Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Transport Asset Standards Authority

For queries regarding this document
standards@transport.nsw.gov.au
www.transport.nsw.gov.au

Technical Note – TN 007: 2021

Issue date: 09 June 2021

Effective date: 09 June 2021

Subject: Update to T HR RS 08001 ST *Climate Comfort and HVAC on Passenger Rolling Stock*

This technical note is issued by the Asset Management Branch (AMB) as an update to T HR RS 08001 ST Climate Comfort and HVAC on Passenger Rolling Stock, version 3.0.

A summary of the amendments is as follows:

- The addition of air filtration standard ISO 16890-1:2016 to the list of referenced documents
- Clarification of definitions and comfort requirements applying to various comfort zones and local annexes including: vestibules; food preparation or service areas; washrooms, WC and so on
- Adjustment of the minimum regulation temperature curve for 'Service Type B' long distance passenger rolling stock (Appendix B ,Figure 1)
- A note that air filtration standard EN 779 has been superseded and addition of ISO 16890:2016 (all parts) to the standard air filtration options

1. Section 3 – Reference documents

Add the following referenced international standard:

ISO 16890-1:2016 Air filters for general ventilation – Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)

© State of NSW through Transport for NSW 2021

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

2. Section 5 – Passenger and crew comfort requirements

2.1. Sub-section 5.1 Vehicle and crew cab classification

After Table 1 in sub-section 5.1, insert the following new sub-section heading:

2.1.1 5.1.1 Comfort envelope requirements

After the final paragraph in sub-section 5.1, insert the following new sub-section 5.1.2:

2.1.2 5.1.2 Comfort requirements for local annexes

Local annexes shall meet the comfort requirements as defined and specified in the applicable European standards specified in Table 1 except where varied as follows:

- For Table 1 'Service Type B' rolling stock, the comfort requirements for local annexes shall comply with EN 13129-1:2016 Section 10.2 and Section 10.3

Normally occupied vestibules shall comply with comfort envelope requirements.

Note: 'Normally occupied' vestibules are areas designed for normal passenger occupation. Vestibules designed for temporary occupation, such as gangways and/ or separated access or egress areas, are required to meet the reduced comfort requirements for local annexes in accordance with the applicable EN standard.

3. Section 6 – System performance requirements

3.1. Sub-section 6.6 CCHVAC air purification and filtration

Replace the second paragraph with the following:

Particle filters shall comply with AS 1324.1 *Air Filters for use in general ventilation and air conditioning – Part 1: Application, performance and construction* or EN779 minimum Grade G3, or ISO 16890-1:2016 ePM10 or better, or otherwise as stated in the contractual specification.

© State of NSW through Transport for NSW 2021

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

4. Appendix B – Limits for regulation temperature settings

Replace Figure 1 in Appendix B with the following Figure 1 and add Table 1:

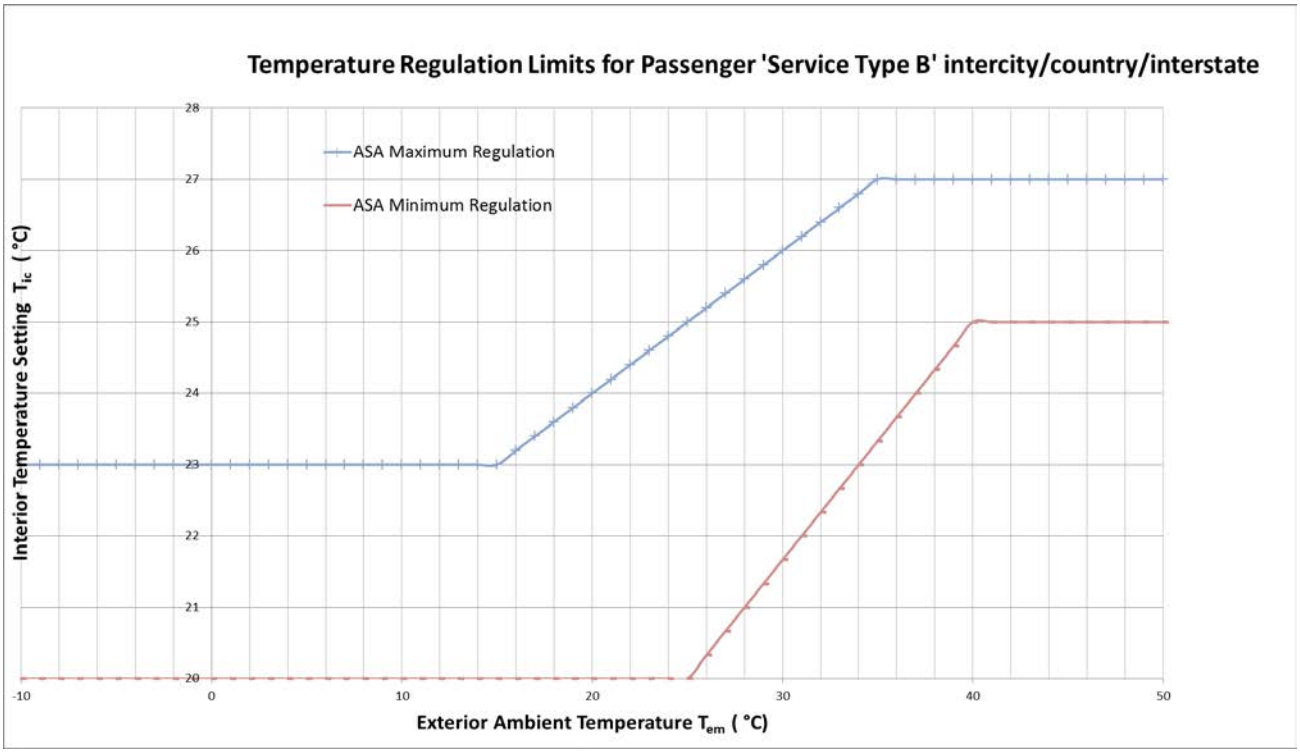

Figure 1 – Regulation Temperature Limits for 'Service Type B' inter-city, country and inter-state services

Table 1 – Regulation Temperature Limits for inter-city, country and inter-state services

Ambient Temperature T_{em} (°C)	Maximum Regulation T_{ic} (°C)	Minium Regulation T_{ic} (°C)	Ambient Temperature T_{em} (°C)	Maximum Regulation T_{ic} (°C)	Minium Regulation T_{ic} (°C)	Ambient Temperature T_{em} (°C)	Maximum Regulation T_{ic} (°C)	Minium Regulation T_{ic} (°C)
-10	23.0	20.0	10	23	20.0	30	26.0	21.7
-9	23.0	20.0	11	23	20.0	31	26.2	22.0
-8	23.0	20.0	12	23	20.0	32	26.4	22.3
-7	23.0	20.0	13	23	20.0	33	26.6	22.7
-6	23.0	20.0	14	23	20.0	34	26.8	23.0
-5	23.0	20.0	15	23	20.0	35	27.0	23.3
-4	23.0	20.0	16	23.2	20.0	36	27.0	23.7
-3	23.0	20.0	17	23.4	20.0	37	27.0	24.0
-2	23.0	20.0	18	23.6	20.0	38	27.0	24.3
-1	23.0	20.0	19	23.8	20.0	39	27.0	24.7
0	23.0	20.0	20	24	20.0	40	27.0	25.0
1	23.0	20.0	21	24.2	20.0	41	27.0	25.0
2	23.0	20.0	22	24.4	20.0	42	27.0	25.0
3	23.0	20.0	23	24.6	20.0	43	27.0	25.0
4	23.0	20.0	24	24.8	20.0	44	27.0	25.0
5	23.0	20.0	25	25	20.0	45	27.0	25.0
6	23.0	20.0	26	25.2	20.3	46	27.0	25.0
7	23.0	20.0	27	25.4	20.7	47	27.0	25.0
8	23.0	20.0	28	25.6	21.0	48	27.0	25.0
9	23.0	20.0	29	25.8	21.3	49	27.0	25.0
						50	27.0	25.0

© State of NSW through Transport for NSW 2021

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Authorisation:

Checked and approved by	Interdisciplinary coordination checked by	Authorised for release
Director Fleet Engineering	Director Engineering	Director Standards Process Development & Publishing

© State of NSW through Transport for NSW 2021

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

For queries regarding this document
standards@transport.nsw.gov.au
www.transport.nsw.gov.au

Technical Note – TN 006: 2018

Issued date: 20 April 2018

Effective date: 20 April 2018

Subject: Update to T HR RS 08001 ST *Climate Comfort and HVAC on Passenger Rolling Stock*

This technical note is issued by the Asset Standards Authority (ASA) as an update to T HR RS 08001 ST *Climate Comfort and HVAC on Passenger Rolling Stock*, version 3.0.

The summary of amendments includes the following:

- update of some references so they refer to a particular edition
- addition of new terms and definitions
- replacement of Table 1, Table 2, and Table 3
- replacement of Figure 4

1. Section 3 Reference documents

Replace the EN standards listed in Section 3 with the following:

- EN 13129-1 shall refer to EN 13129-1:2002 *Railway Applications – Air Conditioning for Main Line Rolling Stock – Part 1: Comfort Parameters*
- EN 13129-2 shall refer to EN 13129-2:2004 *Railway Applications – Air Conditioning for Main Line Rolling Stock – Part 2: – Type Tests*
- All references to EN standard EN 13129 shall refer to EN 13129-1: 2002 *Railway Applications – Air Conditioning for Main Line Rolling Stock – Part 1: Comfort Parameters* or EN 13129-2: 2004 *Railway Applications – Air Conditioning for Main Line Rolling Stock – Part 2 – Type Tests*, or both, as applicable
- EN 14750-1 shall refer to EN 14750-1:2006 *Railway applications – Air conditioning for urban and suburban rolling stock – Part 1: Comfort parameters*
- EN 14750-2 shall refer to EN 14750-2:2006 *Railway applications – Air conditioning for urban and suburban rolling stock – Part 2: Type tests*

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

- EN 14813-1 shall refer to EN 14813-1:2006 *Railway applications – Air conditioning for driving cabs – Part 1: Comfort parameters*
- EN 14813-2 shall refer to EN 14813-2:2006 *Railway applications – Air conditioning for driving cabs – Part 2: Type tests*

Replace ISO 7730 listed in Section 3 as follows:

ISO 7730:2005(E) *Ergonomics of the Thermal Environment – Analytical Determination and Interpretation of Thermal Comfort Using Calculation of the PMV and PPD Indices and Local Thermal Comfort Criteria*

