

# Technical report

## *Testing of AutoSocks on winter roads*

Order no. 70006115

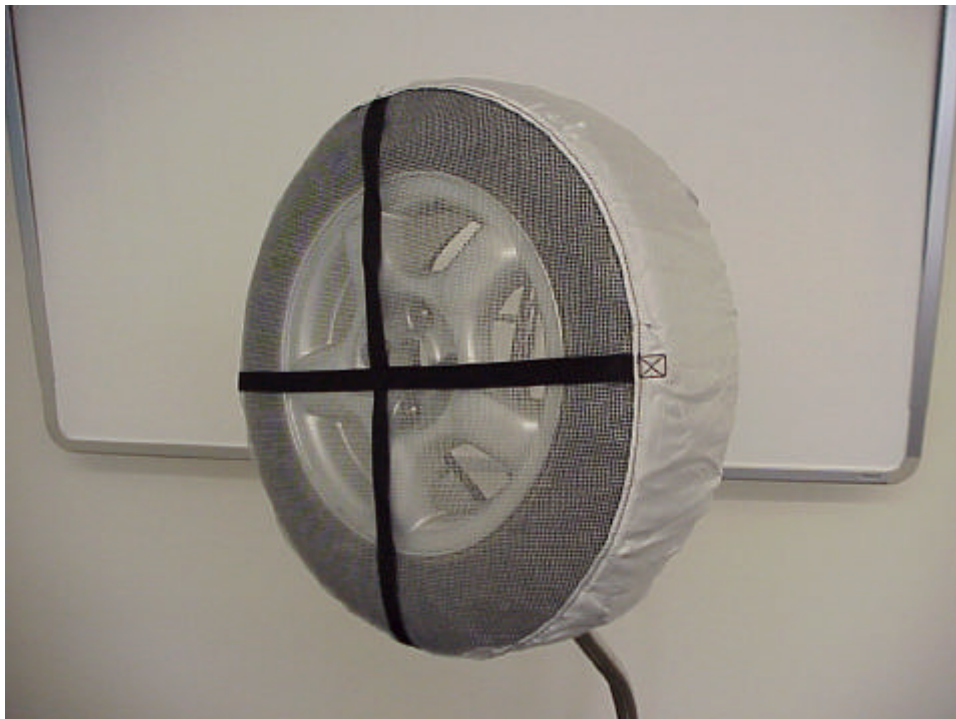
### 0 Customer

#### **AutoSock**

Fred Olsens Gt. 2  
P.O. Box 1159 Sentrum

**0107 Oslo**

**Norway**



## 1 Terms of reference

The purpose of testing was to investigate the safety and service characteristics of an innovative system which considerably improves driving performance on winter roads in comparison with summer tires. The objective of testing and inspection was to review whether both a general type approval by the German Federal Agency for Motor Vehicles (KBA) and the TÜV mark or GS mark for the final product can be obtained. Whether the product is eligible for approval in other countries, too, was to be assessed after completion of these tests and inspections.

### 1.1 Road tests

The first test series was conducted with 2 passenger cars, one with front- and one with rear-wheel drive.

The car models used were a C-class Mercedes (sedan) and a VW Passat Variant. The AutoSocks were compared with summer tires (Pirelli P 6000) and winter tires, (Bridgestone Blizzak).

Due to the findings obtained and the experience gathered during the tests, the product was also compared with a reference snow chain in the tests conducted on a snow-covered test course (inclusion of ÖNORM V5117) after consultation with the customer. The same driving maneuvers were conducted with all combinations. A uniform tire size, 195/65 R15, was used on both test vehicles.

#### 1.1.1 Tests on ice (artificial ice)

- acceleration measurements (traction)
- measurement of braking distance
- assessment of lateral guidance properties (circular drive)

The tests were conducted in the ice stadium in Kaufbeuren.

#### 1.1.2 Tests on snow

- acceleration measurements (traction)
- measurement of braking distance
- assessment of traction and lateral guidance

All tests conducted on a snow-covered surface were carried out in Sölden, Austria. A handling course and two large areas were prepared for the brake and acceleration tests at a height of 2800 m (Rettenbach glacier).

### **1.1.3 Tests on dry/wet road surface**

- measurement of braking distance
- assessment of lateral guidance properties
- safety assessment of road performance
- wear test in real traffic
- wear test as per ÖNORM V5117
- verification of tire-structure temperature

The high-speed tests were conducted on a dry road surface in IDIADA, Spain, the brake tests on a wet road surface in MIRA, England. All the other tests were carried out on the TÜV test course in Jesenwang.

### **1.1.4 Additional assessments**

- Testing as snow chain in line with the definition of the StVZO (Regulation authorizing the use of vehicles for road traffic) by TÜV Product Service GmbH
- ease of mounting and dismounting
- comprehensibility of operating instructions
- packing and stowage

## **1.2 Eligibility for approval**

As far as eligibility for approval is concerned, we submitted an inquiry to this effect to the KBA on October 11, 2000. The inquiry contained a short product profile and a precise description of the scope of the tests and inspections we had carried out. The inquiry addressed the eligibility of the AutoSocks for approval in the form of certification as a snow chain or an anti-skid device. Additionally, we wished to clarify whether the issue of a type approval as per Article 22a (1) No.2 StVZO (Regulation authorizing the use of vehicles for road traffic) or a component type approval as per Article 22 StVZO was possible.

On November 3, 2000, KBA replied to our letter. Unfortunately, we cannot endorse the opinion expressed by the KBA in this letter as it stands: further efforts to clarify the product's eligibility for approval elsewhere are therefore necessary. A brief outline of the KBA's reply is provided below:

- the product may possibly be used as a "traction aid" in emergency situations
- the Autosocks do not satisfy the design characteristics pertaining to snow chains (Article 37 (2) StVZO);
- the product cannot be regarded as an anti-skid device (Article 37 (1) StVZO), since the KBA is of the opinion that the AutoSocks do not comply with the scope of application defined for anti-skid devices by the StVZO;
- in short, the KBA does not see any possibility of approving the product on the basis of Article 37, StVZO.

## **1.3 Award of a quality mark**

Various quality marks can be acquired from TÜV Süddeutschland Group. Their main differences lie in the defined test criteria and scope of testing and inspection necessary for their award. It is in the customer's interest to acquire a top-quality mark (TÜV Mark and GS mark), so that it will be as difficult as possible for potential competitors to acquire the same mark in future, this mark being based on a precisely defined, sophisticated test program.

## 2 Tires

Tire size: 195/65 R15 91H  
Rim size: 6 ½ J x 15 H2, ET 37

Tire type: **Pirelli P 6000 Powergy**  
**Bridgestone Blizzak LM 18**



### 3 Test vehicles

Manufacturer:	Volkswagen
Model:	Passat Variant TDI
Type:	3B
Power:	85 kW
Max. speed.:	194 km/h
Wheelbase:	2707 mm
Track width front axle:	1495 mm
Track width rear axle:	1499 mm
Permissible total weight:	1980 kg
Permissible axle load, front axle:	1050 kg
Permissible axle load, rear axle:	1070 kg
Inflation pressure, front axle:	2.5 bar
Inflation pressure, rear axle:	2.5 bar

Manufacturer:	Mercedes
Model:	C 200 Kompressor
Type:	203
Power:	120 kW
Max. speed:	230 km/h
Wheelbase:	2715 mm
Track width front axle:	1499 mm
Track width rear axle:	1464 mm
Permissible total weight:	1920 kg
Permissible axle load, front axle:	900 kg
Permissible axle load, rear axle:	1020 kg
Inflation pressure, front axle:	2.5 bar
Inflation pressure, rear axle:	2.5 bar

Loading:

Ice: 900 kg on the front axle and 890 kg on the rear axle of both test vehicles.

Snow: For the brake tests, a load of approx. 850 kg was imposed on the front axle and a load of approx. 810 kg on the rear axle of the two test vehicles.

For traction measurement and the handling tests, we opted for uniform load distribution, i.e. a load of 830 kg was imposed on both front and rear axle.

Wet road: For the brake test on a wet road surface, a load which corresponded to approximately 75% of the tire's loading capacity was selected in line with the draft sequel to ECE Directive 92/23 (in the meantime replaced by 2001/43/EC) submitted by the tire industry and TÜV Automotive.

Tire loading capacity: Load index 91 ⇒ 615 kg  
75% ⇒ 470 kg (940 kg max. axle load)

Loading of the test vehicle is always a compromise between ideal tire loading, optimum tire inflation pressure, standard vehicle loading and a feasible test procedure.

## 4 Test procedure

### 4.1 Tests on ice

The tests were conducted in the ice stadium of Kaufbeuren in September 2000. The following criteria were investigated:

- acceleration (traction)
- braking distance
- lateral guidance properties

All tests included comparison with high-quality winter and summer tires. In the test conducted on a circular test course and the brake tests, AutoSocks were mounted on both axles of the test vehicles. In the acceleration tests, AutoSocks were mounted on the test vehicles' driven axles and summer tires were mounted on the non-driven axles. Since, at this stage, AutoSock only intended to use the product as a possible summer-tire supplement in winter (traction aid) and we were not yet able to gauge the total performance potential of the AutoSocks, we waived tests comparing the product as used in combination with winter tires and a comparison with a reference snow chain.

#### 4.1.1 Acceleration (traction) on ice

The test vehicles were accelerated at full throttle in second gear against the engine's drag torque from 5 km/h to 15 km/h; ESP was deactivated. The distance covered until the vehicle reached a speed of 15km/h was measured. Similarly, the speed and acceleration curves must be determined from the records.





#### **4.1.2 Braking on ice**

The surface on which the brake test was conducted consisted of artificial ice. The test vehicles were decelerated from a speed of more than 20 km/h down to standstill by full-brake application and activated anti-lock braking system [ABS]. Recording was conducted in the range between 20 km/h and 5 km/h. Speed and braking distance were measured by means of a Doppler radar sensor. The temperature of the ice was measured regularly to allow exclusion of a change in test conditions caused by different temperatures. Braking distance and speed were recorded, mean deceleration calculated.



#### **4.1.3 Assessment of lateral guidance properties on ice**

A circular track with a diameter of 16 meters was covered at maximum possible speed. Out of ten circles driven, we selected the five best times and calculated a mean value.



#### **4.2 Tests on snow**

The tests were carried out on a test course in Sölden, Austria, at the end of November. In order to ensure constant test conditions for the measurements throughout the entire test series, some of these tests were conducted at night. The following criteria were investigated:

- acceleration (traction)
- braking distance
- lateral guidance properties

In these tests, the AutoSocks were also compared with a reference snow chain as per the Austrian standard, ÖNORM V5117 to gain some experience with a view to a possible future test and better assess the product's prospects of success.

Testing in connection or comparison with summer tires was only possible to a limited extent and only proved expedient within the scope of brake tests.

The surface on which brake and acceleration tests were conducted was prepared regularly to ensure constant snow quality. The temperature of the snow and ambient air and the humidity of the air were measured regularly to exclude impacts caused by changing snow composition.



#### **4.2.1 Acceleration (traction) on snow**

On a gentle slope, the test vehicles were accelerated at full throttle in second gear from 20km/h to 35 km/h against the engine's drag torque; ESP or traction control were deactivated. The distance covered until the vehicle reached the required speed was measured. Similarly, the speed and acceleration curves must also be determined from the records.



Owing to on-site snow conditions, the tests could not be performed on the area originally intended for this purpose. We therefore had to move to a smaller area and could not carry out our standard test process. This had only minor impacts on the result, however.

#### **4.2.2 Braking on a snow-covered surface**

The brake tests were conducted on an area with packed snow. The test vehicles were decelerated from more than 40 km/h to standstill by full-brake application; ABS was activated. The braking distance needed to decelerate the vehicle from 40km/h to 5km/h was measured. Speed and braking distance were measured by means of a Doppler radar sensor. The temperature of the snow and ambient air as well as the humidity of the air were measured constantly to exclude impacts caused by a change in snow composition (measuring procedure see above). The braking distance and speed were recorded and mean deceleration calculated.





#### **4.2.3 Handling on snow (mountain course)**

The vehicles were loaded in line with the conditions outlined above. Handling was assessed by two different drivers on two different courses each. One course was a level, selective handling course, the other a winding, snow-covered mountain pass. Assessment on the mountain pass was divided into two parts. The first consisted of subjective handling assessment. For this purpose, the road had to be driven at a suitable speed with as little slip as possible. On the second course, the vehicle was driven at maximum possible speed. The time needed from start to finish was measured. Each driver conducted this assessment twice.



The tires were evaluated in line with the following criteria:

- General traction performance
- Traction performance on the mountain pass
- Tracking uphill
- Tracking downhill
- General cornering performance
- Hill start
- Starting on a level road
- Brake performance

Evaluation system:

The rating is based on a score from 1-10. The score is defined as follows:

10	excellent
9 or 8	good
7 or 6	fair
5 or 4	adequate
3 or 2	inadequate
1	unsatisfactory



### **4.3 Tests on a dry/wet road surface**

#### **4.3.1 Endurance test on dry high-speed course in IDIADA**

The tests were conducted on the high-speed test course IDIADA Automotive Technology, northern Spain, on September 26, 2000. The test course has an oval shape with banked curves.

Length of straight course:	2x2000 m
Curve radius:	472 m
Overall length:	7576 m
Max. banking of curves:	39°



A VW Passat 1.9 TDI with Dunlop tires, SP Sport 200E, 195/65 R15 V, was used as test vehicle. The vehicle was partially loaded.

Axle load:	front axle: 930 kg	rear axle: 660 kg
Inflation pressure:	front axle: 2.2 bar	rear axle: 2.0 bar

New AutoSocks were mounted on the front axle and the vehicle driven at a constant speed of 70 km/h with almost no lateral acceleration on the 7.56 km long test course. After 19 km, the AutoSocks were defect and revealed considerable cracks. The Sock on the right side was subsequently removed. After 38 km, the Sock on the left side was also dismantled. In comparison with the shorter running distance of 19 km, the wear on the Sock was only slightly greater. When the Sock was removed, it became clear, however, that the tire surface had become very hot and that the central tread blocks had become worn around the edges. Fibers from the Socks adhered to the tire surface.



In view of these results, the test had to be repeated under realistic driving conditions. On this occasion, the tire temperature was to be reviewed as well. (cf. Section 4.3.3.1 and 4.3.3.2).



#### **4.3.2 Assessment of road performance on a dry surface**

The road tests were conducted on TÜV Automotive's test course in Jesenwang near Munich and in the immediate surroundings on October 30, 2000. The temperature of the road surface was between 12.3 °C and 14.2 °C. The tests were conducted with Bridgestone Blizzak winter tires.

##### **4.3.2.1 Mercedes C200 Kompressor**

The AutoSocks were mounted only on the test vehicle's rear axle. Two full brake applications were carried out. In the test, the vehicle equipped with the AutoSocks (hereinafter referred to as Sock vehicle) achieved the same deceleration values as the vehicle equipped with winter tires.

Handling of the Sock vehicle was almost problem-free, but only within the range of reasonable speeds (max. 50 – 70 km/h) and in cases involving even and slow buildup of the steering angle. If the steering angle was built up fast and if high lateral acceleration was involved, the considerable differences in the friction values between the front and the rear axle caused the vehicle's rear end to break away in a sudden and uncontrollable manner. Since the driver is hardly aware of the Socks at speeds of up to 60km/h, this effect must be regarded as particularly critical. As long as the vehicle is being driven in a controlled, steady manner within the range of the actual scope of

application, the Sock vehicle suggests high safety reserves, which are, however, not actually available in the case of swerving maneuvers or fast steering movements. In cases involving extreme oversteering and in cases involving high lateral accelerations, the Socks are badly damaged or destroyed (outer wheel in a curve) or thrown off the wheel (inner wheel in a curve).



#### **4.3.2.2 VW Passat 1,9TDI**

Socks were only mounted on the front axle of the test vehicle. Two full brake applications were carried out. The vehicle equipped with AutoSocks showed good deceleration values.

Within the range of the intended scope of application (50 – 60 km/h), the handling of the Sock vehicle is almost problem-free. Even in cases involving fast buildup of the steering angle, controllable understeering ensues.

### 4.3.3 Wear test

#### 4.3.3.1 Wear test according to Austrian standard (October 30, 2000)

As outlined in the Austrian standard, ÖNORM V 5117, material quality was tested on the non-driven wheels of a VW Passat Variant 1.9 TDI for 1 hour on a dry road surface. Although the test speed exceeded the defined 50 km/h at some stages, the wear symptoms on the Socks were still tolerable (i.e. incipient cracks).

During the wear test, the tire temperature in the tread was additionally verified by means of an insertion thermometer. Temperatures were between 21°C and 35°C. On the tread itself, temperatures were higher; this, however, can be evaluated as uncritical. After expiry of the prescribed 60-minute test duration, a distance of 46 km had been driven. To permit an even more precise statement on wear performance, the test was extended until a distance of 60 km had been driven. Even after this test interval, only incipient cracks could be detected. The Socks still fitted tightly on the tires.

