WINNARD

WINNARD SOLID vs VENTED BRAKE DISC ECE R90 PERFORMANCE COMPARISON TEST

The design of brake discs has been evolving since their introduction with the main objective being to increase performance and reduce the level of heat crazing and cracking. The latest commercial vehicle designs now separate the braking face from the mounting hub which has helped but this does not reduce the level of cracking experienced by earlier conventional designs.

Therefore, through customer consultation and design consideration we have developed a range of solid discs which are direct replacements for the vented original. Operational feedback has shown that these solid discs perform to similar levels as the vented but do not suffer the same degree of heat crazing or cracking and last three to four times longer.

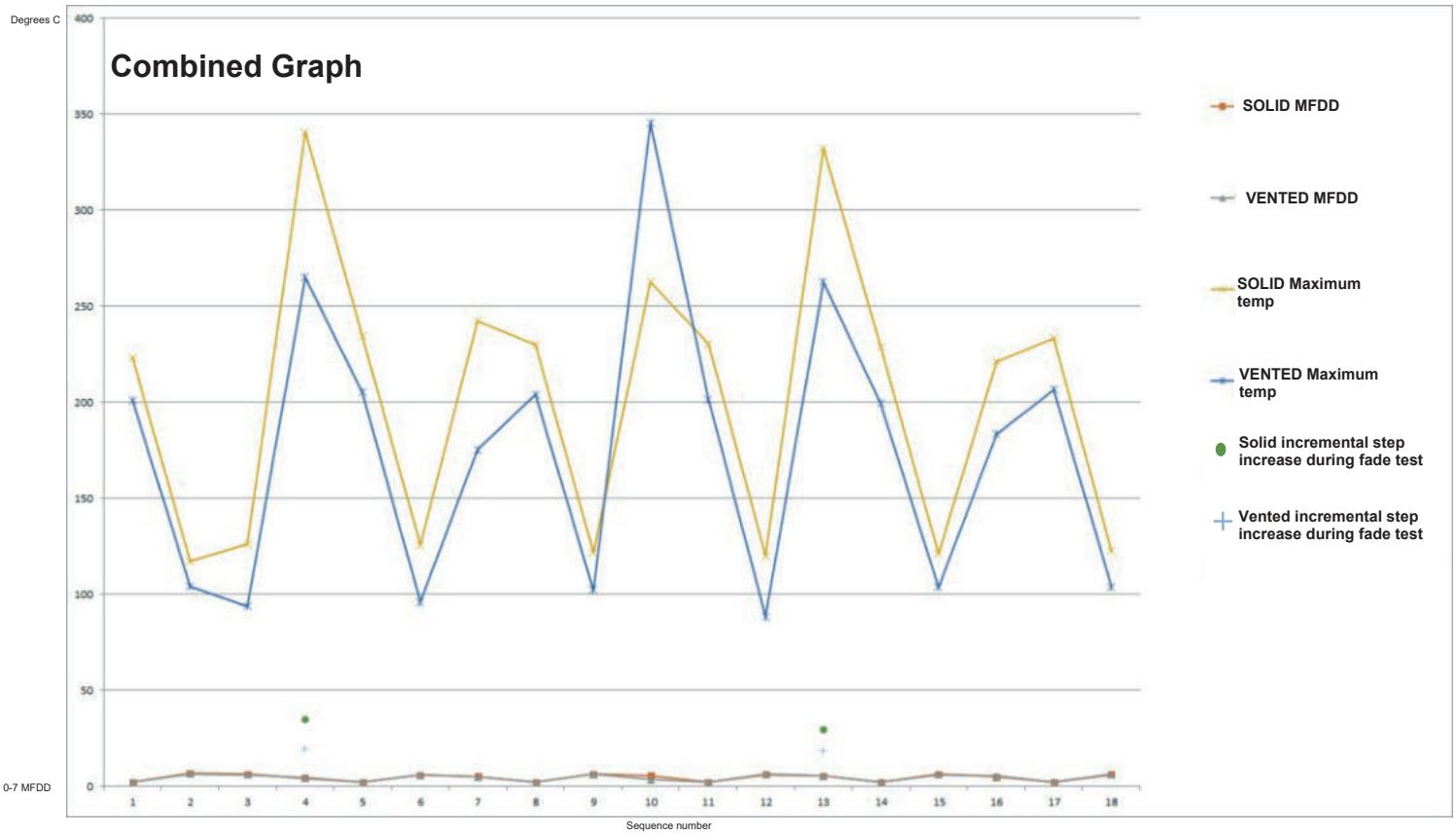
To corroborate this feedback we have undertaken direct comparison tests. These tests have been conducted at an independent UK test facility using the same test protocols as laid out in the ECE R90 certification procedure.

Four brake discs, two solid and two vented along with two sets of WP988S2 brake pads were sent for the following comparison tests:

1. **PERFORMANCE CHECK** (DFP - Dynamic Friction Performance) 250 stop decelerating from 60Kmh down to 3Kmh

