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16. ABSTRACT

Advancements in technology have altered the traditional tire chains drivers use to maneuver their vehicles in winter conditions. The traditional tire chain now has new competition such as cloth and plastic based tire traction control devices. Caltrans' Division of Research, Innovation and System Information was tasked to test the durability of a cloth based tire traction control device using three typical vehicles found on California roadways. The three vehicles used for the test were a front wheel drive Chevy Impala, a rear wheel drive Chevy Tahoe, and a loaded tractor trailer. To test the durability of the tire traction control devices, a closed test track was chosen. To simulate winter conditions during chain controls where there is no snow on the surface, the road surface was constantly kept wet. Each vehicle was driven to test three sets of tire traction control devices over a period of two days. The test results of the durability testing showed that the average distance travelled for the front wheel drive Chevy Impala was 30 miles, the rear wheel drive Chevy Tahoe was 59.3 miles, the tractor was 36.2 miles, and the trailer was 9 miles.

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DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION (DRISI)

TIRE TRACTION CONTROL DEVICE DURABILITY STUDY

October 2015

Task 2944, Traction Control Devices Durability Study

Project P946, Traction Control Device Study

ABSTRACT

Advancements in technology have altered the traditional equipment drivers typically used to drive their vehicles in winter conditions. The traditional tire chain now has new competition such as cloth and plastic based tire traction control devices. Caltrans' Division of Research, Innovation and System Information was tasked to research and test the durability of a cloth based tire traction control device using three typical vehicles found on California roadways. These three vehicles were a front wheel drive Chevy Impala, rear wheel drive Chevy Tahoe and a loaded tractor trailer. To test the durability of the tire traction control devices, a closed test track was chosen the road surface was kept wet to simulate winter conditions during chain controls where there is no snow on the surface. Each vehicle was driven testing three sets of tire traction control devices over two days of testing. The results from the tests were the front wheel drive Chevy Impala averaged thirty miles, the Chevy Tahoe rear wheel drive vehicle averaged fifty-nine and three tenths miles, the tractor averaged thirty six and two tenths miles, and the trailer averaged nine miles.

ACKNOWLEDGEMENT

The Division of Research, Information and System Information would like to thank Coco Briseno, Joe Horton, David Ly, Greg Larson Prakash Sah, David Ly, Minh Thach, Mary Lauv, Pam Putman, Efren Vela, Fouad Ziaullah, Sukh Nagra, Lai Saetern, Herby Lissade, David Frame, Chris Smith, Marcoz Hernandez, Marvin Pruitt, Dana Hendrix, Mark Burkett, Douglas Sexton, Hector Ortiz, Rodrigo Ramos, Salvador Huerta, and Thomas Cowan.

TABLE OF CONTENTS

Acronyms	Page 5
Introduction	Page 6
Literary Search	Page 7
Tire Traction Control Device Durability Test	Page 8
Tractor and Trailer Gross Weight	Page 9
Tire Traction Control Device Cost	Page 9
Results	Page 10
Conclusion	Page 10
Recommendations	Page 11
Appendix A – AutoSock Truck Durability Test	Page 12
Appendix B – Dry Road Durability Test	Page 14
Appendix C – TUV Test Report	Page 22
Appendix D – Test Track Layouts	Page 99
Appendix E – Safety Meeting Report	Page 100
Appendix F – Photographs of Durability Testing	Page 102
Appendix G – Washington Administrative Code 204-24	Page 129

ACRONYMS

The following is a list of acronyms used in the document.

Caltrans	California Department of Transportation
CHP	California Highway Patrol
CVC	California Vehicle Code
DRISI	Division of Research, Innovation and System Information
GPS	Global Positioning Satellite
km	Kilometers
kph	Kilometer per hour
M & S	Mud and Snow
mph	Miles per hour
SUV	Sports Utility Vehicle

INTRODUCTION

California motorists often encounter tire traction controls (or “chain control”) when it is snowing in the mountain regions. When chain control is in effect Caltrans has identified three different requirement levels for tire traction control. These three levels are:

- Requirement One (R1): Chains or snow tread tires required. Snow tires must have a tread depth of 6/32" with a "M & S" imprint on the tire's sidewall.
- Requirement Two (R2): Chains required on all vehicles except four-wheel drives or all-wheel drives with snow tread tires on all four wheels. NOTE: four-wheel and all-wheel drive vehicles must carry traction devices in chain control areas.
- Requirement Three (R3): Chains are required on all vehicles, no exceptions.

Requirement One and Requirement Two are most common chain controls in California and the roads are usually closed before the Requirement Three control is imposed.

Caltrans, partnering with California Highway Patrol (CHP) and local law enforcement, have to ensure the safety of the motorists by enforcing the tire traction restriction conditions. The California Vehicle Code (CVC), Section 605 defines tire traction devices as follows: "Tire traction devices" are devices or mechanisms having a composition and design capable of improving vehicle traction, braking, and cornering ability upon snow or ice-covered surfaces. Tire traction devices shall be constructed and assembled to provide sufficient structural integrity and to prevent accidental detachment from vehicles. Tire traction devices shall, at the time of manufacture or final assembly, bear a permanent impression indicating the name, initials, or trademark of the assembling company or primary manufacturer, and the country in which the devices were manufactured or assembled in final form.

According to the vehicle code, Caltrans and CHP must allow any device that complies with the Vehicle Code to be used on California roads. But to ensure the safety of all motorists on California roads the chain control inspection stations are tasked to inspect not only if vehicles are complying with the traction control requirements but if they are safe to use on the road. New innovative technologies have led to alternative tire traction control devices made of non-metallic materials such as cloth and plastic. These new tire traction control devices on the market cause confusion with the Caltrans inspectors between CVC compliance and what is safe for use on California roads.

The Division of Maintenance and CHP have requested the Division of Research, Innovation, and System Information (DRISI) for assistance in gaining better understanding these new tire traction technologies. DRISI determined the best way to gain quick first-hand knowledge would be to conduct an in-house research to test the durability of the tire traction control devices on a wet road surface. The wet road surface simulates a typical winter condition during chain control which is set miles before encountering snow or to simulate a recently cleared road.

LITERARY SEARCH

Using the Internet, three reports were found consisting of durability tests on dry or wet pavement. The results of all three reports were similar such that the tire traction control devices eventually wore through the fabric but at different rates and distances travelled due to the different tests conducted.

A truck durability test report was done by AutoSock which shows and says that they drove a 21 ton loaded truck at a speed of 30 kph (approximately 19 mph) on a dry asphalt surface (the report can be found as Appendix A). At a distance travelled of 140 km (approximately 87 miles) they noted that the wear was minor and included a photo of one tire to show the wear. They predicted that the tire traction control devices would still be in a useable good condition at 200 km (approximately 124 miles).

A dry surface test report was conducted by Stefan Muche, Engineer at the Institute of Applied Research, Reutlingen University (Appendix B). They drove the traction control devices on a car for 200 km (approximately 124 miles) at a constant speed of 50 kph (31 mph) on a dry asphalt track and recorded the wear every 10 km (approximately 6 miles) with photos. According to them they noticed damage after driving 100 km (approximately 62 miles) but said that there is no safety relevant damages during their 200 km (approximately 124 miles) travelled.

A third report of testing was done by TÜV Automotive which included a dry high-speed course, road performance on a dry surface test using front wheel drive and rear wheel drive cars, wear test according to Austrian standard (ÖNORM V 5117), wear test including verification of tire temperature, and assessment of road performance on a wet surface using front wheel drive and rear wheel drive cars (see Appendix C). These tests were conducted by TÜV to review if the devices would be approved by the German Federal Agency for Motor Vehicles and to get the TÜV mark. One thing that was noticed in this report is that the design tested does not look the same as the ones purchased today. The tested sock devices only had four connection points and two straps on the side of the sock, while the newer ones have eight connection points and four straps.

The dry high speed course test revealed that travelling at a constant speed of 70 kph (approximately 43 mph) the passenger side sock was removed at 19 km (approximately 12 miles) and the driver side sock was removed at 38 km (approximately 24 miles). They noted that the tire surface became very hot, tread blocks were worn around the edges and some fibers from the socks were stuck to the tire surface.

The road performance test on a dry surface was done with a rear wheel drive vehicle (equipped with the socks on the rear wheels) and a front wheel drive vehicle (equipped with the socks on the front wheels). The rear wheel drive vehicle handled fine at a range of maximum speeds of 50 – 70 kph (31 – 43 mph) with gradual steering angles. If the steering angle was built up fast or high lateral acceleration was involved, the vehicle's rear end broke loose in sudden and uncontrollable manner. During these swerving maneuvers or fast steering moments, the socks

were either destroyed on the outer wheels or thrown off the inner wheels. The front wheel drive vehicle handled fine in all situations with a 50 – 60 kph (31 – 37 mph) maximum speed and even during steep steering angles the understeering was controllable.

The wear test was conducted on a front wheel drive with the socks on the non-powered wheels for one hour on a dry road surface. The test exceeded 50 kph (31 mph) at times but the socks went a distance of 46 km (approximately 28.5 miles) before the first signs of incipient cracks appeared on the devices. They drove the vehicle past the one hour test limit to a total distance of 60 km (37 miles) and only small cracks were visible on the socks.

The final tests were assessment of road performance on a wet surface. A rear wheel vehicle was equipped with the socks first and driven at a maximum speeds of 50 – 60 kph (31 – 37 mph). As with the dry road surface tests, the socks were fine in gradual steering, but not in quickly built up fast steering angles and high lateral acceleration where the vehicle's rear end would break away in a sudden and uncontrollable manner. The testers then put socks on all four wheels and conducted the same tests again, this time the test vehicle's tendency to understeer was intensified, it was easy to control and handle. This test led to TÜV to require that rear-wheel drive vehicles must always be equipped with socks on all four tires for safety reasons. The front-wheel drive vehicle operated problem free in its test, even during steering angles that were built up quickly, the unsteering was easily controllable.

TIRE TRACTION CONTROL DEVICE DURABILITY TEST

DRISI, District Personnel, and the Division of Maintenance, conducted the durability test on Tuesday, July 21 and Wednesday, July 22 at the Caltrans District 7 Division of Maintenance Regional Training Facility & Maintenance Equipment Training Center located at 5200 W. Imperial Highway, Los Angeles.

The AutoSock brand tire traction control device was chosen to test the durability of a cloth based tire traction control devices operating on a wet road surface. The durability tests were performed using three vehicles typically found on California roads. These three vehicles were a Chevrolet Impala, Chevrolet Tahoe, and an International Harvester tractor with a flatbed transport trailer (with load). Two test tracks were designed to maximize the amount of tests conducted at the same time while ensuring safety of all personnel on site (see test track layouts Appendix D). Safety instructions were given prior to testing and all personnel signed the safety meeting report understanding the instructions (see safety meeting Appendix E).

The tire traction control device durability test consisted of driving and recording the condition of each device. This evaluation was performed on a wet road surface until the traction control device degraded to a condition past the manufacturer's recommended condition for removal. The manufacturer of the AutoSock tire traction control device recommends removal of the tire traction control device when "the wear limit is reached as soon as 50% of the white road contact fabric is worn out and the underlying black safety material has become visible" or

"afterwards or in the event of serious damage occurring". Each tire traction control device was checked every five miles till removal (see example Appendix F). The test plan developed to gather the data during the testing is attached for reference (see Appendix G).

All vehicle tests were completed successfully. The road surface was kept wet throughout the entire test and maintained by an on-site water truck. One tire traction control device test on the Chevrolet Tahoe was done over a two day span. During this time the Tahoe never left a wet road surface and was stored at a secured, on-site location. The tire traction control devices were not removed overnight to prevent damage caused by removal. Vehicle tracking data from the Chevrolet Impala and Tahoe showed that neither vehicle went over the tire traction control manufacturer's recommended speed limit of thirty miles per hour. Two of the trailer tests ended up with the one of tire traction control devices breaking and getting stuck on the axle between the trailer's two wheels.

TRACTOR AND TRAILER GROSS WEIGHT

During the testing, brought one of their enforcement vehicles over to the test facility to weigh the tractor trailer with full load. The gross weight of the tractor trailer was 61,350 pounds which is far under the maximum weight of 80,000 pounds that is allowed on California roads. The following data table is the weight per CHP testing.