2. Section 4 Terms and definitions

Add the following terms in Section 4:

T_{sf} interior surface temperature

DT_{sf} range of interior surface temperature within the comfort zone

3. Section 5 Passenger and crew comfort requirements

Replace Table 1 in Section 5.1 with the following:

Table 1 - Interior climate comfort performance standards for heavy rail passenger services

Climate comfort area	Service Type A Total journey time not exceeding 1.5 hours (for example, urban, suburban)	Service Type B Total journey time exceeding 1.5 hours (for example, intercity, country, interstate)
Passenger, passenger and crew shared areas, and non-cab crew areas	EN 14750-1 Category A or EN 13129-1	EN 13129-1
Occupied crew cabs	EN 14813-1 Category A	EN 14813-1 Category A

Replace Table 2 in Section 5.1 with Table 2a, Table 2b, and Table 2c as follows:

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Table 2a - Service Type A (urban / suburban) - Limits for climate comfort parameters for passenger, and shared passenger and crew comfort zones

Comfort parameter	**Extended climate range** **Extreme low ambient** **$T_a \leq -5$ ºC**	**Extended climate range** **Low ambient** **-5 ºC $\leq T_a \leq$ 0 ºC**	**Normal climate range** **Normal operating range** **0 ºC $\leq T_a \leq$ 40 ºC**	**Extended climate range** **High ambient** **40 ºC $< T_a \leq$ 46 ºC**	**Extended climate range** **Extreme high ambient** **46 ºC $< T_a$**
System operating range without shutting down	50 ºC $\leq T_a$(op range limits) ≤ -10 ºC	50 ºC $\leq T_a$(op range limits) ≤ -10 ºC	50 ºC $\leq T_a$(op range limits) ≤ -10 ºC	50 ºC $\leq T_a$(op range limits) ≤ -10 ºC	50 ºC $\leq T_a$(op range limits) ≤ -10 ºC
Systems RAMS performance in accordance with EN 50126	Contractual specification	Contractual specification	Contractual specification	Contractual specification	Contractual specification
Mean interior temperature (T_{im}) relative to temperature setting (T_s) within the limits for T_{im}	±3.0 °C	±2.5 °C	±2 °C	±2.5 ºC	±3 °C
Temperature regulation curve (T_s v T_a)	Refer to Appendix B Figure 2	Refer to Appendix B Figure 2	Refer to Appendix B Figure 2	Refer to Appendix B Figure 2	Refer to Appendix B Figure 2
Mean interior temperature (T_{im})	18 ºC $\leq T_{im} \leq$ 22 °C	19 ºC $\leq T_{im} \leq$ 22 °C	19 ºC $\leq T_{im} \leq$ 30 °C	25 ºC $\leq T_{im} \leq$ 30 °C	26 ºC $\leq T_{im} \leq$ 30 °C
Relative humidity	EN 14750-1:2002 Annex C, Fig C.1	EN 14750-1:2002 Annex C, Fig C.1	EN 14750-1:2002 Annex C, Fig C.1	EN 14750-1:2002 Annex C, Fig C.1	EN 14750-1:2002 Annex C, Fig C.1
Maximum vertical temperature difference within the comfort zone (sitting pax)	4.5	4.0	4.0	4.0	4.5
Maximum vertical temperature difference within the comfort zone (standing pax)	5.0	4.5	4.5	4.5	5.0
Maximum horizontal temperature difference within the comfort zone	4.5	4.0	4.0	4.0	4.5
Maximum air speed	EN 14750-1:2002 Annex B, Fig B.1	EN 14750-1:2002 Annex B, Fig B.1	EN 14750-1:2002 Annex B, Fig B.1	EN 14750-1:2002 Annex B, Fig B.1	EN 14750-1:2002 Annex B, Fig B.1
Minimum fresh air flow rate for normal operation (m^3/h/person)	EN 14750-1:2002 Annex G Category A	EN 14750-1:2002 Annex G Category A	EN 14750-1:2002 Annex G Category A	EN 14750-1:2002 Annex G Category A	EN 14750-1:2002 Annex G Category A

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Comfort parameter	**Extended climate range** **Extreme low ambient** **$T_a \leq -5$ ºC**	**Extended climate range** **Low ambient** **-5 ºC $\leq T_a \leq$ 0 ºC**	**Normal climate range** **Normal operating range** **0 ºC $\leq T_a \leq$ 40 ºC**	**Extended climate range** **High ambient** **40 ºC < $T_a \leq$ 46 ºC**	**Extended climate range** **Extreme high ambient** **46 ºC < T_a**
Minimum fresh air flow rate by alternative assessment (m^3/h/person)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)
Maximum vehicle heat transfer coefficient, h (w/m^2/°C)	h ≤ 2.5	h ≤ 2.5	h ≤ 2.5	h ≤ 2.5	h ≤ 2.5
Time allowed for heat-up or cool-down without passengers before entering service	t ≤ 60 min unless varied by the contractual specification	t ≤ 45 min unless varied by the contractual specification	t ≤ 30 min unless varied by the contractual specification	t ≤ 45 min unless varied by the contractual specification	t ≤ 60 min unless varied by the contractual specification
Climate comfort standard under normal operating conditions ISO 7730:2005 Annex A Table A.1	N/A	N/A	Category C ISO 7730:2005 Annex A Table A.1	N/A	N/A
Percentage of time in passenger service meeting climate comfort performance standard of Appendix C.2 Figure 4 and Figure 5. This performance parameter allows for door open-close and transients but excludes time in high or low conditions (refer Figure 4a)	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	90% refer Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2
Maximum range and limits of surface* temperatures (DT_{sf}, T_{sf}) *Excluding glazing and heater and cooler outlet surfaces	DT_{sf} < 15 °C and 8 °C < T_{sf} < 32 °C	DT_{sf} < 12 °C and 10 °C < T_{sf} < 32 °C	DT_{sf} < 10 °C and 15 °C < T_{sf} < 32 °C	DT_{sf} < 12 °C and 15 °C < T_{sf} < 35 °C	DT_{sf} < 15 °C and 15 °C < T_{sf} < 37 °C

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Table 2b - Service Type B (intercity/country/interstate) - Limits for climate comfort parameters for passenger, and shared passenger/ and crew comfort zones

Comfort parameter	**Extended climate range** **Extreme low ambient** **$T_a \leq -5^oC$**	**Extended climate range** **Low ambient** **$-5^oC \leq T_a \leq 0^oC$**	**Normal climate range** **Normal operating range** **$0^oC \leq T_a \leq 40^oC$**	**Extended climate range** **High ambient** **$40^oC < T_a \leq 46^oC$**	**Extended climate range** **Extreme high ambient** **$46^oC < T_a$**
System operating range without shutting down	50 ºC ≤ Ta(op range limits) ≤ -10 ºC	50 ºC ≤ Ta(op range limits) ≤ -10 ºC	50 ºC ≤ Ta(op range limits) ≤ -10 ºC	50 ºC ≤ Ta(op range limits) ≤ -10 ºC	50 ºC ≤ Ta(op range limits) ≤ -10 ºC
Systems RAMS performance in accordance with EN 50126	Contractual specification	Contractual specification	Contractual specification	Contractual specification	Contractual specification
Mean interior temperature (T_{im}) relative to temperature setting (T^s) within the limits for T_{im}	±2.5 °C	±2.0 °C	±1.5 °C	±2.0 ºC	±3.0 °C
Temperature regulation curve (T_s v T_a)	Refer to Appendix B Figure 1	Refer to Appendix B Figure 1	Refer to Appendix B Figure 1	Refer to Appendix B Figure 1	Refer to Appendix B Figure 1
Mean interior temperature (T_{im})	18 ºC ≤ T_{im} ≤ 22 °C	19 ºC ≤ T_{im} ≤ 23 °C	20 ºC ≤ T_{im} ≤ 27 °C	25 ºC ≤ T_{im} ≤ 29 °C	25 ºC ≤ T_{im} ≤ 30 °C
Relative humidity	EN 13129-1:2002 Annex C, Fig C.1	EN 13129-1:2002 Annex C, Fig C.1	EN 13129-1:2002 Annex C, Fig C.1	EN 13129-1:2002 Annex C, Fig C.1	EN 13129-1:2002 Annex C, Fig C.1
Maximum vertical temperature difference within the comfort zone (sitting pax)	4.5	4.0	3.5	4.0	4.5
Maximum vertical temperature difference within the comfort zone (standing pax)	5.0	4.5	4.0	4.5	5.0
Maximum horizontal temperature difference within the comfort zone	3.5	3.0	2.5	3.0	3.5
Maximum air speed	EN 13129-1:2002 Annex B, Fig B.1	EN 13129-1:2002 Annex B, Fig B.1	EN 13129-1:2002 Annex B, Fig B.1	EN 13129-1:2002 Annex B, Fig B.1	EN 13129-1:2002 Annex B, Fig B.1

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Comfort parameter	**Extended climate range** **Extreme low ambient** **$T_a \leq -5°C$**	**Extended climate range** **Low ambient** **$-5°C \leq T_a \leq 0°C$**	**Normal climate range** **Normal operating range** **$0°C \leq T_a \leq 40°C$**	**Extended climate range** **High ambient** **$40°C < T_a \leq 46°C$**	**Extended climate range** **Extreme high ambient** **$46°C < T_a$**
Minimum fresh air flow rate for normal operation (m^3/h/person)	EN 13129-1:2002 Annex F, Table F.1	EN 13129-1:2002 Annex F, Table F.1	EN 13129-1:2002 Annex F, Table F.1	EN 13129-1:2002 Annex F, Table F.1	EN 13129-1:2002 Annex F, Table F.1
Minimum fresh air flow rate by alternative assessment (m^3/h/person)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)
Maximum vehicle heat transfer coefficient, h ($w/m^2/°C$)	$h \leq 2.5$	$h \leq 2.5$	$h \leq 2.5$	$h \leq 2.5$	$h \leq 2.5$
Time allowed for heat-up or cool-down without passengers before entering service	$t \leq 60$ min unless varied by the Contractual Specification	$t \leq 45$ min unless varied by the Contractual Specification	$t \leq 30$ min unless varied by the Contractual Specification	$t \leq 45$ min unless varied by the Contractual Specification	$t \leq 60$ min unless varied by the Contractual Specification
Climate comfort standard under normal operating conditions ISO 7730:2005 Annex A, Table A.1	N/A	N/A	Category B ISO 7730:2005 Annex A Table A.1	N/A	N/A
Percentage of time in passenger service meeting climate comfort performance standard of Appendix C.2 Figure 4 and Figure 5. This performance parameter allows for door open-close, but excludes time in high or low ambient conditions (refer Figure 4b)	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	90 % refer Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2
Maximum range and limits of surface* temperatures (DT_{sf}, T_{sf}) *Excluding glazing and heater and cooler outlet surfaces	$DT_{sf} < 15$ °C and 8 °C $< T_{sf} < 30$ °C	$DT_{sf} < 12$ °C and 10 °C $< T_{sf} < 30$ °C	$DT_{sf} < 10$ °C and 15 °C $< T_{sf} < 30$ °C	$DT_{sf} < 12$ °C and 15 °C $< T_{sf} < 32$ °C	$DT_{sf} < 15$ °C and 15 °C $< T_{sf} < 35$ °C