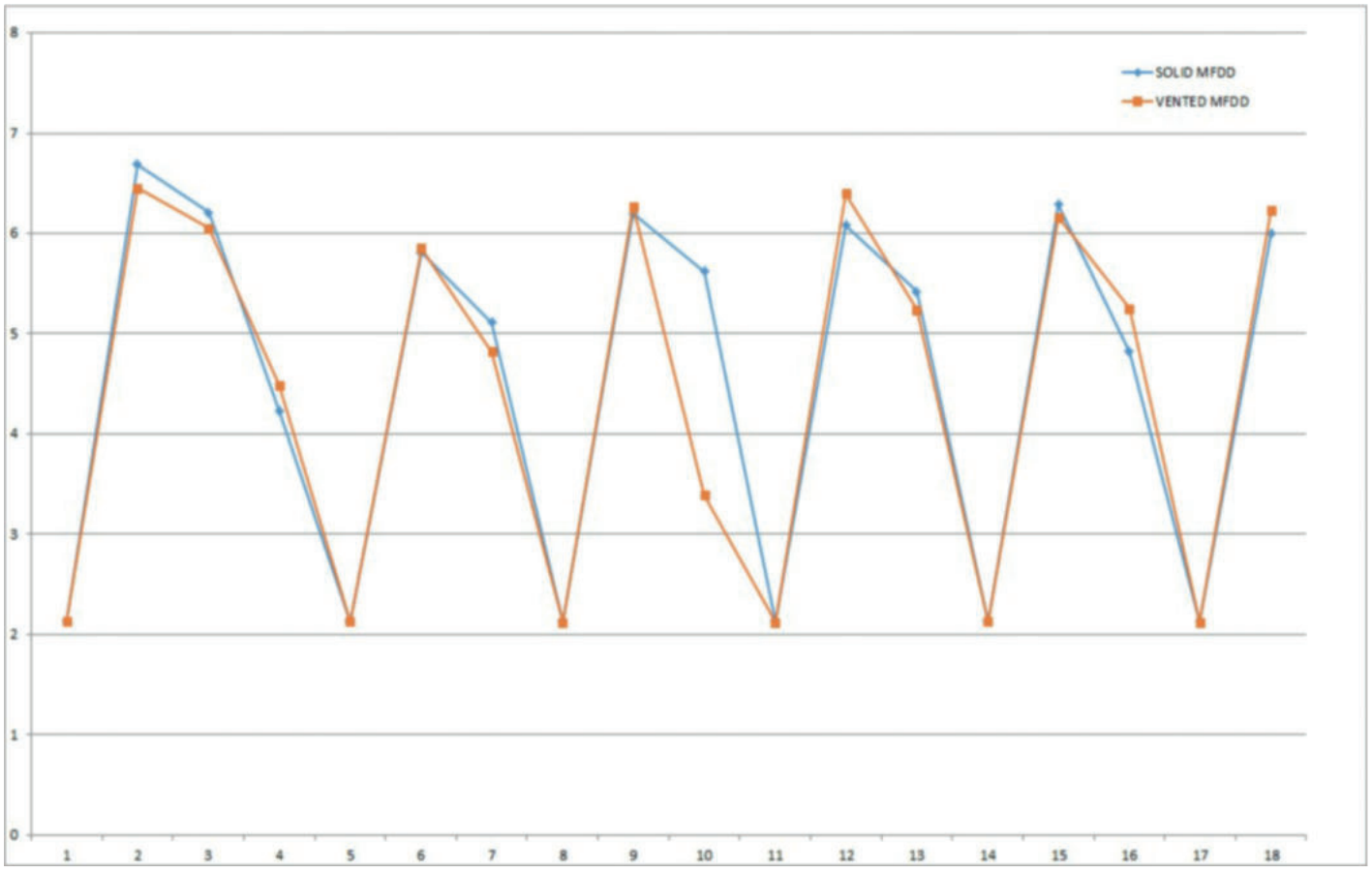
   This test is designed to check the deceleration capabilities of the braking system so it is a check of the friction material and the brake disc capabilities. Test checks: Deceleration, Fade and Final temperature.

PERFORMANCE CHECK TEST RESULTS

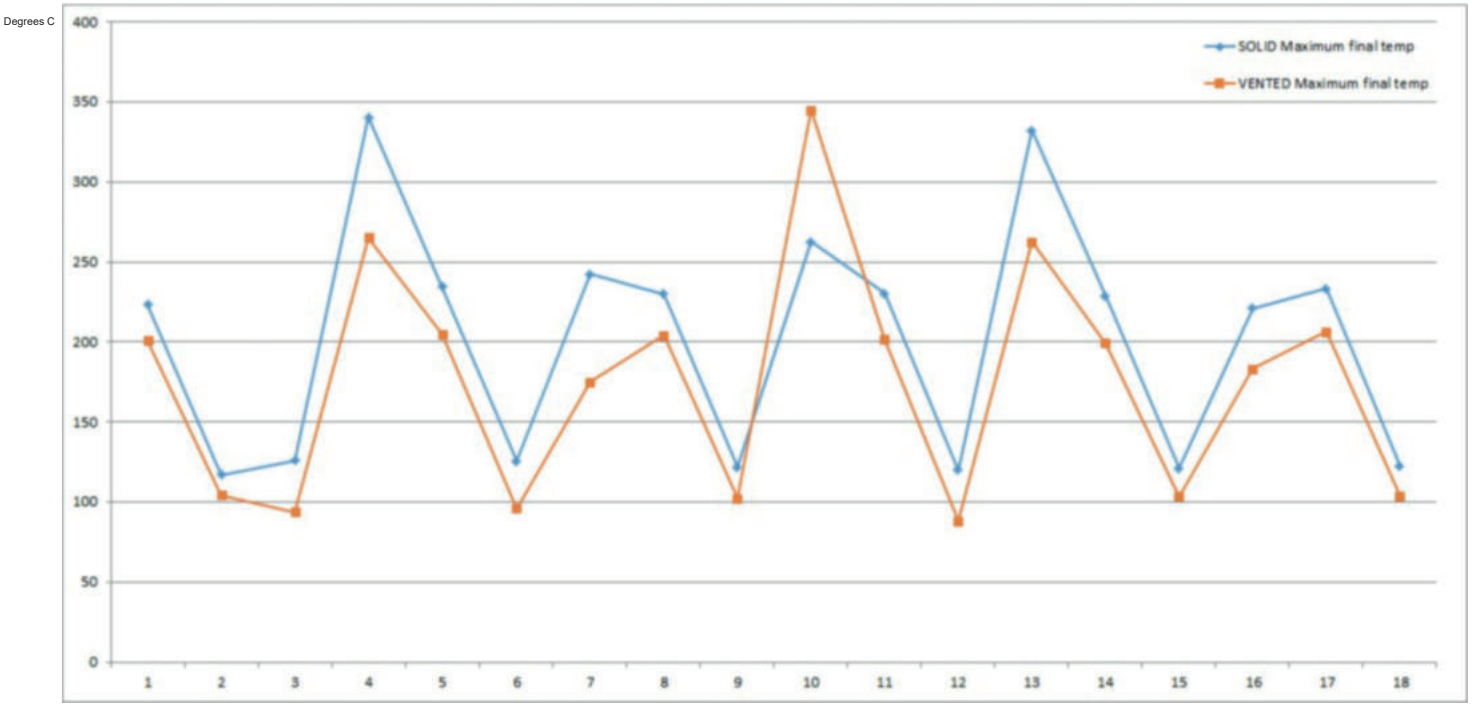


*MFDD = Mean Fully Developed Deceleration

MFDD Graph - Closer scale 0-8



Maximum Final Temperature Graph



Test summary

MFDD results are within normal operating parameters, average variation of 2.4%

Average final temperature variation 15.6% which is also within acceptable parameters.

2. **THERMAL FATIGUE TEST** (Designed to test the disc to destruction) Asses the brake rotor's thermal capability.