Time [min]	Distance [km]	Temperature [°C] VA	Temperature [°C] HA	Comments
10	8	21.6	21.6	Condition o.k., tight fit
20	17	25.3	30.8	Condition o.k., tight fit
30	24	29.0	32.4	Condition o.k., tight fit
40	33	30.5	33.6	Condition o.k., tight fit
60	46	32.8	34.2	First signs of incipient cracks, tight fit
75	60	32.0	34.7	Small cracks, tight fit

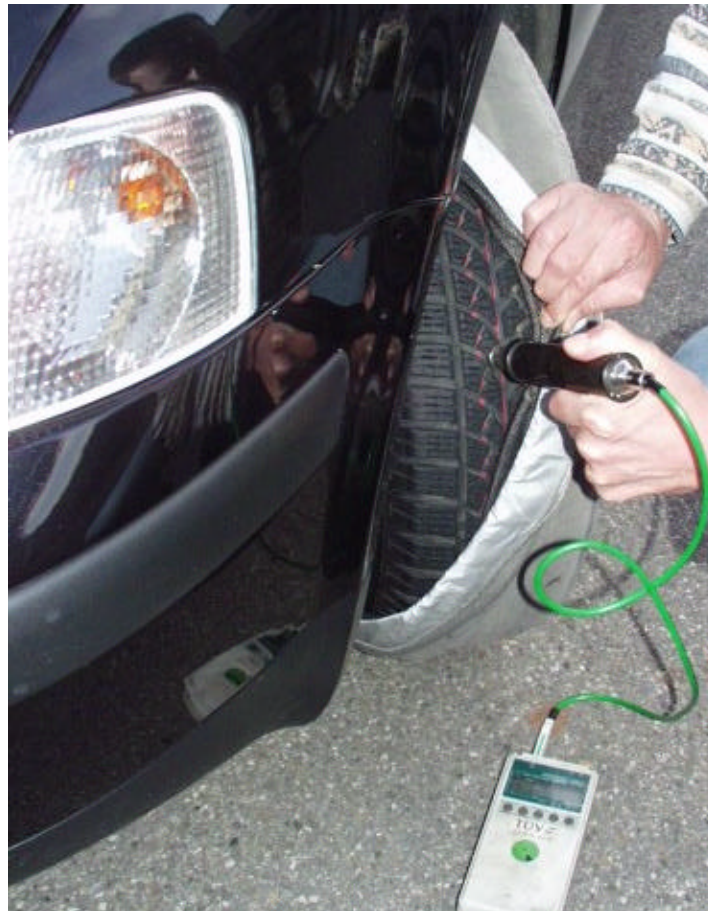


#### **4.3.3.2 Wear test including verification of tire temperature**

Within the scope of the wear test on the driven rear axle of the Mercedes, a distance of 55 km was driven. After the tests, incipient cracks were detected on the Socks, in particular around the seams (minor damage on the tread-block surface; no overheating of the tires).

During a wear test conducted on the driven front axle of the Passat Variant, the temperature of the tire's tread was once again checked over a distance of 34.5 km. In this test, temperatures were between 36.6°C and 37.5°C at speeds of between 50 km/h and 80 km/h.

After the tests, incipient cracks were visible on the AutoSocks, which, however, still fitted perfectly.



#### **4.3.4 Assessment of road performance on a wet surface**

##### **4.3.4.1 Mercedes C200 Compressor**

The AutoSocks were mounted on the rear axle of the test vehicle. Handling of the Sock vehicle on a wet road surface was practically problem-free. However, this applied only to the range of reasonable speeds (max. 50- 60 km/h) and in cases involving even and slow buildup of the steering angle. If the steering angle was built up fast and in cases involving high lateral acceleration, the considerable differences in friction values between the front and the rear axle caused the vehicle's rear end to break away in a sudden and uncontrollable manner. The damage detected on the AutoSocks was identical to the damage detected after testing on a dry road surface (destruction of the Sock mounted on the outer wheel in a curve).

Subsequently, the Socks were mounted on both axles of the test vehicle and the tests repeated. The vehicle showed almost problem-free, safe road performance (speeds between 50 km/h and 60 km/h). Although, the test vehicle's tendency towards understeering is intensified under these conditions, it is still easily to handle and

control. This finding resulted in the requirement, that vehicles with conventional drive (rear-wheel drive) must always be equipped with 4 Socks for safety reasons. Currently, in the interests of safety, we cannot comply with the customer's understandable wish to waive this requirement for marketing reasons. Should this critical driving performance be rectified by new AutoSock models, it would have to be reviewed and assessed in a new test series.



#### **4.3.4.2 VW Passat 1,9TDI**

Socks were only mounted on the front axle of the test vehicle. Within the intended scope of application (max. 50 – 60 km/h), handling of the Sock vehicle on a wet road proved to be problem-free. Even when the steering angle was built up quickly, controllable understeering ensued.



#### **4.3.4.3 Braking-distance on a wet road**

The tests were conducted on the MIRA test course in England in October. In these tests, too, the AutoSocks put up a convincing performance with favorable results.

The brake test was conducted on artificially rained asphalt. The test vehicle was decelerated from a speed of more than 60 km/h to standstill by means of full brake application; ABS was activated. Recording was conducted in the range between 60 km/h and 10km/h. Speed and braking distance were measured by means of a Doppler radar sensor.

Braking distance and speed were recorded and mean deceleration calculated.

#### **4.3.5 Summary of the results obtained on a dry and wet road surface**

The road performance of vehicles with Socks on the front axle can be regarded as uncritical. Since it may be assumed that the road performance of vehicles equipped with snow chains is certainly more problematic, the use of the AutoSocks on a dry and a wet road surface may be endorsed with certain restrictions. Attention should, however, be drawn to the fact that the AutoSocks should only be used on snow-covered or ice-covered roads and that their use on dry and wet road surfaces can only be approved in exceptional cases (multiple transition from dry/wet and snow-covered/ice-covered road surfaces).

Due to the highly critical oversteering reaction of the Mercedes with rear-wheel drive, the product's fitness for use cannot be confirmed without restrictions. Attention should be drawn to the fact that vehicles on which AutoSocks are mounted only on the rear axle do not display acceptable road performance. Additional tests we conducted demonstrated that major improvements in road performance ensued when the AutoSocks were mounted on both axles of the Mercedes. The lower transmissible lateral guidance forces acting on the front axle caused a far smoother transition and a controllable understeering reaction.

We can therefore approve the following uses:

- Case 1: use on the front axle of vehicles with front-wheel drive or vehicles with four-wheel drive;
- Case 2: simultaneous use on both axles for vehicles with rear-wheel drive;
- Exclusive use on the rear axle cannot be approved.

## **5 Test conditions**

### **5.1 Traction ice surface**

Air temperature: 7,0°C – 9,5°C  
Surface temperature: -4,2°C – -3,6°C

### **5.2 Braking ice surface**

Air temperature: 2,4°C – 7,7°C  
Surface temperature: -3,6°C – -1,8°C

### **5.3 Centrifugal force ice surface (circle)**

Air temperature: 4,6°C – 7,8°C  
Surface temperature: -3,0°C – -2,1°C

### **5.4 Traction snow surface**

Air temperature: -5,5°C – -5,0°C  
Snow temperature: -5,5°C – -4,3°C

### **5.5 Braking snow surface**

Air temperature: -5,5°C – -2,0°C  
Snow temperature: -4,8°C – -3,0°C

### **5.6 Handling snow surface**

Air temperature: -2,3°C – 1,0°C  
Snow temperature: -2,3°C – -1,5°C

### **5.7 Endurance test dry surface**

Air temperature: 20,4°C – 22,6°C  
Surface temperature: 19,0°C – 21,3°C

### **5.8 Handling dry surface**

Air temperature: 9,8°C – 13,7°C  
Surface temperature: 8,4°C – 11,9°C

### **5.9 Wear test ÖNORM V5117**

Air temperature: 7,2°C – 12,4°C  
Surface temperature: 8,4°C – 10,9°C

### **5.10 Wear test with record of tire temperature**

Air temperature: 12,3°C – 14,8°C  
Surface temperature: 10,6°C – 13,2°C

### **5.11 Handling wet surface**

Air temperature: 9,7°C – 14,2°C  
Surface temperature: 9,8°C – 11,3°C

### **5.12 Braking wet surface**

Air temperature: 10,7°C – 12,4°C  
Surface temperature: 9,7°C – 13,3°C

## 6 Results:

### 6.1 Traction ice surface

<b>VW Passat</b>	<b>acceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	0,32	100,0
Pirelli P6000	0,20	62,3
Pirelli P6000 + AutoSocks	0,72	235,5

<b>Mercedes C</b>	<b>acceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	0,39	100,0
Pirelli P6000	0,28	71,2
Pirelli P6000 + AutoSocks	0,60	150,6

See enclosures 1.1 to 1.6

### 6.2 Braking ice surface

<b>VW Passat</b>	<b>deceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	1,09	100,0
Pirelli P6000	0,97	87,6
Pirelli P6000 + AutoSocks	1,41	132,6

<b>Mercedes C</b>	<b>deceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	0,93	100,0
Pirelli P6000	0,85	90,3
Pirelli P6000 + AutoSocks (new)	1,13	138,2
Pirelli P6000 + AutoSocks (used)	1,29	122,8

See enclosures 2.1 to 2.6

### 6.3 Centrifugal force ice surface (circle)

<b>VW Passat</b>	<b>time [s]</b>	<b>%</b>
Bridgestone Blizzak	16,1	100,0
Pirelli P6000	16,3	97,6
Pirelli P6000 + AutoSocks	19,1	85,2

<b>Mercedes C</b>	<b>time [s]</b>	<b>%</b>
Bridgestone Blizzak	18,0	100,0
Pirelli P6000	17,3	105,7
Pirelli P6000 + AutoSocks	17,1	105,4

See enclosures 3.1 to 3.6

### 6.4 Traction snow surface

<b>VW Passat</b>	<b>acceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	1,03	100,0
Bridgestone + AutoSocks	1,20	114,8
Bridgestone +snow chain	1,23	119,7

<b>Mercedes C</b>	<b>acceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	1,00	100,0
Bridgestone + AutoSocks	1,05	105,0
Bridgestone + snow chain	1,01	101,0

See enclosures 4.1 to 4.6

## 6.5 Braking snow surface

<b>VW Passat</b>	<b>deceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	2,72	100,0
Bridgestone + AutoSocks	2,84	106,7
Pirelli P6000	1,65	59,8
Bridgestone + snow chain	2,73	100,8
Pirelli P6000 + AutoSocks	2,62	79,1

<b>Mercedes C</b>	<b>deceleration [m/s<sup>2</sup>]</b>	<b>%</b>
Bridgestone Blizzak	2,79	100,0
Pirelli P6000	1,77	63,1
Pirelli P6000 + AutoSocks	2,81	100,7
Bridgestone + snow chain	2,69	97,1

See enclosures 5.1 to 5.6

## 6.6 Handling snow surface

<b>VW Passat</b>	<b>general impression</b>	<b>time [s]</b>
Bridgestone Blizzak	6,38	73,3
Bridgestone + AutoSocks	7,75	68,9
Bridgestone + snow chain	6,88	74,0

<b>Mercedes C</b>	<b>general impression</b>	<b>time [s]</b>
Bridgestone Blizzak	5,75	76,6
Bridgestone + AutoSocks	7,38	64,1
Bridgestone + snow chain	7,38	66,8

See enclosures 6.1 to 6.6

## 6.7 Braking wet surface

<i>Mercedes C</i>	<i>deceleration [m/s<sup>2</sup>]</i>	<i>%</i>
Bridgestone Blizzak	8,14	100,0
Pirelli P6000	9,15	113,6
Pirelli P6000 + AutoSocks	8,11	99,5
Bridgestone + AutoSocks	6,95	84,3

See enclosures 7.1 to 7.3

## 6.8 Additional evaluations

### 6.8.1 Testing as anti-skid device conducted by TÜV Product Service

As the results obtained over the course of the test series were mostly very positive, the decision was taken to have the AutoSocks tested as snow-chain by TÜV Product Service.

Testing consisted of tests in line with the Austrian standard ÖNORM V5117:1996 and TÜV Product Service's own test program (No. PP50003:1999) which included additional criteria e.g. also relating to the regulations applicable in Germany and Austria.

Testing was completed with a negative result. Below, only the test criteria which were evaluated unfavorably will be dealt with.

In all tests, the AutoSocks were compared with the so-called reference snow chain.

#### 6.8.1.1 Dynamic lift off

During dynamic testing, e.g. on a test rig, the anti-skid device must not lift off the tire tread by more than 25 mm.

Although the defined limit was slightly exceeded, it can still be classed as acceptable.

### **6.8.1.2 Performance during acceleration**

The vehicle must be accelerated from standstill over a distance of at least 50m. The selected slip of the drive wheels must allow maximum possible acceleration. Over the test course, every used gear must be driven to the revs limit.

The AutoSocks must achieve a value corresponding to at least 70% of that achieved by the reference snow chain. The value achieved, however, was only 24.4%.

The difference in the results achieved by TÜV Automotive can be explained by the possibility for the driver to influence performance. In the test procedure selected by TÜV Automotive, the driver's influence on the final result is practically nil, since acceleration performance depends only on the vehicle and the transmissible forces on the drive axle.

### **6.8.1.3 Performance on a snow-covered road surface**

The road surface must have an adequate snow cover. Snow temperature should range between  $-1^{\circ}\text{C}$  to  $-8^{\circ}\text{C}$ . The maximum tensile force in the speed range between 10 km/h and 30 km/h must be determined. This can be done either by an increasing load, e.g. by decelerating a trailer or via the influence of gradients. Abrupt braking by the towed vehicle must be avoided. The AutoSocks must achieve a value which corresponds to at least 70% of that of the reference snow chain. A value of 39.6% was achieved.

The difference can be explained as already outlined under 6.8.1.2.

### **6.8.2 Ease of mounting and dismounting**

The mounting of the AutoSocks does not require much effort. They are easy to handle, even when the wheels are already stuck. If the product is handled properly, the risk of injury can be excluded during the mounting process. After mounting has been completed, the AutoSocks align themselves automatically.

Frozen Socks pose a slight problem, since they are difficult to mount.

To further facilitate dismounting, the addition of a band made of textile material across the diameter of the AutoSocks has been recommended.



### **6.8.3 Operating instructions**

These requirements with respect to the operating instructions refer to use of the product as a "winter traction aid". In this case, every set of AutoSocks must be accompanied by operating instructions in German, which must contain the following information:

- reference to the maximum speed of 50 km/h;
- extensive instructions re mounting and dismounting (including illustrations);
- reference to the necessary verification of the condition of the Autosocks and information pertaining to their maintenance and storage. In addition, information should be provided as to when the Autosocks are no longer in a fit condition for further use;
- general rules of driving conduct to ensure safety when driving with AutoSocks (in particular explicit information on the use of the product with different drive systems);
- special reference to the fact that the product must not be used instead of snow chains and must be immediately dismounted once the emergency situation ceases to exist.

These requirements have been satisfied by the customer in the meantime.

### **6.8.4 Packing and stowage**

With respect to packing possibilities, we can only provide recommendations based on our experiences with the product gained in the trial phase at this stage. Compact, moisture- and water-proof packaging should be developed. Ideally, this packaging would be made of material similar to that of the AutoSocks. Care should be taken to ensure that the packing is large enough to stow AutoSocks that are slightly iced up after use, too.

These requirements have been satisfied by the customer in the meantime.

### **6.8.5 Development of TÜV Mark "Winter traction aid"**

After extensive consultation with TÜV Product Service GmbH, the TÜV Mark for "Winter traction aid" (test program PP53219:2000) was awarded on July 20, 2001. To safeguard the interests of AutoSock, a highly sophisticated test program was devised. With the development of this test mark, we succeeded in creating a quality label which, owing to its stringent requirements, satisfies both the requirements of end users, i.e. a high utility value and the requirements of AutoSock, i.e. to make it as difficult as possible for potential competitors or imitators to obtain the same test mark.

## **7 Enclosures**

- 0.1 Overall view of results
- 0.2 Ranking
- 0.3 Ranking (cont.)
- 0.4 Ranking (cont.)
  
- 1.1 Data sheet traction, VW Passat ice
- 1.2 Diagram traction distance, VW Passat ice [m]
- 1.3 Diagram traction, VW Passat ice [%]
- 1.4 Data sheet acceleration, Mercedes C ice
- 1.5 Diagram traction distance, Mercedes C ice [m]
- 1.6 Diagram acceleration, Mercedes C ice [%]
  
- 2.1 Data sheet braking, VW Passat ice
- 2.2 Diagram braking distance, VW Passat ice [m]
- 2.3 Diagram deceleration, VW Passat ice [%]
- 2.4 Data sheet braking, Mercedes C ice
- 2.5 Diagram braking distance, Mercedes C ice [m]
- 2.6 Diagram deceleration, Mercedes C ice [%]
  
- 3.1 Data sheet lap time, VW Passat circle ice
- 3.2 Diagram lap time, VW Passat circle ice[s]
- 3.3 Diagram centrifugal force, VW Passat circle ice[%]
- 3.4 Data sheet lap time, Mercedes C circle ice
- 3.5 Diagram lap time, Mercedes C circle ice[s]
- 3.6 Diagram centrifugal force, Mercedes C circle ice[%]
  
- 4.1 Data sheet traction, VW Passat snow
- 4.2 Diagram traction distance, VW Passat snow [m]
- 4.3 Diagram acceleration, VW Passat snow [%]
- 4.4 Data sheet traction, Mercedes C snow
- 4.5 Diagram traction distance, Mercedes C snow [m]
- 4.6 Diagram acceleration, Mercedes C snow [%]

- 5.1 Data sheet braking, VW Passat snow
- 5.2 Diagram braking distance, VW Passat snow [m]
- 5.3 Diagram deceleration, VW Passat snow [%]
- 5.4 Data sheet braking, Mercedes C snow
- 5.5 Diagram braking distance, Mercedes C snow [m]
- 5.6 Diagram deceleration, Mercedes C snow [%]
  
- 6.1 Data sheet handling, VW Passat snow
- 6.2 Diagram handling, VW Passat snow
- 6.3 Diagram lap time [s], VW Passat snow handling track
- 6.4 Data sheet Handling, Mercedes C snow
- 6.5 Diagram Handling, Mercedes C snow
- 6.6 Diagram lap time [s], Mercedes C snow handling track
  
- 7.1 Data sheet braking, Mercedes C wet surface
- 7.2 Diagram braking, Mercedes C wet surface [m]
- 7.3 Diagram deceleration , Mercedes C wet surface [%]

This report consists of 35 pages and 43 pages of enclosures.  
Munich, September 18, 2001

