it is deemed that removing the handrails would negatively impact the user, as they can be used as an aid by passengers to help lift themselves up from the seat and help support the user in remaining on the seat whilst the tram is moving.

In the C module, the clearance between each end of the two overhead horizontal handrails is 13 millimetres with the adjacent interior panel (see Figures 4 and 5).



*Figure 4: Horizontal handrail in C module – 1*



*Figure 5: Horizontal handrail in C module – 2*

The length of the horizontal handrail could be reduced to increase the clearance between the ends of the horizontal handrail and the adjacent interior panel. However due to the height of the handrail, the small amount of space available to hold onto, and the option to use the handhold loops; it is deemed very unlikely that a passenger would try to hold this part of the handrail.

On the Bombardier CR4000, London Trams deems it uneconomical to carry out the works required to increase the clearances between the handrails and vehicle body in the instances where this is below the 45 millimetres specified by the Regulations, when compared to the benefits this would bring to passengers.

## Stadler Variobahn

There is a 20-millimetre clearance between the inner seat handholds and the lower 20 millimetres of the handrails that are fixed to the back of the seats (see Figure 6).



*Figure 6: Vertical handrail adjacent to seat handhold*

The non-compliance covers a very small portion of the lower part of the handrail and is an area which users are unlikely to use. There have been no reports of customer incidents or injuries relating to these handrails.

There are vertical handrails fitted parallel to each draft screen. They form part of the structure on which the draft screen is fixed to. The clearance between the vertical handrail and edge of the draft screen is as low as 40 millimetres (this value varies) (see Figure 7).



*Figure 7: Draft screen vertical handrail*

It is not possible to move the handrail laterally within the vehicle. Alternatively the draft screens could be replaced with glass of a smaller dimension to increase the clearance.

On the Stadler Variobahn, London Trams deems it uneconomical to carry out the works required to increase the clearances between the handrails and vehicle body in the instances where this is below the 45 millimetres specified by the Regulations, when compared to the benefits this would bring to passengers for a 5 millimetre change.

## 5.2. Bombardier CR4000 vehicles only

### Schedule 1, Part 1, 19(b) – Floor Obstruction

There is a small section of raised floor surface between the passenger doorway and the wheelchair space which could obstruct a wheelchair user when attempting to enter or leave the wheelchair space. The floor obstruction represents a step of approximately 18 millimetres at its maximum height decreasing to 0 millimetres approaching the centre of the passenger saloon (see Figures 8 & 9).



Figure 8: Profile view of floor obstruction.



Figure 9: Top down view of floor obstruction.

The raised floor edge forms part of the structure of the floor and as such cannot be removed. It would be possible to add a chamfered edge adjacent to the raised floor edge to reduce the impact of the floor obstruction. However, London Trams believes it would be uneconomical when weighed up against any benefit that this would bring to the customers.

### Schedule 1, Part 2, 3 – Door Edge Lighting

All doorways on the Bombardier CR4000 tram are non-compliant with this clause. No lighting is fitted on the tram which specifically illuminates the passenger doorways.

Two parallel channels of ceiling mounted fluorescent tube lighting (36W, 6500K, 3250lm) are installed along the length of the saloon, with diffusers fitted which spread the light out across the saloon. There are no obstacles in the way of the path of the light from the ceiling lights to the passenger doorway edges. There is also a band of yellow strip fitted across the full length of the edge of the passenger doorways which highlights the passenger doorway edge and is compliant with the Regulations.

It is not possible to comply with this Regulation without major changes to the internal structure of the tram at a significant cost. London Trams believes that the current level of lighting sufficiently illuminates the inner doorway of the vehicle and that it would be uneconomical to make the changes required when weighed up against any benefit that this would bring to the customers.

## 6. The effect which non-compliance would have on a disabled person's ability to use trams of the description to which the application relates

### 6.1. All Vehicles

#### Schedule 1, Part 1, 10(4)(b) – Distance between handrails and other parts of vehicle

Limited or no impact – On the Stadler Variobahn and Bombardier CR4000 fleets, the non-compliant handrails are situated away from the wheelchair spaces. On both fleets they are located near to or as part of the priority seating. However there is no disbenefit to any user of the vehicle as a result of these non-compliant handrails.

On the Bombardier CR4000, the non-compliant handrails of the longitudinally mounted, priority seats, provide support to disabled persons both when in the seat and for assistance when lifting themselves from the seat. It is deemed that removing these handrails would have a negative impact on disabled persons. This is similarly the case with the handrails fitted to the back of the priority seats on the Stadler Variobahn trams; providing additional points which users can grab for support when sitting and standing up from the seats.

From May 2017 to August 2019, no customer complaints were received concerning the trapping of body parts between the handrails and vehicle body. Similarly, there were no incidents reported in relation to the above from January 2014 to August 2019.

## **6.2. Bombardier CR4000 vehicles only**

### Schedule 1, Part 1, 19(b) – Floor Obstruction

*Limited or no impact* – There is a small floor obstruction between the passenger doorways and wheelchair spaces.

There is sufficient space for a reference wheelchair to navigate from the passenger doorway to the wheelchair space, such that the floor obstruction can be avoided. The obstruction is small, and unlikely to cause any difficulty to a wheelchair with the maximum height of 18 millimetres only covering a small width at the edge closest to the handrail.

From May 2017 to August 2019, no customer complaints were received concerning issues accessing and exiting the wheelchair spaces. Similarly, there were no incidents reported in relation to the above from January 2014 to August 2019.

### Schedule 1, Part 2, 3 – Door Edge Lighting

*Limited or no impact* – All passenger doorways in the Bombardier CR4000 fleet are non-compliant, including those which are nearest to the wheelchair space(s) and the priority seats.

There are two main elements which enhance the visibility of the passenger door edge. The ceiling light diffuser acts to spread the light throughout the saloon ensuring there are no 'dark spots', and a band of yellow strip is fitted the full length of each passenger doorway edge.

## **7. The measures proposed, if the application is granted, to enable a disabled person to use the rail vehicle**

London Trams does not believe there are any further measures which could be taken to address the non-compliant clauses listed in Section 4 which are economic to carry out and provide value to customers.



**8. Any proposals for later modifications of rail vehicles to secure compliance with RVAR within a stated period**

There are currently no proposals for later modifications relating to the non-compliant clauses listed in Section 4.

**9. Supplementary information for consideration**

None.

**10. Unless permanent exemption is sought, the period during which exemption is to apply**

London Trams is requesting permanent exemptions for the clauses listed in Section 4 for all vehicles listed in Section 2.

London Trams, Bombardier CR4000 Stock, Vehicle Numbers 2530 – 2553  
Permanent exemption – until end of life of the fleet

London Trams, Stadler Variobahn Stock, Vehicle Numbers 2554 – 2565  
Permanent exemption – until end of life of the fleet