This is one cycle of the test procedure, full test goes to 15 cycles

"Bedding in" procedure 100 brake applications
Initial speed: 60 km/h, Final speed: 30 km/h. fmdd alternating between 1 m/s^2 and 2 m/s^2
Initial temperature : less than 300°C (beginning at room temperature)

1. Conditioned braking 10 brake applications from 60 to 30 km/h
dm alternating between 1 m/s^2 and 2 m/s^2. Initial temperature: less than 250°C

2. High-speed braking 2 Brake applications from 130 to 80 km/h, fmdd 3 m/s^2 Initial temperature: less than 100°C

3. Conditioned braking See test stage 1

4. High-speed braking See test stage 2

5. Conditioned braking See test stage 1

6. Continuous braking (1) 5 Brake applications at a constant speed of: 85 km/h
Decelerating torque corresponding to 0.5 m/s^2. Braking period 60 s. Initial temperature: less than 80°C

7. Conditioned braking See test stage 1

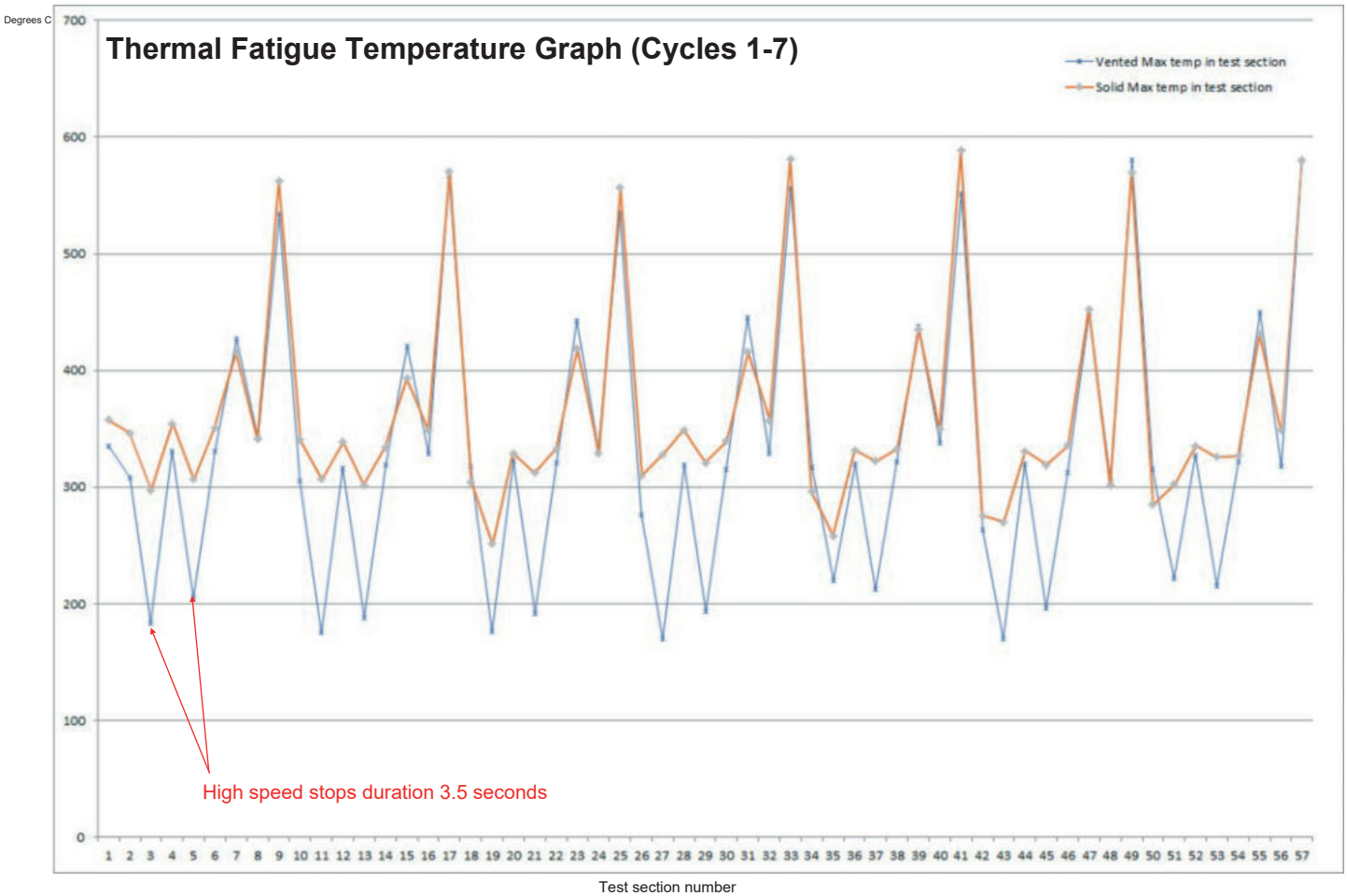
8. Continuous braking (2) 5 Brake applications at a constant speed of: 85 km/h
Decelerating torque corresponding to 1.0 m/s^2. Braking period 40 s. Initial temperature: less than 80°C

9. Repeat test stages 1 to 8 up to 14 times until the disc develops a crack of certain size or position.

THERMAL FATIGUE TEST RESULTS

Vented disc failed at cycle 7. One crack extended to the external diameter, see images at the end of the report.

Solid disc went to the end of the test, cycle 15, without any major cracks on the braking surfaces, images also added.