TÜV AUTOMOTIVE GMBH  
Tire/Wheel-Test-Center

Dipl.-Ing. Michael Staude

Enclosure 0.1

<b>Overall view of results</b>						
<b>Test</b>	<b>Tire</b>	<b>BS-Blizzak LM 18 195/65 R15 91H M+S</b>	<b>Pirelli P6000 Powergy 195/65 R15 91H</b>	<b>AutoSocks on Pirelli</b>	<b>AutoSocks on Bridgestone</b>	<b>Snow chain on Bridgestone</b>
Lap time [s] ice Passat		16,11	16,33	19,09		
Lap time [s] ice Mercedes		18,01	17,30	17,06		
Traction distance [m] ice Passat		24,60	38,09	10,67		
Traction distance [m] ice Mercedes		19,46	27,36	12,89		
Braking distance [m] ice Passat		13,33	14,83	10,24		
Braking distance [m] ice Mercedes		15,54	17,00	12,01		
Braking distance [m] wet surface Mercedes		16,58	14,76	16,65	19,42	
Lap time [s] snow Passat		73,30			68,91	73,96
Lap time [s] snow Mercedes		76,60			64,15	66,85
Rating of handling snow Passat		6,38			7,75	6,88
Rating of handling snow Mercedes		5,75			7,38	7,38
Braking distance [m] snow Passat		22,42	36,83	29,38	20,05	22,08
Braking distance [m] snow Mercedes		21,77	34,23		21,61	22,57
Traction distance [m] snow Passat		30,76			26,58	25,88
Traction distance [m] snow Mercedes		31,86			30,36	31,61

Enclosure 0.2

<b>Ranking</b>					
	<b>Lap time ice Passat</b>	<b>Lap time ice Mercedes</b>	<b>Traction ice Passat</b>	<b>Traction ice Mercedes</b>	<b>Braking ice Passat</b>
<b>Best</b>	Bridgestone	AutoSocks on Pirelli	AutoSocks on Pirelli	AutoSocks on Pirelli	AutoSocks on Pirelli
	Pirelli	Pirelli	Bridgestone	Bridgestone	Bridgestone
<b>Worst</b>	AutoSocks on Pirelli	Bridgestone	Pirelli	Pirelli	Pirelli

Enclosure 0.3

<b>Ranking (cont.)</b>					
	<b>Braking ice Mercedes</b>	<b>Braking wet Mercedes</b>	<b>Lap time snow Passat</b>	<b>Lap time snow Mercedes</b>	<b>Lap time snow Passat</b>
<b>Best</b>	AutoSocks on Pirelli	Pirelli	AutoSocks on Bridgestone	AutoSocks on Bridgestone	AutoSocks on Bridgestone
	Bridgestone	Bridgestone	Bridgestone	Snow chain on Bridgestone	Snow chain on Bridgestone
	Pirelli	AutoSocks on Pirelli	Snow chain on Bridgestone	Bridgestone	Bridgestone
<b>Worst</b>		AutoSocks on Bridgestone			

Enclosure 0.4

<b>Ranking (cont.)</b>					
	<b>Handling snow Mercedes</b>	<b>Braking snow Passat</b>	<b>Braking snow Mercedes</b>	<b>Traction snow Passat</b>	<b>Traction snow Mercedes</b>
<b>Best</b>	AutoSocks on Bridgestone	AutoSocks on Bridgestone	AutoSocks on Bridgestone	Snow chain on Bridgestone	AutoSocks on Bridgestone
	Snow chain on Bridgestone	Snow chain on Bridgestone	Bridgestone	AutoSocks on Bridgestone	Snow chain on Bridgestone
	Bridgestone	Bridgestone	Snow chain on Bridgestone	Bridgestone	Bridgestone
		AutoSocks on Pirelli	Pirelli		
<b>Worst</b>		Pirelli			

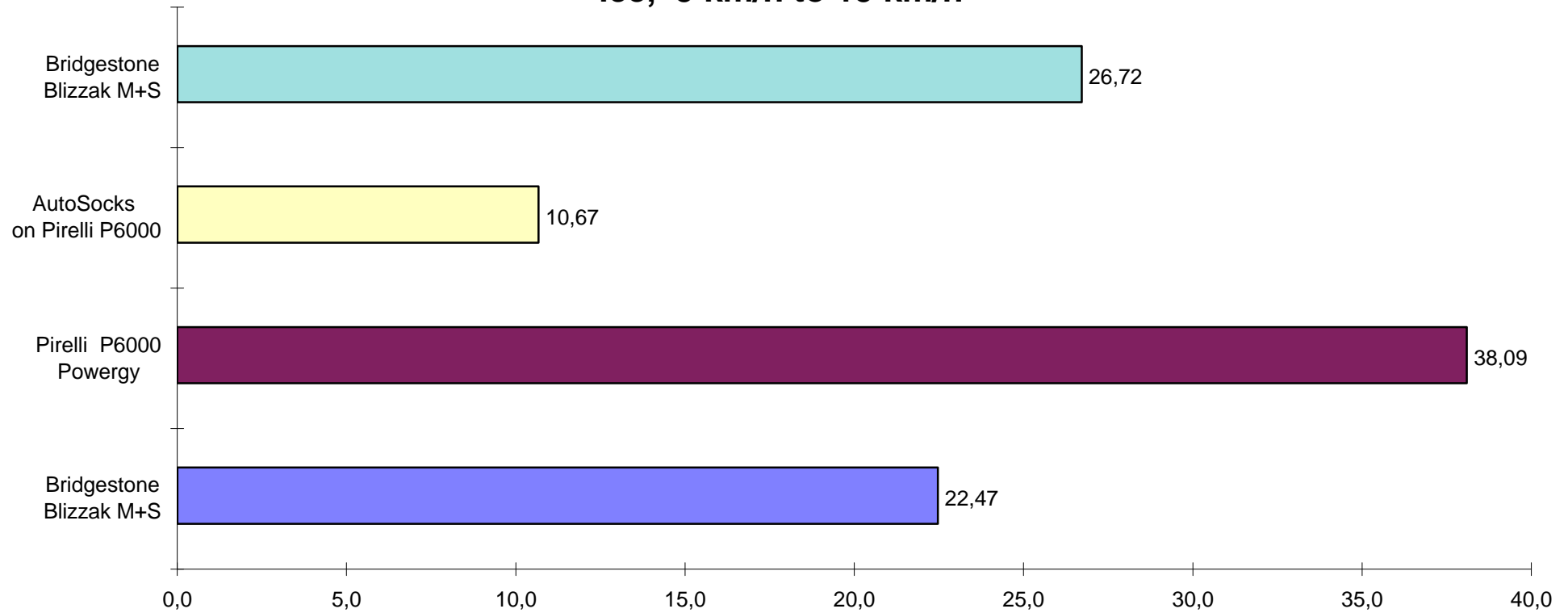
Enclosure 1.1

Data Sheet	Traction distance ice 5 km/h to 15 km/h			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	12.9.00			<b>Vehicle:</b> VW Passat
<b>Air temperature:</b>	Ø: 8,1°C	max: 9,5°C	min: 7,0°C	<b>Model:</b> 3B
<b>Surface temperature:</b>	Ø: -3,9°C	max: -3,6°C	min: -4,2°C	<b>V<sub>1</sub> [km/h]:</b> 5
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b> 15
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b> 890
<b>Total decelareted weight (kg):</b>	1790			
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>62,28%</b>	<b>235,55%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>-37,72%</b>	<b>135,55%</b>	<b>0,00%</b>
Value Nr. 1 [m]	22,75	37,77	11,28	25,90
Value Nr. 2 [m]	22,78	37,64	10,51	26,89
Value Nr. 3 [m]	22,62	37,26	10,15	26,20
Value Nr. 4 [m]	22,01	38,10	10,20	26,76
Value Nr. 5 [m]	22,18	39,70	11,21	27,84
<b>Mean value</b>	<b>22,47</b>	<b>38,09</b>	<b>10,67</b>	<b>26,72</b>
Standard variation	0,314	0,847	0,486	0,667
Variancy	0,099	0,717	0,236	0,446
<b>Mean acceleration [m/s<sup>2</sup>]</b>	<b>0,34</b>	<b>0,20</b>	<b>0,72</b>	<b>0,29</b>
Reference value	0,34	0,33	0,31	0,29
<b>Percentage value</b>	<b>100,00%</b>	<b>62,28%</b>	<b>235,55%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>-37,72%</b>	<b>135,55%</b>	<b>0,00%</b>



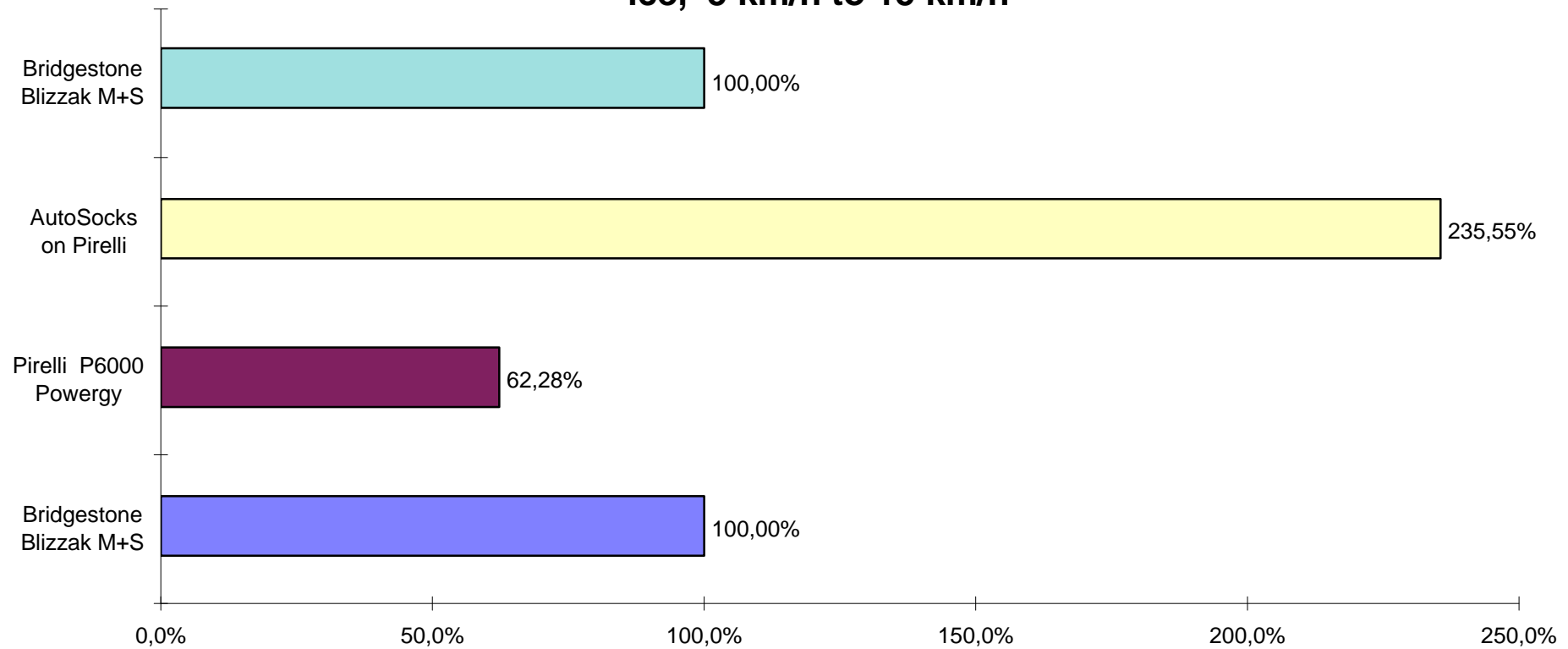
Enclosure 1.2

**Traction distance [m] VW Passat  
ice, 5 km/h to 15 km/h**



Enclosure 1.3

**Acceleration VW Passat  
ice, 5 km/h to 15 km/h**

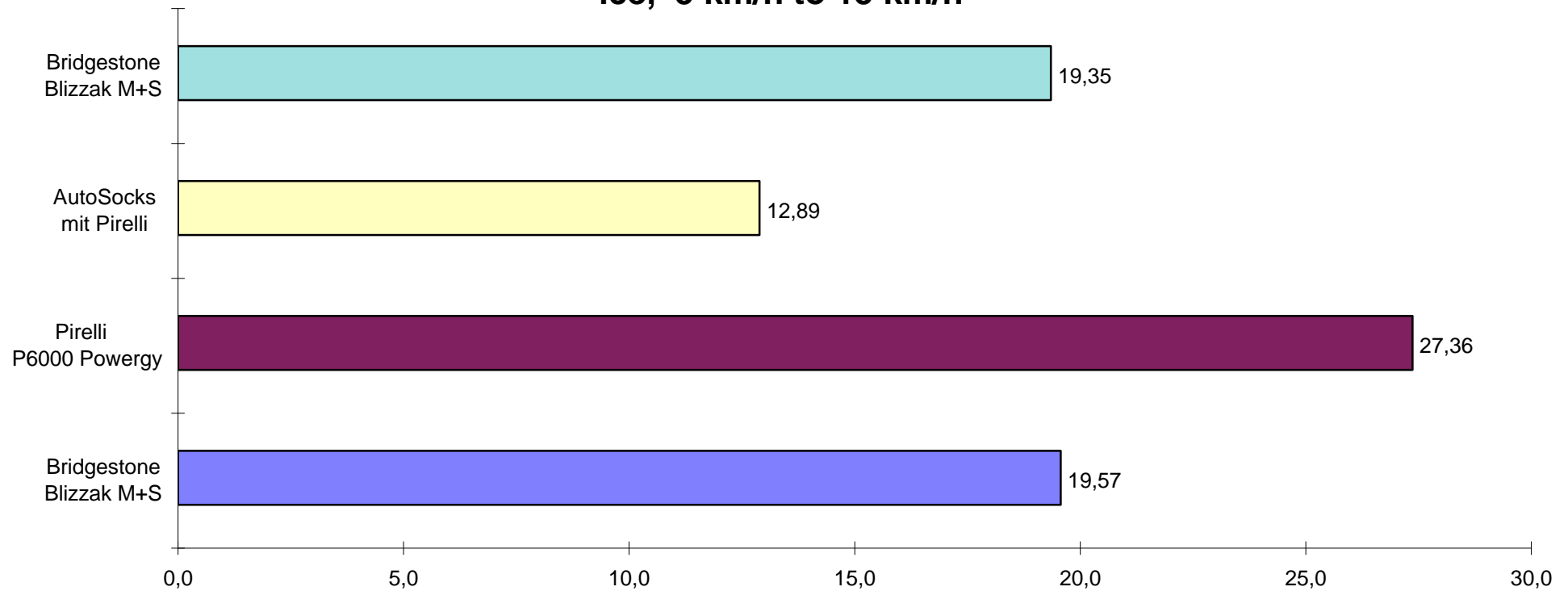


Enclosure 1.4

Data Sheet	Traction distance ice 5 km/h to 20 km/h			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	12.9.00			<b>Vehicle:</b> Mercedes C
<b>Air temperature:</b>	Ø: 8,7°C	max: 9,4°C	min: 8,3°C	<b>Model:</b> 203
<b>Surface temperature:</b>	Ø: -3,9°C	max: -4,0°C	min: -3,7°C	<b>v<sub>1</sub> [km/h]:</b> 5
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b> 15
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b> 890
<b>Total decelerated weight (kg):</b>	1790			
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>71,24%</b>	<b>150,64%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>-28,76%</b>	<b>50,64%</b>	<b>0,00%</b>
Value No. 1 [m]	19,40	27,91	13,53	19,28
Value No. 2 [m]	19,82	26,45	13,60	19,51
Value No. 3 [m]	19,38	28,09	12,76	18,70
Value No. 4 [m]	19,02	27,32	12,24	19,71
Value No. 5 [m]	20,22	27,05	12,33	19,54
<b>Mean value</b>	<b>19,57</b>	<b>27,36</b>	<b>12,89</b>	<b>19,35</b>
Standard variation	0,413	0,593	0,577	0,382
Variancy	0,170	0,352	0,333	0,146
<b>Mean acceleration [m/s<sup>2</sup>]</b>	<b>0,39</b>	<b>0,28</b>	<b>0,60</b>	<b>0,40</b>
Reference value	0,39	0,40	0,40	0,40
<b>Percentage value</b>	<b>100,00%</b>	<b>71,24%</b>	<b>150,64%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>-28,76%</b>	<b>50,64%</b>	<b>0,00%</b>

