



GTR24 Temperature limits for non-gray cast iron rotors

28.Sept.2023



UNECE GTR24 Temperature Limits vs. advanced Disc results

Existing default Temperature Metrics and Tolerances

Table 10.2.

**Default temperature metrics and tolerances for brakes during Trip #10 of the WLTP-
Brake cycle**

<i>Group</i>	<i>ABT [A₁]</i>	<i>IBT [A₂] ± Tolerance</i>	<i>FBT [A₃] ± Tolerance</i>
$WL_{n-f}/DM \leq 45$	$\geq 50 \text{ }^\circ\text{C}$	$65 \pm 25 \text{ }^\circ\text{C}$	$95 \pm 35 \text{ }^\circ\text{C}$
$45 < WL_{n-f}/DM \leq 65$	$\geq 55 \text{ }^\circ\text{C}$	$75 \pm 25 \text{ }^\circ\text{C}$	$115 \pm 35 \text{ }^\circ\text{C}$
$65 < WL_{n-f}/DM \leq 85$	$\geq 60 \text{ }^\circ\text{C}$	$85 \pm 25 \text{ }^\circ\text{C}$	$130 \pm 35 \text{ }^\circ\text{C}$
$WL_{n-f}/DM > 85$	$\geq 65 \text{ }^\circ\text{C}$	$95 \pm 25 \text{ }^\circ\text{C}$	$150 \pm 35 \text{ }^\circ\text{C}$

- Temperature limits are derived from standard grey cast iron discs
- Temperature ranges are determined by the Wheel Load to Disc Mass (WL/DM) ratio
- WL/DM ratio only considers grey cast iron rotors
- Lightweight materials / rotor concepts are not taken into account

- (a) The minimum operational flow shall be defined in the range between 100-300 m³/h;
- (b) The maximum operational flow shall be at least 5 times the minimum operational flow;
- (c) The maximum operational flow shall be at least 1000 m³/h greater than the minimum operational flow.



UNECE GTR 24

Chapter 10.1.3 Computation of Verification Parameters and Acceptance Criteria

Text reference: <https://unece.org/transport/documents/2023/04/working-documents/grpe-proposal-new-un-gtr-laboratory-measurement-brake>

- (d) All three criteria [ABT, IBT, FBT] shall be fulfilled for the successful completion of the cooling airflow adjustment section. In case the cooling adjustment test does not meet all metrics from Table 10.2., the testing facility shall repeat the procedure adjusting the cooling airflow accordingly;

- (e) If there is no suitable cooling airflow meeting all three metrics specified in Table 10.2., the testing facility shall select a suitable cooling airflow that fulfils the acceptable criteria for at least two parameters, one of which shall always be the average Trip #10 temperature (ABT). In such a case, if the measured brake temperature for the failing metric (IBT or FBT) is below the lower threshold value specified in Table 10.2., the testing facility shall demonstrate that a test with the minimum operational flow of the system was performed. If the measured brake temperature for the failing metric (IBT or FBT) is higher than the upper threshold value specified in Table 10.2., the testing facility shall demonstrate that a test with the maximum operational flow of the system was performed. The corresponding Event-Based and Time Based files for the non-successful cooling adjustment tests shall be included in the test output;

Table 10.2.
Default temperature metrics and tolerances for brakes during Trip #10 of the WLTP-
Brake cycle

Group	ABT [A_1]	IBT [A_2] ± Tolerance	FBT [A_3] ± Tolerance
$WL_{n-f}/DM \leq 45$	≥ 50 °C	65 ± 25 °C	95 ± 35 °C
$45 < WL_{n-f}/DM \leq 65$	≥ 55 °C	75 ± 25 °C	115 ± 35 °C
$65 < WL_{n-f}/DM \leq 85$	≥ 60 °C	85 ± 25 °C	130 ± 35 °C
$WL_{n-f}/DM > 85$	≥ 65 °C	95 ± 25 °C	150 ± 35 °C



UNECE GTR 24

Chapter 10.1.3 Computation of Verification Parameters and Acceptance Criteria

- (f) ...
If the minimum operational flow is applied and both the IBT and FBT are below the lower threshold values specified in Table 10.2., the testing facility shall continue with the bedding and emissions measurement section applying the minimum operational flow of the system. In such a case, the reporting data shall include the ABT, IBT, and FBT values derived from the cooling adjustment section with the application of the minimum operational flow. The corresponding Event-Based and Time-Based files shall be included in the test output;
- (g) If the **minimum operational flow is applied** and **all three temperature metrics are below the lower threshold** values specified in Table 10.2., the cooling air adjustment shall be considered **invalid**.