Axle (From Front to Back)	Left Side	Right Side
X1	5900	5450
X2	7000	6500
X3	6500	6200
X4	6350	5500
X5	5600	6350

TIRE TRACTION CONTROL DEVICE COST

DRISI purchased four tire traction control device sets per vehicle for three tests and one spare set in case of malfunction. The AutoSock devices were purchased from McGee Company (an authorized reseller of the AutoSock devices).

Test vehicle, tire size, AutoSock model number, and cost are noted below.

Vehicle	Tire Size	AutoSock Model Number	Cost per Set	Total Cost per Vehicle
2008 Chevy Impala	P225/60R16	685	$89	$356
2014 Chevy Tahoe	P265/70R17	699	$89	$356

1996 International Harvester 9400	11R/24.5	AL89	$226	$904
2000 LANDOLL 660A Trailer	235/75R 17.5	AL64	$199	$796

The total amount spent on the tire traction control devices for this test was: $2,412.

RESULTS

The results for the durability testing for three runs per vehicle are shown below:

Vehicle Type	Test 1	Test 2	Test 3
Car	35 miles	30 miles	25 miles
SUV	75 miles	45 miles	58 miles
Tractor	38.5 miles	45 miles	25 miles
Trailer	8.5 miles	10 miles	8.6 miles

Average tire traction control device distance travelled per vehicle.

Car	30 miles
SUV	59.3 miles
Tractor	36.2 miles
Trailer	9.0 miles

CONCLUSION

All tire traction control devices showed wear and eventually made holes at the point where the orange straps connected to the tire surface fabric. The durability test eventually wore tears and holes in the fabric surface that contacted the roadway that grew with further distance travelled. When these holes were large enough to view from a distance the tire traction control devices were removed from the tire and replaced with new ones. This damage was typical for all tire traction control devices tested during the durability test.

The test data was gathered under ideal driving habits normally observed on California roads; all drivers drove their vehicles below the maximum allowed speed limit during winter conditions and did not perform any swerving maneuvers. Extreme driving habits observed on California roadways often exceed the speed limits and perform swerving maneuvers. The Global Positioning Satellite vehicle tracking data shows that the car and SUV never went above the Manufacturer's recommended speed limit of 30 mph throughout the durability test.

All the comments from the testers said that tire traction control devices tested were easy to put on, but once wet they tended to be more difficult to remove since they stuck to the tire. There were some comments from the drivers while operating the vehicles during the durability test that needed to be noted. One driver of the SUV said he lost a little control while driving around a turn. A car driver said he felt like he was driving on sand while the tire control devices were on the vehicle. Another car driver commented that they felt like they lost a bit of traction on turns in the car. At no point did any vehicle lose traction while driving with the tire traction control devices equipped on the vehicles.

Out of all the four different tires tested, only the trailer tire traction control device had a low total distance traveled. All four of the trailer's failed when the mesh siding broke and separated from the fabric that contacts the road surface and the eventually the straps breaking loose. One tire traction control device was wrapped around the axle between the outside tire and inside tire at time of removal. In the fourth run of the trailer's test, the failed driver's side tire traction control device was removed and the passenger side tire traction control device was left to determine how long it would travel before failing. Eventually the passenger side tire traction control device failed at fifteen miles, which was five miles past the point where the driver's side tire traction control device was removed.

There is a possible explanation for the reason the trailer's tire traction control device failed at such a low mileage. The researcher believes that a tight left turn on one point of the tractor-trailer test track caused additional stress on the side of the tire traction control device which accelerated the wear on the device. Although tight turns like this are not that common on highways with high speed limits, but this type of turns could be encountered on winding roads (such as switchbacks) or at highway on and off ramps.

RECOMMENDATIONS

The Researcher recommends that the Division of Maintenance and the California Highway Patrol consider adopting the criteria that Washington State has in regards for allowing any tire traction control devices to be used on their roadways. The Washington Administrative Code 204-24 has a very specific description for tire chains and cable tire chains which they use as a reference standard for testing alternative tire traction control devices. Washington requires that all alternative tire traction control devices must meet or exceed a tire chain that is approved for use in the state of Washington. The minimum required tests are on the durability testing of the proposed product, acceleration and deceleration on both snow and ice, and the tire traction force on snow. Section 204-24-305 details the exact requirements necessary to pass to be allowed on Washington roadways. The tire traction control device standards used in Washington are under the Washington Administrative Code Chapter 204-24 can be found in this report under Appendix H.

APPENDIX A – AUTOSOCK TRUCK DURABILITY TEST

Dr. Burkhard Boenigk
Fred Olsens gate 2
N – 0107 Oslo
Norway

Your ref: **Jörn Remsöy** **Our ref:** **Oslo, 29.11.2007.**

Re.: Truck Durability test November 2007

Dr. Boenigk!

27 November 2007 we performed a durability test with AutoSocks for Trucks at Sundvollen close to Oslo. The truck was loaded, and had a total weight of 21 tons. The tire dimension was 315/80R22,5 (Goodyear Regional RHD), and the AutoSock model was AL84. Testing was performed on a dry asphalt surface with air temperature around 0 degrees Celsius. A GPS Data Logging System, Racelogic VBOX III, was used to log and track the position and velocity during the test.

The wear of the RCF of the AutoSocks for Trucks is documented in the enclosed report from Dag Anders Moldestad. The RCF (Road Contact Fabric) of the AutoSock for Trucks was analysed to be in good shape after a test distance of 140 km with an average speed of 30 km/h. This indicates that the RCF of the AutoSock for Trucks also will be in usable good condition even after 200 km driving. On the pictures below, you will see that the wear out of the RCF are minor after 140 km distance.

Best regards
AutoSock Operation AS

Jørn Remsøy
Product Manager Trucks

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By test start 0 km :

By end of the test, 140 km

APPENDIX B – DRY ROAD DURABILITY TEST

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AutoSock Operations AS
Dr Burkhard Bönigk
Fred Olsen gt 2
0152 Oslo

Norway

Datum: 12.09.2006

AutoSock safety and durability test drive on dry asphalt

Dear Dr Bönigk,

we finished the test report of the safety and durability test campaign on dry asphalt as discussed earlier. Please find the according test report enclosed to this mail.

We could not examine any safty relevant damages during the 200 km. The AutoSocks were very well centered from the beginning on through the whole distance.

There were no damages to the seams or fabrics attached to the road contact fabric.

The road contact fabric itself showed withwise damages through both layers of the road contact fabric. After approximately 100 km driven distance, one could see the tire tread through the „cuts“ in the road contact fabric. But the stearing of the car and the overall handling was not impacted by these damages, which can clearly be identified in the attached report. Also no damages to the overall structure of the traction aid caused by the „cuts“ could be determined.

Once the damages to the road contact fabric got bigger, one could determine a slight vibration through the sterring wheel. But I never felt uncomfortable while driving with the traction aids mounted to the test car.

Please see the attached test reports for details.

If you have further questions, please call me or send me an email.

Best regards

Stefan Muche

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REPORT

Testing of the durability and safety of the AutoSock traction aid under realistic conditions on dry asphalt

by

Stefan Muche
Engineer
Institute of Applied Research
Reutlingen University
2006-09-08

Hochschule Reutlingen
Reutlingen University

Preface:

In order to obtain precise information on the safety of the textile traction aid AutoSock and its durability under realistic conditions, a car has been equipped with this traction aid and been driven 200 km on dry asphalt on a defined testing track. .As the traction aid is intended to being used on ice- and snowcovered roads and not on dry asphalt, the testing conditions are regarded as a worst case scenario in regards to durability and wear.

Testing Procedure:

A Volkswagen Golf 5, equipped with summer tires, was driven 200km on a dry asphalt track.
In order to obtain precise information on the fitting of the traction on the tire as well as the wear of the product, photos were taken every 10 km.

The pictures were taken from the side and the front of each equipped tire every time in order to analyse the performance of the traction aid.

Testing Parameters:

Testing date:	September 6th, 2006
Testing time:	12.00 am – 06.00 pm
Car:	Volkswagen Golf 5, 1.6 Liter fuel Engine
Front axle load:	approximately 690 kg
Tires:	Pirelli P6000 in 205/55 R16 Summer tires, inflated to 2.0 bar
Velocity:	50 km/h constant
Traction aid:	AutoSock size 62
Testing Track:	Between Adelshofen and Luttenwang, Bavaria
Length of Track:	approximately 1850m
Track surface:	Asphalt, dry
Track temperature:	34,7°C at 12.00 am / 27,9°C @ 06.00 pm
Driver:	Stefan Muche

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Fig.1: Test car equipped with traction aid


Fig.2: Pirelli test tire


Fig.3: Testing track

Test Results:

The following photos were taken during the testing campaign every 5 km until 200 km have been reached:

Driven distance	Left side	Left front	Right side	Right front
10 km				
20 km				
30 km				

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Driven distance	Left side	Left front	Right side	Right front
40 km				
50 km				
60 km				
70 km				
80 km				
90 km				
100 km				

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Driven distance	Left side	Left front	Right side	Right front
110 km				
120 km				
130 km				
140 km				
150 km				
160 km				

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Driven distance	Left side	Left front	Right side	Right front
170 km				
180 km				
190 km				
200 km				

Analysis of results:

Fitting / Safety:

The fitting performance of the AutoSock traction aid has been on a constant good level, as to be seen in the above pictures. The crossing point of the two orange straps has been situated in the middle of the wheel from the beginning of the test drive through the whole driven distance till the end on both sides. The traction aid was easy to mount as the fixation on the wheel is solved with a black elastic strap which is sewed to the backside of the AutoSock traction aid.
During driving the author could not determine any extraodinary driving behaviour which might be caused by the traction aid. Steering and handling of the car did appear normal throughout the test. Once bigger damages in form of widthwise cuts occured at the road contact fabric of the traction aid, a slight vibration was experienced during driving. This started at approximately 140 km driven distance.

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Reutlingen University

Durability:

As can be seen in the above pictures, the white road contact fabric which was placed on the tread of the tire showed whidthwise damages most likely caused by friction and abrasion between tire and trach surface. The first complete damage of both plies of the road contact fabric (white outer layer and black inner layer) was identified after 90 km, when the tire tread was clearly visible underneath the damaged area.
Although these widthwise „cuts“ did increase during the next 100 km till the end of the test drive, no deformation or any other impact of these damaged to the structure of the AutoSock traction aid were determined.

The seams fixing the road contact fabric with the white inner fabric on the inside of the tire and the front fabric on the outside of the tire showed no damaged after 200km for both driven traction aids. Also the two above mentioned fabrics did not show any major damages such as cuts. Only slight arbrasion could be determined but there was no damage to the structure of both fabrics.

Stefan Muche

8th September, 2006

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APPENDIX C – TUV TEST REPORT

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TÜV AUTOMOTIVE

Technical report
Testing of AutoSocks on winter roads
Order no. 70006115

0 Customer

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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).

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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

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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.

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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

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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

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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 $\Rightarrow$ 615 kg
75% $\Rightarrow$ 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.

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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.

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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.

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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

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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.

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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.

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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.

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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.

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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

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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

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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 dismounted. 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).

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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

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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.

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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

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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.

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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

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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.

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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.

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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 surafce

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

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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

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6 Results:

6.1 Traction ice surface

VW Passat	***acceleration [m/s²]***	***%***
Bridgestone Blizzak	0,32	100,0
Pirelli P6000	0,20	62,3
Pirelli P6000 + AutoSocks	0,72	235,5

Mercedes C	***acceleration [m/s²]***	***%***
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

VW Passat	***deceleration [m/s²]***	***%***
Bridgestone Blizzak	1,09	100,0
Pirelli P6000	0,97	87,6
Pirelli P6000 + AutoSocks	1,41	132,6

Mercedes C	***deceleration [m/s²]***	***%***
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

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6.3 Centrifugal force ice surface (circle)

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

Mercedes C	***time [s]***	***%***
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

VW Passat	***acceleration [m/s²]***	***%***
Bridgestone Blizzak	1,03	100,0
Bridgestone + AutoSocks	1,20	114,8
Bridgestone +snow chain	1,23	119,7

Mercedes C	***acceleration [m/s²]***	***%***
Bridgestone Blizzak	1,00	100,0
Bridgestone + AutoSocks	1,05	105,0
Bridgestone + snow chain	1,01	100,7

See enclosures 4.1 to 4.6

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6.5 Braking snow surface

VW Passat	***deceleration [m/s²]***	***%***
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

Mercedes C	***deceleration [m/s²]***	***%***
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

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

Mercedes C	***general impression***	***time [s]***
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

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6.7 Braking wet surface

Mercedes C	*deceleration [m/s²]*	*%*
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.