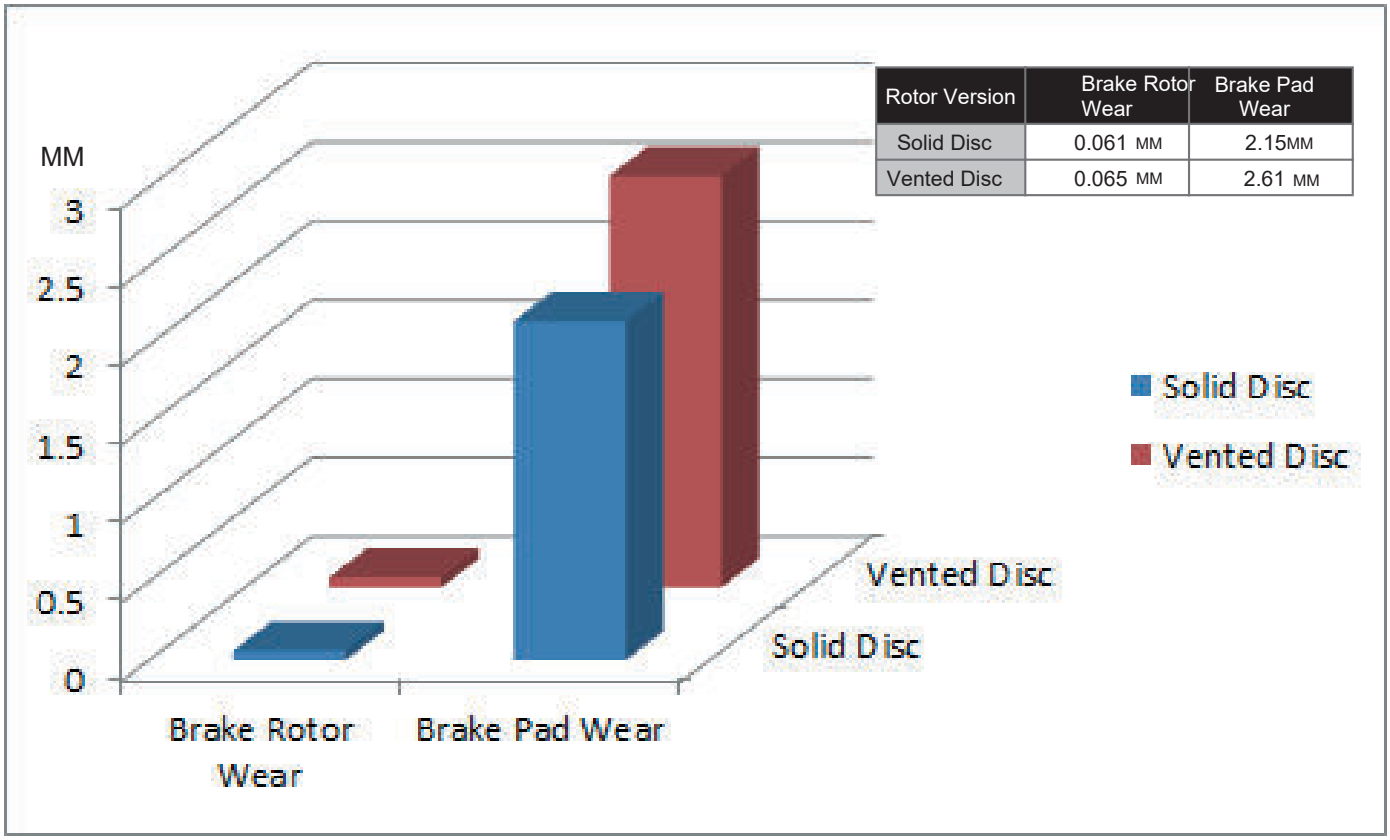


Thermal fatigue test summary

The overall temperatures of the solid brake disc are very similar to the vented. There is a noticeable difference in the temperature of the solid disc on the High Speed stops, points 3, 5, 11, 13 etc. These particular stops only last for around 3.5 seconds and do not allow the solid disc to absorb the heat generated. This does not cause any negative drop in braking performance or rotor integrity. Overall average temperature difference is 9.9%

Thermal Fatigue brake disc and pad wear comparisons

Average Wear at the end of Cycle 7 Graph



Rotor Version	Brake Rotor Wear	Brake Pad Wear
Solid Disc	0.061 MM	2.15MM
Vented Disc	0.065 MM	2.61 MM

Average wear summary

At the end of test cycle 7 , the point at which the vented disc cracked, the results show that the level of wear in the solid brake disc is 6.5% less than the vented and the brake pads have worn by 21% less.

Conclusion

These test results provide conclusive proof that the braking performance and temperature generation of a solid brake disc have no negative operational consequences to either the brake disc or brake pads and meet the requirements to pass an ECE R90 test.

The solid disc completed the thermal fatigue test program, 15 cycles, without any major cracking of the braking surfaces. This is an impressive result as this test is the toughest possible and most discs fail well before the 15th cycle. Furthermore, the central heat crazing seen on the solid brake disc does not look too severe and we believe it could have continued the test and possibly completed another 15 cycles but dynamometer time would not allow.

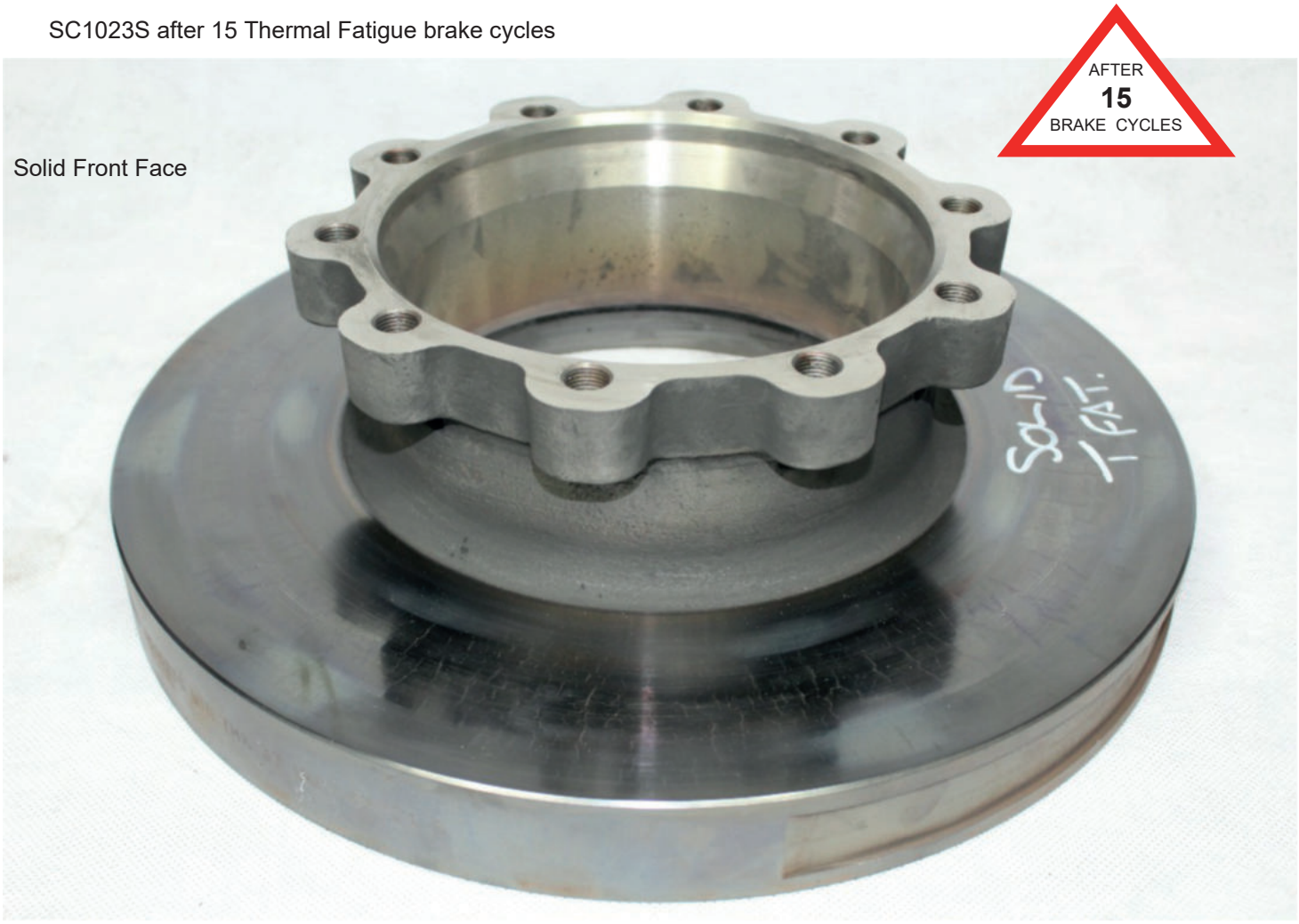
To conclude, if a customer has specific operational issue, where the brake disc is subjected to high operating temperatures, which result in accelerated / premature heat crazing and cracking, then the we believe the best solution is to fit a solid version and use a quality brake pad such as our Stage 2 material.