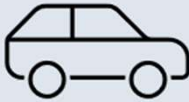

GTR24 Temperature limits Vs. Advanced disc results. Example of Vehicle Classification.

Group	ABT [A ₁]	IBT [A ₂] ± Tolerance	FBT [A ₃] ± Tolerance
WL _{n-f} /DM ≤ 45	≥ 50 °C	65 ± 25 °C	95 ± 35 °C
45 < WL _{n-f} /DM ≤ 65	≥ 55 °C	75 ± 25 °C	115 ± 35 °C
65 < WL _{n-f} /DM ≤ 85	≥ 60 °C	85 ± 25 °C	130 ± 35 °C
WL _{n-f} /DM > 85	≥ 65 °C	95 ± 25 °C	150 ± 35 °C

- (a) Average brake temperature over Trip #10 of the WLTP-Brake cycle (ABT);
- (b) Average initial brake temperature of six selected brake events from Trip #10 of the WLTP-Brake cycle (IBT);
- (c) Average final brake temperature of six selected brake events from Trip #10 of the WLTP-Brake cycle (FBT).

Specific brake events from Trip #10 of the WLTP-Brake cycle

Parameter	Unit	Deceleration event					
		#46	#101	#102	#103	#104	#106
Start time	s	2088	4438	4459	4494	4522	4903
End time	s	2092	4447	4467	4503	4529	4918
Brake duration	s	4.0	9.0	8.0	9.0	7.0	15.0
Initial speed	km/h	97.4	112.0	68.2	80.9	73.4	132.5
Final speed	km/h	82.7	56.1	12.0	35.3	39.3	34.0

Vehicle	Grey Cast Iron	CSiC
	WL/DM = 52	91
	49	103

- If a middle class vehicle with the associated brake system such as a grey cast iron rotor is classified in WL/DM group 45 ≤ 65, same vehicle, which is equipped with e.g. CSiC Ceramic rotors will be categorized in Group > 85.
- Unrealistic group classification for non grey cast iron rotors.
- Similar results reported by three independent OEMs and one supplier



GTR24 Temperature limits Vs. Advanced disc results. Temperature Results of variable cooling airflow (950→300).

10.1.3. Computation of Verification Parameters and Acceptance Criteria

Table 10.2.
Default temperature metrics and tolerances for brakes during Trip #10 of the WLTP-
Brake cycle

Group	ABT [A ₁]	IBT [A ₂] ± Tolerance	FBT [A ₃] ± Tolerance
WL _{n-f} /DM ≤ 45	≥ 50 °C	65 ± 25 °C	95 ± 35 °C
45 < WL _{n-f} /DM ≤ 65	≥ 55 °C	75 ± 25 °C	115 ± 35 °C
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WL _{n-f} /DM > 85	≥ 65 °C	95 ± 25 °C	150 ± 35 °C

Lowest T-Limit for WL/DM 85 **65°C** **70 °C** **115°C**

Lowest T-Limit for 65 < WL/DM ≤ 85 **> 60°C** **> 60 °C** **> 95 °C**

WL [kg]	DM [kg]	WL/DM	Moment [kg m ²]	Operational flow	Trip 10 Start Temp	Average T [°C]	IBT [°C]	FBT [°C]
658	8	82,2	71,2	950,0	40,0	50,4	59,2	113,9
658	8	82,2	71,2	500,0	40,0	50,2	57,7	105,9
658	8	82,2	71,2	300,0	40,0	54,2	59,2	107,2

- (a) The minimum operational flow shall be defined in the range between 100-300 m³/h;
- (b) The maximum operational flow shall be at least 5 times the minimum operational flow;
- (c) The maximum operational flow shall be at least 1000 m³/h greater than the minimum operational flow.