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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°C to –8°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.

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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.

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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 [%]

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Enclosure 0.1

Overall view of results

Test / Tire	BS-Blizzak LM 18 195/65 R15 91H M+S	Pirelli P6000 Powergy 195/65 R15 91H	AutoSocks on Pirelli	AutoSocks on Bridgestone	Snow chain on Bridgestone
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

Page 36/78

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Enclosure 0.2

Ranking					
	Lap time ice Passat	**Lap time ice Mercedes**	**Traction ice Passat**	**Traction ice Mercedes**	**Braking ice Passat**
Best	Bridgestone	AutoSocks on Pirelli	AutoSocks on Pirelli	AutoSocks on Pirelli	AutoSocks on Pirelli
	Pirelli	Pirelli	Bridgestone	Bridgestone	Bridgestone
Worst	AutoSocks on Pirelli	Bridgestone	Pirelli	Pirelli	Pirelli

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Enclosure 0.3

Ranking (cont.)					
	Braking ice Mercedes	**Braking wet Mercedes**	**Lap time snow Passat**	**Lap time snow Mercedes**	**Lap time snow Passat**
Best	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
Worst		AutoSocks on Bridgestone			

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Enclosure 0.4

Ranking (cont.)					
	Handling snow Mercedes	**Braking snow Passat**	**Braking snow Mercedes**	**Traction snow Passat**	**Traction snow Mercedes**
Best	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		
Worst		Pirelli			

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TÜV AUTOMOTIVE

Enclosure 1.1

Data Sheet	Traction distance ice 5 km/h to 15 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	12.9.00			**Vehicle:**	VW Passat
Air temperature:	Ø: 8,1°C	max: 9,5°C	min: 7,0°C	**Model:**	3B
Surface temperature:	Ø: -3,9°C	max: -3,6°C	min: -4,2°C	**V_1 [km/h]:**	5
ABS:	on			**v_2 [km/h]:**	15
Front axle load (kg):	900			**Rear axle load (kg):**	890
Total decelareted weight (kg):	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	
Percentage value [µ]	**100,00%**	**62,28%**	**235,55%**	**100,00%**	
Difference in % [µ]	**0,00%**	**-37,72%**	**135,55%**	**0,00%**	
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	
Mean value	**22,47**	**38,09**	**10,67**	**26,72**	
Standard variation	0,314	0,847	0,486	0,667	
Variancy	0,099	0,717	0,236	0,446	
Mean acceleration [m/s²]	**0,34**	**0,20**	**0,72**	**0,29**	
Reference value	0,34	0,33	0,31	0,29	
Percentage value	**100,00%**	**62,28%**	**235,55%**	**100,00%**	
Difference in %	**0,00%**	**-37,72%**	**135,55%**	**0,00%**	

Page 40/78

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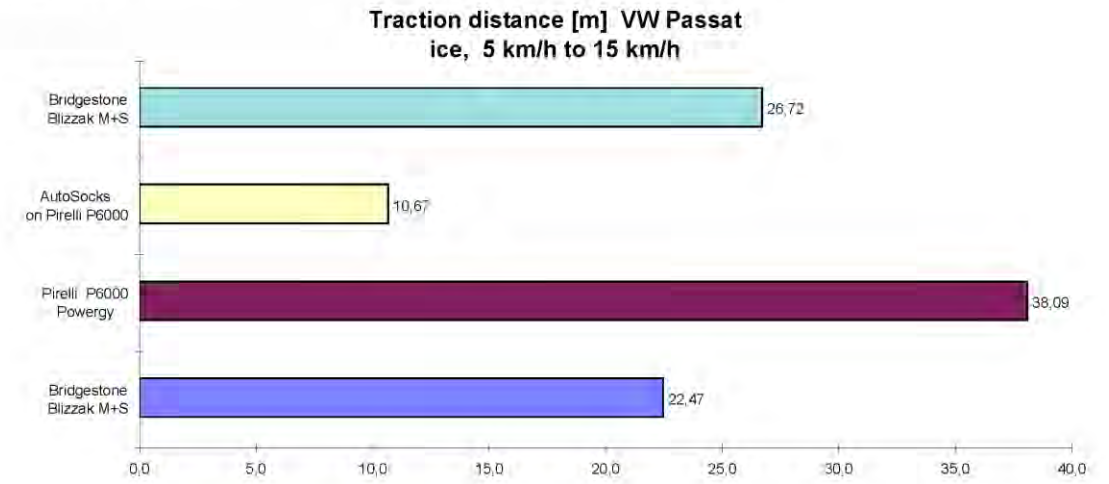
Enclosure 1.2



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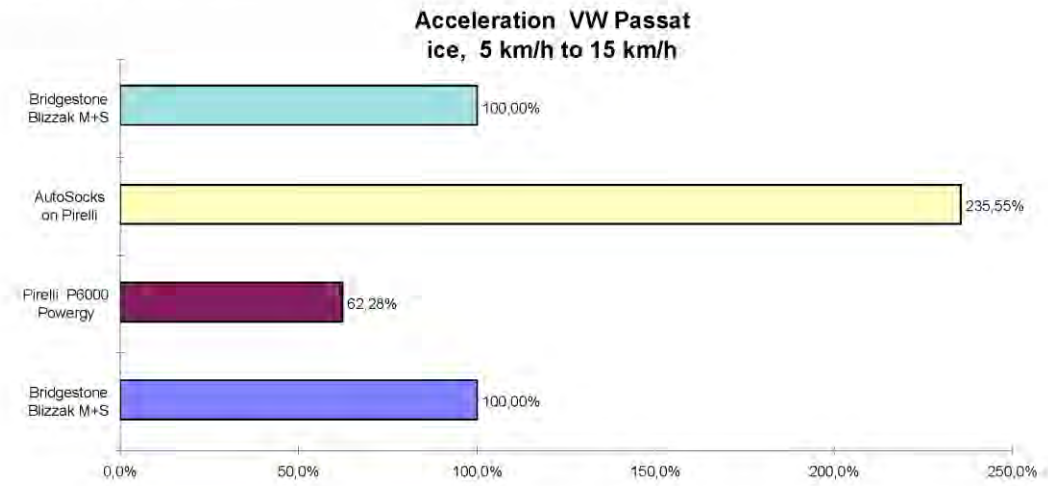
Enclosure 1.3



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Enclosure 1.4

Data Sheet	Traction distance ice 5 km/h to 20 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	12.9.00			**Vehicle:**	Mercedes C
Air temperature:	Ø: 8,7°C	max: 9,4°C	min: 8,3°C	**Model:**	203
Surface temperature:	Ø: -3,9°C	max: -4,0°C	min: -3,7°C	**v_1 [km/h]:**	5
ABS:	on			**v_2 [km/h]:**	15
Front axle load (kg):	900			**Rear axle load (kg):**	890
Total decelareted weight (kg):	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	
Percentage value [µ]	**100,00%**	**71,24%**	**150,64%**	**100,00%**	
Difference in % [µ]	**0,00%**	**-28,76%**	**50,64%**	**0,00%**	
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	
Mean value	**19,57**	**27,36**	**12,89**	**19,35**	
Standard variation	0,413	0,593	0,577	0,382	
Variancy	0,170	0,352	0,333	0,146	
Mean acceleration [m/s²]	**0,39**	**0,28**	**0,60**	**0,40**	
Reference value	0,39	0,40	0,40	0,40	
Percentage value	**100,00%**	**71,24%**	**150,64%**	**100,00%**	
Difference in %	**0,00%**	**-28,76%**	**50,64%**	**0,00%**	

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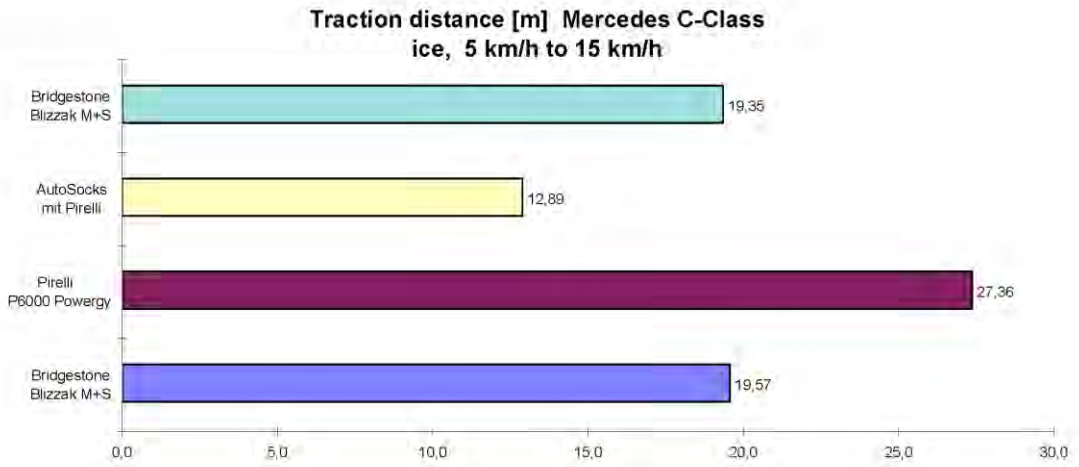
Enclosure 1.5



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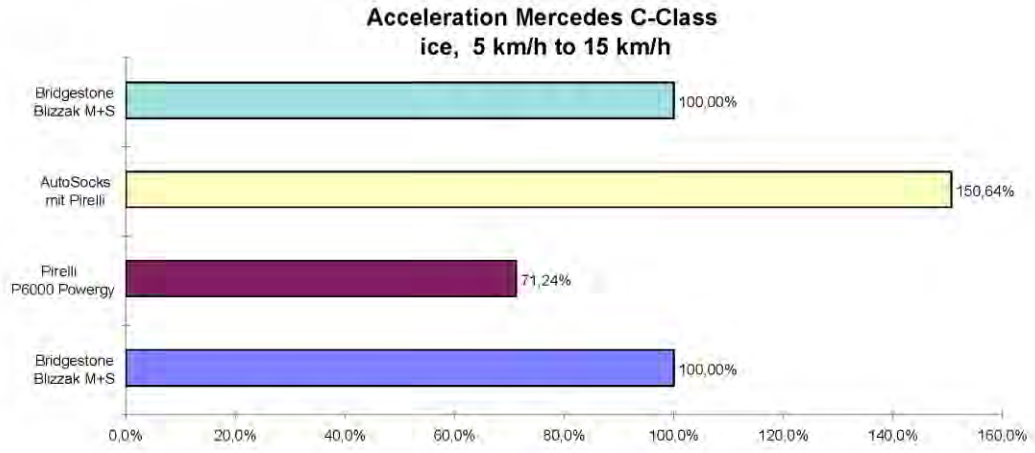
Enclosure 1.6



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TÜV AUTOMOTIVE

Enclosure 2.1

Data Sheet	Braking ice 20 km/h to 5 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	13.9.00			**Vehicle:**	VW Passat
Air temperature:	Ø: 3,7°C	max: 5,1°C	min: 2,4°C	**Model:**	3B
Surface temperature:	Ø: -3,5°C	max: -3,3°C	min: -3,6°C	**v_1 [km/h]:**	20
ABS:	on			**v_2 [km/h]:**	5
Front axle load (kg):	900			**Rear axle load (kg):**	890
Total decelareted weight (kg):	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	
Percentage value [µ]	**100,00%**	**87,56%**	**132,58%**	**100,00%**	
Difference in % [µ]	**0,00%**	**-12,44%**	**32,58%**	**0,00%**	
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	
Mean value	**12,45**	**14,83**	**10,24**	**14,21**	
Standard variation	0,888	0,356	0,256	0,127	
Variancy	0,789	0,127	0,066	0,016	
Mean deceleration [m/s²]	**1,16**	**0,98**	**1,41**	**1,02**	
Reference value	1,16	1,11	1,07	1,02	
Percentage value	**100,00%**	**87,56%**	**132,58%**	**100,00%**	
Difference in %	**0,00%**	**-12,44%**	**32,58%**	**0,00%**	