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Table 2c - Service Type A or B - Limits for climate comfort parameters for occupied crew cabs

Comfort parameter	**Extended climate range** **Extreme low ambient** **$T_a \leq -5$ ºC**	**Extended climate range** **Low ambient** **-5 ºC ≤ T_a ≤ 0 ºC**	**Normal climate range** **Normal operating range** **0 ºC ≤ T_a ≤ 40 ºC**	**Extended climate range** **High ambient** **40 ºC < T_a ≤ 46 ºC**	**Extended climate range** **Extreme high ambient** **46 ºC < T_a**
System operating range without shutting down	50 ºC ≤ Ta(op) ≤-10 ºC	50 ºC ≤ Ta(op) ≤-10 ºC	50 ºC ≤ Ta(op) ≤-10 ºC	50 ºC ≤ Ta(op) ≤-10 ºC	50 ºC ≤ Ta(op) ≤-10 ºC
Systems RAMS performance in accordance with EN 50126	Contractual specification	Contractual specification	Contractual specification	Contractual specification	Contractual specification
Mean interior temperature (T_{im}) relative to temperature setting (T_s) within the limits for T_{im}	±2.0 °C	±1.5 °C	±1.5 °C	±1.5 ºC	±2.0 °C
Temperature regulation curve (T_s v T_a)	Refer to Appendix B Figure 3	Refer to Appendix B Figure 3	Refer to Appendix B Figure 3	Refer to Appendix B Figure 3	Refer to Appendix B Figure 3
Mean interior temperature (T_{im})	18 ºC ≤ T_{im} ≤ 24 °C	18 ºC ≤ T_{im} ≤ 24 °C	18 ºC ≤ T_{im} ≤ 27 °C	24 ºC ≤ T_{im} ≤ 27 °C	24 ºC ≤ T_{im} ≤ 28 °C and RH ≤ 48%
Relative humidity	EN 14183-1:2006 Annex B, Fig B.1 (Category A)	EN 14183-1:2006 Annex B, Fig B.1 (Category A)	EN 14183-1:2006 Annex B, Fig B.1 (Category A)	EN 14183-1:2006 Annex B, Fig B.1 (Category A)	EN 14183-1:2006 Annex B, Fig B.1 (Category A)
Maximum vertical temperature difference within the comfort zone (sitting pax)	4.0	3.5	3.0	3.5	4.0
Maximum vertical temperature difference within the comfort zone (standing pax)	4.5	4.0	3.5	4.0	4.5
Maximum horizontal temperature difference within the comfort zone	4.0	3.5	3.0	3.5	4.0
Maximum air speed	EN 14183-1:2006 Annex A, Fig A.1 (Category A)	EN 14183-1:2006 Annex A, Fig A.1 (Category A)	EN 14183-1:2006 Annex A, Fig A.1 (Category A)	EN 14183-1:2006 Annex A, Fig A.1 (Category A)	EN 14183-1:2006 Annex A, Fig A.1 (Category A)

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Comfort parameter	**Extended climate range** **Extreme low ambient** **$T_a \leq -5$ ºC**	**Extended climate range** **Low ambient** **-5 ºC $\leq T_a \leq$ 0 ºC**	**Normal climate range** **Normal operating range** **0 ºC $\leq T_a \leq$ 40 ºC**	**Extended climate range** **High ambient** **40 ºC $< T_a \leq$ 46 ºC**	**Extended climate range** **Extreme high ambient** **46 ºC $< T_a$**
Minimum fresh air flow rate for normal operation (m^3/h/person)	30 m^3/h/person	30 m^3/h/person	30 m^3/h/person	30 m^3/h/person	30 m^3/h/person
Minimum fresh air flow rate by alternative assessment (m^3/h/Person)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)	Safe operating limit with assurance argument meeting SFAIRP criteria (refer Section 5.2 and Section 11)
Maximum vehicle heat transfer coefficient, h ($w/m^2/°C$)	$h \leq 2.5$	$h \leq 2.5$	$h \leq 2.5$	$h \leq 2.5$	$h \leq 2.5$
Time allowed for heat-up or cool-down without passengers before entering service	$t \leq 60$ min unless varied by the Contractual Specification	$t \leq 45$ min unless varied by the Contractual Specification	$t \leq 30$ min unless varied by the Contractual Specification	$t \leq 45$ min unless varied by the Contractual Specification	$t \leq 60$ min unless varied by the Contractual Specification
Climate comfort standard under normal operating conditions ISO 7730:2005 Annex A Table A.1	N/A	N/A	Category A ISO 7730:2005 Annex A Table A.1	N/A	N/A
Percentage of time in passenger service meeting climate comfort performance standard of Appendix C.2 Figure 4 and Figure 5. This performance parameter allows for door open-close and transients but excludes time in high or low conditions (refer Figure 5)	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	98 % refer Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2	Time in these conditions is not counted for calculation of the performance standard of Appendix C.2
Maximum range and limits of surface* temperatures (DT_{sf}, T_{sf}) *Excluding glazing and heater and cooler outlet surfaces	$DT_{sf} < 12$ °C and 12 °C $< T_{sf} <$ 30 °C	$DT_{sf} < 9$ °C and 15 °C $< T_{sf} <$ 30 °C	$DT_{sf} < 7$ °C and 18 °C $< T_{sf} <$ 30 °C	$DT_{sf} < 9$ °C and 20 °C $< T_{sf} <$ 32 °C	$DT_{sf} < 12$ °C and 20 °C $< T_{sf} <$ 35 °C

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Table 3 of Appendix C.2 is replaced with Table 3a and Table 3b as follows:

Table 3a - Climate comfort performance scale for passenger, and passenger and crew shared areas for Service Type A – urban and suburban

PMV scale	-3	-2	-1	-0.7	0	+0.7	+1	+2	+3
PPD	90	75	25	15	5	15	25	75	90
Survey score	1	2	3	4	5	4	3	2	1
Descriptor	Cold (Uncomfortable)	Cool (Discomfort)	Slightly cool (Minor discomfort)	Comfortably cool	Neutral unaware	Comfortably warm	Slightly warm (Minor discomfort)	Warm (Discomfort)	Hot (Uncomfortable)

Table 3b - Climate comfort performance scale for passenger, and passenger and crew shared areas for Service Type B – intercity, country and interstate

PMV scale	-3	-2	-1	-0.5	0	+0.5	+1	+2	+3
PPD	90	75	25	10	5	10	25	75	90
Survey score	1	2	3	4	5	4	3	2	1
Descriptor	Cold (Uncomfortable)	Cool (Discomfort)	Slightly cool (Minor discomfort)	Comfortably cool	Neutral unaware	Comfortably warm	Slightly warm (Minor discomfort)	Warm (Discomfort)	Hot (Uncomfortable)

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

4. Appendix C.2

Replace Figure 4 of Appendix C.2 with Figure 4a and Figure 4b as follows:

Time in passenger service under normal ambient operating conditions (A) 0 °C ≤ T_a ≤ 40 °C	Time not in passenger service and time operating in extended ambient operating conditions

Time in passenger service meeting the ISO 7730 Annex A.1 Category 'C' climate comfort level (B)	Time in passenger service NOT meeting the Category 'C' climate comfort level (C)

24 hour period

Passenger, passenger and crew shared areas:
Performance level = (B / A) * 100% = (B*100%) / [B + C]
Performance standard PL ≥ 90%

Figure 4a - Climate comfort performance standard for passenger, and passenger and crew shared areas for Service Type A – urban and suburban

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Time in passenger service under normal ambient operating conditions (A) 0 °C ≤ T_a ≤ 40 °C	Time not in passenger service and time operating in extended ambient operating conditions

Time in passenger service meeting the ISO 7730 Annex A.1 Category 'B' climate comfort level (B)	Time in passenger service NOT meeting the Category 'B' climate comfort level (C)

24 hour period

Passenger, passenger and crew shared areas:
Performance level = (B / A) * 100% = (B*100%) / [B + C]
Performance standard PL ≥ 90%

Figure 4b - Climate comfort performance standard for passenger, and passenger and crew shared areas for Service Type B – intercity, country and interstate

Authorisation:

	Technical content prepared by	Checked and approved by	Interdisciplinary coordination checked by	Authorised for release
Signature				
Date				
Name	Harry Snaith	Michael Uhlig	Jason R Gordon	Jagath Peiris
Position	Principal Engineer Rolling Stock Mechanical Systems	Lead Rolling Stock Engineer	Chief Engineer	Director Network Standards and Services

© State of NSW through Transport for NSW 2018

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

T HR RS 08001 ST

Standard

Climate Comfort and HVAC on Passenger Rolling Stock

Version 3.0

Issued date: 09 December 2016

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Important message

This document is one of a set of standards developed solely and specifically for use on Transport Assets (as defined in the Asset Standards Authority Charter). It is not suitable for any other purpose.

The copyright and any other intellectual property in this document will at all times remain the property of the State of New South Wales (Transport for NSW).

You must not use or adapt this document or rely upon it in any way unless you are providing products or services to a NSW Government agency and that agency has expressly authorised you in writing to do so. If this document forms part of a contract with, or is a condition of approval by a NSW Government agency, use of the document is subject to the terms of the contract or approval. To be clear, the content of this document is not licensed under any Creative Commons Licence.

This document may contain third party material. The inclusion of third party material is for illustrative purposes only and does not represent an endorsement by NSW Government of any third party product or service.

If you use this document or rely upon it without authorisation under these terms, the State of New South Wales (including Transport for NSW) and its personnel does not accept any liability to you or any other person for any loss, damage, costs and expenses that you or anyone else may suffer or incur from your use and reliance on the content contained in this document. Users should exercise their own skill and care in the use of the document.