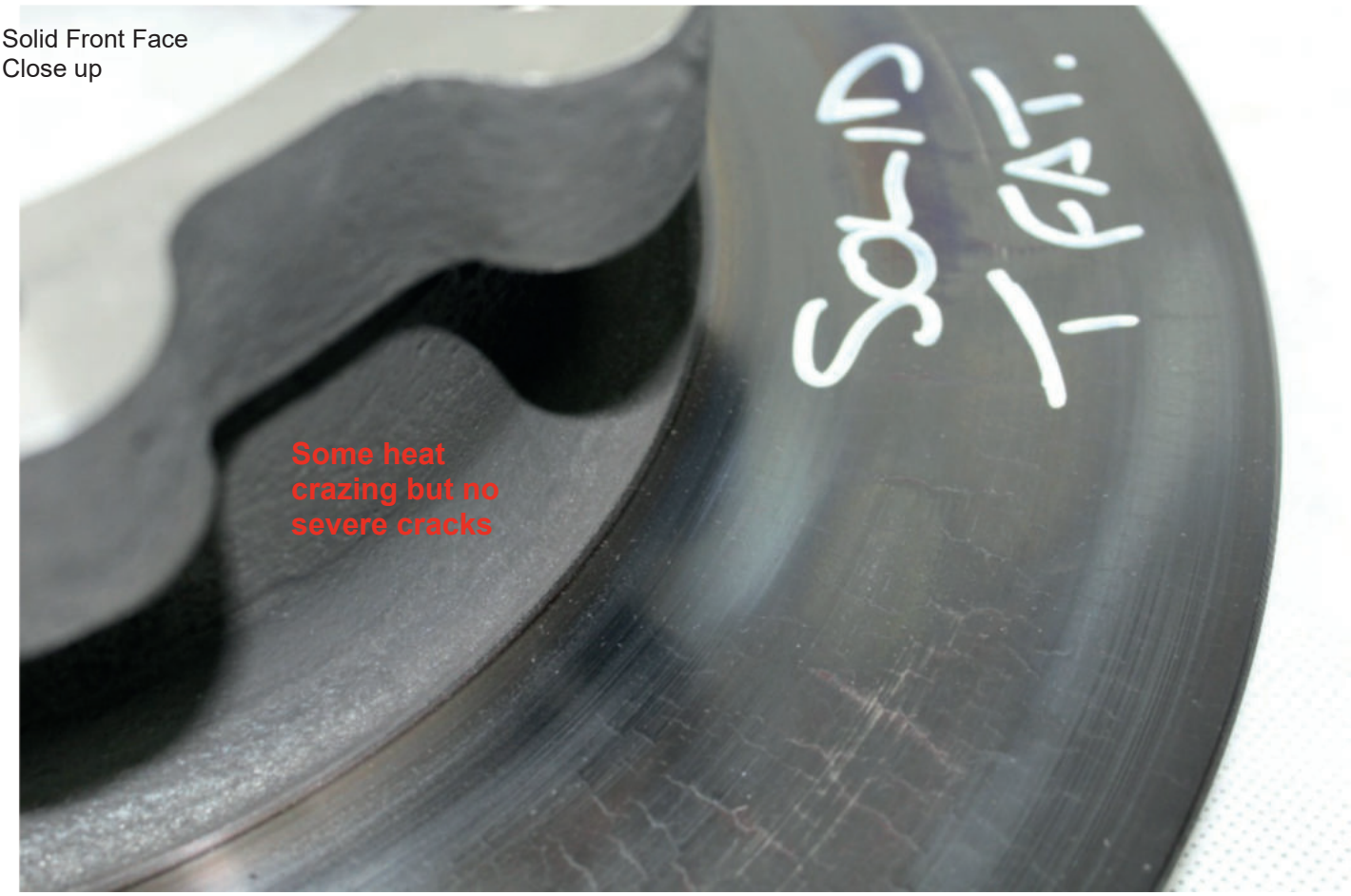
Images of the tested brake discs and corresponding brake pads are illustrated below.