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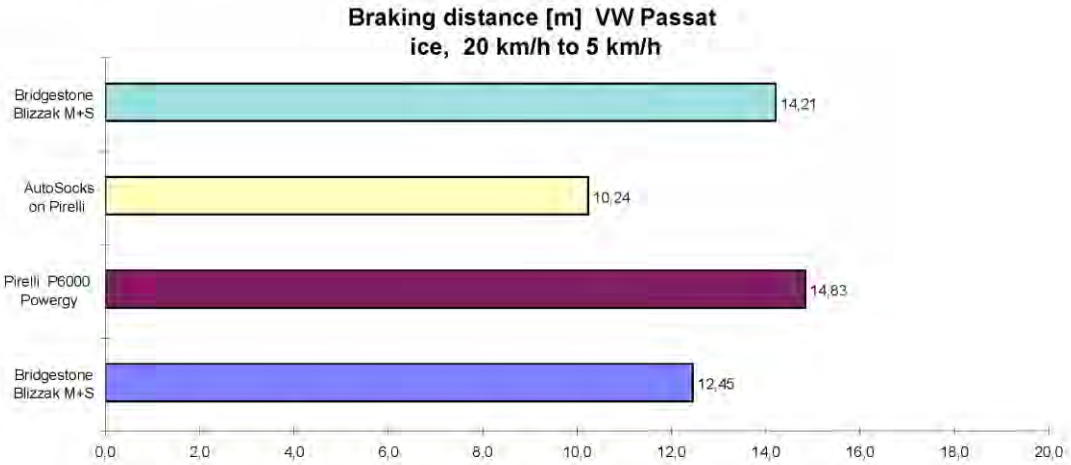

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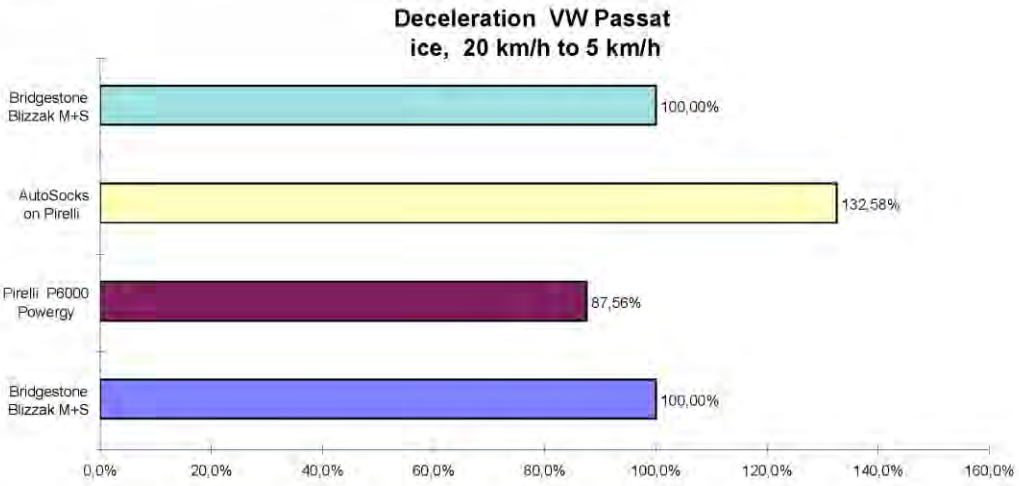
Enclosure 2.3



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TÜV AUTOMOTIVE

Enclosure 2.4

Data Sheet	Braking distance ice 20 km/h to 5 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	14.9.00			**Vehicle:**	Mercedes C
Air temperature:	Ø: 5,5°C	max: 7,7°C	min: 3,9°C	**Model:**	203
Surface temperature:	Ø: -2,4°C	max: -1,8°C	min: -2,5°C	**v_1 [km/h]:**	20
ABS:	on			**v_2 [km/h]:**	5
Front axle load (kg):	900			**Rear axle load (kg)**	890
Total decelareted weight (kg):	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
Percentage value [µ]	**100,00%**	**90,33%**	**138,25%**	**122,77%**	**100,00%**
Difference in % [µ]	**0,00%**	**-9,67%**	**38,25%**	**22,77%**	**0,00%**
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
Mean value	**15,18**	**17,00**	**11,23**	**12,80**	**15,89**
Standard variation	0,166	0,235	0,464	0,281	0,395
Variancy	0,028	0,055	0,215	0,079	0,156
Mean deceleration [m/s²]	**0,95**	**0,85**	**1,29**	**1,13**	**0,91**
Reference value	0,95	0,94	0,93	0,92	0,91
Percentage value	**100,00%**	**90,33%**	**138,25%**	**122,77%**	**100,00%**
Difference in %	**0,00%**	**-9,67%**	**38,25%**	**22,77%**	**0,00%**

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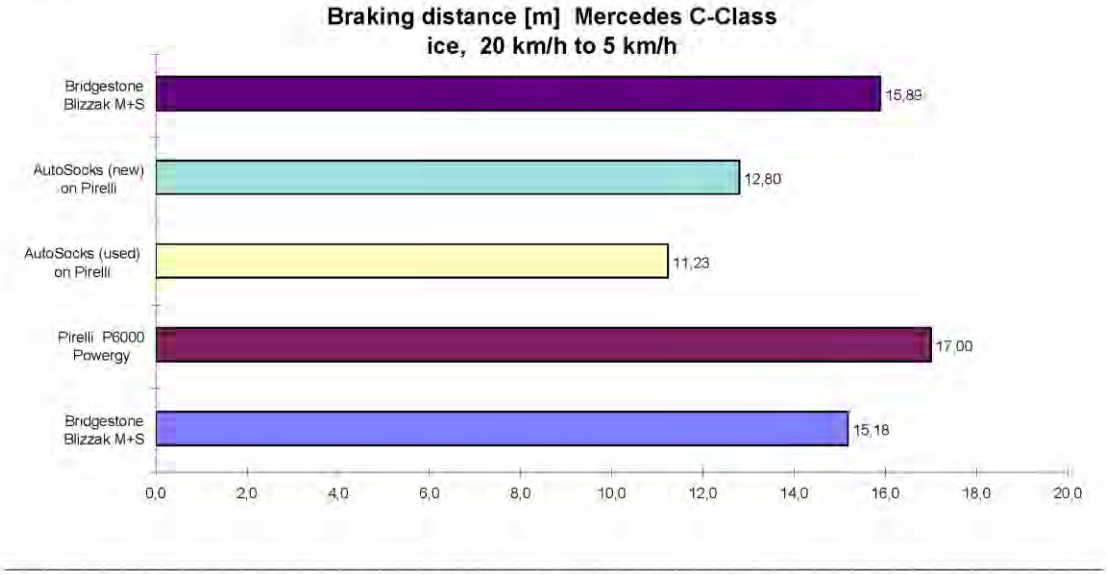
Enclosure 2.5



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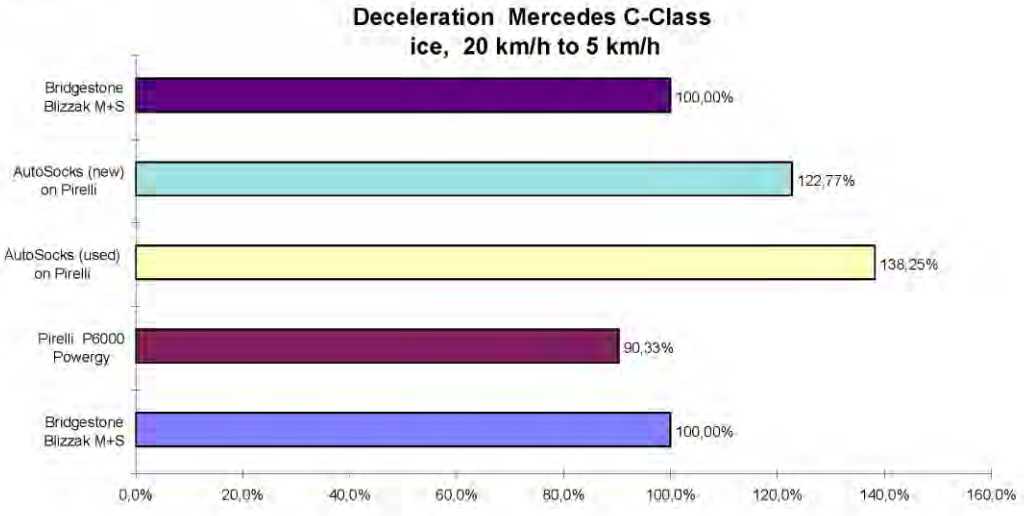
Enclosure 2.6



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Enclosure 3.1

Data Sheet	Lap time (ice, circle, radius 8m)				
Customer:	KOSA			**Order No.:**	70006115
Date:	13.9.00			**Vehicle:**	VW Passat
Air temperature:	Ø: 7,5°C	max: 7,8°C	min: 7,2°C	**Model:**	3B
Surface temperature:	Ø: -3,3°C	max: -2,9°C	min: -3,5°C	**Radius (m):**	8
ABS:	on				
Front axle load (kg):	900			**Rear axle load (kg):**	890
Total decelareted weight (kg):	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	
Percentage value [µ]	**100,00%**	**97,58%**	**85,17%**	**100,00%**	
Difference in % [µ]	**0,00%**	**-2,42%**	**-14,83%**	**0,00%**	
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	
Mean value	**15,62**	**16,33**	**19,09**	**16,59**	
Standard variation	0,256	0,216	0,712	0,402	
Variancy	0,065	0,047	0,507	0,162	
Time 5 laps [s]	**78,10**	**81,63**	**95,43**	**82,96**	
Centrifugal force [N]	362,03	346,37	296,28	340,82	
Reference value	362,03	354,96	347,89	340,82	
Percentage value	**100,00%**	**97,58%**	**85,17%**	**100,00%**	
Difference in %	**0,00%**	**-2,42%**	**-14,83%**	**0,00%**	

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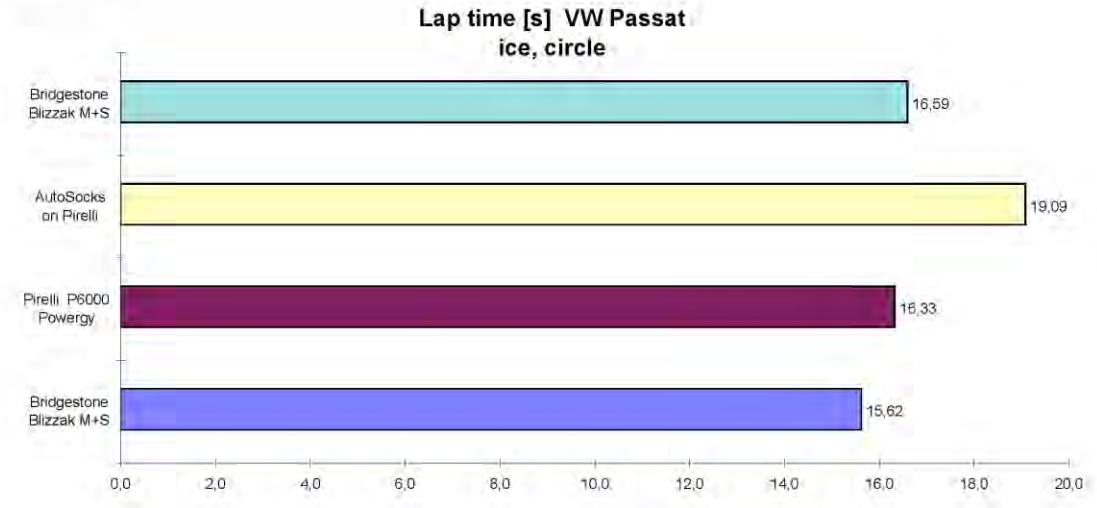
Enclosure 3.2