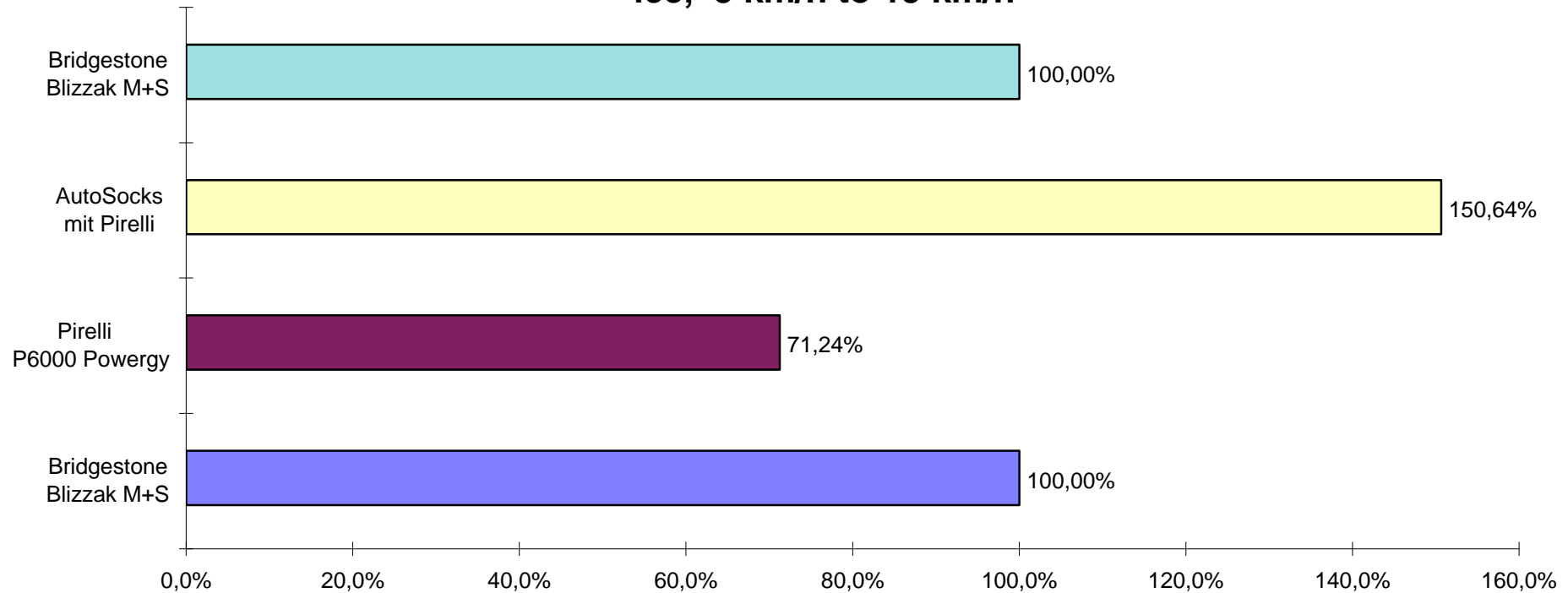
Enclosure 1.5

**Traction distance [m] Mercedes C-Class  
ice, 5 km/h to 15 km/h**



Enclosure 1.6

**Acceleration Mercedes C-Class  
ice, 5 km/h to 15 km/h**

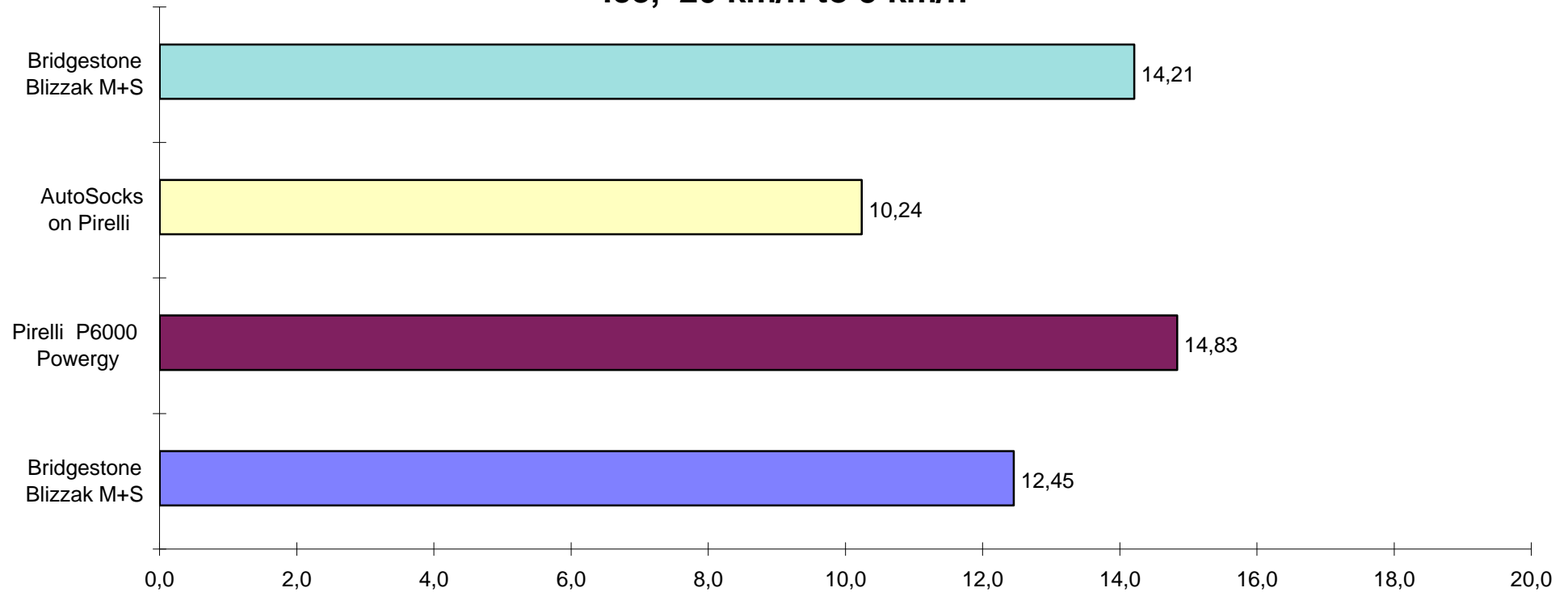


Enclosure 2.1

Data Sheet	Braking ice 20 km/h to 5 km/h			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	13.9.00			<b>Vehicle:</b> VW Passat
<b>Air temperature:</b>	Ø: 3,7°C	max: 5,1°C	min: 2,4°C	<b>Model:</b> 3B
<b>Surface temperature:</b>	Ø: -3,5°C	max: -3,3°C	min: -3,6°C	<b>v<sub>1</sub> [km/h]:</b> 20
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b> 5
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b> 890
<b>Total decelerated weight (kg):</b>	1790			
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>87,56%</b>	<b>132,58%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>-12,44%</b>	<b>32,58%</b>	<b>0,00%</b>
Value No. 1 [m]	11,67	14,64	10,41	14,21
Value No. 2 [m]	11,23	14,44	10,61	14,37
Value No. 3 [m]	12,63	15,15	9,97	14,16
Value No. 4 [m]	13,12	14,58	10,25	14,30
Value No. 5 [m]	13,62	15,36	9,94	14,00
<b>Mean value</b>	<b>12,45</b>	<b>14,83</b>	<b>10,24</b>	<b>14,21</b>
Standard variation	0,888	0,356	0,256	0,127
Variancy	0,789	0,127	0,066	0,016
<b>Mean deceleration [m/s<sup>2</sup>]</b>	<b>1,16</b>	<b>0,98</b>	<b>1,41</b>	<b>1,02</b>
Reference value	1,16	1,11	1,07	1,02
<b>Percentage value</b>	<b>100,00%</b>	<b>87,56%</b>	<b>132,58%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>-12,44%</b>	<b>32,58%</b>	<b>0,00%</b>

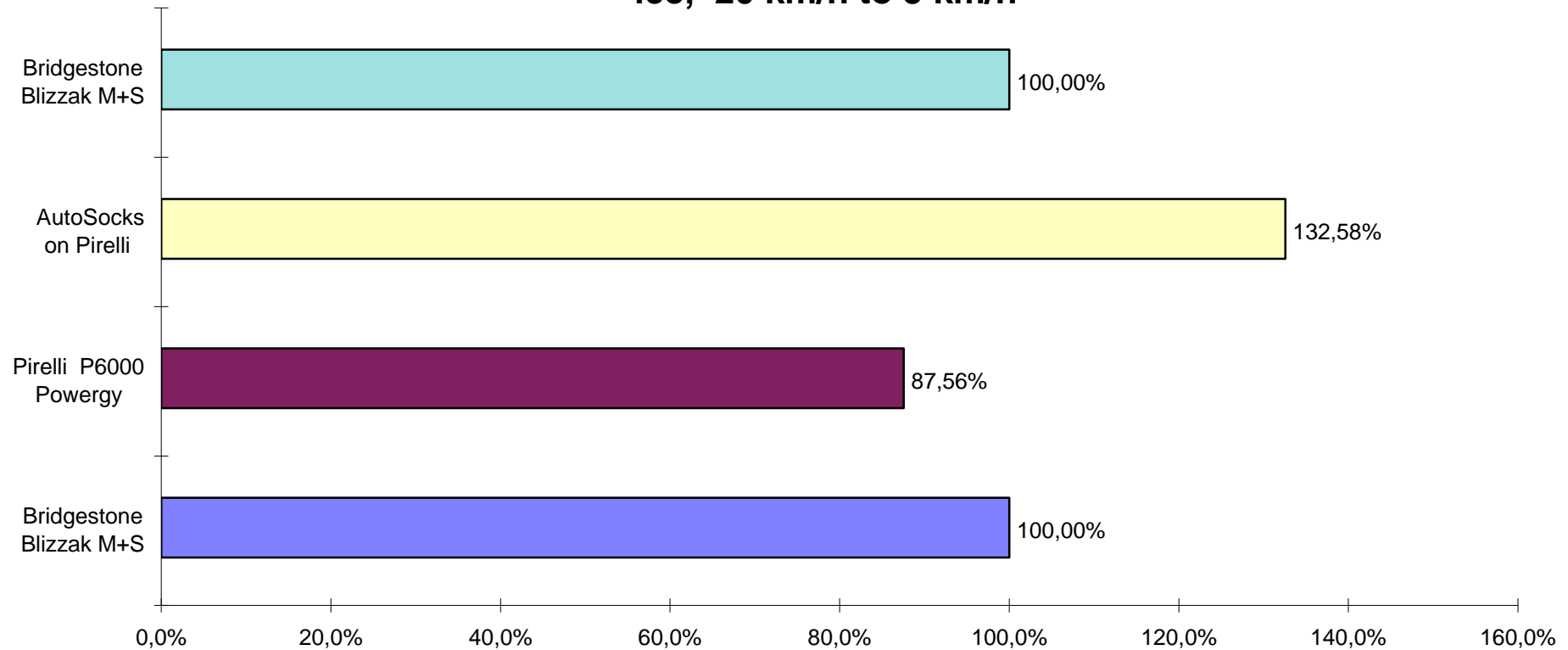
Enclosure 2.2

**Braking distance [m] VW Passat  
ice, 20 km/h to 5 km/h**



Enclosure 2.3

**Deceleration VW Passat  
ice, 20 km/h to 5 km/h**



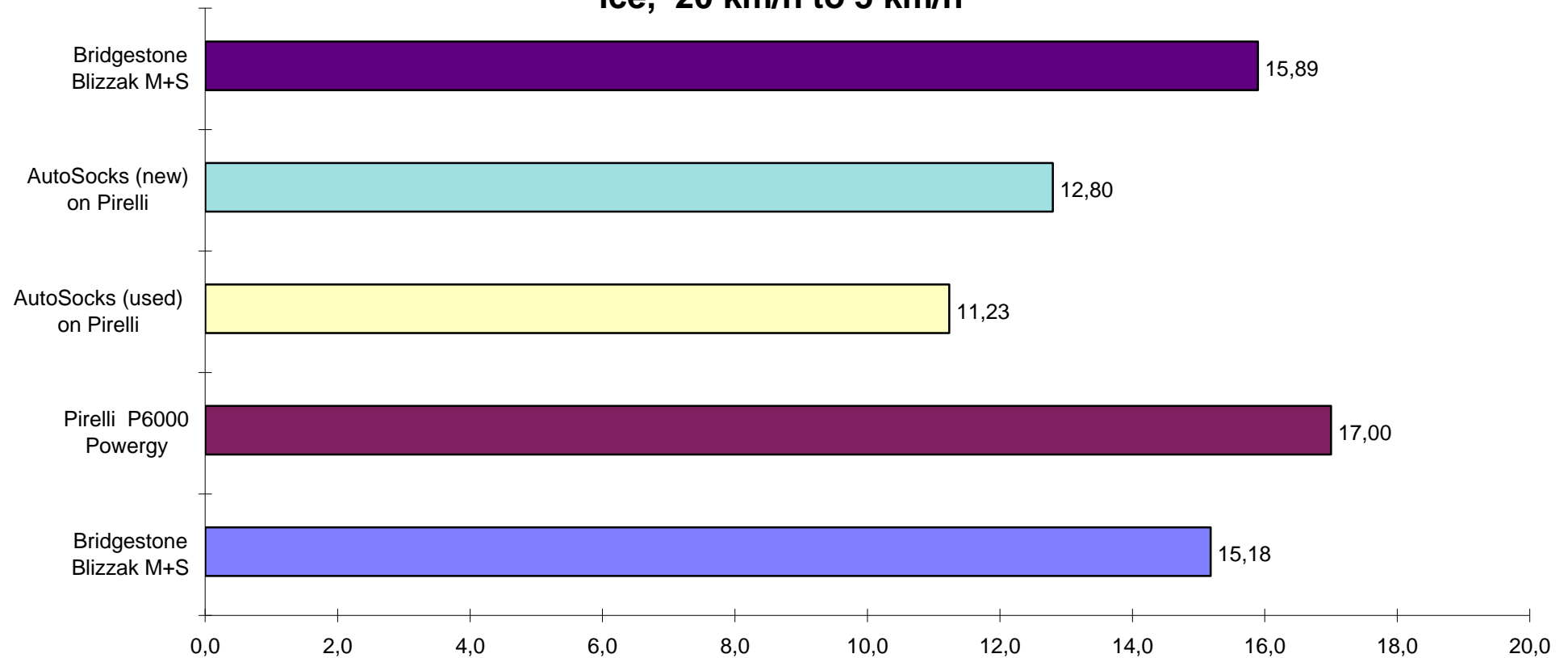


Enclosure 2.4

Data Sheet	Braking distance ice 20 km/h to 5 km/h				
<b>Customer:</b>	KOSA			<b>Order No.:</b>	70006115
<b>Date:</b>	14.9.00			<b>Vehicle:</b>	Mercedes C
<b>Air temperature:</b>	Ø: 5,5°C	max: 7,7°C	min: 3,9°C	<b>Model:</b>	203
<b>Surface temperature:</b>	Ø: -2,4°C	max: -1,8°C	min: -2,5°C	<b>v<sub>1</sub> [km/h]:</b>	20
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b>	5
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b>	890
<b>Total decelareted weight (kg):</b>	1790				
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks (used) on Pirelli	AutoSocks (new) on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>90,33%</b>	<b>138,25%</b>	<b>122,77%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>-9,67%</b>	<b>38,25%</b>	<b>22,77%</b>	<b>0,00%</b>
Value No. 1 [m]	15,03	16,65	10,71	13,15	16,12
Value No. 2 [m]	14,94	16,95	11,03	13,09	15,41
Value No. 3 [m]	15,28	17,34	10,85	12,75	16,54
Value No. 4 [m]	15,27	17,15	11,84	12,48	15,74
Value No. 5 [m]	15,38	16,89	11,73	12,51	15,66
<b>Mean value</b>	<b>15,18</b>	<b>17,00</b>	<b>11,23</b>	<b>12,80</b>	<b>15,89</b>
Standard variation	0,166	0,235	0,464	0,281	0,395
Variancy	0,028	0,055	0,215	0,079	0,156
<b>Mean deceleration [m/s<sup>2</sup>]</b>	<b>0,95</b>	<b>0,85</b>	<b>1,29</b>	<b>1,13</b>	<b>0,91</b>
Reference value	0,95	0,94	0,93	0,92	0,91
<b>Percentage value</b>	<b>100,00%</b>	<b>90,33%</b>	<b>138,25%</b>	<b>122,77%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>-9,67%</b>	<b>38,25%</b>	<b>22,77%</b>	<b>0,00%</b>