Report complied by Carl Jones, Thos. Winnard & Sons Ltd Sept 2017 - updated 2022

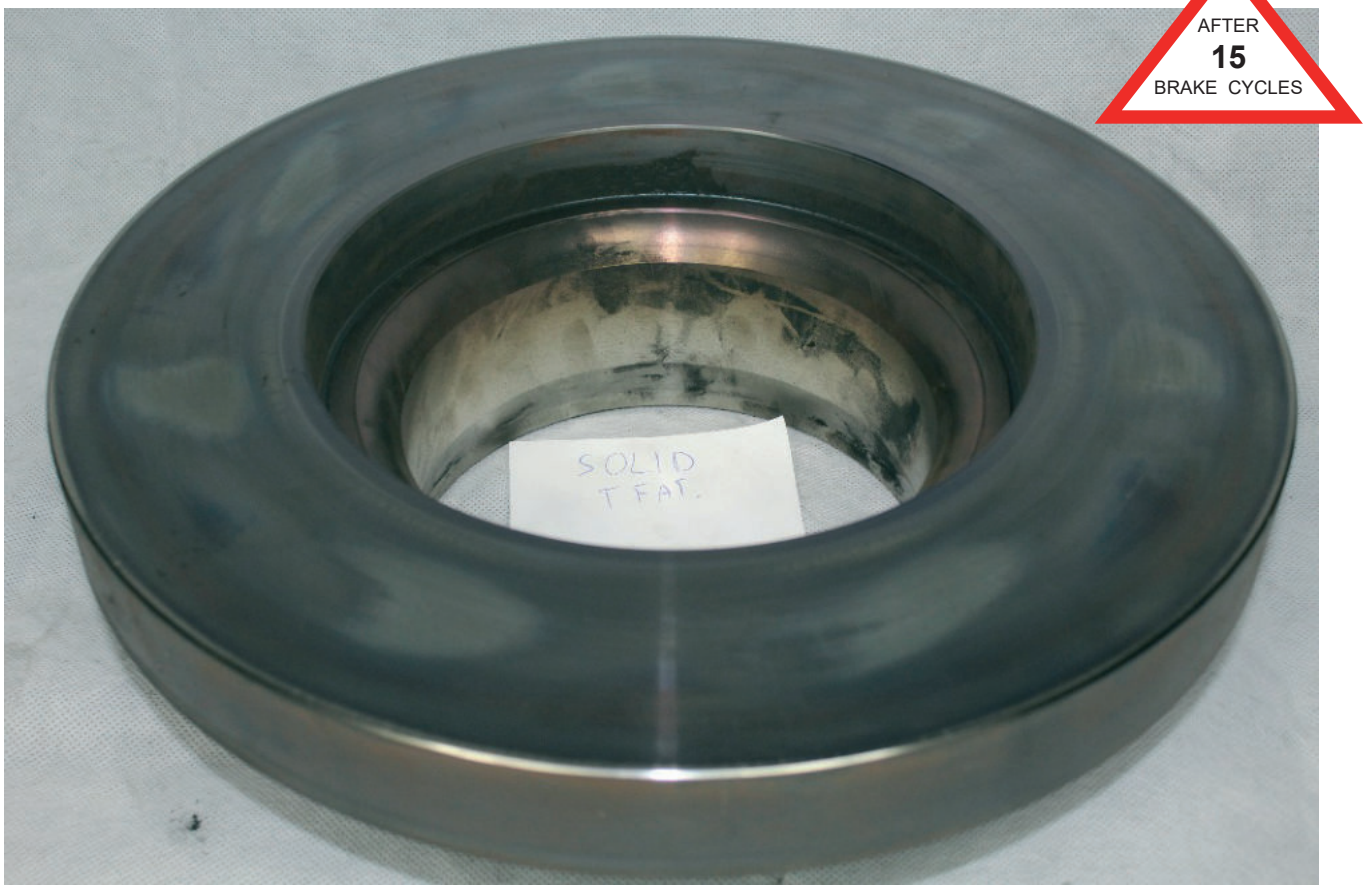
Product images

SC1023S after 15 Thermal Fatigue brake cycles

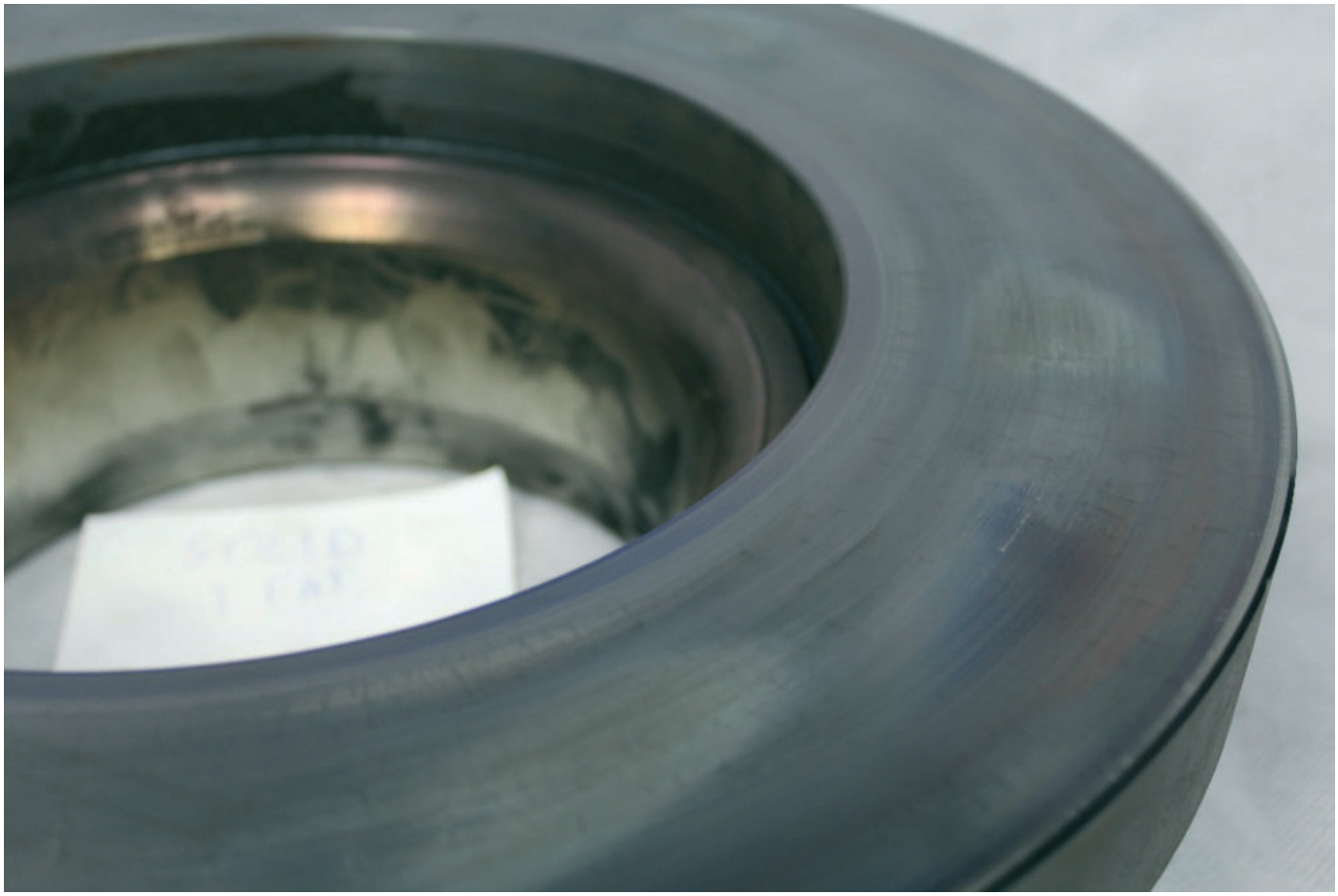