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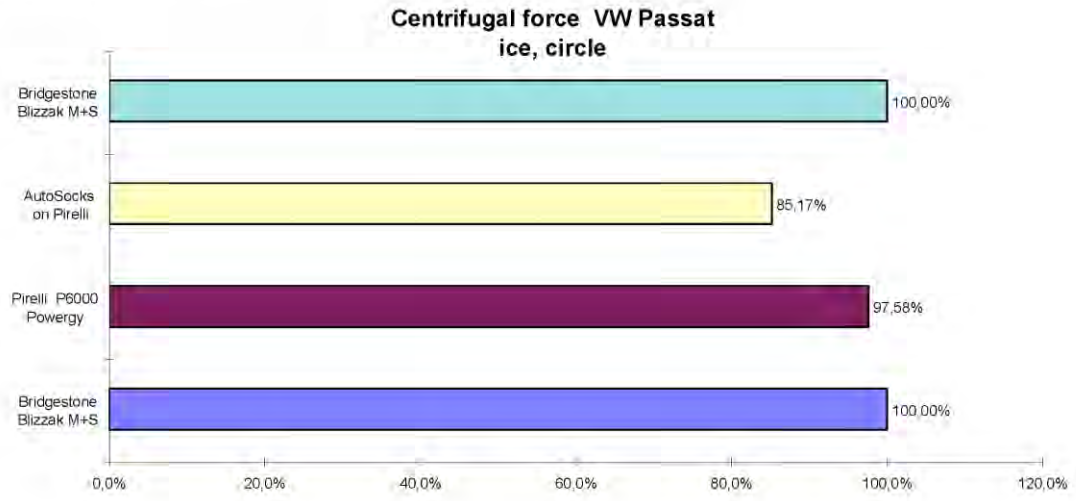
Enclosure 3.3



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Enclosure 3.4

Data Sheet	Lap time (ice, circle, radius 8m)				
Customer:	KOSA			**Order No.:**	70006115
Date:	14.9.00			**Vehicle:**	Mercedes C
Air temperature:	Ø: 4,9°C	max: 5,3°C	min: 4,6°C	**Model:**	203
Surface temperature:	Ø: -2,3°C	max: -2,1°C	min: -3,0°C	**Radius (m):**	8
ABS:	on				
Front axle load (kg):	900			**Rear axle load (kg):**	890
Total decelareted weight (kg):	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	
Percentage value [µ]	**100,00%**	**105,67%**	**105,36%**	**100,00%**	
Difference in % [µ]	**0,00%**	**5,67%**	**5,36%**	**0,00%**	
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	
Mean value	**18,46**	**17,30**	**17,06**	**17,57**	
Standard variation	0,341	0,189	0,489	0,297	
Variancy	0,117	0,036	0,239	0,088	
Time 5 laps [s]	**73,92**	**68,93**	**68,14**	**70,77**	
Centrifugal force [N]	380,37	407,91	412,64	397,30	
Reference value	380,37	386,02	391,66	397,30	
Percentage value	**100,00%**	**105,67%**	**105,36%**	**100,00%**	
Difference in %	**0,00%**	**5,67%**	**5,36%**	**0,00%**	

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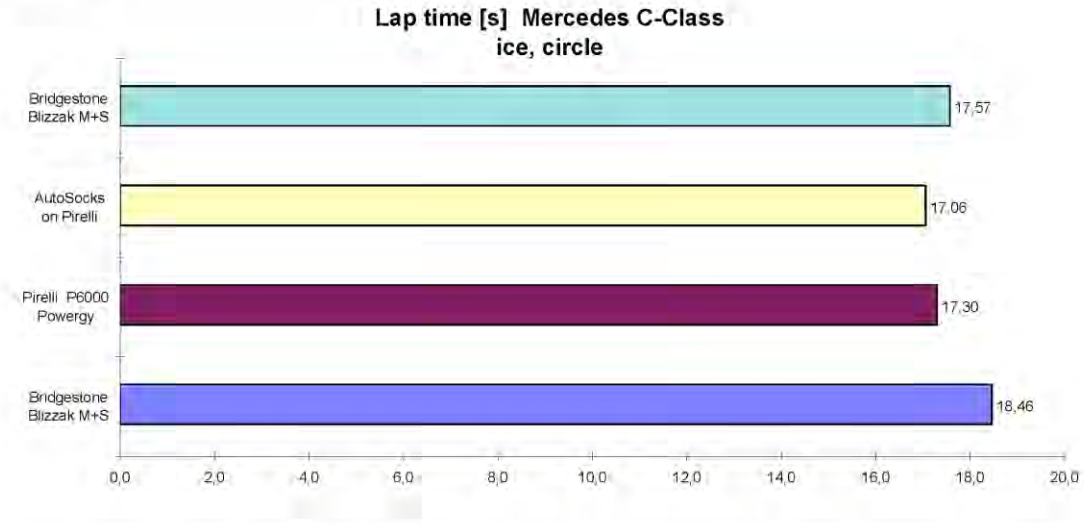
Enclosure 3.5



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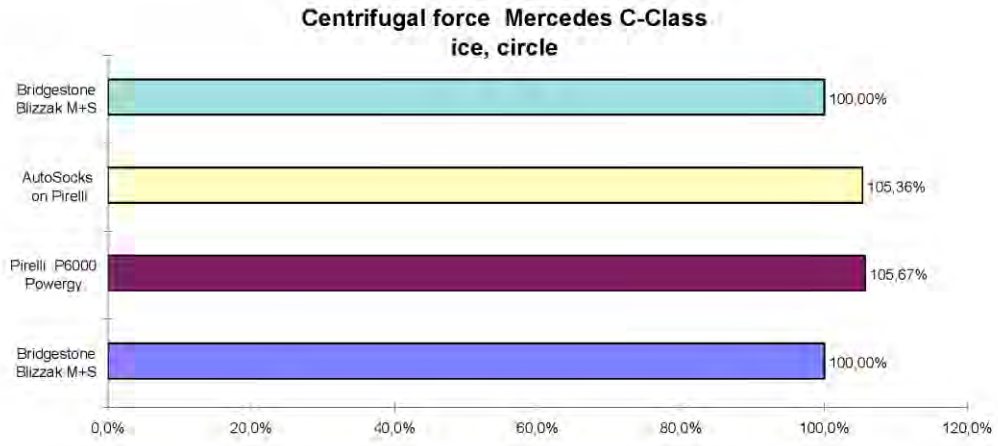

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Enclosure 4.1

Data Sheet	Traction snow 20 km/h to 35 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	23.11.00			**Vehicle:**	VW Passat
Air temperature:	Ø: -5,1°C	max: -5,0°C	min: -5,5°C	**Model:**	3B
Surface temperature:	Ø: -4,5°C	max: -4,3°C	min: -4,8°C	**v_1 [km/h]:**	20
ABS:	on			**v_2 [km/h]:**	35
Front axle load (kg):	830			**Rear axle load (kg):**	830
Total decelareted weight (kg):	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	
Percentage value [µ]	**100,00%**	**114,85%**	**119,66%**	**100,00%**	
Difference in % [µ]	**0,00%**	**14,85%**	**19,66%**	**0,00%**	
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		
Mean value	**30,09**	**26,58**	**25,88**	**31,43**	
Standard variation	0,500	0,431	0,563	0,438	
Variancy	0,250	0,185	0,317	0,192	
Mean acceleration [m/s²]	**1,06**	**1,20**	**1,23**	**1,01**	
Reference value	1,06	1,04	1,03	1,01	
Percentage value	**100,00%**	**114,85%**	**119,66%**	**100,00%**	
Difference in %	**0,00%**	**14,85%**	**19,66%**	**0,00%**	

Page 58/78

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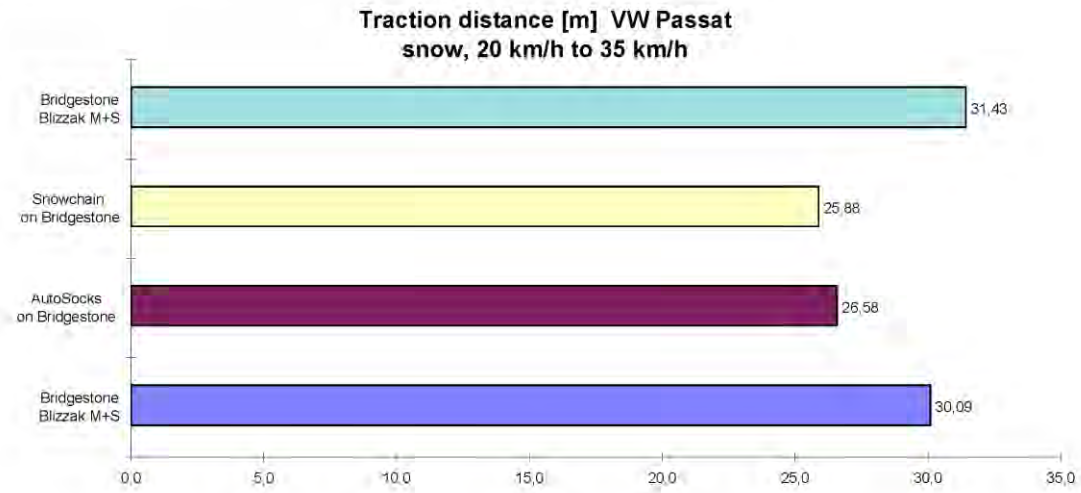

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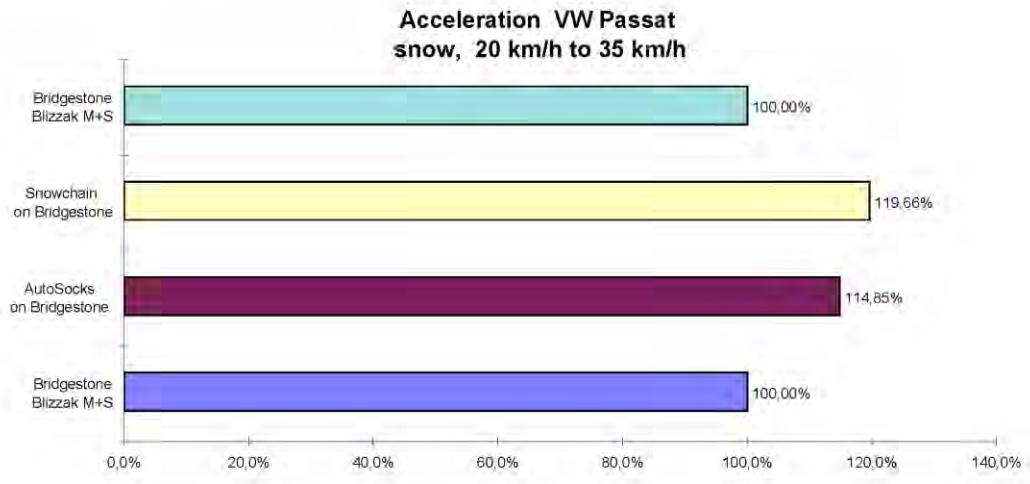

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Enclosure 4.4

Data Sheet	Traction snow 20 km/h to 35 km/h				
Customer:	KOSA			Order No.:	70006115
Date:	23.11.00			Vehicle:	Mercedes C
Air temperature:	Ø: -5,1°C	max: -5,0°C	min: -5,5°C	Model:	203
Surface temperature:	Ø: -4,8°C	max: -4,5°C	min: -5,5°C	v_1 [km/h]:	20
ABS:	on			v_2 [km/h]:	35
Front axle load (kg):	830			Rear axle load (kg):	830
Total decalareted weight (kg):	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	
Percentage value [μ]	**100,00%**	**105,02%**	**100,68%**	**100,00%**	
Difference in % [μ]	**0,00%**	**5,02%**	**0,68%**	**0,00%**	
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	
Mean value	**31,95**	**30,36**	**31,61**	**31,76**	
Standard variation	0,673	0,626	0,186	0,382	
Variancy	0,453	0,392	0,035	0,146	
Mean acceleration [m/s²]	**1,00**	**1,05**	**1,01**	**1,00**	
Reference value	1,00	1,00	1,00	1,00	
Percentage value	**100,00%**	**105,02%**	**100,68%**	**100,00%**	
Difference in %	**0,00%**	**5,02%**	**0,68%**	**0,00%**	