This document may not be current and is uncontrolled when printed or downloaded. Standards may be accessed from the Asset Standards Authority website at www.asa.transport.nsw.gov.au.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Standard governance

Owner: Lead Rolling Stock Engineer, Asset Standards Authority

Authoriser: Chief Engineer, Asset Standards Authority

Approver: Executive Director, Asset Standards Authority on behalf of the ASA Configuration Control Board

Document history

Version	Summary of changes
1.0	First issue
2.0	Second issue, December 2014 Changes to Table 2 and removal of reference to EN 45545 (Section 5.2)
3.0	Third issue Incorporation of content from technical note TN 084: 2015

For queries regarding this document,
please email the ASA at
standards@transport.nsw.gov.au
or visit www.asa.transport.nsw.gov.au

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Preface

The Asset Standards Authority (ASA) is a key strategic branch of Transport for NSW (TfNSW). As the network design and standards authority for NSW Transport Assets, as specified in the *ASA Charter*, the ASA identifies, selects, develops, publishes, maintains and controls a suite of requirements documents on behalf of TfNSW, the asset owner.

The ASA deploys TfNSW requirements for asset and safety assurance by creating and managing TfNSW's governance models, documents and processes. To achieve this, the ASA focuses on four primary tasks:

- publishing and managing TfNSW's process and requirements documents including TfNSW plans, standards, manuals and guides
- deploying TfNSW's Authorised Engineering Organisation (AEO) framework
- continuously improving TfNSW's Asset Management Framework
- collaborating with the Transport cluster and industry through open engagement

The AEO framework authorises engineering organisations to supply and provide asset related products and services to TfNSW. It works to assure the safety, quality and fitness for purpose of those products and services over the asset's whole of life. AEOs are expected to demonstrate how they have applied the requirements of ASA documents, including TfNSW plans, standards and guides, when delivering assets and related services for TfNSW.

Compliance with ASA requirements by itself is not sufficient to ensure satisfactory outcomes for NSW Transport Assets. The ASA expects that professional judgement be used by competent personnel when using ASA requirements to produce those outcomes.

About this document

This standard covers the requirements for climate comfort and heating, ventilation, and air conditioning (HVAC) for passenger rolling stock owned by Transport for NSW (TfNSW).

This document has been approved by the ASA configuration control board and is a third issue.

Version 3 of this document incorporates the contents stated in the technical note TN 084: 2015 *Update to T HR RS 08001 ST Climate Comfort and HVAC on Passenger Rolling Stock*.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Table of contents

1. Introduction ... 7
2. Purpose ... 7
2.1. Scope ... 7
2.2. Application ... 7
3. Reference documents ... 8
4. Terms and definitions ... 10
5. Passenger and crew comfort requirements ... 11
5.1. Vehicle and crew cab classification ... 11
5.2. Fresh air rates and air quality ... 12
6. System performance requirements ... 13
6.1. Climate and operating conditions ... 13
6.2. System cooling and heating capacity ... 13
6.3. Interior noise ... 13
6.4. Fresh air inlets ... 14
6.5. Internal pressure ... 14
6.6. CCHVAC Air purification and filtration ... 14
6.7. Operating modes ... 15
6.8. System efficiency ... 15
6.9. System design and general requirements ... 15
7. Power supply and system requirements ... 16
8. System safety requirements and failure modes ... 16
9. Communication, monitoring and control ... 17
9.1. Interior climate comfort regulation ... 17
9.2. Crew monitoring and controls ... 19
10. Vehicle and network integration requirements ... 19
11. RAMS, asset management and through life support ... 20
11.1. Reliability and availability ... 20
11.2. Maintainability ... 21
11.3. Safety ... 21
11.4. Asset management and through life support ... 21
12. Environmental and sustainability requirements ... 22
12.1. Refrigerants ... 23
12.2. Restricted and prohibited materials ... 23
13. Verification, validation and documentation requirements ... 23
13.1. Configuration management and systems engineering ... 23
13.2. Testing, verification and validation ... 24
13.3. Documentation deliverables ... 24
Appendix A Climate data and operating conditions for the NSW network ... 25

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Appendix B Temperature regulation curve limits for passenger rolling stock for NSW 26

Appendix C Process logic and climate comfort performance standard 28

C.1. Process logic for CCHVAC design 28

C.2. Climate comfort performance standard 30

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

1. Introduction

The Climate Comfort and HVAC on Passenger Rolling Stock standard specifies the requirements for climate comfort, heating, ventilation and air conditioning (CCHVAC) for passenger rolling stock owned by Transport for New South Wales (TfNSW).

This standard applies the principles of climate comfort science as presented in ISO 7730 *Ergonomics of the thermal environment – Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria* and ASHRAE 55-2013 *Thermal Environment Conditions for Human Occupancy* within the limits for climate parameters prescribed in European standards for railway applications. Using this approach, the interior climate control on passenger rolling stock will deliver a high level of climate comfort throughout the range of operating conditions experienced in NSW while maximising energy efficiency. In line with these principles, interior climate comfort levels will be monitored and optimised by fine tuning the control algorithm in response to customer and crew survey.

2. Purpose

The purpose of this standard is to ensure that an appropriate standard for interior climate comfort for passengers and crew and other personnel is maintained on TfNSW passenger rolling stock in service on the NSW and interstate rail network.

This standard specifies the requirements for CCHVAC for passenger rolling stock used primarily on NSW rail networks and owned by TfNSW. This standard includes guidance notes to assist in meeting the requirements.

2.1. Scope

This standard specifies the minimum operating standards for CCHVAC for passenger rolling stock owned by TfNSW. This standard references and requires compliance with several international standards. Where conflict exists between the requirements stated in international standards and this standard, then the requirements providing the higher level of safety and climate comfort takes precedence.

2.2. Application

This standard is intended for use by all stakeholders involved with passenger rolling stock operated on behalf of TfNSW.

This ASA standard applies to heavy rail passenger rolling stock for service primarily in NSW including interstate services that traverse parts of interstate rail networks. This standard currently does not apply to light rail vehicles and rapid transit rolling stock.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

3. Reference documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

International standards

ANSI/ASHRAE 55-2013 Thermal Environment Conditions for Human Occupancy

EN 779 Particulate air filters for general ventilation – Determination of the filtration performance

EN 13129-1 Air conditioning for mainline rolling stock – Part 1: Comfort parameters

EN 13129-2 Air conditioning for mainline rolling stock – Part 2: Type tests

EN 14067 Part 5: 2006 Aerodynamics – Part 5: Requirements and test procedures for aerodynamics in tunnels

EN 14750-1 Railway applications – Air conditioning for urban and suburban rolling stock – Part 1: Comfort parameters

EN 14750-2 Railway applications – Air conditioning for urban and suburban rolling stock – Part 2: Type tests

EN 14813-1 Railway applications – Air conditioning for driving cabs – Part 1: Comfort parameters

EN 14813-2 Railway applications – Air conditioning for driving cabs – Part 2: Type tests

EN 50126 Railway applications – Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) -- Part 1: Basic requirements and generic process

IEC 61133 Railway applications – Rolling stock – Testing of rolling stock on completion of construction and before entry into service

ISO 7730 Ergonomics of the Thermal Environment – Analytical Determination and Interpretation of Thermal Comfort Using Calculation of the PMV and PPD Indices and Local Thermal Comfort Criteria

ISO 15288:2008 Systems and Software Engineering – System life cycle processes

Australian standards

AS 1324.1 Air filters for use in general ventilation and air conditioning – Part 1: Application, performance and construction

AS 1324.2 Air filters for use in general ventilation and air conditioning – Part 2: Methods of test

AS 1668.2 The use of ventilation and air conditioning in buildings – Part 2: Mechanical ventilation in buildings

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

AS 4260 High efficiency particulate air (HEPA) filters – Classification, construction and performance

AS 7513.3 Railway Rolling Stock – Interior Environment – Part 3: Passenger Rolling Stock (published by RISSB)

HB 40 The Australian Air Conditioning and Refrigeration Code of Good Practice

Transport for NSW standards

T HR RS 00000 ST RSU 000 Series – Minimum Operating standards for Rolling Stock – General Requirements

T HR HF 00001 ST Human Factors Integration – Rolling Stock

T MU AM 01001 ST Life Cycle Costing

T MU AM 01002 MA Maintenance Requirements Analysis Manual

T MU HF 00001 GU AEO Guide to Human factors Integration

T MU HF 00001 ST Human Factors Integration – General Requirements

T HR RS 00117 ST Electric Circuits and Equipment for Passenger Rolling Stock

T HR RS 00126 ST Electronic Equipment Supplied for Passenger Rolling Stock

T HR RS 00164 ST Electrical Cable for Passenger Rolling Stock

T HR RS 01701 ST Mounting and Installation of Electrical Equipment

T HR RS 10001 ST Electric Auxiliary Power Supply and Battery System for Passenger Rolling Stock

T HR RS 17010 ST Passenger Rolling Stock Fire Safety

T MU RS 17001 ST Environmental Conditions for Rolling Stock

T MU RS 17002 ST Prohibited and Restricted Materials

TS 20001 System Safety Standard for New or Altered Assets

TS 10752 Railway Asset Product Configuration Information Requirements

T MU AM 06006 ST Systems Engineering

Legislation

Ozone Protection and Synthetic Greenhouse Gas Management Act 1989 and all related legislation and Amendments

Rail Safety (Adoption of National Law) Act NSW 2012 and Regulations

Safe Work Australia: Workplace Exposure Standards for Airborne Contaminants

Work Health and Safety Act 2011 and Regulations

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Other reference documents (not cited)

AIRAH (Australian Institute of Refrigeration, Air conditioning and Heating) Handbook DA09

ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Applications Handbook

National Industrial Chemicals Notification and Assessment Scheme (NICNAS)

Safe Work Australia: Workplace Exposure Standards for Airborne Contaminants

UNIFE Railway Industry Substance List [www.unife-database.org]

4. Terms and definitions

The following terms and definitions apply in this document:

AEO Authorised Engineering Organisation

ASA Asset Standards Authority

CCHVAC climate comfort, heating, ventilation, and air conditioning

contractual specification the contract between rolling stock purchaser and supplier

EAPS electrical auxiliary power supply

FMECA failure modes, effects, and criticality analysis

HVAC heating, ventilation, and air conditioning

interior climate comfort satisfaction associated with temperature and atmosphere of the interior environment (based on 'six climate parameters' defined in ISO 7730 and ASHRAE 55-2013)

PMV predicted mean vote

PPD predicted percentage dissatisfied

RAMS reliability, availability, maintainability, and safety

regulation temperature curve the relationship between external ambient temperature (Ta) and the interior temperature setting (Ts)

RH relative humidity

SFAIRP so far as is reasonably practicable

Ta ambient air temperature external to the vehicle and adjacent to the CCHVAC fresh air inlet (effectively the temperature of the air entering the system) and equivalent to 'Tem' as defined in EN 13129

TfNSW Transport for New South Wales

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Ti actual interior air temperature at a point in space within the comfort envelope (equivalent to 'Tir' in EN 13129)

Tim mean interior temperature as defined in the referenced EN standards allowing for minor differences in vehicle design and definitions of 'normally occupied areas' (comfort envelope) of the vehicle. The mean interior temperature of each comfort envelope/occupied area may be treated separately

Ts interior temperature setting as determined by the regulation temperature curve equivalent to 'Tic' in the referenced EN standards

vestibule normally occupied space that may include a combination of standing and seating areas, may be in proximity of the passenger bodyside doors, and may be separate from the main seating area

5. Passenger and crew comfort requirements

Section 5.1 describes the classification of vehicles and crew cabs. Section 5.2 describes the rates of fresh air and air quality.