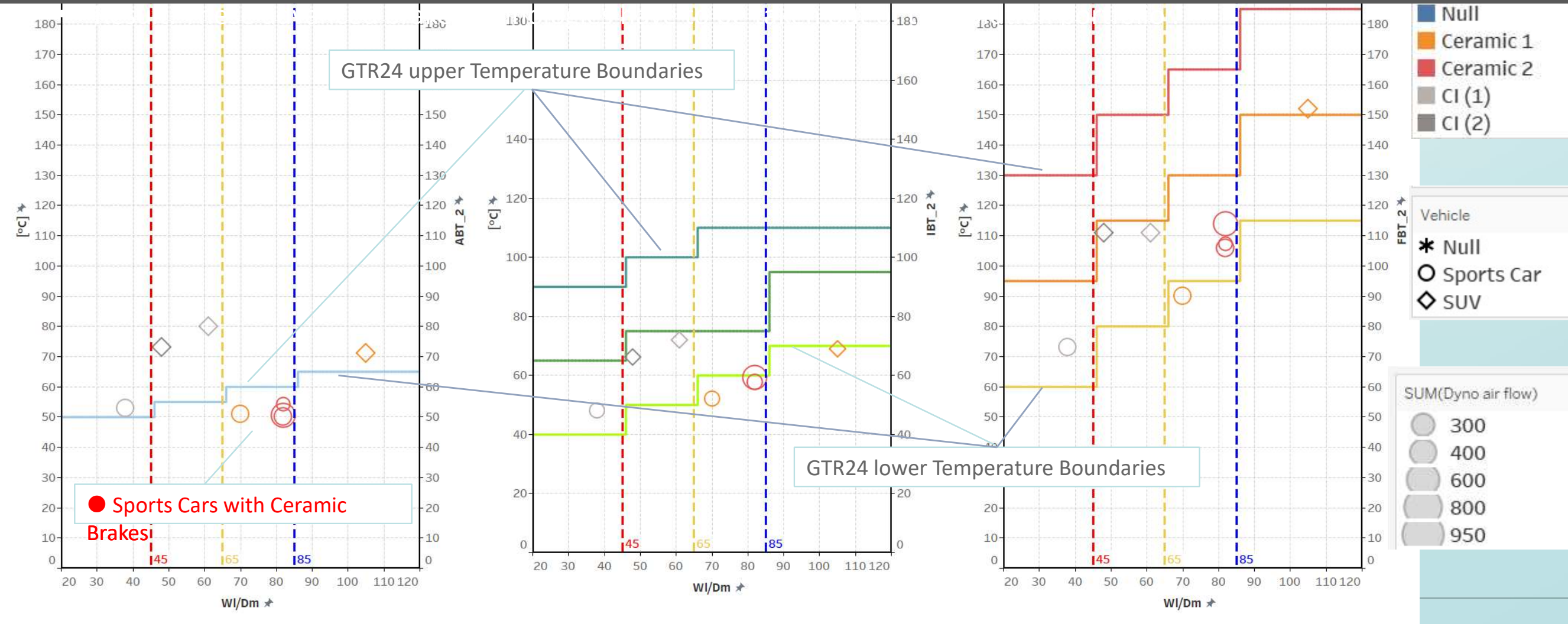
- Even if the cooling air flow is set to a minimum, the temperatures (specifically ABT) specified in table 10.2 cannot be maintained.
- Result: Currently, CSIC brakes and further advanced brakes unable to be homologated according to GTR24.
- Risk: These advanced brake technologies have to be taken out of the solution portfolio .

ABT

IBT

FBT

- Even if the cooling air flow is set to a minimum, the temperatures (specifically ABT) specified in table 10.2 cannot be maintained.
- Result: Currently, CSIC brakes and further advanced brakes unable to be homologated according to GTR24.