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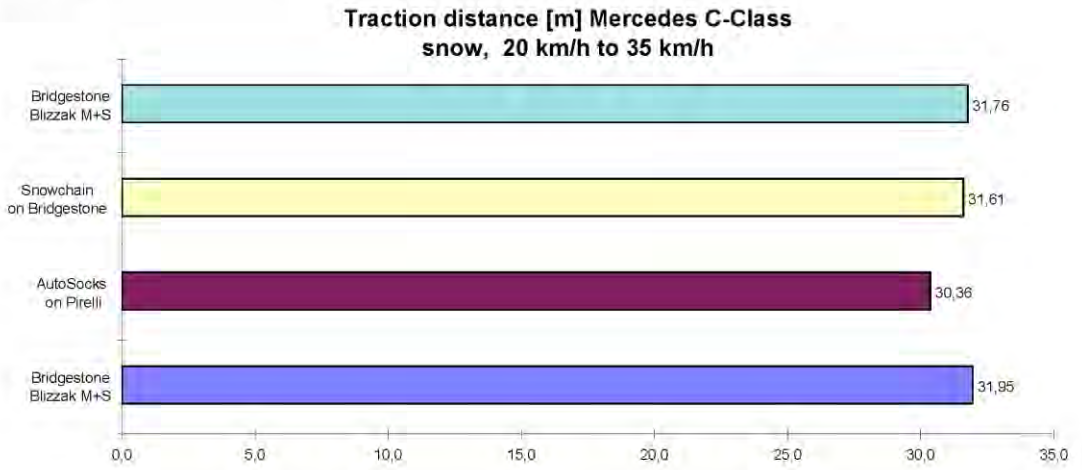

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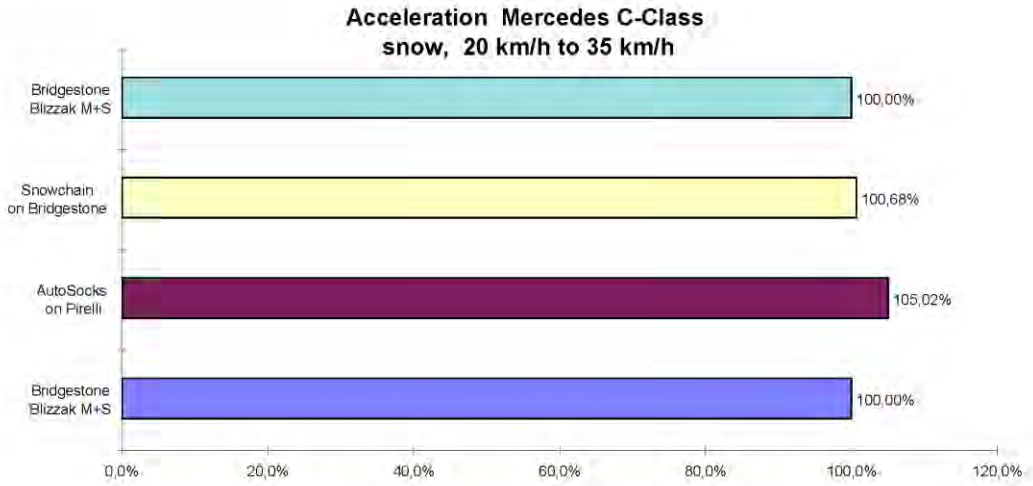

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Enclosure 5.1

Data Sheet	Braking snow 40 km/h to 5 km/h					
Customer:	KOSA				**Order No.:**	70006115
Date:	23.11.00				**Vehicle:**	VW Passat
Air temperature:	Ø: -5,1°C	max: -5,0°C	min: -5,5°C		**Model:**	3B
Surface temperature:	Ø: -4,5°C	max: -4,3°C	min: -4,8°C		**v_1 [km/h]:**	40
ABS:	on				**v_2 [km/h]:**	5
Front axle load (kg):	850				**Rear axle load (kg):**	810
Total decelareted weight (kg):	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
Percentage value [µ]	**100,00%**	**106,66%**	**59,84%**	**100,83%**	**79,07%**	**100,00%**
Difference in % [µ]	**0,00%**	**6,66%**	**-40,16%**	**0,83%**	**-20,93%**	**0,00%**
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	26,8	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
Mean value	**20,56**	**20,05**	**36,83**	**22,08**	**29,38**	**24,28**
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
Mean deceleration [m/s²]	**2,95**	**3,03**	**1,65**	**2,75**	**2,07**	**2,50**
Reference value	2,95	2,84	2,76	2,73	2,62	2,50
Percentage value	**100,00%**	**106,66%**	**59,84%**	**100,83%**	**79,07%**	**100,00%**
Difference in %	**0,00%**	**6,66%**	**-40,16%**	**0,83%**	**-20,93%**	**0,00%**
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: $s=(v_2^2-v_1^2)/2a$						

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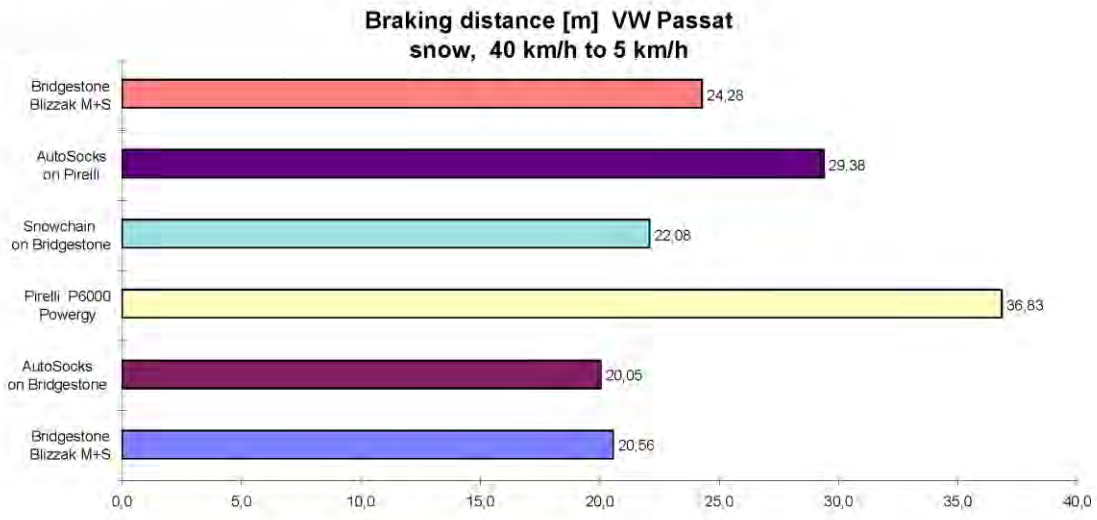
Enclosure 5.2



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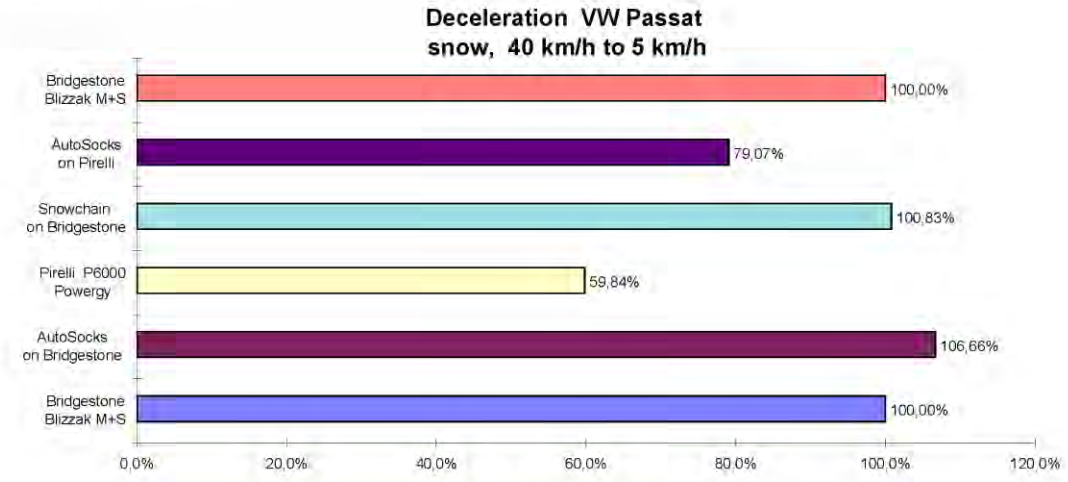
Enclosure 5.3



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Enclosure 5.4

Data Sheet	Braking snow 40 km/h to 5 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	23.11.00			**Vehicle:**	Mercedes C
Air temperature:	Ø: -2,6°C	max: -2,0°C	min: -3,0°C	**Model:**	203
Surface temperature:	Ø: -3,6°C	max: -3,0°C	min: -4,0°C	**v_1 [km/h]:**	40
ABS:	on			**v_2 [km/h]:**	5
Front axle load (kg):	850			**Rear axle load (kg)**	810
Total decelareted weight (kg):	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
Percentage value [µ]	**100,00%**	**63,14%**	**100,73%**	**97,08%**	**100,00%**
Difference in % [µ]	**0,00%**	**-36,86%**	**0,73%**	**-2,92%**	**0,00%**
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	
Mean value	**21,47**	**34,23**	**21,61**	**22,57**	**22,07**
Standard variation	0,298	0,911	0,379	0,360	0,249
Variancy	0,089	0,830	0,144	0,130	0,062
Mean deceleration [m/s²]	**2,83**	**1,77**	**2,81**	**2,69**	**2,75**
Reference value	2,83	2,81	2,79	2,77	2,75
Percentage value	**100,00%**	**63,14%**	**100,73%**	**97,08%**	**100,00%**
Difference in %	**0,00%**	**-36,86%**	**0,73%**	**-2,92%**	**0,00%**
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: $s=(v2^2-v1^2)/2a$					

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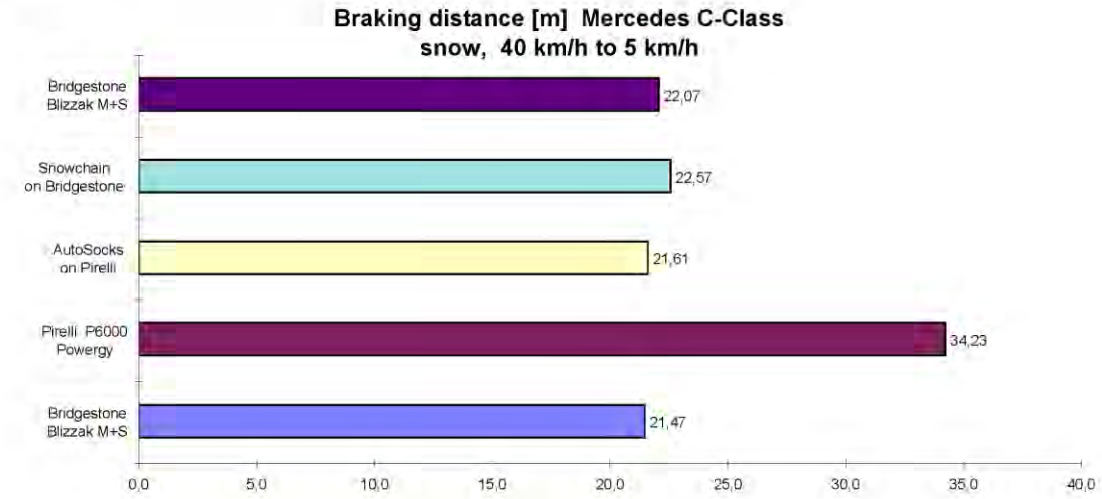
Enclosure 5.5



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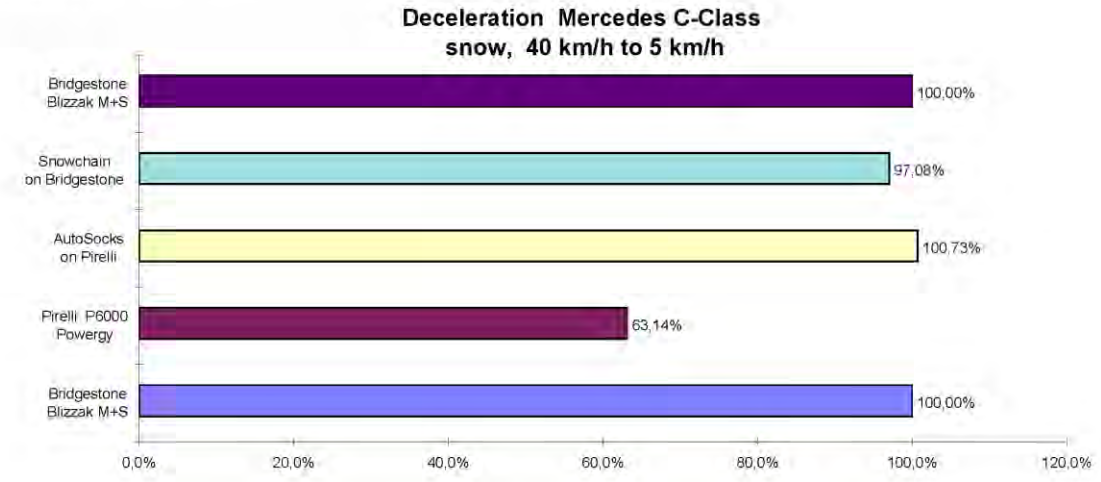