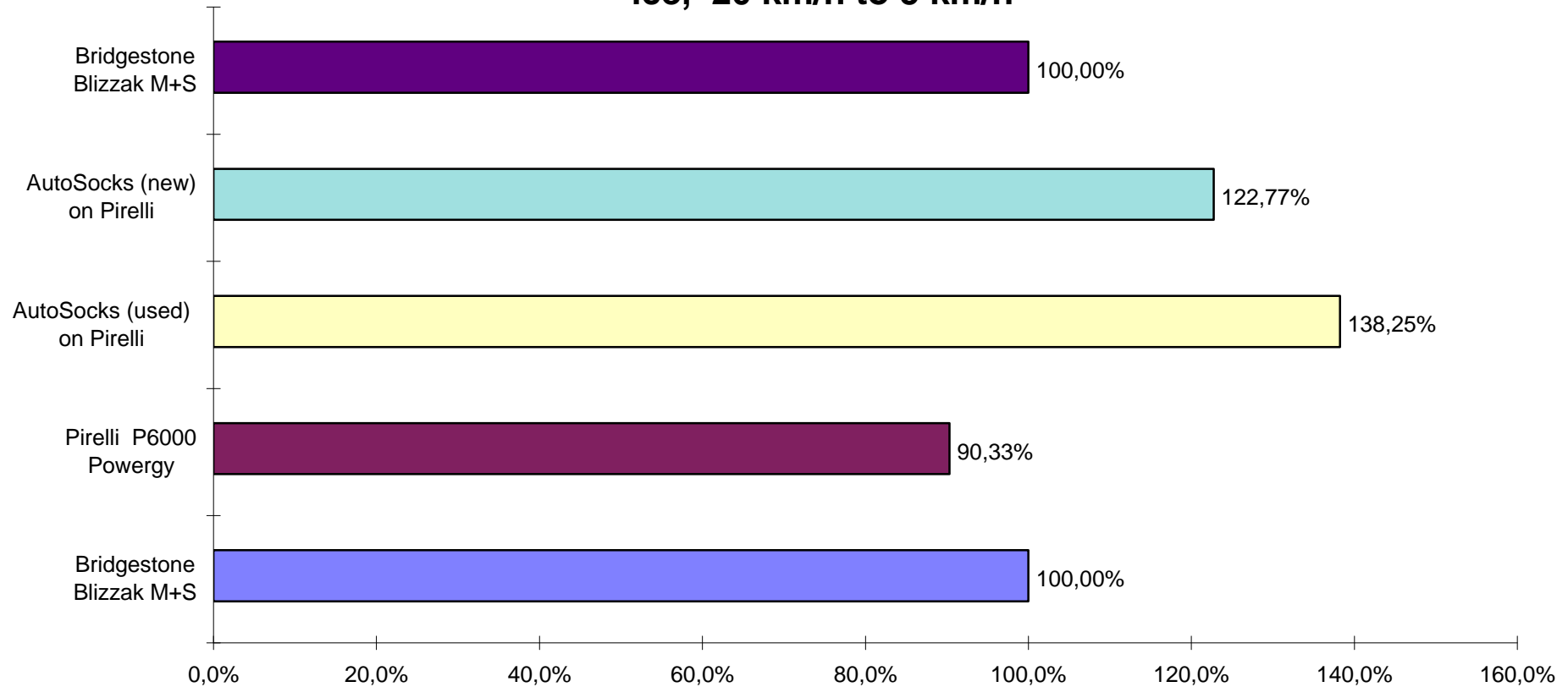
Enclosure 2.5

**Braking distance [m] Mercedes C-Class  
ice, 20 km/h to 5 km/h**



Enclosure 2.6

**Deceleration Mercedes C-Class  
ice, 20 km/h to 5 km/h**

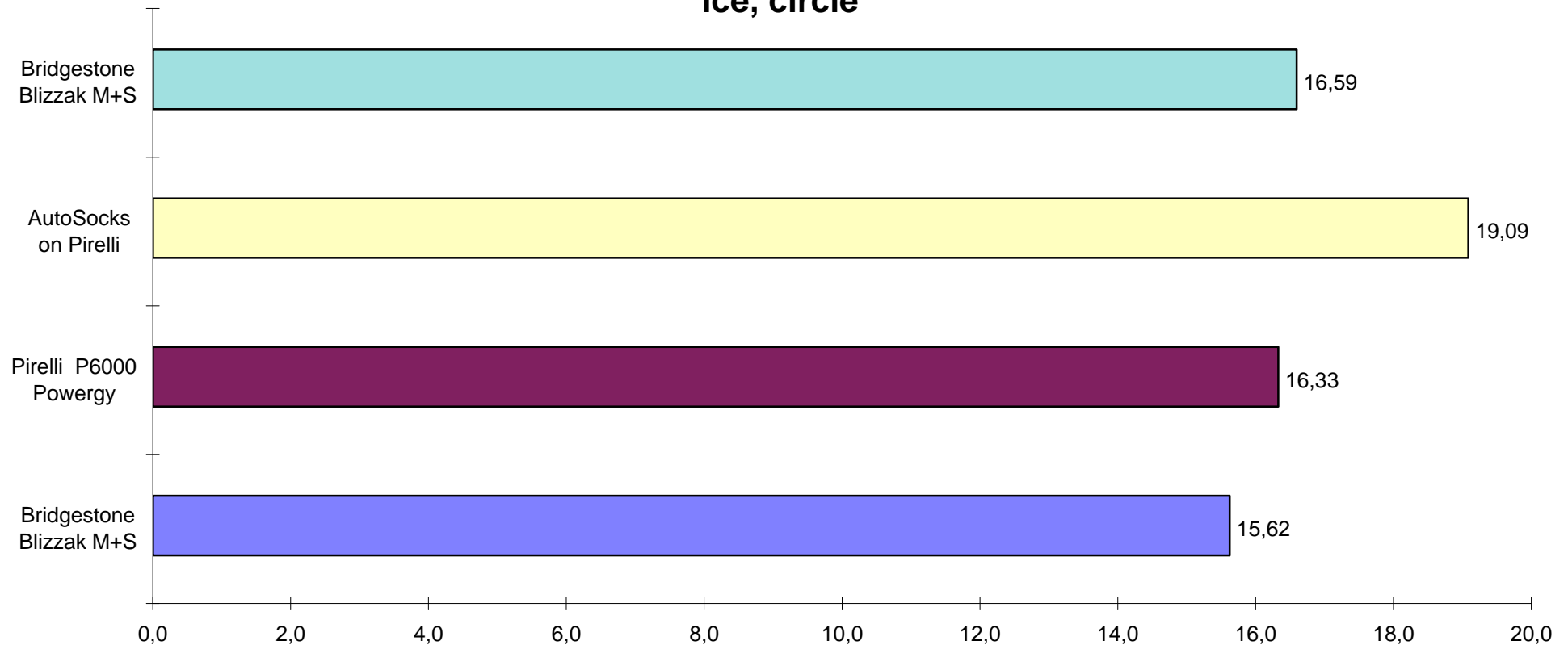


Enclosure 3.1

Data Sheet	Lap time (ice, circle, radius 8m)			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	13.9.00			<b>Vehicle:</b> VW Passat
<b>Air temperature:</b>	Ø: 7,5°C	max: 7,8°C	min: 7,2°C	<b>Model:</b> 3B
<b>Surface temperature:</b>	Ø: -3,3°C	max: -2,9°C	min: -3,5°C	<b>Radius (m):</b> 8
<b>ABS:</b>	on			
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b> 890
<b>Total decelerated weight (kg):</b>	1790			
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [µ]</b>	<b>100,00%</b>	<b>97,58%</b>	<b>85,17%</b>	<b>100,00%</b>
<b>Difference in % [µ]</b>	<b>0,00%</b>	<b>-2,42%</b>	<b>-14,83%</b>	<b>0,00%</b>
Value No. 1 [s]	15,42	16,54	19,99	16,76
Value No. 2 [s]	15,23	16,15	17,84	16,12
Value No. 3 [s]	15,90	16,54	18,95	16,85
Value No. 4 [s]	15,71	16,40	19,20	16,12
Value No. 5 [s]	15,84	16,00	19,45	17,11
<b>Mean value</b>	<b>15,62</b>	<b>16,33</b>	<b>19,09</b>	<b>16,59</b>
Standard variation	0,256	0,216	0,712	0,402
Variancy	0,065	0,047	0,507	0,162
<b>Time 5 laps [s]</b>	<b>78,10</b>	<b>81,63</b>	<b>95,43</b>	<b>82,96</b>
Centrifugal force [N]	362,03	346,37	296,28	340,82
Reference value	362,03	354,96	347,89	340,82
<b>Percentage value</b>	<b>100,00%</b>	<b>97,58%</b>	<b>85,17%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>-2,42%</b>	<b>-14,83%</b>	<b>0,00%</b>

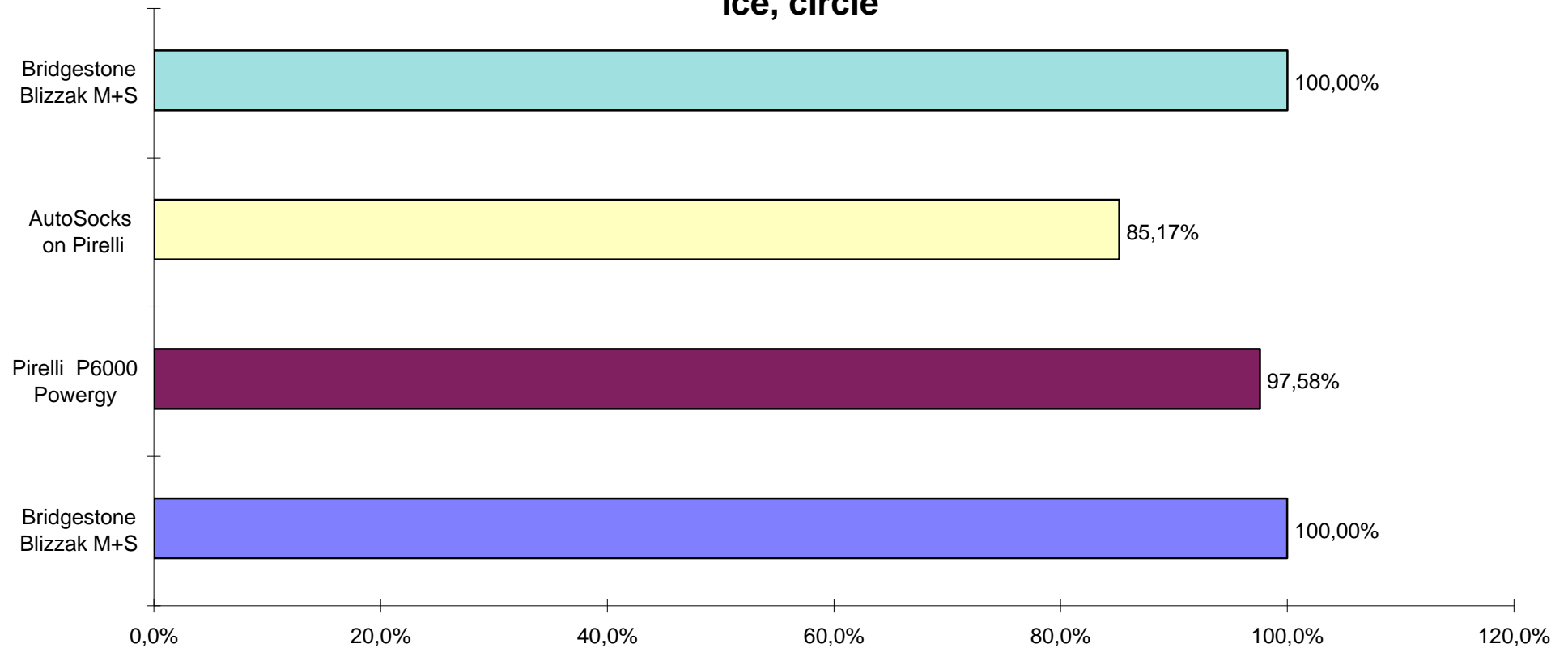
Enclosure 3.2

**Lap time [s] VW Passat  
ice, circle**



Enclosure 3.3

### Centrifugal force VW Passat ice, circle

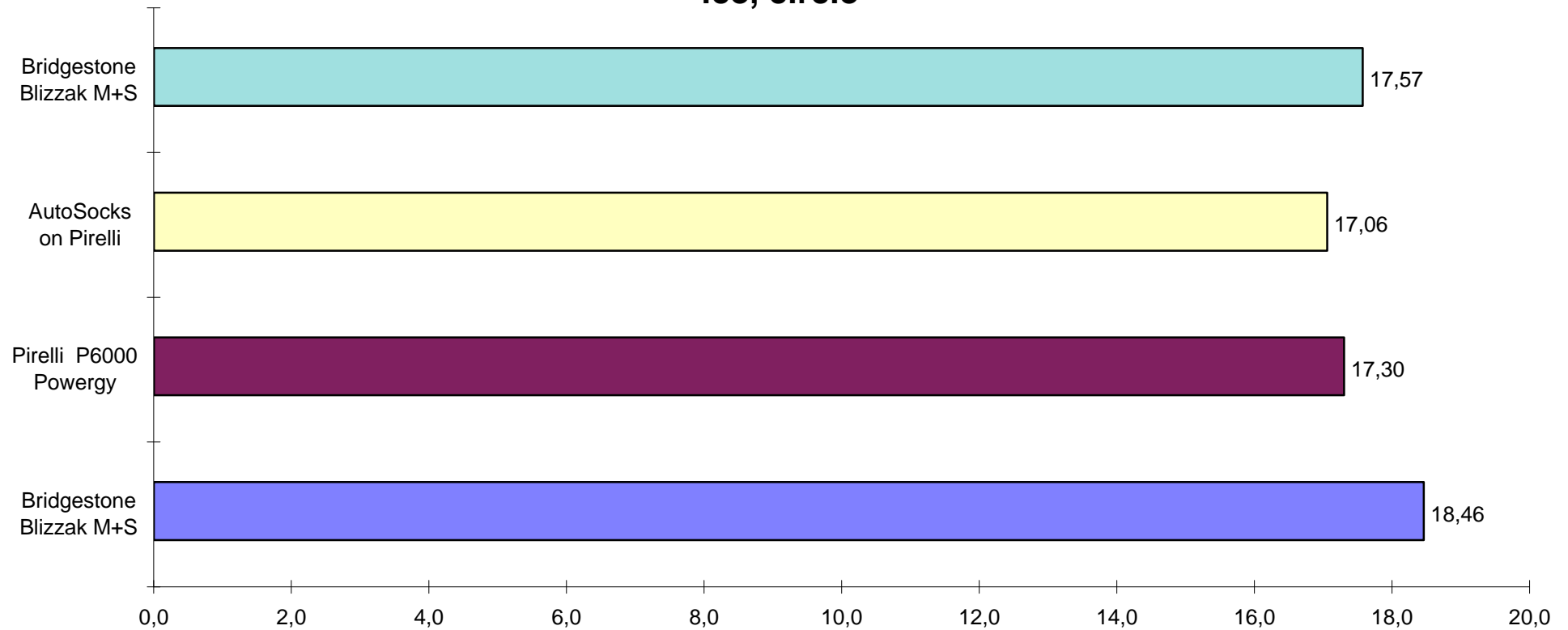


Enclosure 3.4

Data Sheet	Lap time (ice, circle, radius 8m)			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	14.9.00			<b>Vehicle:</b> Mercedes C
<b>Air temperature:</b>	Ø: 4,9°C	max: 5,3°C	min: 4,6°C	<b>Model:</b> 203
<b>Surface temperature:</b>	Ø: -2,3°C	max: -2,1°C	min: -3,0°C	<b>Radius (m):</b> 8
<b>ABS:</b>	on			
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b> 890
<b>Total decelerated weight (kg):</b>	1790			
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>105,67%</b>	<b>105,36%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>5,67%</b>	<b>5,36%</b>	<b>0,00%</b>
Value No. 1 [s]	18,37	17,56	17,14	17,08
Value No. 2 [s]	17,87	17,23	16,59	17,89
Value No. 3 [s]	18,57	17,08	16,60	17,42
Value No. 4 [s]	18,91	17,14	17,93	17,62
Value No. 5 [s]	18,57	17,48	17,02	17,84
<b>Mean value</b>	<b>18,46</b>	<b>17,30</b>	<b>17,06</b>	<b>17,57</b>
Standard variation	0,341	0,189	0,489	0,297
Variancy	0,117	0,036	0,239	0,088
<b>Time 5 laps [s]</b>	<b>73,92</b>	<b>68,93</b>	<b>68,14</b>	<b>70,77</b>
Centrifugal force [N]	380,37	407,91	412,64	397,30
Reference value	380,37	386,02	391,66	397,30
<b>Percentage value</b>	<b>100,00%</b>	<b>105,67%</b>	<b>105,36%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>5,67%</b>	<b>5,36%</b>	<b>0,00%</b>

Enclosure 3.5

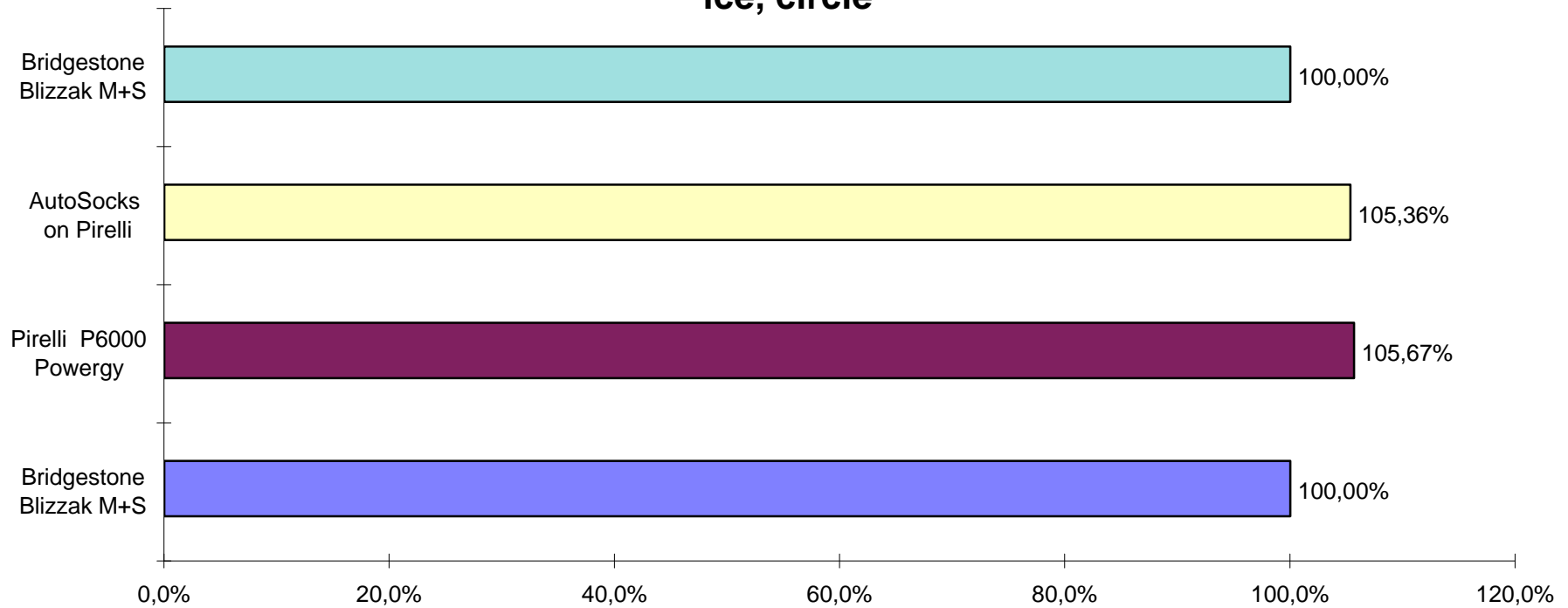
**Lap time [s] Mercedes C-Class  
ice, circle**