5.1. Vehicle and crew cab classification

Except where varied by this standard, TfNSW heavy rail passenger rolling stock assets shall comply with the performance standards listed in Table 1.

Table 1 – Interior climate comfort performance standards for heavy rail passenger services

Climate comfort area	Service Type A Total journey time not exceeding 1.5 hours (for example, urban, suburban)	Service Type B Total journey time exceeding 1.5 hours (for example, inter-city, country, inter-state)
Passenger, passenger / crew shared areas and non-cab crew areas	EN 14750 Category A or EN 13129	EN 13129
Occupied crew cabs	EN 14813 Category A	EN 14813 Category A

Note: The applicable vehicle journey time or service type should be stated in the contractual specification or determined from the operational requirements.

Interior climate comfort for all passengers and crew shall meet the climate comfort requirements of the applicable performance standard specified in Table 1, for the full range of climatic and environmental operating conditions in the relevant parts of the rail network and not limited by the climatic zones defined in the various Euronorm standards.

The regulation temperature curves shall be within the limits defined in Figure 1, Figure 2 or Figure 3 in Appendix B, as applicable.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Note: The supplier may select the regulation curve in consultation with the operator. The regulation may be subsequently adjusted to maintain the climate comfort standard defined in Section 9.1.

The range of interior temperature with respect to the interior temperature setting shall comply with the limits shown in Table 2.

Table 2 – Limits for the range of interior temperature (Ti) with respect to the interior temperature setting (Ts)

Service type	Comfort envelope	-10ºC ≤ Ta ≤ 40ºC Normal operating range	40ºC < Ta ≤ 46ºC High ambient	46ºC < Ta Extreme high ambient
(A) Urban / suburban	Passenger / crew	±2°C	±2ºC and Tim ≤ 30ºC	±3°C and Tim ≤ 30 °C
(B) Intercity / country / interstate	Passenger / crew	±1°C	±2ºC and Tim ≤ 29ºC	±3°C and Tim ≤ 30 °C RH ≤ 45%
All	Occupied crew cabs with local controls per Section 9	±1.5°C	±1.5°C and Tim ≤ 27°C	±1.5°C and Tim ≤ 27°C

In Table 2, the three columns on the right together give the ambient temperature range (fresh air inlet temperature).

The climate comfort limits defined in the applicable EN standards, including fresh air supply rates, shall cover all vehicle areas normally occupied by passengers or crew.

5.2. Fresh air rates and air quality

Fresh air supply rates for all passenger areas shall be not less than the normal operational limits given in the applicable standard from Table 1 for all operating conditions and for the number of passengers stipulated in the contractual specification. The rates shall apply equally for seated and standing passengers.

Fresh air supply rates for crew cabs shall be not less than the normal operational limits given in the applicable standard from Table 1 for all operating conditions and for the number of cab occupants stipulated in the contractual specification.

Note: In some applications it may be acceptable for fresh air supply rates to be lower than the rates given in the referenced standards for limited periods, provided a detailed risk assessment has been conducted verifying that the associated risk has been reduced to so far as is reasonably practicable (SFAIRP) level and the risk has been accepted by TfNSW.

Special areas such as toilets and kitchens shall have ventilation and exhaust air provision complying with a relevant national or international standard and be designed to prevent fumes, odours, fire or smoke from reaching other occupied parts of the vehicle.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Note: an example of a national ventilation standard is AS 1668.2 The use of ventilation and air conditioning in buildings – Part 2: Mechanical ventilation in buildings.

Air supplied to occupied areas shall be substantially free of dust, contaminants and impurities.

Air quality shall comply with Safe Work Australia's *Workplace Exposure Standards for Airborne Contaminants*.

6. System performance requirements

Section 6.1 through to Section 6.9 describes the system performance requirements for the CCHVAC system.

6.1. Climate and operating conditions

Equipment shall be designed to operate under the full range of climatic operating conditions in the relevant parts of the rail network, including the local environment where the equipment is installed on the rolling stock. The climatic operating conditions for the relevant TfNSW rail networks are defined in T MU RS 17001 ST *Environmental Conditions for Rolling Stock*.

Equipment mounted on the outside of the rolling stock shall be designed to allow for higher local ambient temperatures than the ambient air temperatures prevailing in the rail corridor.

Note: Sources of NSW climate data and operating conditions are given in Appendix A for reference. Temperatures in the rail corridor may be higher than recorded by the Bureau of Meteorology (BoM) weather stations.

6.2. System cooling and heating capacity

The CCHVAC system shall have sufficient cooling and heating capacities to establish and maintain the specified interior climate comfort levels for all passenger loading, exterior climate and operating conditions.

The CCHVAC system shall have sufficient cooling and heating capacities to establish the specified interior climate comfort levels with zero passenger loading from a stabled condition. This shall be done under all exterior climate conditions within the time limits stated in the contractual specification.

Note: Programmable control systems can be used to effect scheduled automatic 'start-up', 'stabled mode' and 'shut-down' routines to prevent operational delays.

6.3. Interior noise

The CCHVAC system shall generate minimal noise and vibration in the occupied interior areas of the vehicles and comply with the vehicle interior limits specified in the applicable standard from Table 1 or as stated in the contractual specification. Vibration shall not exceed the limits

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

stated in AS 7513.3 *Railway Rolling Stock – Interior Environment – Part 3: Passenger Rolling Stock*.

Notes: Higher air speeds at higher interior temperatures are likely to result in higher noise levels and this should be allowed for in the contractual specification.

CCHVAC system design should apply aerodynamic principles for airflows, fans, and ducts. Noise minimisation can be achieved by applying engineering techniques for managing equipment noise performance, mounting and damping, sound absorption, attenuation and transmission paths.

6.4. Fresh air inlets

Fresh air shall be drawn from an area where there is no possibility that the air has been heated by set borne equipment.

The CCHVAC system shall minimise exterior smoke and fumes entering the vehicle interior.

The CCHVAC system shall minimise the ingress or accumulation of dust, water, contaminants and debris.

6.5. Internal pressure

The static pressure inside each car shall be maintained at a positive pressure relative to atmosphere to prevent uncontrolled ingress of fumes, dust or unconditioned air.

The CCHVAC system (see note 1) shall maintain passenger comfort when entering and exiting tunnels by controlling the rate of pressure change in the trains. Pressure comfort criteria are provided in Annex B of EN 14067-5: 2006 *Railway applications – Aerodynamics – Part 5: Requirements and test procedures for aerodynamics in tunnels*.

Note 1: In this context the CCHVAC system includes interfaces with other vehicle systems and is considered to be the rolling stock vehicle system that controls the sealing and ventilation of the vehicle, that is, the passage of air between the interior and exterior. Refer to Section 10 for vehicle and network integration requirements.

6.6. CCHVAC Air purification and filtration

Air supplied by the HVAC system shall be filtered or purified to remove particles, contaminants and impurities to an acceptable air quality standard by suitable filters or other means.

Particle filters shall comply with AS 1324.1 *Air filters for use in general ventilation and air conditioning – Part 1: Application, performance and construction* or EN 779 minimum Grade G3 or otherwise as stated in the contractual specification.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

High efficiency particle air (HEPA) filters shall comply with AS 4260 *High efficiency particulate air (HEPA) filters – Classification, construction and performance* or equivalent international standard.

Other types of air purifiers or filters shall meet the appropriate national or international standard.

The CCHVAC system shall manage the effects of condensation and water ingress to prevent issues of safety, discomfort to passengers and crew, negative impacts on other parts of the rolling stock, corrosion, maintainability and system integrity for whole of life.

6.7. Operating modes

The CCHVAC control system shall control HVAC operating modes to match the vehicle operating modes including, but not limited to, the following:

- normal service operation with door open-close cycles as stipulated in the contractual specification
- service operation, stationary with passenger doors open for extended periods (automatic detection and control)
- out of service train operation (train operating without passengers)
- stabled – night time and day time
- start up (train preparation)
- presentation / cleaning (restricted access)
- maintenance (restricted access)
- degraded and emergency modes – refer to Section 8

6.8. System efficiency

In managing all operating modes, the CCHVAC control system shall optimise climate comfort and minimise energy consumption over the life of the vehicle.

6.9. System design and general requirements

Human factors shall be integrated into the design of the CCHVAC system in accordance with the following standards:

- T HR HF 00001 ST *Human Factors Integration – Rolling Stock*
- T MU HF 00001 ST *Human Factors Integration – General Requirements*
- T MU HF 00001 GU *AEO Guide to Human Factors Integration*

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

The CCHVAC system shall comply with Handbook HB 40 *Australian Air Conditioning and Refrigeration Code of Good Practic*e.

7. Power supply and system requirements

The CCHVAC system shall be compatible with and powered from the vehicle electrical auxiliary power supply (EAPS) complying with T HR RS 10001 ST *Electric Auxiliary Power Supply and Battery System for Passenger Rolling Stock*.

The CCHVAC system shall incorporate suitable power supply and circuit protection equipment complying with the referenced standards.

In the event of loss of the vehicle main power supply, emergency mode functions including emergency ventilation shall continue to operate from the vehicle EAPS.

On demand, emergency ventilation shall be provided for the period required to meet operational safety requirements as stated in the contractual specification, and not less than the period stated in Section 8 of this document.