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Enclosure 6.1

Data Sheet	Handling snow		
Client	Kosa	**Order No.**	70006115
Date	24.11.00	**Vehicle**	VW Passat TDI
Driver	Reithmaier / Staude	**Tire size**	195/65 R 15
	1	**2**	**3**
	Bridgestone Blizzak	**AutoSocks on Bridgestone**	**Snow Chain on Bridgestone**
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
Mean value	6,38	7,75	6,88
Lap time	73,30	68,91	73,96
Passing 1st bend possible?	only with ESP turned off	yes	yes

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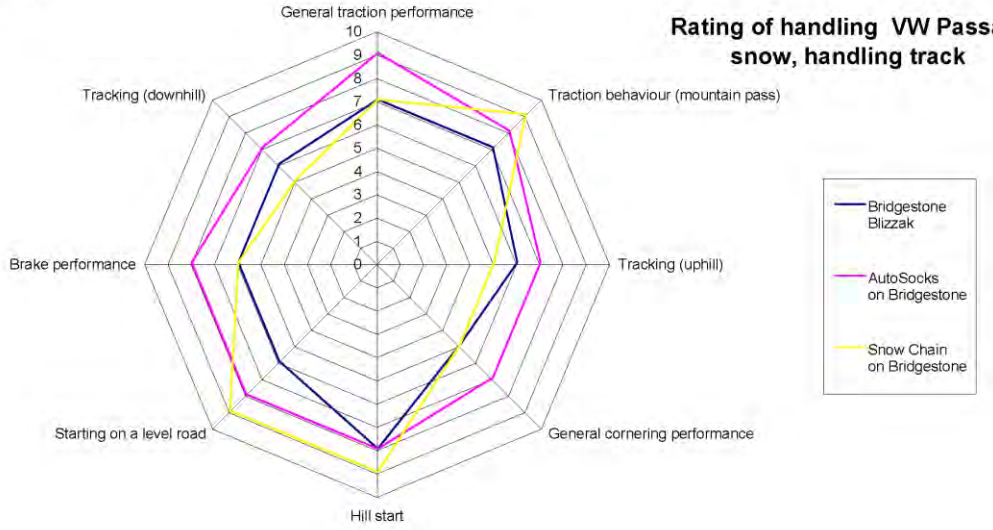
Enclosure 6.2



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D-80339 Munich • Germany

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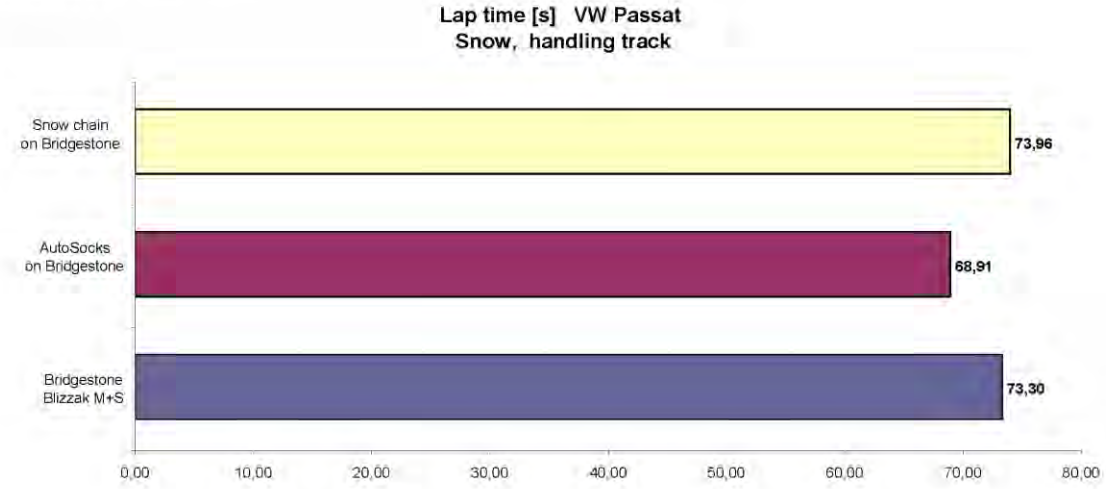
Telefax +49 89 5190-3286

Enclosure 6.3



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Telefax +49 89 5190-3286

Enclosure 6.4

Data Sheet	Handling snow		
Client	Kosa	**Order No.**	70006115
Date	19./20.11.2000	**Vehicle**	Mercedes C 200 K
Driver	Reithmaier	**Tire size**	195/65 R 15
	1	**2**	**3**
	Bridgestone Blizzak	**AutoSocks on Bridgestone**	**Snow chain on Bridgestone**
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
Mean value	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

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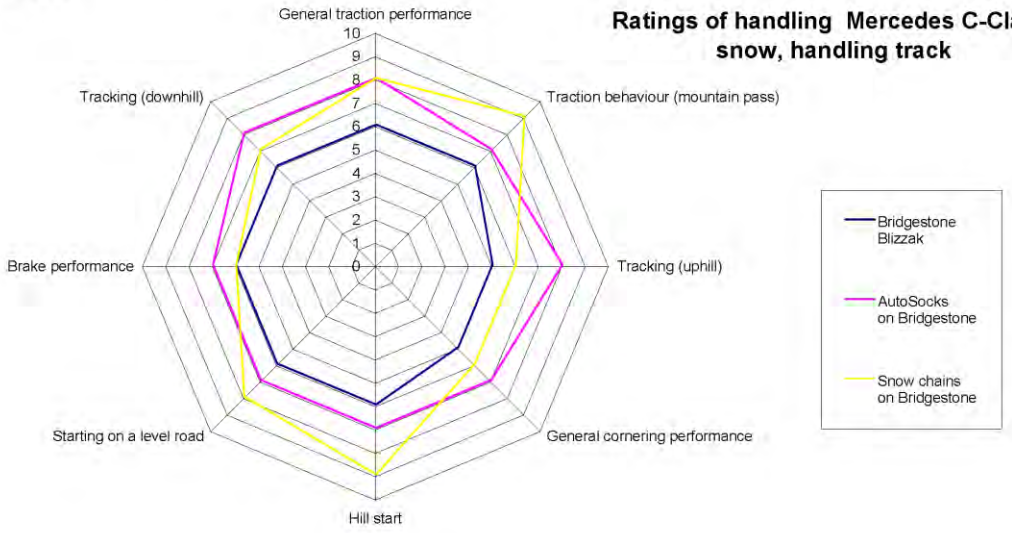
Enclosure 6.5



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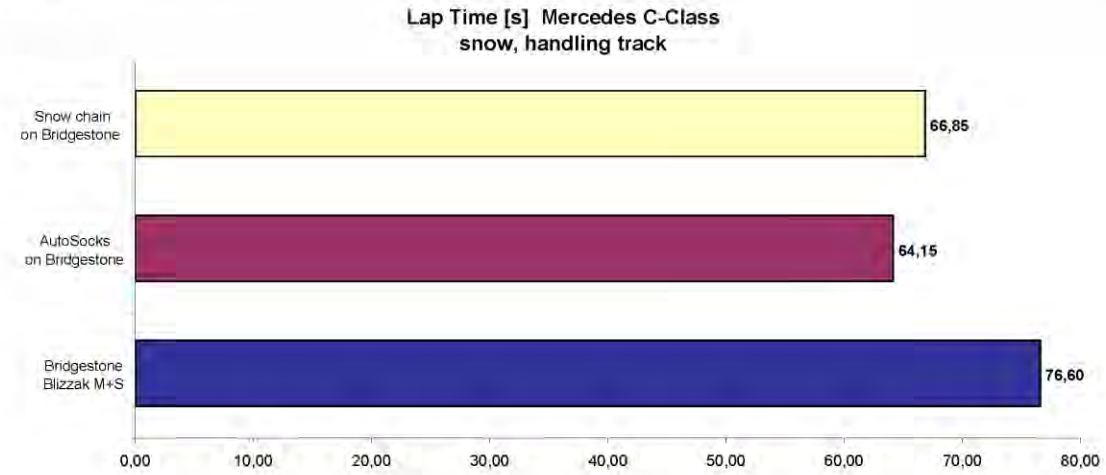
Enclosure 6.6



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Telefax +49 89 5190-3286

Enclosure 7.1

Data Sheet	Braking wet surface 60 km/h to 10 km/h				
Customer:	KOSA			**Order No.:**	70006115
Date:	16.10.00			**Vehicle:**	Mercedes C
Air temperature:	Ø: 11,4°C	max: 12,4°C	min: 10,7°C	**Model:**	203
Surface temperature:	Ø: 10,7°C	max: 13,3°C	min: 9,7°C	**v_1 [km/h]:**	60
ABS:	on			**v_2 [km/h]:**	10
Front axle load (kg):	900			**Rear axle load (kg)**	890
Total decelareted weight (kg):	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
Percentage value [µ]	**100,00%**	**113,65%**	**99,51%**	**84,33%**	**100,00%**
Difference in % [µ]	**0,00%**	**13,65%**	**-0,49%**	**-15,67%**	**0,00%**
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
Mean value	**16,98**	**14,76**	**16,65**	**19,42**	**16,18**
Standard variation	0,090	0,403	0,111	0,388	0,302
Variancy	0,008	0,163	0,012	0,151	0,091
Mean deceleration [m/s²]	**7,95**	**9,15**	**8,11**	**6,95**	**8,34**
Reference value	7,95	8,05	8,15	8,25	8,34
Percentage value	**100,00%**	**113,65%**	**99,51%**	**84,33%**	**100,00%**
Difference in %	**0,00%**	**13,65%**	**-0,49%**	**-15,67%**	**0,00%**

Page 76/78

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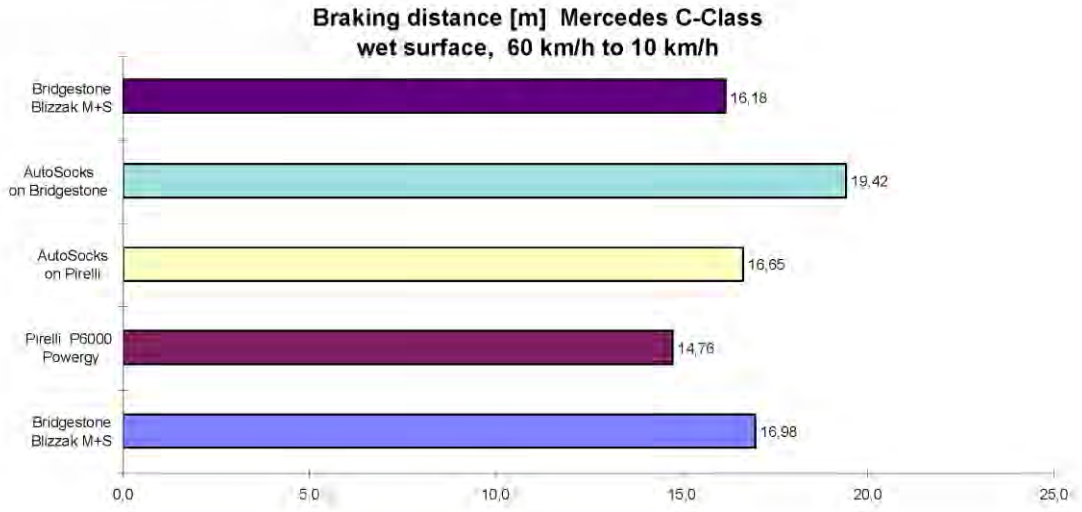
Enclosure 7.2