Enclosure 3.6

### Centrifugal force Mercedes C-Class ice, circle

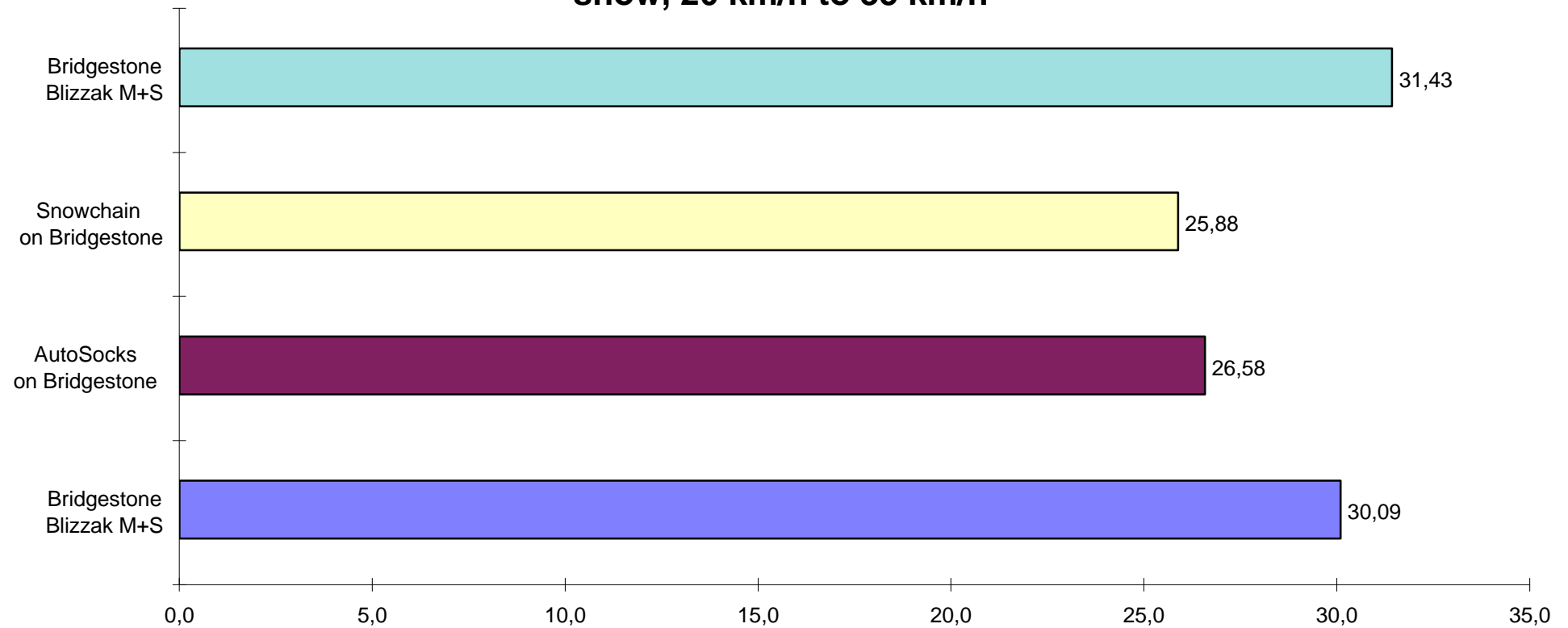


Enclosure 4.1

Data Sheet	Traction snow 20 km/h to 35 km/h			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	23.11.00			<b>Vehicle:</b> VW Passat
<b>Air temperature:</b>	Ø: -5,1°C	max: -5,0°C	min: -5,5°C	<b>Model:</b> 3B
<b>Surface temperature:</b>	Ø: -4,5°C	max: -4,3°C	min: -4,8°C	<b>v<sub>1</sub> [km/h]:</b> 20
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b> 35
<b>Front axle load (kg):</b>	830			<b>Rear axle load (kg):</b> 830
<b>Total decelerated weight (kg):</b>	1660			
	Bridgestone Blizzak M+S	AutoSocks on Bridgestone	Snowchain on Bridgestone	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>114,85%</b>	<b>119,66%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>14,85%</b>	<b>19,66%</b>	<b>0,00%</b>
Value No. 1 [m]	30,63	26,76	25,13	30,82
Value No. 2 [m]	30,33	26,95	26,49	31,62
Value No. 3 [m]	30,51	25,76	26,54	31,84
Value No. 4 [m]	29,44	26,87	25,82	
Value No. 5 [m]	29,54	26,54	25,42	
<b>Mean value</b>	<b>30,09</b>	<b>26,58</b>	<b>25,88</b>	<b>31,43</b>
Standard variation	0,500	0,431	0,563	0,438
Variancy	0,250	0,185	0,317	0,192
<b>Mean acceleration [m/s<sup>2</sup>]</b>	<b>1,06</b>	<b>1,20</b>	<b>1,23</b>	<b>1,01</b>
Reference value	1,06	1,04	1,03	1,01
<b>Percentage value</b>	<b>100,00%</b>	<b>114,85%</b>	<b>119,66%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>14,85%</b>	<b>19,66%</b>	<b>0,00%</b>

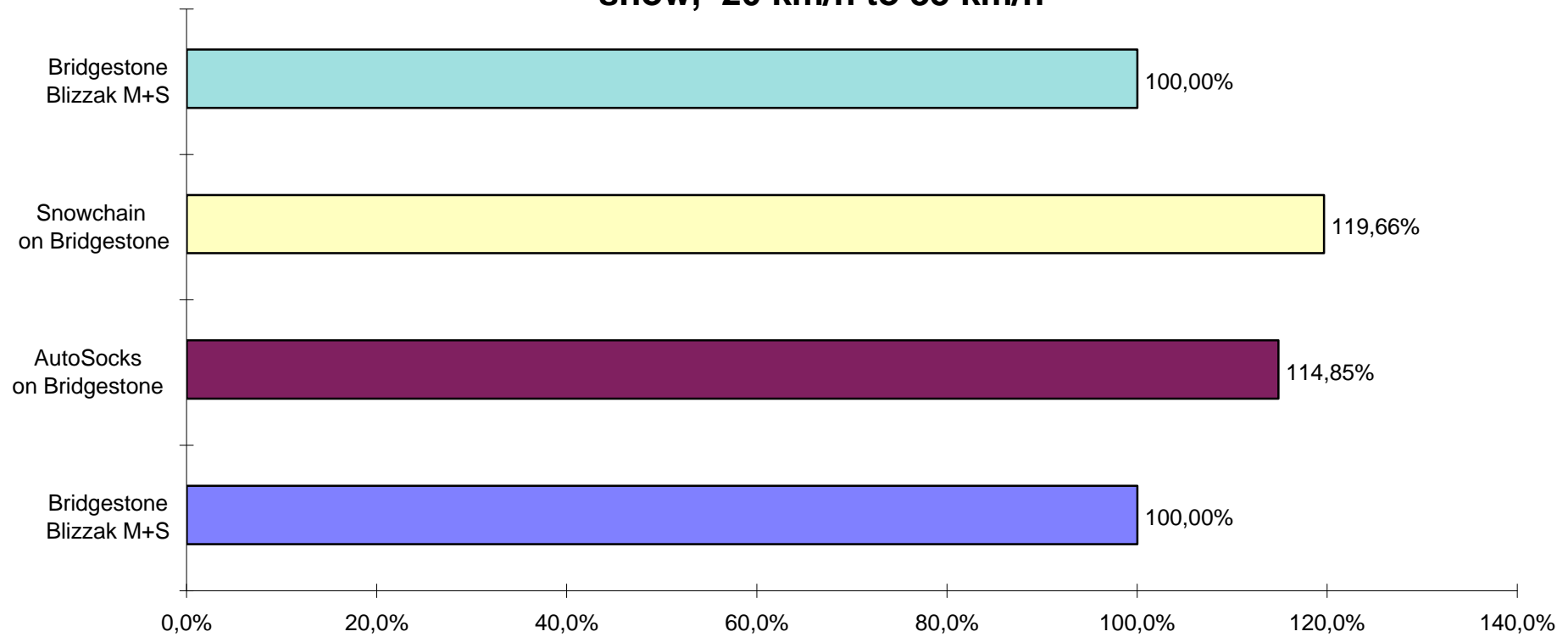
Enclosure 4.2

**Traction distance [m] VW Passat  
snow, 20 km/h to 35 km/h**



Enclosure 4.3

**Acceleration VW Passat  
snow, 20 km/h to 35 km/h**

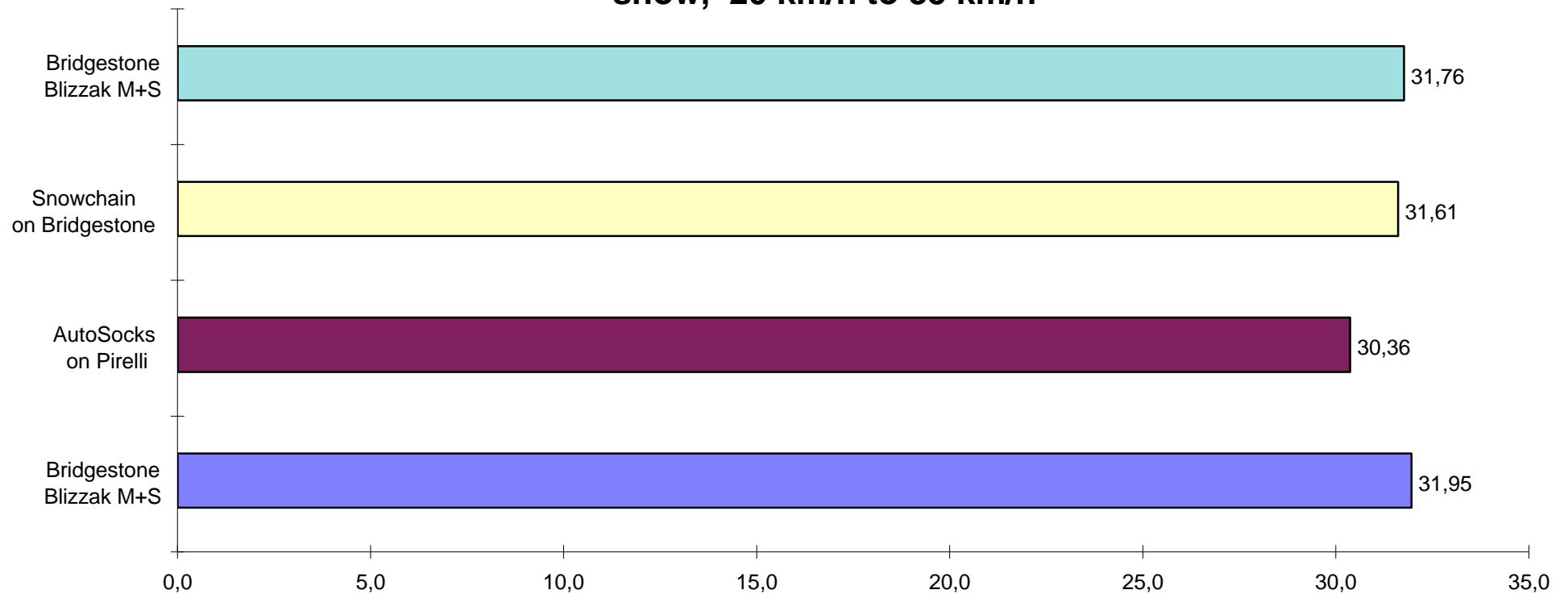


Enclosure 4.4

Data Sheet	Traction snow 20 km/h to 35 km/h			
<b>Customer:</b>	KOSA			<b>Order No.:</b> 70006115
<b>Date:</b>	23.11.00			<b>Vehicle:</b> Mercedes C
<b>Air temperature:</b>	Ø: -5,1°C	max: -5,0°C	min: -5,5°C	<b>Model:</b> 203
<b>Surface temperature:</b>	Ø: -4,8°C	max: -4,5°C	min: -5,5°C	<b>v<sub>1</sub> [km/h]:</b> 20
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b> 35
<b>Front axle load (kg):</b>	830			<b>Rear axle load (kg):</b> 830
<b>Total decelerated weight (kg):</b>	1660			
	Bridgestone Blizzak M+S	AutoSocks on Pirelli	Snowchain on Bridgestone	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>105,02%</b>	<b>100,68%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>5,02%</b>	<b>0,68%</b>	<b>0,00%</b>
Value No. 1 [m]	32,52	30,57	31,87	31,35
Value No. 2 [m]	31,05	30,44	31,74	32,28
Value No. 3 [m]	31,24	29,16	31,39	31,50
Value No. 4 [m]	32,67	30,96	31,64	31,85
Value No. 5 [m]	32,28	30,69	31,41	31,83
<b>Mean value</b>	<b>31,95</b>	<b>30,36</b>	<b>31,61</b>	<b>31,76</b>
Standard variation	0,673	0,626	0,186	0,382
Variancy	0,453	0,392	0,035	0,146
<b>Mean acceleration [m/s<sup>2</sup>]</b>	<b>1,00</b>	<b>1,05</b>	<b>1,01</b>	<b>1,00</b>
Reference value	1,00	1,00	1,00	1,00
<b>Percentage value</b>	<b>100,00%</b>	<b>105,02%</b>	<b>100,68%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>5,02%</b>	<b>0,68%</b>	<b>0,00%</b>

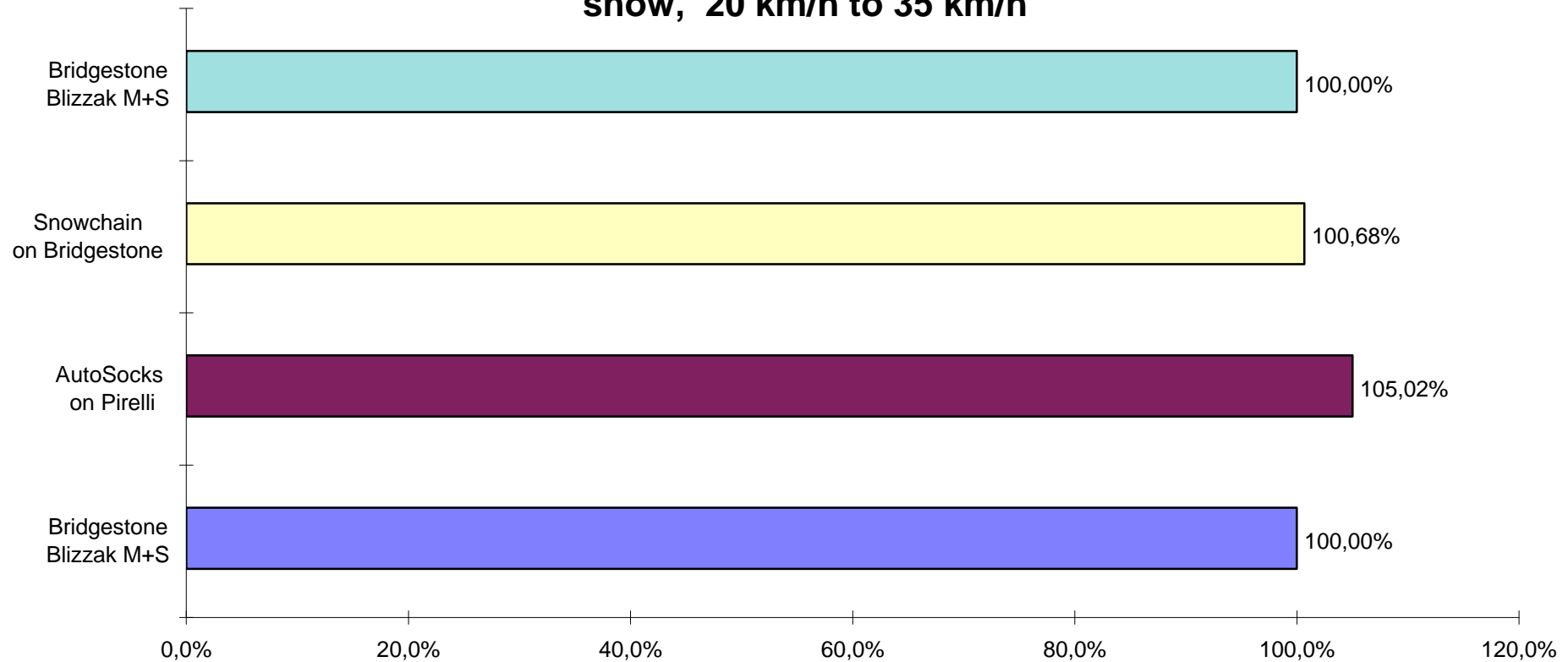
Enclosure 4.5

**Traction distance [m] Mercedes C-Class  
snow, 20 km/h to 35 km/h**



Enclosure 4.6

**Acceleration Mercedes C-Class  
snow, 20 km/h to 35 km/h**



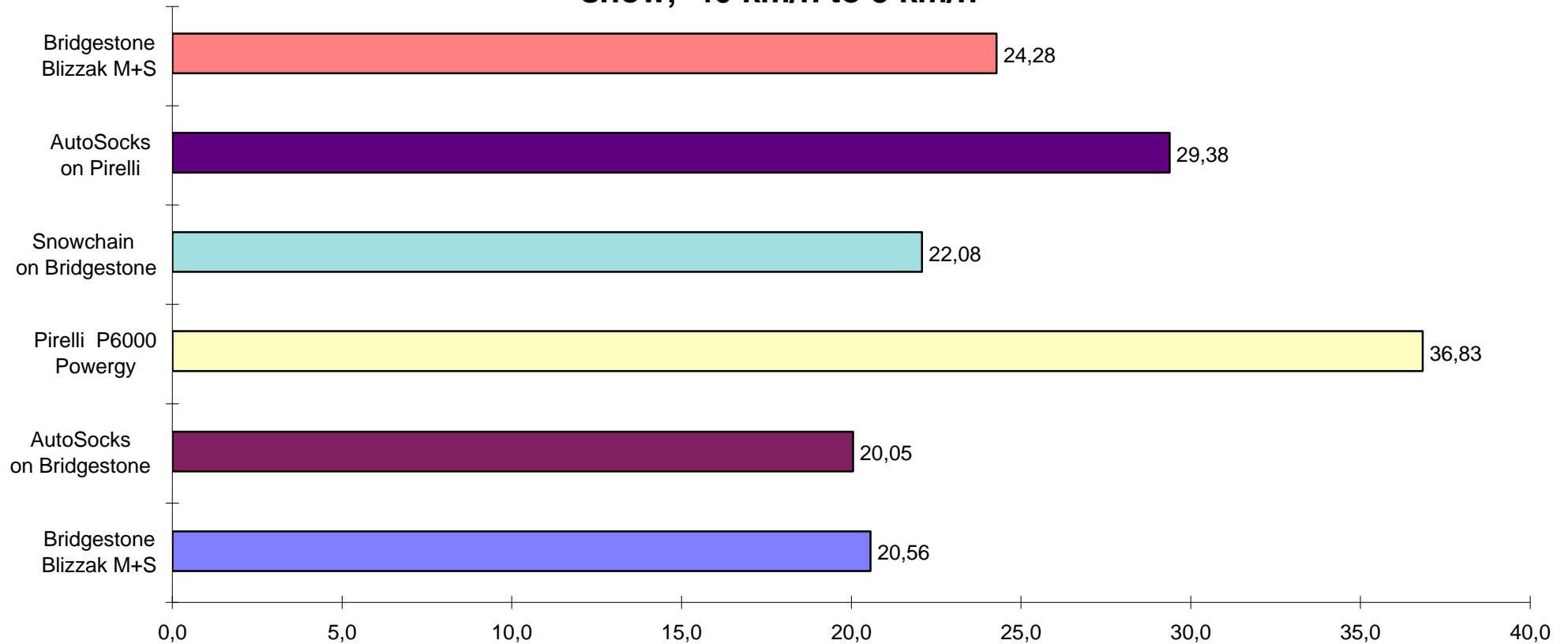
Enclosure 5.1

Data Sheet	Braking snow 40 km/h to 5 km/h					
<b>Customer:</b>	KOSA					<b>Order No.:</b> 70006115
<b>Date:</b>	23.11.00					<b>Vehicle:</b> VW Passat
<b>Air temperature:</b>	Ø: -5,1°C	max: -5,0°C	min: -5,5°C			<b>Model:</b> 3B
<b>Surface temperature:</b>	Ø: -4,5°C	max: -4,3°C	min: -4,8°C			<b>v<sub>1</sub> [km/h]:</b> 40
<b>ABS:</b>	on					<b>v<sub>2</sub> [km/h]:</b> 5
<b>Front axle load (kg):</b>	850					<b>Rear axle load (kg):</b> 810
<b>Total decelareted weight (kg):</b>	1660					
	Bridgestone Blizzak M+S	AutoSocks on Bridgestone	Pirelli P6000 Powergy	Snowchain on Bridgestone	AutoSocks on Pirelli	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>106,66%</b>	<b>59,84%</b>	<b>100,83%</b>	<b>79,07%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>6,66%</b>	<b>-40,16%</b>	<b>0,83%</b>	<b>-20,93%</b>	<b>0,00%</b>
Value No. 1 [m]	20,12	19,78	37,50	22,40	29,7	24,8
Value No. 2 [m]	21,29	20,58	36,60	21,74	28,8	24,6
Value No. 3 [m]	20,42	20,19	35,95	21,31	29,5	23,4
Value No. 4 [m]	20,03	20,02	37,50	22,32	29,8	24,9
Value No. 5 [m]	20,96	19,66	36,60	22,64	29,1	23,8
<b>Mean value</b>	<b>20,56</b>	<b>20,05</b>	<b>36,83</b>	<b>22,08</b>	<b>29,38</b>	<b>24,28</b>
Standard variation	0,487	0,324	0,596	0,486	0,397	0,614
Variancy	0,237	0,105	0,356	0,236	0,157	0,377
<b>Mean deceleration [m/s<sup>2</sup>]</b>	<b>2,95</b>	<b>3,03</b>	<b>1,65</b>	<b>2,75</b>	<b>2,07</b>	<b>2,50</b>
Reference value	2,95	2,84	2,76	2,73	2,62	2,50
<b>Percentage value</b>	<b>100,00%</b>	<b>106,66%</b>	<b>59,84%</b>	<b>100,83%</b>	<b>79,07%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>6,66%</b>	<b>-40,16%</b>	<b>0,83%</b>	<b>-20,93%</b>	<b>0,00%</b>
Pirelli braking distance was measured from 20 km/h to 5 km/h. The value for 40 km/h to 5 km/h is calculated: $s=(v_2^2-v_1^2)/2a$						