The CCHVAC system and all related components shall comply with the applicable requirements of the following TfNSW standards:

- T HR RS 00117 ST *Electric Circuits and Equipment for Passenger Rolling Stock*
- T HR RS 01701 ST *Mounting and Installation of Electrical Equipment*
- T HR RS 00126 ST *Electronic Equipment Supplied for Passenger Rolling Stock*
- T HR RS 00164 ST *Electrical Cable for Passenger Rolling Stock*

8. System safety requirements and failure modes

If the CCHVAC system fails to provide ventilation, then the emergency ventilation system shall provide ventilation for all vehicle occupants at a rate not less than the rates specified in the applicable standard in Table 1 for normal operation for a period of at least 1.5 hours, or otherwise as stipulated in the contractual specification.

If the forced ventilation system fails then adequate ventilation shall be provided to all vehicle occupants by alternative means.

The CCHVAC system shall be integrated with the vehicle fire and emergency system and designed to prevent or restrict fire propagation such as by shutting down ventilation or air conditioning or both when and where appropriate.

The CCHVAC system shall manage system faults, failures and degraded and emergency operating modes, including but not limited to the following:

- degraded and emergency modes

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

- emergency ventilation
- fire and smoke external to vehicle
- fire and smoke internal to vehicle
- tunnel operation
- system failures and redundancy
- system safety and protections

The CCHVAC system and ducting shall provide suitable access for cleaning to limit the accumulation of dust or other combustible materials that could aid fire propagation.

The CCHVAC system shall comply with T HR RS 17010 ST *Passenger Rolling Stock Fire Safety*.

Suitable system safety protections, isolations and security shall be provided for individual CCHVAC units and complete system protecting all people that interact with the system including passengers, crew, cleaning, maintenance, testing and commissioning personnel at all stages of the life cycle.

9. Communication, monitoring and control

The interior climate shall be regulated by a programmable control system.

Control of individual CCHVAC units shall be integrated and units shall not work against each other.

9.1. Interior climate comfort regulation

The control of the CCHVAC system shall be optimised for each operating mode and allow for inter-car door and passenger bodyside door operation as well as coupling and uncoupling of units in the consist.

The interior climate comfort control shall have sensor and algorithm inputs to monitor in real time the relevant climate parameters including interior and exterior air temperatures, surface radiant temperatures, humidity, passenger loading and air speeds.

Values for clothing factor and metabolic rate shall be taken from ISO 7730 *Ergonomics of the Thermal Environment – Analytical Determination and Interpretation of Thermal Comfort Using Calculation of the Pmv And Ppd Indices and Local Thermal Comfort Criteria* or ASHRAE 55-2013 and adjusted for NSW population and crew preferences and seasonal variations.

The interior climate comfort control shall monitor and control the six climate comfort parameters (defined in ISO 7730 and ASHRAE 55-2013), optimise the climate comfort envelopes for the prevailing conditions, minimise local discomfort factors and minimise energy consumption.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

The interior climate comfort control system shall record internal and external conditions in real time. The data shall be available for analysis and continual improvement, including adjustment of the control program and interior climate comfort algorithm.

The initial basis for optimising interior climate comfort envelopes shall be the predicted mean vote (PMV) / predicted percentage dissatisfied (PPD) scale as defined in ISO 7730 and ASHRAE 55-2013.

Customer surveys shall be used to validate the interior climate comfort performance and to generate local preference data for adjustment and optimisation of the control algorithm.

The CCHVAC system shall deliver a minimum climate comfort performance level for passenger and passenger and crew shared areas and non-cab crew areas equivalent to 'Category B' of ISO 7730 Annex A Table A.1. Unless varied by the contractual specification, this performance level shall be maintained for at least 90% of passenger service train operating time (see note 1).

The CCHVAC system shall deliver a minimum climate comfort performance level for occupied crew cab areas equivalent to 'Category A' of ISO 7730 Table A.1. This performance level shall be maintained for 98% of cab crew train operating time (see note 2).

Note 1: Maintaining optimum thermal environmental conditions for 100% of the train passenger service operating time is not practicable and hence allowance is made for transient periods including door-open times and other non steady-state periods. The percentage time limit should be rationalised on the full passenger service operating time within any 24 hour period as indicated in Figure 4 of Appendix C.

Note 2: Maintaining optimum thermal environmental conditions for 100% of the cab crew-operating time is not practicable and hence allowance is made for transient periods. The percentage time limit should be rationalised on the full cab crew-operating time within any 24 hour period and does not include train preparation (crew cab heat-up or cool-down periods) cleaning or stabling time as indicated in Figure 5 of Appendix C.2.

Refer to Appendix C for guidance.

Crew shall be provided with local climate comfort controls for heating, cooling, airflow rate and direction, ventilation and control of local discomfort factors such as local heating or cooling.

Design of crew cab climate control shall ensure that local climate controls are adequate to meet the climate comfort performance requirements under all local conditions.

Note: Due to the high solar radiation levels in Australia and NSW in summer and low overnight temperatures in winter, crew cabs are subject to steep temperature gradients, high local heating factors and large temperature transients.

Climate control of occupied crew areas shall be independent of passenger areas and there shall not be interference between the two areas.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Note: Meeting this requirement does not mandate separate HVAC units for passenger and crew areas but requires that the control of one area does not cause a system imbalance resulting in local discomfort in another area.

Control settings and sensor readings shall be recorded for analysis.

Crew surveys shall be used to validate the interior climate comfort performance and to generate local preference data.

9.2. Crew monitoring and controls

Normal operation of the passenger CCHVAC system shall be automatic and maintain optimum conditions with minimal need for crew intervention.

Crew controls shall be minimised and designed with appropriate human factors integration and cab design principles in accordance with Section 6.

Operating modes and status shall be indicated to crew.

Modes other than for train service operation (such as presentation and maintenance, programming and so forth) shall have appropriate access restrictions.

Faults shall be indicated to crew with clear indication of vehicle, consist and train serviceability.

Manual override controls shall be provided for degraded and emergency modes including the following:

- close of external ventilation
- emergency shutdown

Local controls shall be provided for the crew to adjust climate comfort of occupied cabs.

Note: Crew cab local climate controls should include air conditioning on and off, air temperature, flow rate and direction, ventilation on and off and air flow rate and direction, local heating on and off and temperature, air flow rate and direction.

10. Vehicle and network integration requirements

The CCHVAC system shall interface with other vehicle systems including but not limited to the following:

- vehicle interior design
- train communications, monitoring and control systems
- fire and emergency
- door systems
- access and egress

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

- condensation control system
- coupling and uncoupling of vehicles, units and consists
- electrical system including the electrical auxiliary power supply (EAPS)
- vehicle operating modes

The CCHVAC system shall comply with the relevant requirements of the *Minimum Operating Standards for Rolling Stock* which includes but not limited to the following sections:

- T HR RS 00000 ST *RSU 000 Series — General Requirements*
- T HR RS 00100 ST *RSU 100 Series — General Interface Requirements*
- T HR RS 00200 ST *RSU 200 Series — Common Interface Requirements*
- T HR RS 00300 ST *RSU 300 Series — Locomotive Specific Interface Requirements*
- T HR RS 00500 ST *RSU 500 Series — Locomotive Hauled Passenger Vehicle Specific Interface Requirements*
- T HR RS 00600 ST *RSU 600 Series — Multiple Unit Train Specific Interface Requirements*
- T HR RS 00700 ST *RSU 700 Series — Infrastructure Maintenance Rolling Stock Specific Interface Requirements*
- T HR RS 00810 ST to T HR RS 00890 ST (*RSU A1 to I) — Appendices*

11. RAMS, asset management and through life support

Section 11.1 through to Section 11.4 describe the asset management and through life support.

11.1. Reliability and availability

The reliability and availability of the CCHVAC system shall be maximised in accordance with EN 50126 *Railway applications – The specification and demonstration of Reliability, Availability, Maintainability and Safety (RAMS) -- Part 1: Basic requirements and generic process* and shall meet the availability and reliability requirements stated in the contractual specification.

The CCHVAC system for the train shall have suitable level of redundancy so that failure of individual components has minimal effect on the train interior climate and system availability.

The reliability and availability performance of the CCHVAC system shall be independent of ambient operating conditions.

Note: Meeting the overall reliability and availability performance requirements (aggregated overall operating hours) do not justify low reliability and availability performance aggregated over operating periods having adverse conditions. ('adverse

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

conditions' being periods of extreme weather such as high or low ambient temperature, humidity, dust level, precipitation, wind speed and so forth)

11.2. Maintainability

The maintainability of the CCHVAC system shall be maximised in accordance with EN 50126 and meet the maintainability requirements stated in the contractual specification.

11.3. Safety

The safety of the CCHVAC system shall be maximised in accordance with EN 50126. All hazards to people and environment for all stages of the life cycle (including design, manufacture, installation, testing, service operation, maintenance, and disposal) shall be identified and reduced to so far as is reasonably practicable (SFAIRP) level in accordance with TS 20001 *System Safety Standard for New or Altered Assets* as well as all relevant safety-related legislation including the Rail Safety National Law and the Work, Health and Safety Act.

Safety functions related to the CCHVAC system shall be identified and included in the failure modes, effects and criticality analysis (FMECA) conducted for the sets, including but not limited to the following:

- safe operating environment for crew
- air quality
- emergency ventilation
- smoke and fire and emergency modes
- isolation and safety of each individual CCHVAC unit for maintenance
- safety in service and maintenance operations

11.4. Asset management and through life support

Section 11.4.1 and Section 11.4.2 describe the asset management and through life support requirements for the CCHVAC system.

11.4.1. Technical maintenance plan (TMP)

A technical maintenance plan (TMP) for the CCHVAC system shall be provided complying with the principles defined in T MU AM 01002 MA *Maintenance Requirements Analysis Manual*.

The TMP for the CCHVAC system shall include the following items:

- service and planned maintenance schedule (for whole of life)
- RAMS performance monitoring

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

- configuration items list
- parts list
- obsolescence management plan
- mid and late-life overhaul and upgrade management plan
- in-service support plan

11.4.2. Manuals

Detailed manuals of the CCHVAC system shall be provided to TfNSW to support the whole of life asset management of the system covering the following requirements:

- installation
- operation
- climate control, monitoring and adjustment
- service, maintenance and overhaul instructions
- performance and condition monitoring and fault identification and correction
- safety, hazardous materials, risk register/hazard log, safe handling procedures
- end of life recycling and disposal
- system and circuit diagrams
- parts list

12. Environmental and sustainability requirements

The CCHVAC system shall generate minimal noise and the vehicle shall comply with the environmental requirements of T HR RS 00100 ST *Minimum Operating Standards for Rolling Stock- General Interface Standards* including RSU 150.