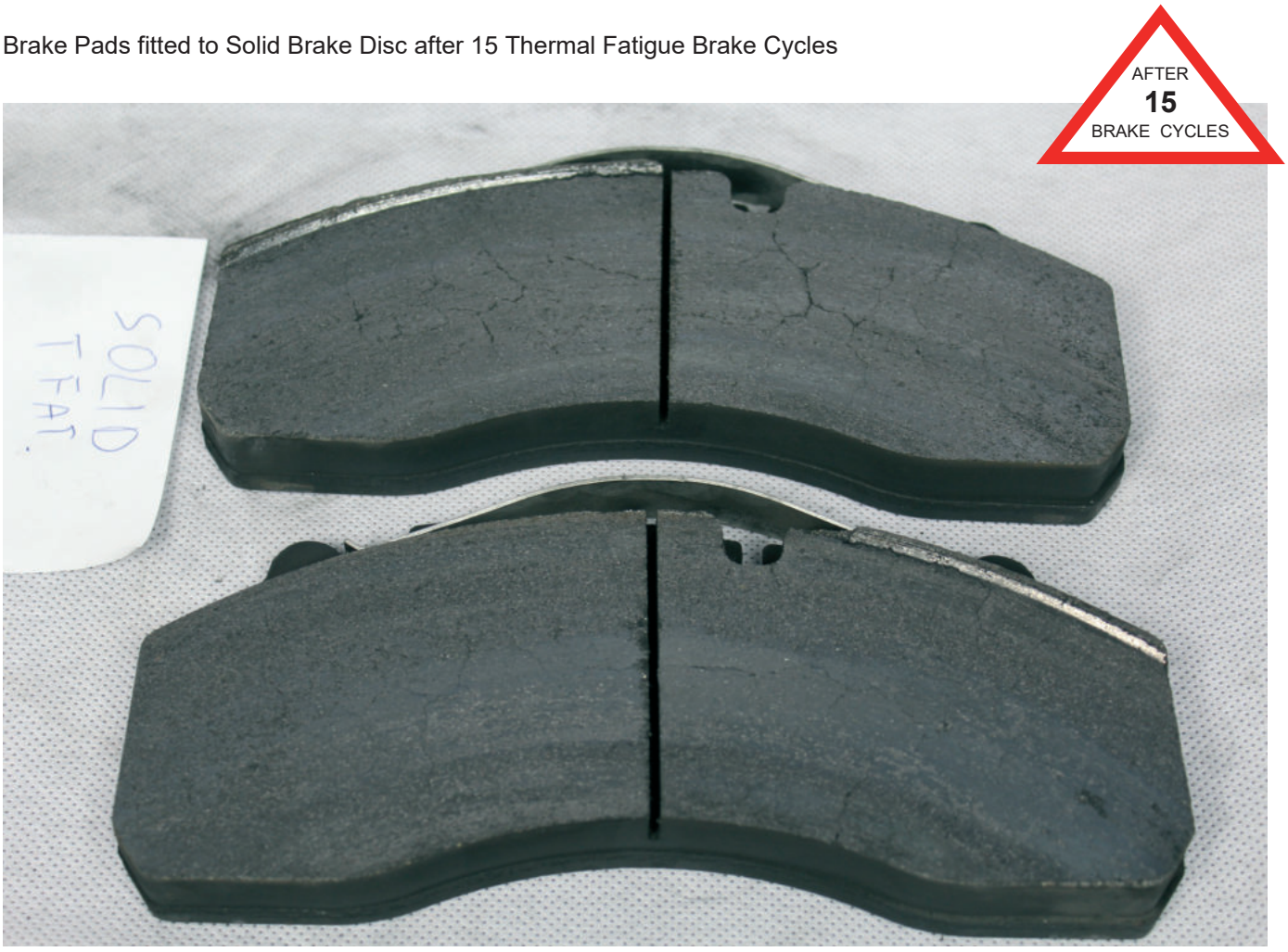
Solid Back Face



Solid Back Face Close up

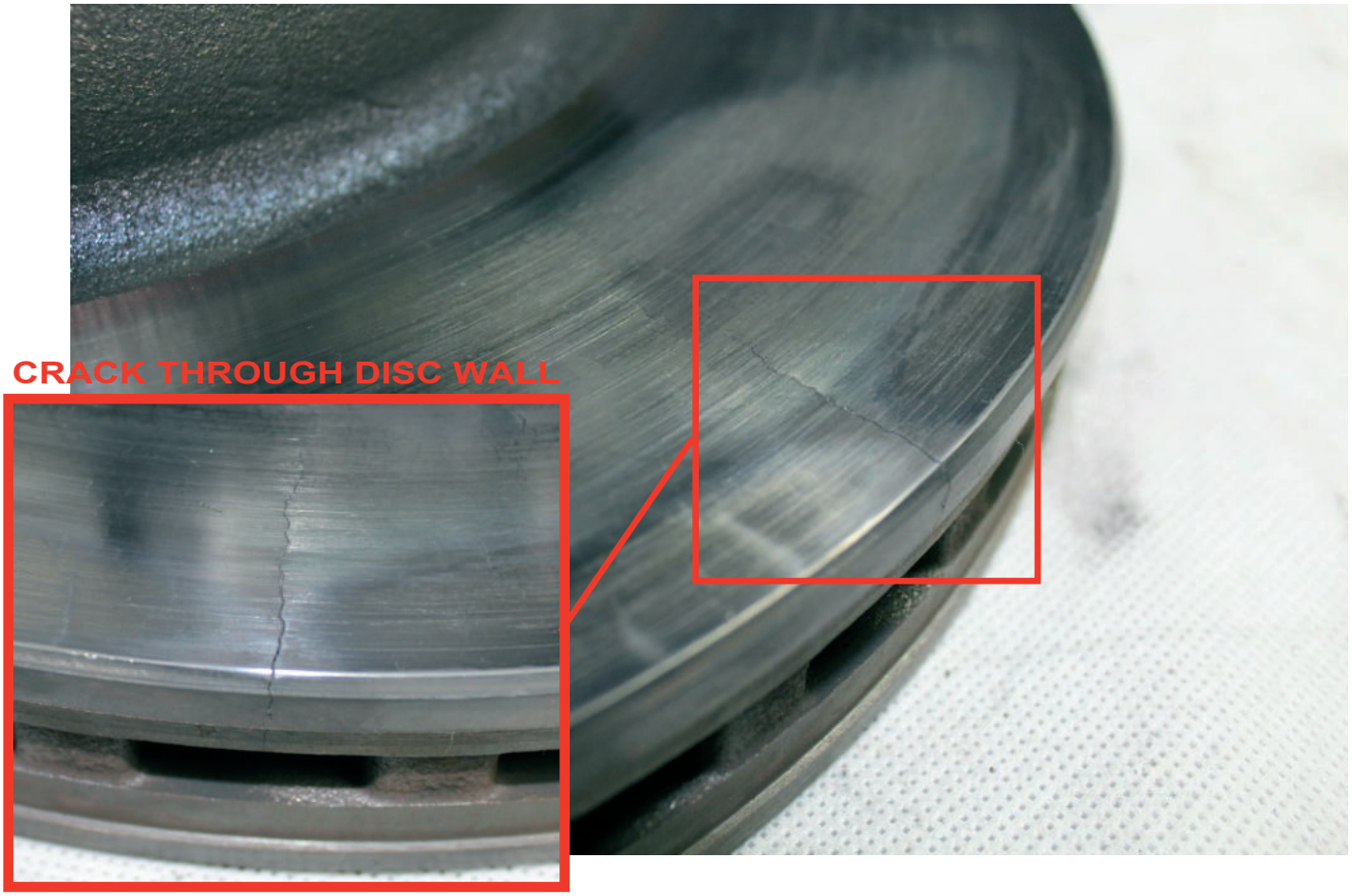


Brake Pads fitted to Solid Brake Disc after 15 Thermal Fatigue Brake Cycles

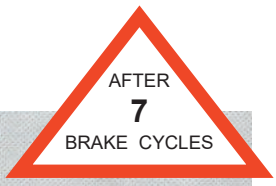