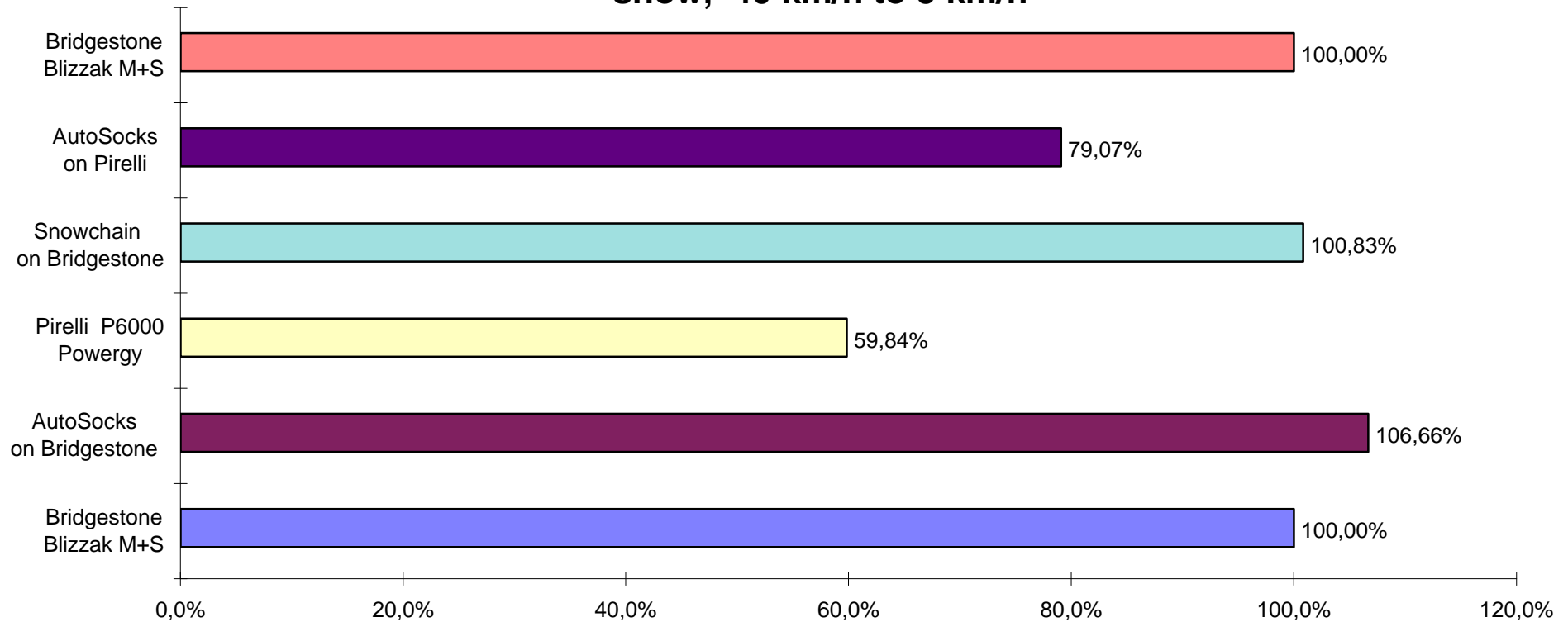
Enclosure 5.2

### Braking distance [m] VW Passat snow, 40 km/h to 5 km/h



Enclosure 5.3

**Deceleration VW Passat  
snow, 40 km/h to 5 km/h**

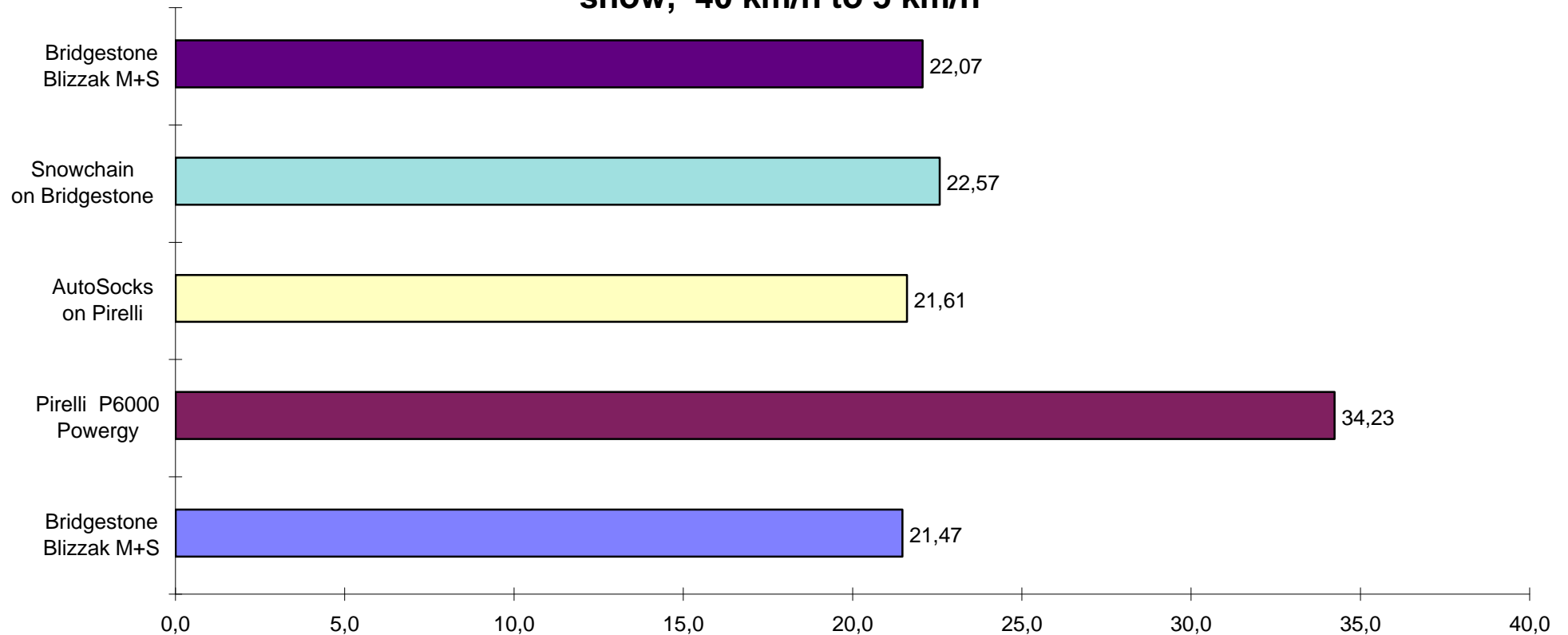


Enclosure 5.4

Data Sheet	Braking snow 40 km/h to 5 km/h				
<b>Customer:</b>	KOSA			<b>Order No.:</b>	70006115
<b>Date:</b>	23.11.00			<b>Vehicle:</b>	Mercedes C
<b>Air temperature:</b>	Ø: -2,6°C	max: -2,0°C	min: -3,0°C	<b>Model:</b>	203
<b>Surface temperature:</b>	Ø: -3,6°C	max: -3,0°C	min: -4,0°C	<b>v<sub>1</sub> [km/h]:</b>	40
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b>	5
<b>Front axle load (kg):</b>	850			<b>Rear axle load (kg):</b>	810
<b>Total decelareted weight (kg):</b>	1660				
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	Snowchain on Bridgestone	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>63,14%</b>	<b>100,73%</b>	<b>97,08%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>-36,86%</b>	<b>0,73%</b>	<b>-2,92%</b>	<b>0,00%</b>
Value No. 1 [m]	21,50	35,12	21,50	22,07	22,40
Value No. 2 [m]	21,95	35,53	22,23	22,21	21,80
Value No. 3 [m]	21,18	33,76	21,56	22,78	22,00
Value No. 4 [m]	21,13	33,38	21,69	22,91	
Value No. 5 [m]	21,59	33,38	21,05	22,90	
<b>Mean value</b>	<b>21,47</b>	<b>34,23</b>	<b>21,61</b>	<b>22,57</b>	<b>22,07</b>
Standard variation	0,298	0,911	0,379	0,360	0,249
Variancy	0,089	0,830	0,144	0,130	0,062
<b>Mean deceleration [m/s<sup>2</sup>]</b>	<b>2,83</b>	<b>1,77</b>	<b>2,81</b>	<b>2,69</b>	<b>2,75</b>
Reference value	2,83	2,81	2,79	2,77	2,75
<b>Percentage value</b>	<b>100,00%</b>	<b>63,14%</b>	<b>100,73%</b>	<b>97,08%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>-36,86%</b>	<b>0,73%</b>	<b>-2,92%</b>	<b>0,00%</b>
Pirelli braking distance was measured from 20 km/h to 5 km/h. The value for 40 km/h to 5 km/h is calculated: $s=(v_2^2-v_1^2)/2a$					

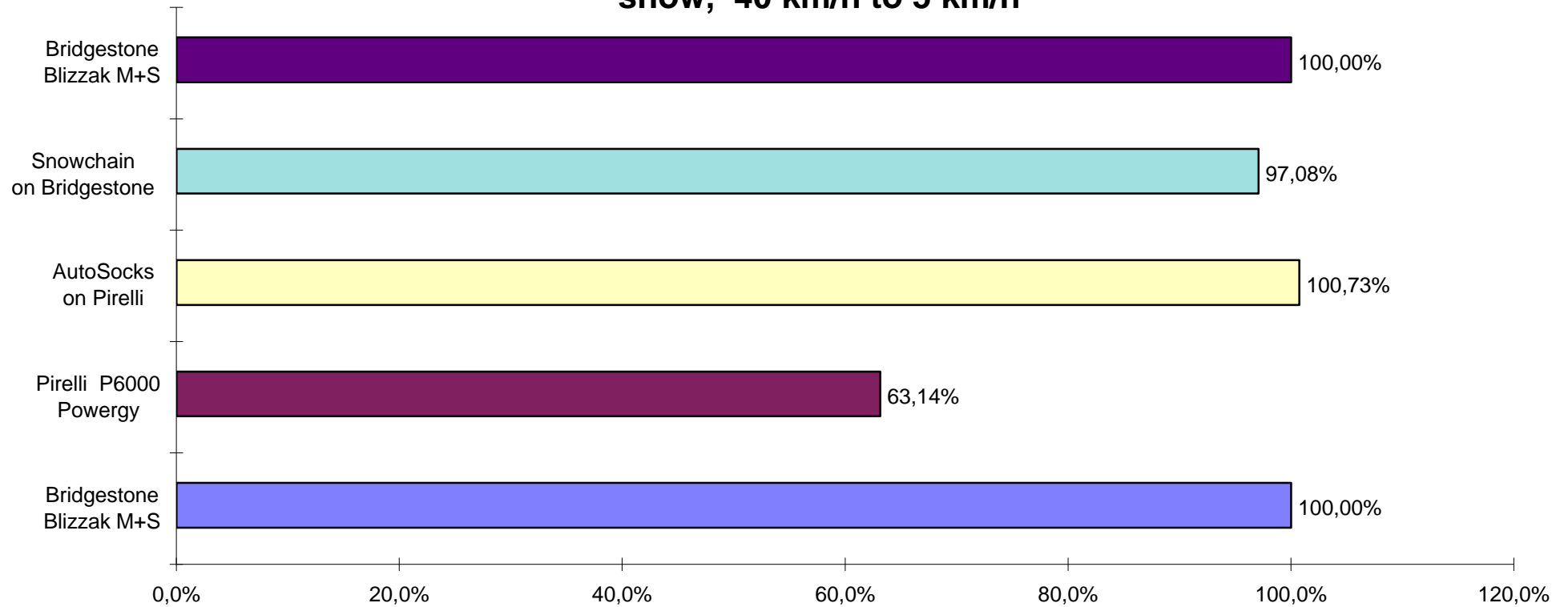
Enclosure 5.5

**Braking distance [m] Mercedes C-Class  
snow, 40 km/h to 5 km/h**



Enclosure 5.6

**Deceleration Mercedes C-Class  
snow, 40 km/h to 5 km/h**

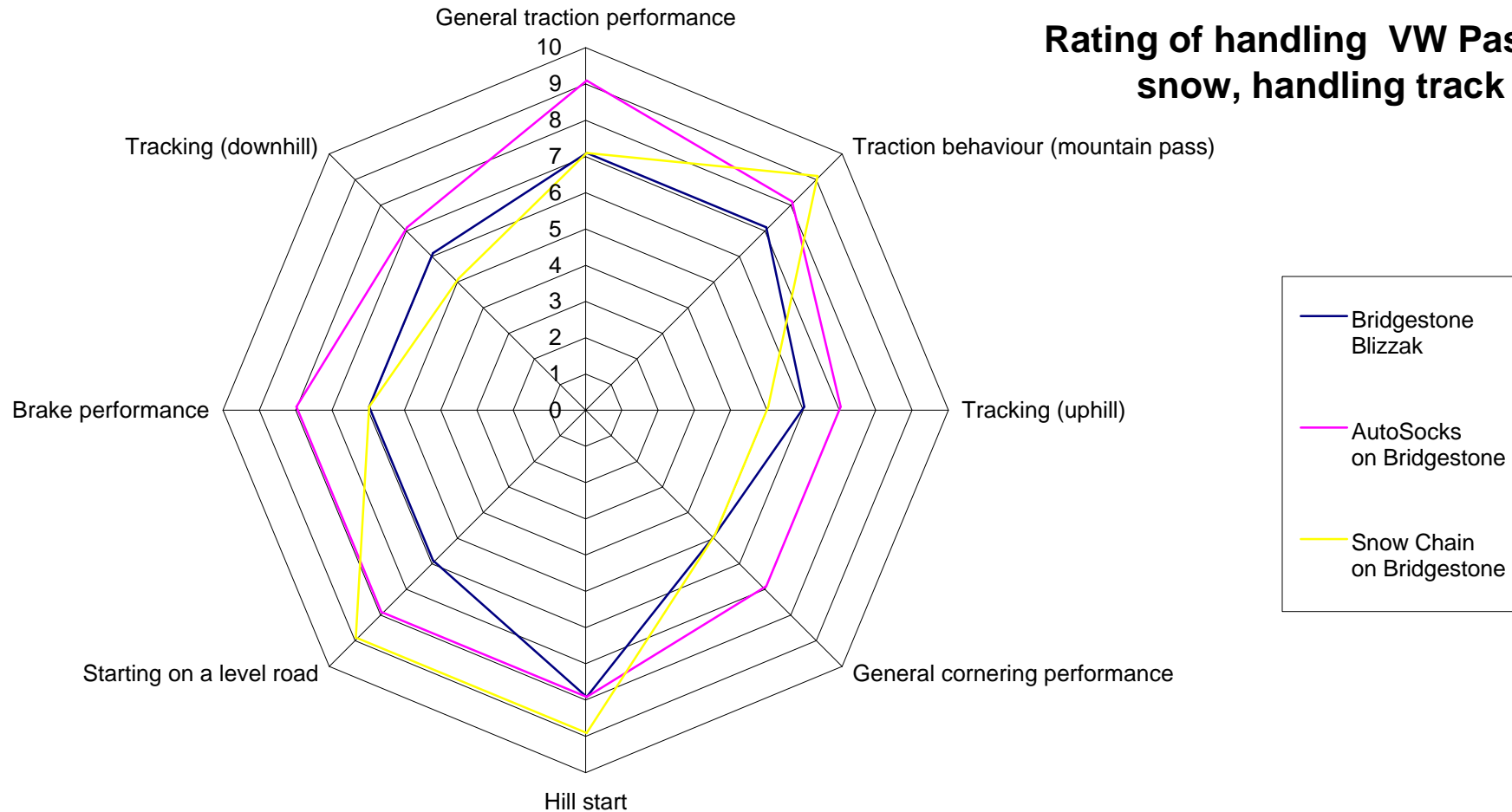


Enclosure 6.1

Data Sheet	Handling snow		
<b>Client</b>	Kosa	<b>Order No.</b>	70006115
<b>Date</b>	24.11.00	<b>Vehicle</b>	VW Passat TDI
<b>Driver</b>	Reithmaier / Staude	<b>Tire size</b>	195/65 R 15
	<b>1</b>	<b>2</b>	<b>3</b>
	<b>Bridgestone Blizzak</b>	<b>AutoSocks on Bridgestone</b>	<b>Snow Chain on Bridgestone</b>
General traction performance	7	9	7
Traction behaviour (mountain pass)	7	8	9
Tracking (uphill)	6	7	5
General cornering performance	5	7	5
Hill start	8	8	9
Starting on a level road	6	8	9
Brake performance	6	8	6
Tracking (downhill)	6	7	5
<b>Mean value</b>	<b>6,38</b>	<b>7,75</b>	<b>6,88</b>
Lap time	73,30	68,91	73,96
Passing 1st bend possible?	only with ESP turned off	yes	yes