The CCHVAC system shall be designed for minimum life cycle cost in accordance with T MU AM 01001 ST *Life Cycle Costing*.

Labels shall be clearly legible from the expected viewing positions in large font, permanent, indelible for the life of the rolling stock and appropriately positioned for service personnel.

Materials used in the rolling stock subsystems, to the maximum extent reasonably feasible, shall satisfy the following:

- be reusable or recyclable
- cause minimum environmental degradation in the supply chain
- minimise hazards to human health and safety and to the environment

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

12.1. Refrigerants

The refrigerant used in the CCHVAC system shall be selected to meet the following requirements:

- compliance with Australian legislation including the *Ozone Protection and Synthetic Greenhouse Gas Management Act 1989* and all related legislation and amendments
- system safety, environment, capacity, performance and reliability requirements
- maximised energy efficiency and minimised energy consumption over the life of the vehicle
- the system shall use the most environmentally friendly refrigerant within the constraints of zero ozone depleting potential and low global warming potential balanced with whole of life energy consumption
- consideration of future technology and legislation trends, options for upgrading at mid-life stage, late life stage and end of life recycling and disposal

12.2. Restricted and prohibited materials

Materials likely to cause harm to the environment or human health shall not be used during the life cycle of the rolling stock. Materials used in the rolling stock shall comply with the requirements of T MU RS 17002 ST *Prohibited and Restricted Materials*.

13. Verification, validation and documentation requirements

Section 13.1 through to Section 13.3 describes the requirements for verification, validation and documentation.

13.1. Configuration management and systems engineering

The supplier AEO shall provide asset configuration information to TfNSW in accordance with TS 10752 *Railway Asset Product Configuration Information Requirements* and as detailed in the contractual specification.

> *Note: Details of the ASA Authorised Engineering Organisation system are described in the standards available on the ASA website.*

In complying with T MU AM 06006 ST *Systems Engineering*, the CCHVAC system shall be integrated with the rolling stock using 'systems engineering' methodology following the principles of ISO 15288: 2008 *Systems and Software Engineering – System life cycle processes*.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

13.2. Testing, verification and validation

The supplier AEO shall develop a detailed verification and validation plan including inspection and testing where applicable, to cover all requirements. The following shall be included:

- acceptance testing in accordance with IEC 61133 *Rolling stock – Testing of rolling stock on completion of construction and before entry into service.*
- system functions and integration requirements
- type testing and routine testing in accordance with the referenced EN standards (Table 1) with the provision for extended climate range for NSW (Appendix B) including higher temperature and solar radiation levels
- control algorithm based on ISO 7730 or ASHRAE 55-2013 climate comfort envelopes with adjustments if needed to suit the NSW climate and passenger and crew preferences
- in-service interior climate comfort monitoring, data logging and data analysis
- customer and crew survey, satisfaction performance assessment and system optimisation
- in-service overall system performance monitoring and assessment including the following:
    - system safety
    - climate comfort
    - energy consumption and efficiency
    - reliability and availability
    - whole of life cost

In each case, the performance shall be plotted with the design baseline on a time-base showing current and past-to-date performance at agreed time intervals for whole of life.

Type testing should be based on the applicable EN standards (Part 2: Type tests, Test Level 2 (TL2) where applicable) recognising that some of the test parameters will need to be adjusted to cover the NSW climate range. The details of the type testing may be determined by the supplier and varied from the EN standards as necessary to provide assurance that the in-service validation requirements shall be complied with. The supplier shall be responsible for meeting the in-service validation requirements specified in Section 9 of this standard.

13.3. Documentation deliverables

CCHVAC system documentation shall be managed in accordance with the supplier AEO's configuration management requirements and the requirements of the contractual specification.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Appendix A Climate data and operating conditions for the NSW network

The information regarding climate data and operating conditions for the NSW rail network are available from the following sources:

- T MU RS 17001 ST *Environmental Conditions for Rolling Stock*
- Australian Government – Bureau of Meteorology (BoM)
- Australian Institute for Refrigeration, Air Conditioning and Heating – AIRAH Guideline DA09
- American Society of Heating Refrigeration and Air Conditioning Engineers ASHRAE Climate Data

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Appendix B Temperature regulation curve limits for passenger rolling stock for NSW

Figure 1 through to Figure 3 provides information relating to the regulation temperature limits for passenger and crew compartments in rolling stock.

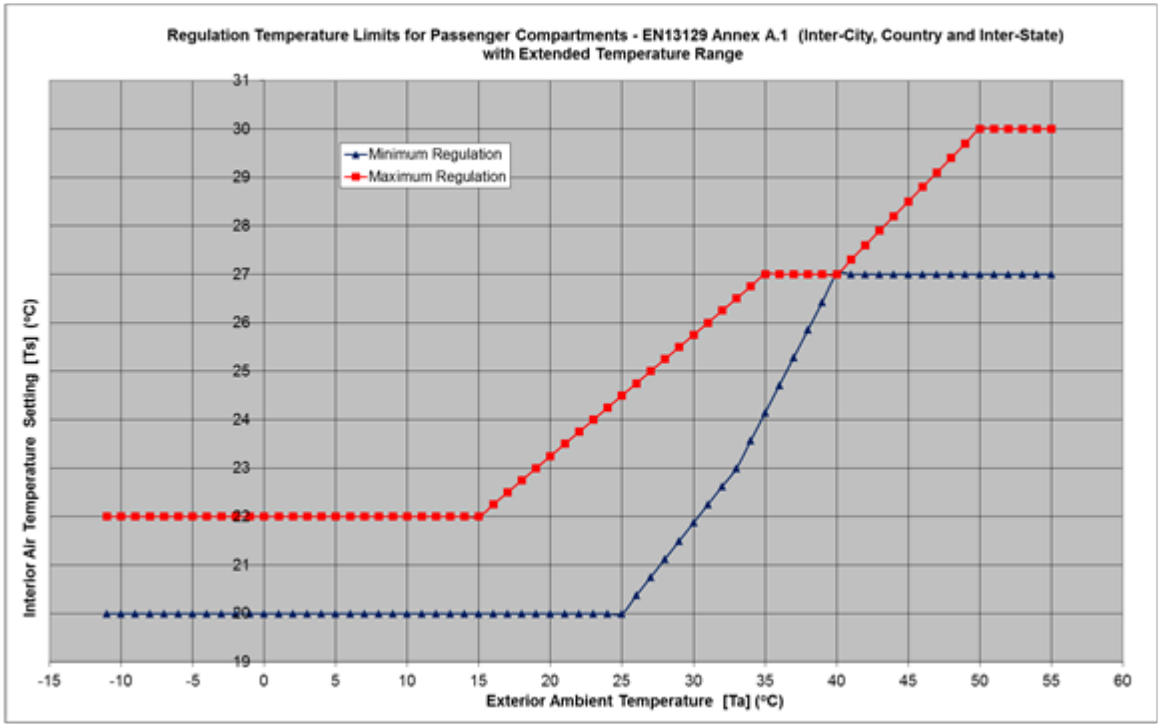

Figure 1 – Regulation temperature limits of EN 13129-1 Annex A.1 (inter-city, country and inter-state services) modified to suit the NSW climate

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

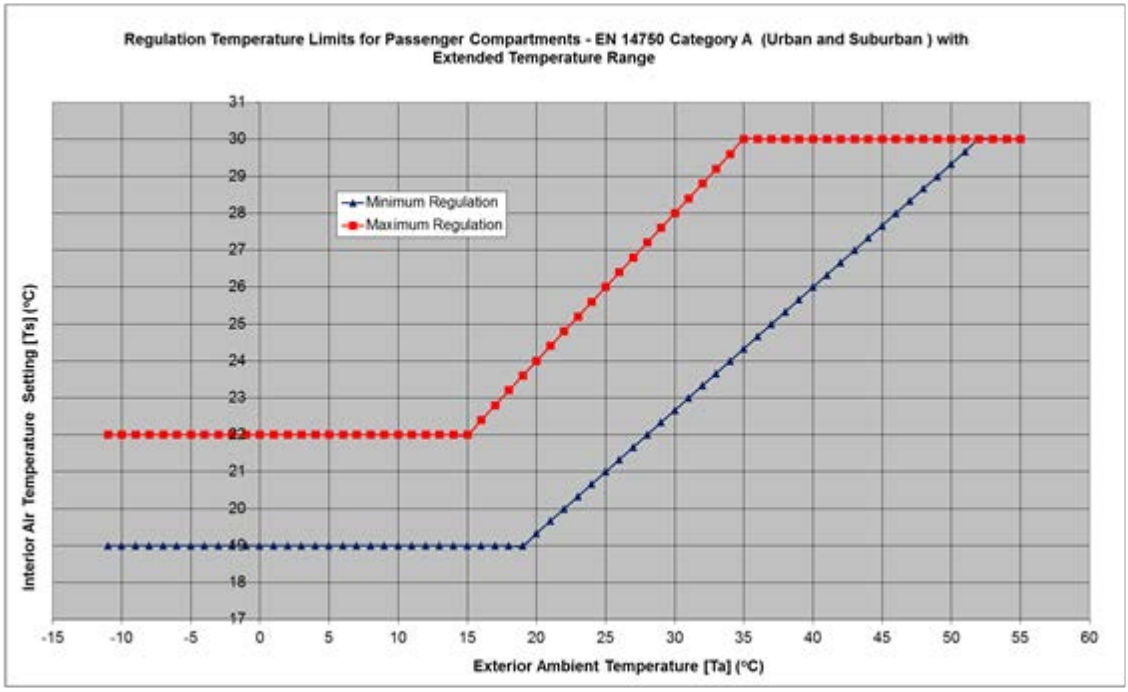

Figure 2 – Upper and lower regulation temperature limits for passenger areas of urban and suburban passenger trains, taken from EN 14750 1 Annex A.1 and modified to suit the NSW climate