GTR24 Temperature limits Vs. Advanced disc results. Proposed Solution and recommendation.

Short-term

- Define existing default T metrics (table 10.1) for discs with gray cast iron core materials only
- For **non**-gray cast iron core materials :
 - Set a standard air flow of [700 - 800 m³/h] for brake emission measurements
 - Delete T-criteria for these rotors
 - Report resulting ABT, IBT, FBT



GTR24 Temperature limits Vs. Advanced disc results. Proposed Solution and recommendation.

Long-term

- Define different T metrics (additional to Table 10.1) for **non**-gray cast iron core materials
- Items to be confirmed:
 - Different tables for different new materials needed?
 - Providing sufficient number of full vehicle measurements to be able to derive the correct temperature behaviour

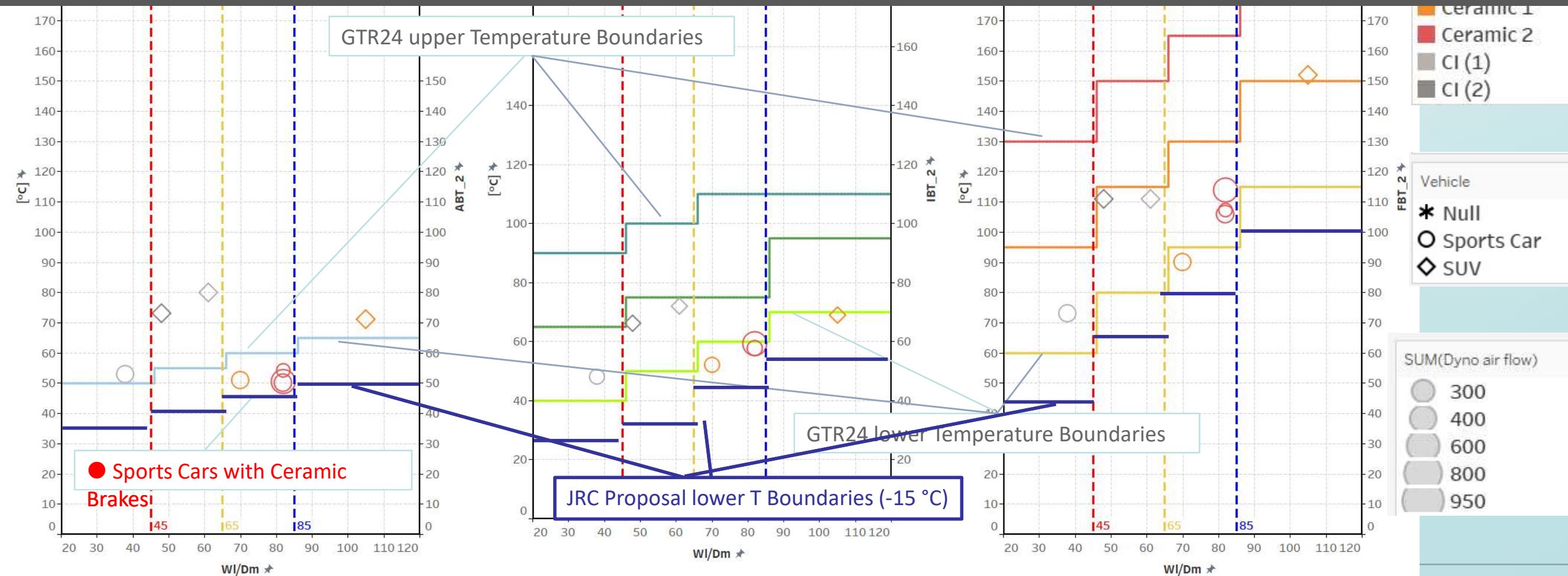
ABT

IBT

FBT

- JRC proposal:

“ Introduction in the GTR of an asterisk below the temperatures Table stating that "For CCGI discs, the defined temperature regimes at the lower end may be relaxed by 15C. This applies to all 4 WL/DM groups".





Thank you