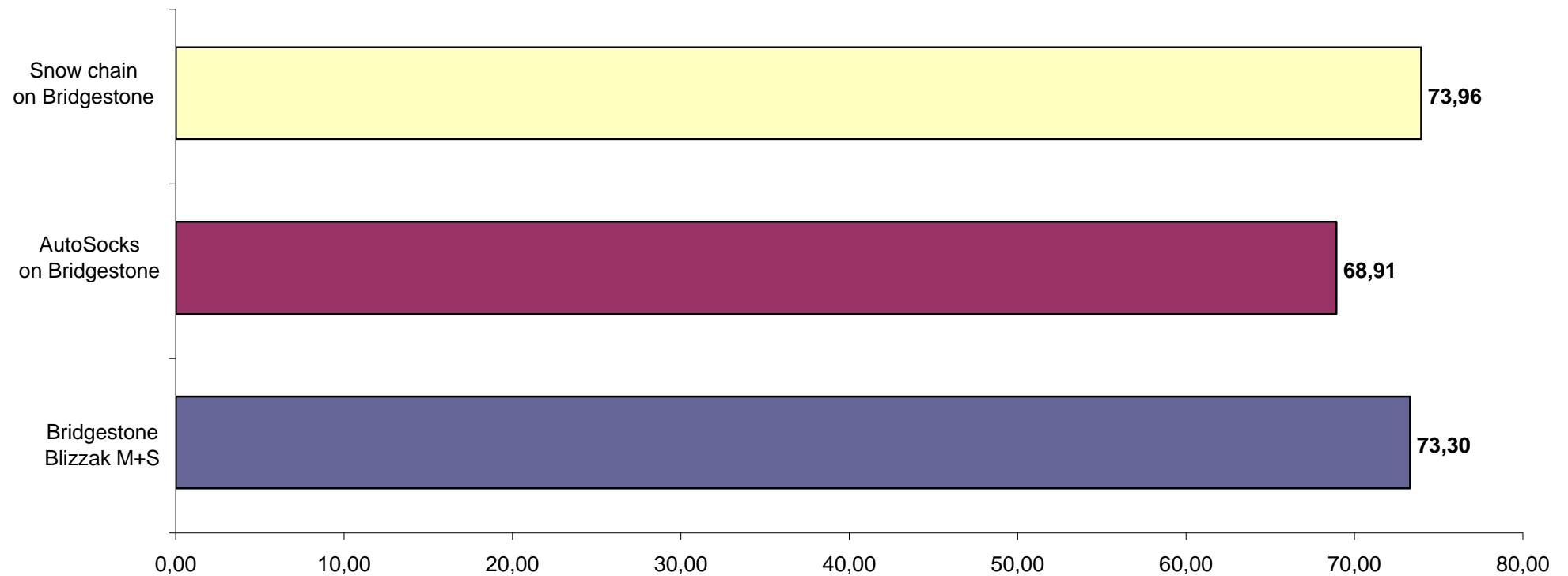
Enclosure 6.2

### Rating of handling VW Passat snow, handling track



Enclosure 6.3

**Lap time [s] VW Passat  
Snow, handling track**



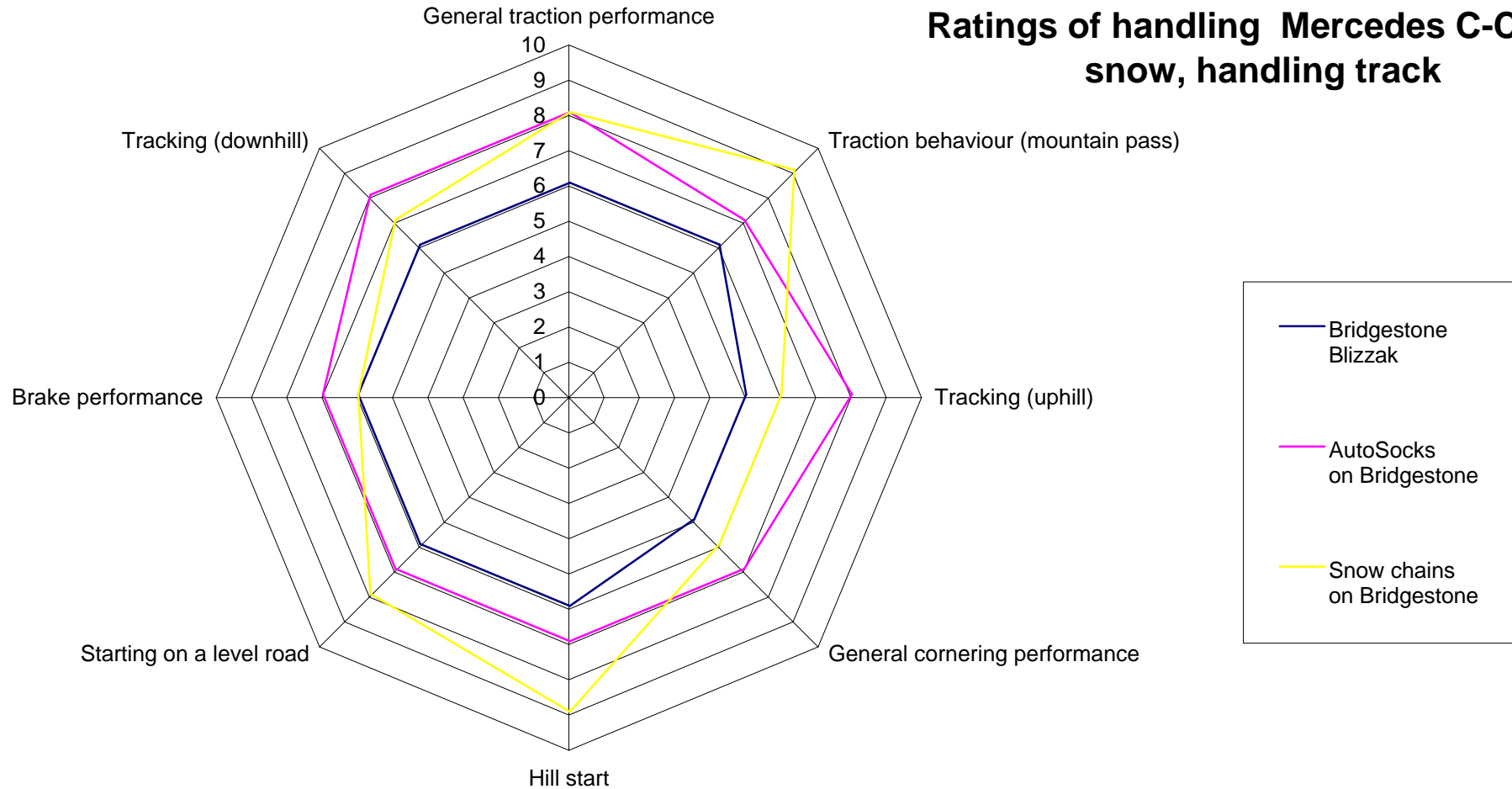


Enclosure 6.4

Data Sheet	Handling snow		
<b>Client</b>	Kosa	<b>Order No.</b>	70006115
<b>Date</b>	19./20.11.2000	<b>Vehicle</b>	Mercedes C 200 K
<b>Driver</b>	Reithmaier	<b>Tire size</b>	195/65 R 15
	<b>1</b>	<b>2</b>	<b>3</b>
	<b>Bridgestone Blizzak</b>	<b>AutoSocks on Bridgestone</b>	<b>Snow chain on Bridgestone</b>
General traction performance	6	8	8
Traction behaviour (mountain pass)	6	7	9
Tracking (uphill)	5	8	6
General cornering performance	5	7	6
Hill start	6	7	9
Starting on a level road	6	7	8
Brake performance	6	7	6
Tracking (downhill)	6	8	7
<b>Mean value</b>	5,75	7,38	7,38
Lap time	76,60	64,15	66,85
Passing 1st bend possible?	only with ESP turned off	only with ESP turned off	yes

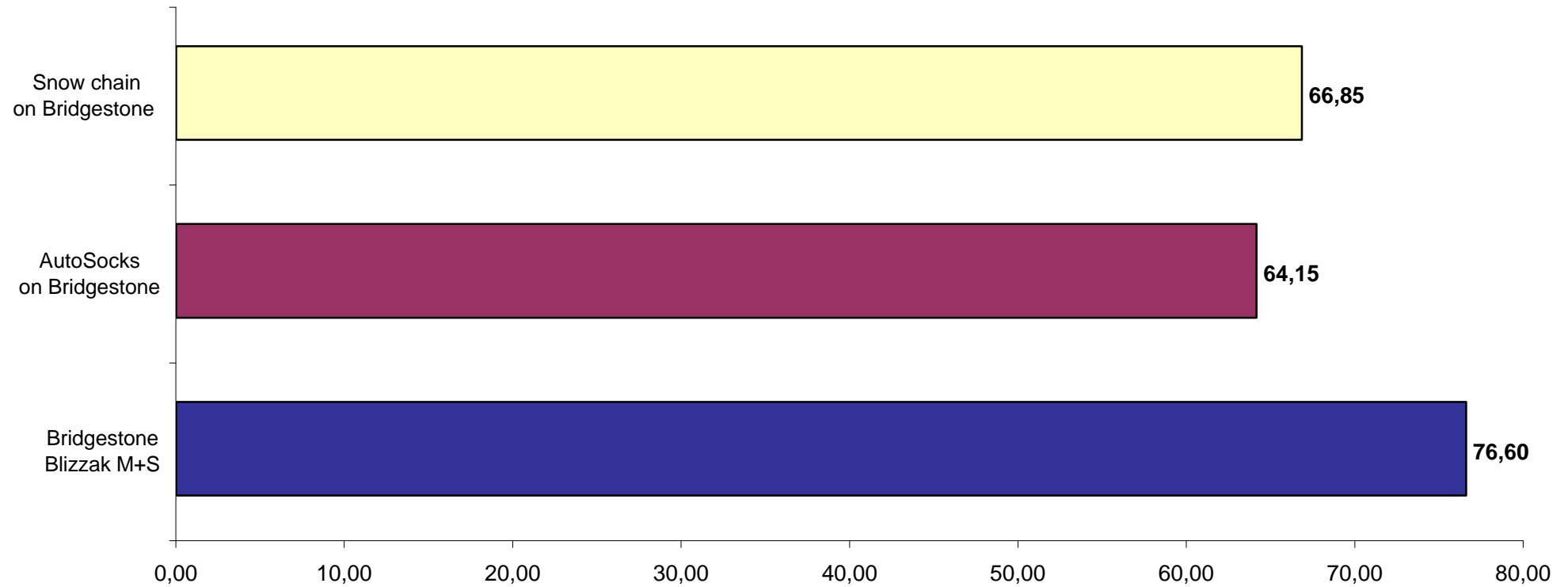
Enclosure 6.5

## Ratings of handling Mercedes C-Class snow, handling track



Enclosure 6.6

**Lap Time [s] Mercedes C-Class  
snow, handling track**

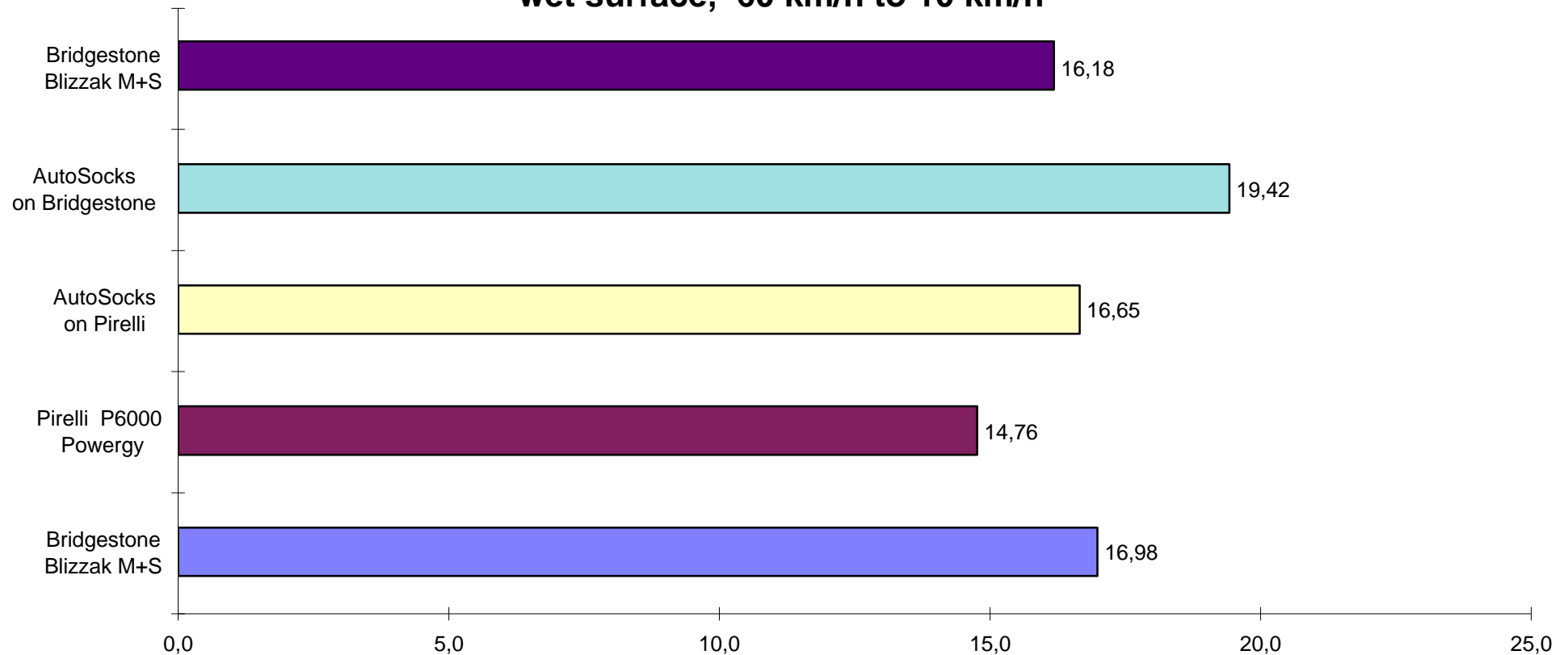


Enclosure 7.1

Data Sheet	Braking wet surface 60 km/h to 10 km/h				
<b>Customer:</b>	KOSA			<b>Order No.:</b>	70006115
<b>Date:</b>	16.10.00			<b>Vehicle:</b>	Mercedes C
<b>Air temperature:</b>	Ø: 11,4°C	max: 12,4°C	min: 10,7°C	<b>Model:</b>	203
<b>Surface temperature:</b>	Ø: 10,7°C	max: 13,3°C	min: 9,7°C	<b>v<sub>1</sub> [km/h]:</b>	60
<b>ABS:</b>	on			<b>v<sub>2</sub> [km/h]:</b>	10
<b>Front axle load (kg):</b>	900			<b>Rear axle load (kg):</b>	890
<b>Total decelareted weight (kg):</b>	1790				
	Bridgestone Blizzak M+S	Pirelli P6000 Powergy	AutoSocks on Pirelli	AutoSocks on Bridgestone	Bridgestone Blizzak M+S
	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H	195/65 R15 91H
<b>Percentage value [μ]</b>	<b>100,00%</b>	<b>113,65%</b>	<b>99,51%</b>	<b>84,33%</b>	<b>100,00%</b>
<b>Difference in % [μ]</b>	<b>0,00%</b>	<b>13,65%</b>	<b>-0,49%</b>	<b>-15,67%</b>	<b>0,00%</b>
Value No. 1 [m]	17,07	14,34	16,50	20,13	15,94
Value No. 2 [m]	16,82	14,50	16,70	19,14	16,02
Value No. 3 [m]	17,00	15,16	16,68	19,52	16,20
Value No. 4 [m]	16,96	14,47	16,82	19,06	16,76
Value No. 5 [m]	17,06	15,33	16,57	19,24	15,99
<b>Mean value</b>	<b>16,98</b>	<b>14,76</b>	<b>16,65</b>	<b>19,42</b>	<b>16,18</b>
Standard variation	0,090	0,403	0,111	0,388	0,302
Variancy	0,008	0,163	0,012	0,151	0,091
<b>Mean deceleration [m/s<sup>2</sup>]</b>	<b>7,95</b>	<b>9,15</b>	<b>8,11</b>	<b>6,95</b>	<b>8,34</b>
Reference value	7,95	8,05	8,15	8,25	8,34
<b>Percentage value</b>	<b>100,00%</b>	<b>113,65%</b>	<b>99,51%</b>	<b>84,33%</b>	<b>100,00%</b>
<b>Difference in %</b>	<b>0,00%</b>	<b>13,65%</b>	<b>-0,49%</b>	<b>-15,67%</b>	<b>0,00%</b>

Enclosure 7.2

**Braking distance [m] Mercedes C-Class  
wet surface, 60 km/h to 10 km/h**



Enclosure 7.3

**Deceleration Mercedes C-Class  
wet surface, 60 km/h to 10 km/h**