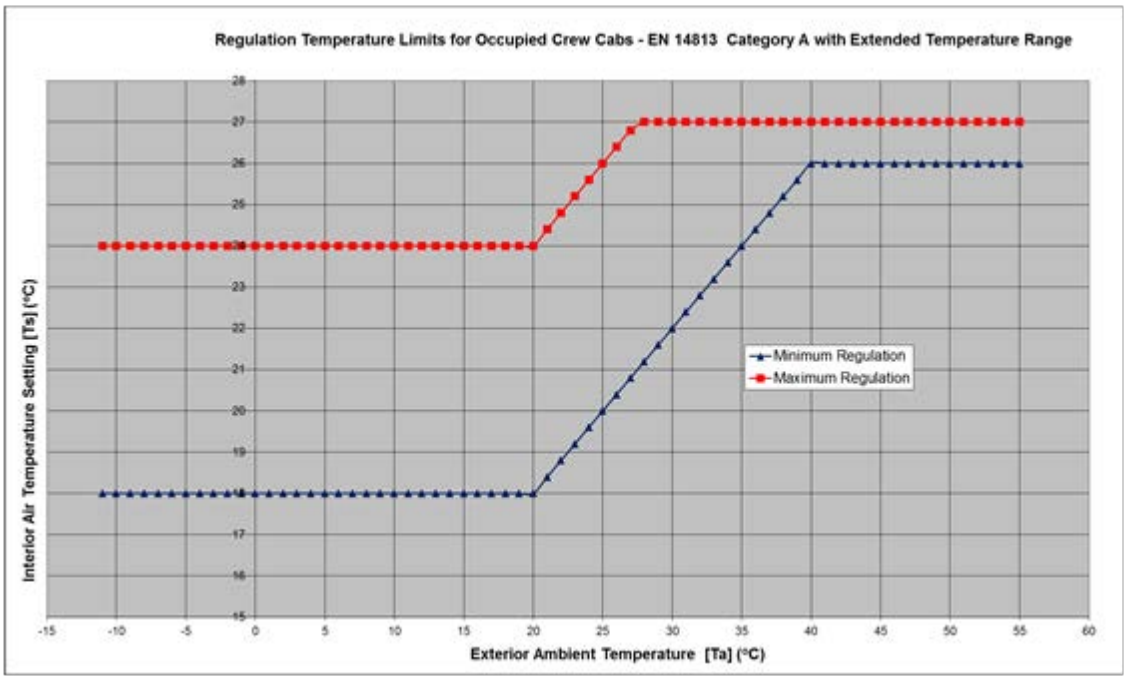

Figure 3 – Upper and lower regulation temperature limits for crew occupied cabs of passenger trains, taken from EN 14813-1 Annex A.1 and modified to suit the NSW climate

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Appendix C Process logic and climate comfort performance standard

Appendix C.1 describes the process logic for the CCHVAC design and Appendix C.2 describes the climate comfort performance standard.

C.1. Process logic for CCHVAC design

The following are the steps required to carry out the CCHVAC design:

i. Determine applicable EN standard in accordance with Table 1.

Guidance note: This should be stated in the contractual specification or determined from the operating requirements of the rolling stock.

ii. Determine climate comfort limits in accordance with the applicable EN varied by Appendix B and Table 2.

Guidance note: The referenced EN standards and Appendix B provide upper and lower limits for temperature regulation curves but not the actual temperature regulation curve, which is to be determined by the supplier at step iv and step v below.

iii. Design the rolling stock interior and CCHVAC system – integrate vehicle systems.

iv. Program the CCHVAC regulation using ISO 7730 / ASHRAE 55 to maintain PMV between -0.5 and +0.5 (passenger and passenger/crew shared areas) and between -0.2 and +0.2 (occupied crew cabs) for all exterior conditions.

The control algorithm should maintain the comfort envelopes within the limits provided by the PMV scale subject to the constraints of temperature regulation given in Appendix B. For optimisation, other inputs can be used such as previous experience with existing rolling stock and knowledge of passenger and crew preferences and seasonal variations (refer to step 6). If the Appendix B limits for temperature regulation conflict with the PMV requirements, then the Appendix B limits shall be maintained pending survey results (refer to step 6 below).

v. Monitor climate comfort parameters in-service.

Some parameters can be measured in real time using sensors such as air temperatures, humidity, and passenger loading. Input parameters such as clothing factor and metabolic rate shall be taken from ISO 7730 or ASHRAE 55. Other parameters such as air speeds and surface radiant temperatures can be determined indirectly from measurements, type test, and design data.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

vi. Monitor and optimise climate comfort satisfaction levels in-service (passenger and crew survey).

Passenger and crew climate comfort surveys shall be used to assess the performance level of the system. A satisfaction scale of 1 to 5 can be used where score of 4 to 5 corresponds approximately to a PMV score between -0.5 and +0.5 (passenger and passenger/crew shared areas) and -0.2 and +0.2 for occupied crew cab areas. The control algorithm should be adjusted (fine-tuned) until optimum satisfaction levels are sustained. Survey design and frequency shall be agreed between purchaser and supplier. Guidance on suitable survey design can be obtained by references such as ASHRAE 55 and other publications. If the survey results require the Appendix B temperature regulation limits or the PMV requirements to be exceeded, then notify ASA so that the limits in this standard can be reviewed.

© State of NSW through Transport for NSW 2016

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

C.2. Climate comfort performance standard

For thermal comfort scale, refer to ISO 7730. Refer to Table A.1 of Annex A for categories of thermal environment.

Table 3 and Table 4 show suggested survey comfort scales and descriptors aligned with the PMV scoring system of ISO 7730 for passenger and passenger/crew areas and occupied crew cab areas. The target comfort ranges are represented by the bold outline boxes, that is, Category B for passenger areas and Category A for crew cabs.

Table 3 – Climate comfort performance scale for passenger and passenger/crew shared areas

PMV scale	-3	-2	-1	-0.5	0	+0.5	+1	+2	+3
PPD	90	75	25	10	5	10	25	75	90
Survey Score	1	2	3	4	5	4	3	2	1
Descriptor	Cold (Uncomfortable)	Cool (Discomfort)	Slightly cool (Minor discomfort)	Comfortably cool	Neutral unaware	Comfortably warm	Slightly warm (Minor discomfort)	Warm (Discomfort)	Hot (Uncomfortable)

Table 4 – Climate comfort performance scale for occupied crew cab areas

PMV scale	-2	-1	-0.5	-0.2	0	+0.2	+0.5	+1	+2
PPD	75	25	10	6	5	6	10	25	75
Survey Score	1	2	3	4	5	4	3	2	1
Descriptor	Cool (Discomfort)	Slightly cool (Minor discomfort)	Comfortably cool	Neutral-cool comfortable	Neutral unaware	Neutral-warm comfortable	Comfortably warm	Slightly warm (Minor discomfort)	Warm (Discomfort)

Note: Deviation from the PMV scale may be needed to meet NSW passenger crew preferences and an exact correspondence between survey score and PMV scale is not required.

© State of NSW through Transport for NSW

Superseded by T HR RS 08001 ST v4.0, 09/06/2021

Figure 4 and Figure 5 indicate the % time requirements of the performance standard for passenger and passenger/crew shared areas and for occupied crew cabs.

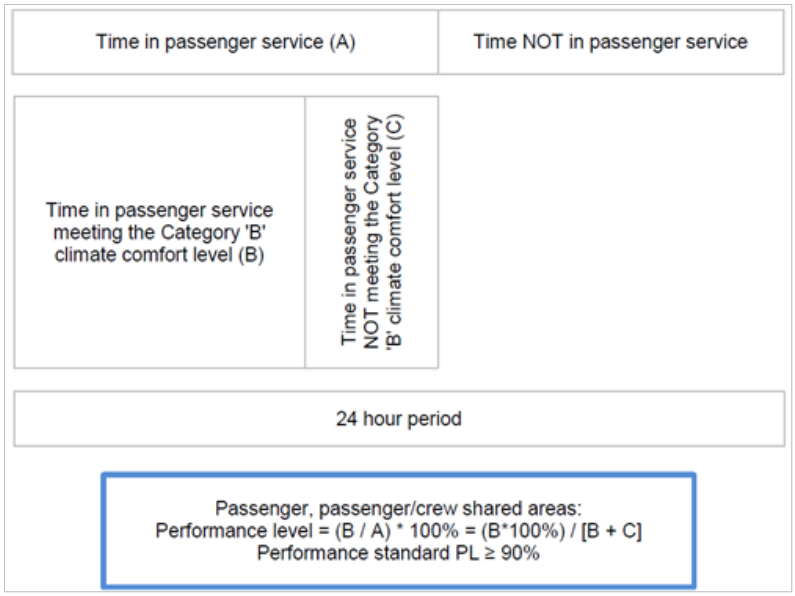

Figure 4 – Climate comfort performance standard for passenger and passenger/crew shared areas

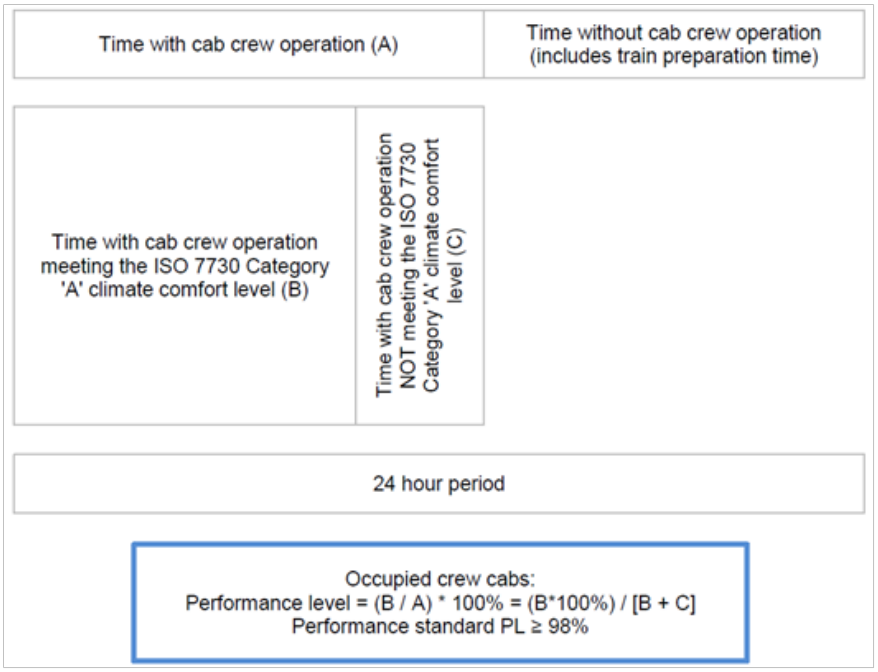

Figure 5 – Climate comfort performance standard for occupied crew cabs