SC1023 after 7 Thermal Fatigue brake

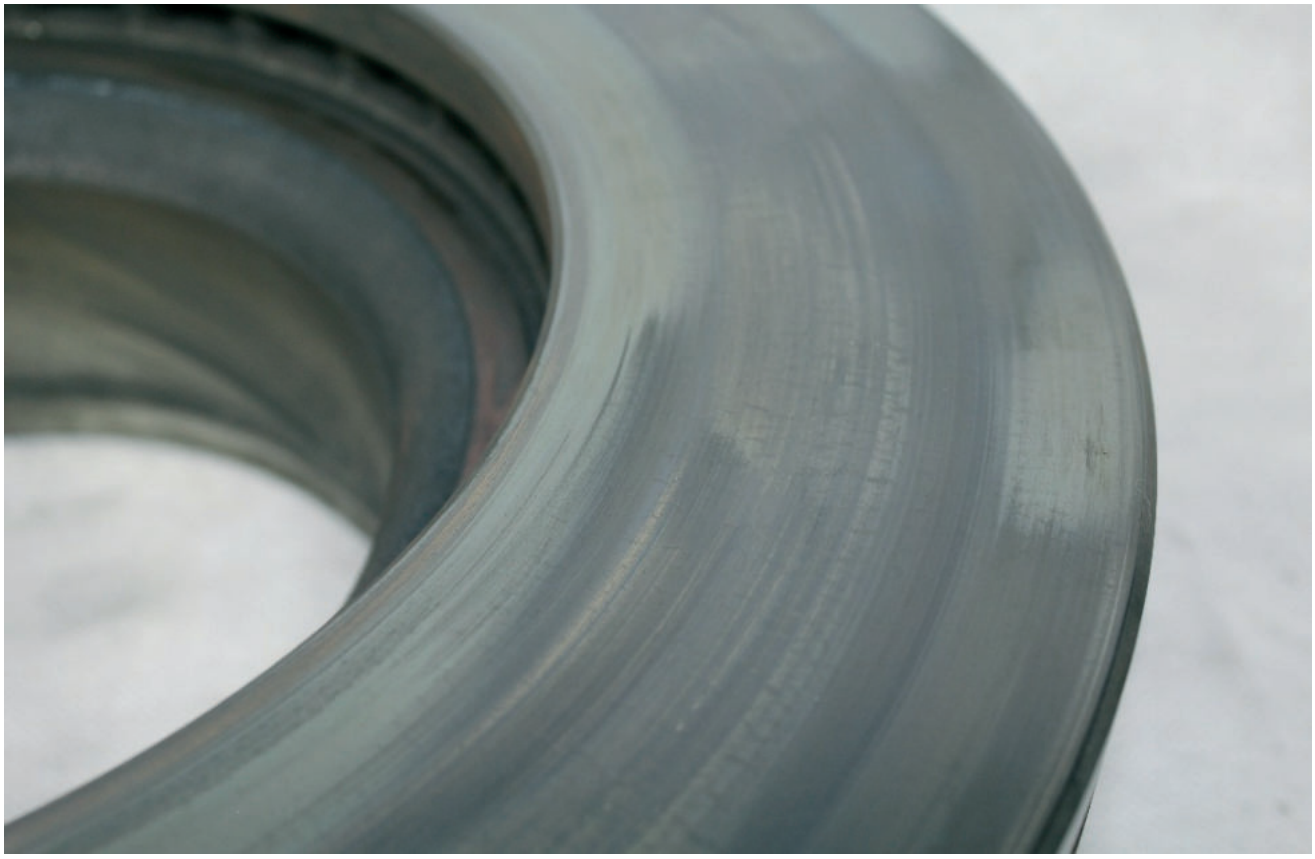
Vented Front Face Close up



Vented Back Face



Vented Back Face Close up



Brake Pads fitted to Vented Brake Disc after 7 Thermal Fatigue Brake Cycles

AFTER
7
BRAKE CYCLES