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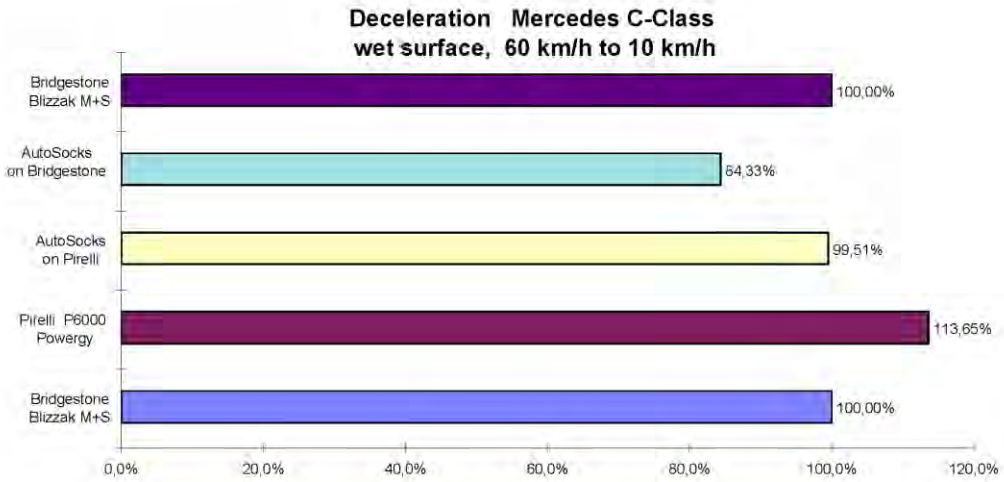
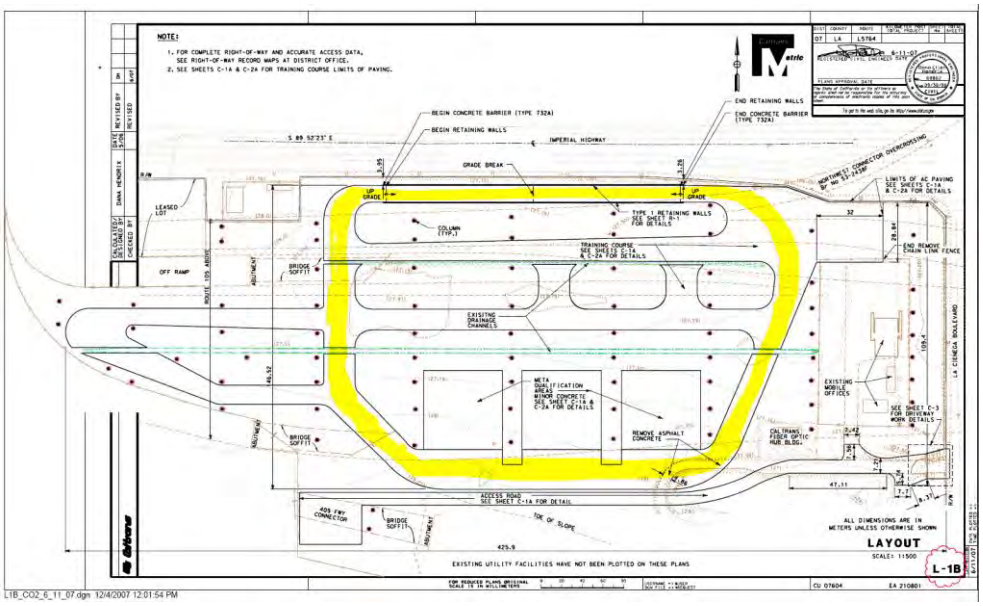
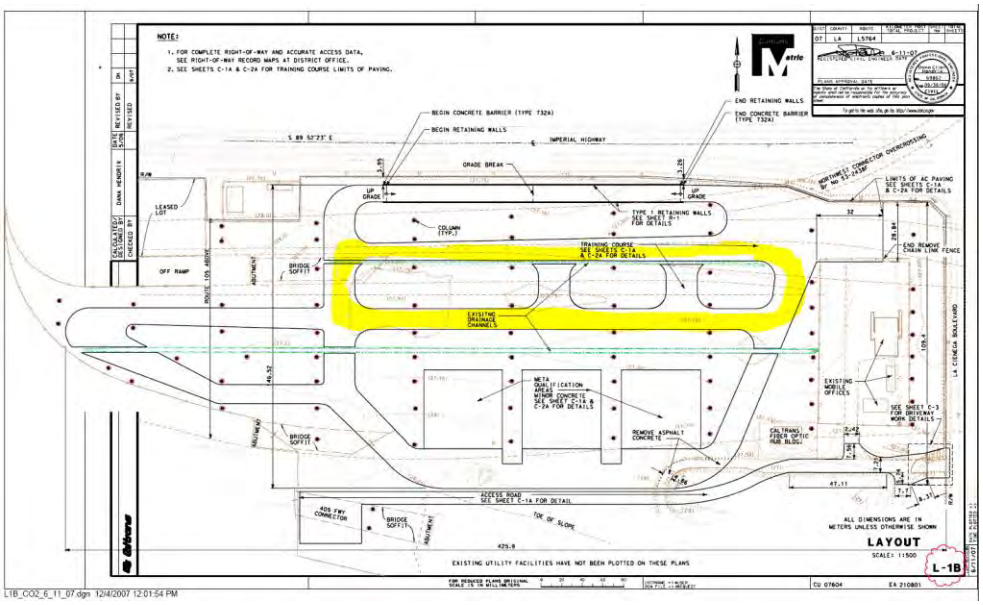
Enclosure 7.3



APPENDIX D – TEST TRACK LAYOUTS



Tractor Trailer Test Track



Chevrolet Impala and Tahoe Test Track

APPENDIX E – SAFETY MEETING REPORT

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAFETY MEETING REPORT
PM-S-0110 (REV. 05/2009)

ACTION AND DISTRIBUTION:

- ☐ 1. First-line supervisor conducts meeting, completes, and sign form.
- ☐ 2. First-line supervisor retains and posts one copy.
- ☐ 3. First-line supervisor sends original to second-line supervisor for review.
- ☐ 4. Second-line supervisor reviews, signs original, and returns to first-line supervisor to file.
- ☐ 5. Additional routing to:

Note: See Chapter 2, Safety Meetings, in the Caltrans Safety Manual for details.

DATE	OFFICE / CREW / PROJECT NAME	COST CENTER / PROJECT NUMBER
7/21/15	Tire Traction Device Testing	0015000324

PRINT NAME OF EMPLOYEES (Add additional sheets if required)

SAFETY TOPICS DISCUSSED

See Attached

SAFETY SUGGESTIONS/COMMENTS

SUPERVISOR'S COMMENTS

FIRST-LINE SUPERVISOR SIGNATURE	DATE	SECOND-LINE SUPERVISOR SIGNATURE	DATE
[signature]	7/24/15	Chris Smith	7/21/15

SUGGESTED TOPICS FOR DISCUSSION

☐ Safe work habits	☐ Maintenance, Chapter 8	☐ Respirator safety	☐ Safety vest
☐ Safe work conditions	☐ Traffic control/flagging	☐ Confined spaces	☐ Body protection
☐ Codes of Safe Operating/Work Practice	☐ Slip/trip/fall hazards	☐ Hard hats	☐ Foot protection
☐ First aid treatment	☐ Protective vehicles	☐ Safety glasses	

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July 21

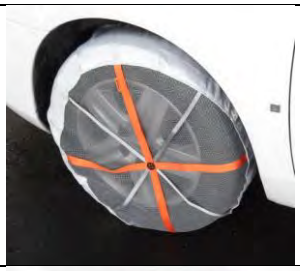
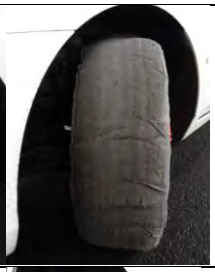
Safety Meeting

Cover safe area - where to cross
Hard Hat & Vest
No persons on foot on course unless all vehicles have stopped & has been delayed open
Cover traffic intersection west end
if we loss a traction device all stop
~~took~~ Honk if we Run into outside pedestrians

Name
David Frame
Eric Williams
Fouad Ziaullah
Sukh Nagra.
Lai T. Saetern
Douglas Peyton
Hector Ortiz
Bradley Mizuno
Dana Hendrix
Mark Burkett
Rodrigo Ramos
Salvador Huerta
Thomas Cowan
Chris Arnold

APPENDIX F – PHOTOGRAPHS OF DURABILITY TESTING

These are the photos taken during the first tire traction control device durability test on the Chevrolet Impala. The photos show the condition of the tire traction control devices every five miles. The following is the first durability test.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
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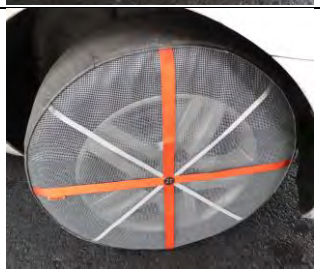
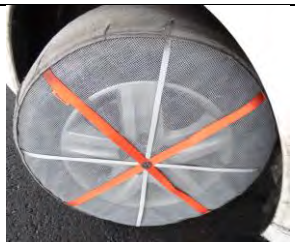
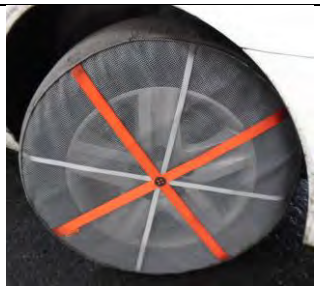
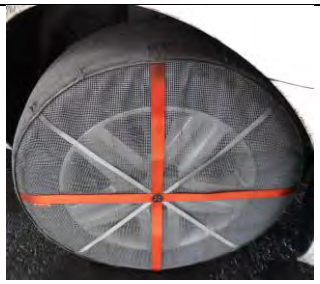
This is the second durability test on the Chevy Impala.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10				
15				

20				
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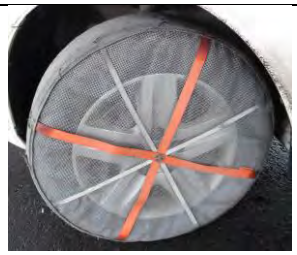
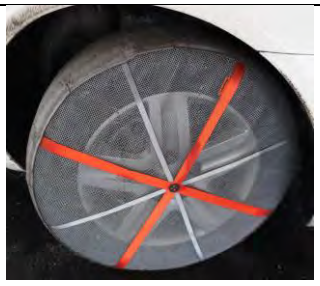
30				

Third durability test on Chevy Impala.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10				
15				

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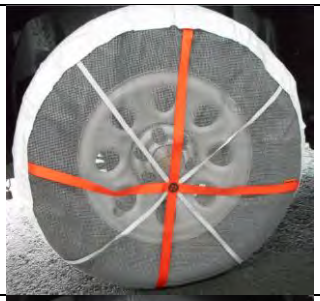
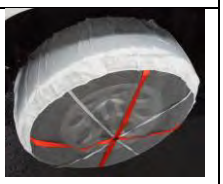
25				

This is the first durability test for the Chevy Tahoe.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
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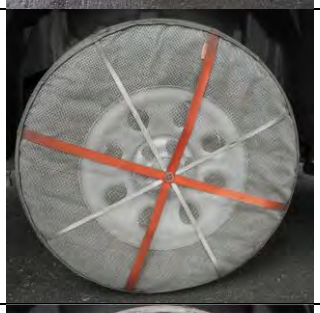
30				
35				
40				
45				

50				
55				
60				
65				
70				

75				

This is the second durability test for the Chevy Tahoe.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
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15				
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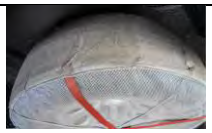
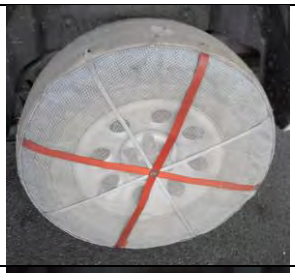
25				
30				
35				
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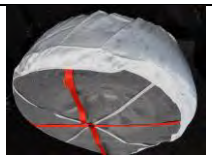
45				

This is the third durability test for the Chevy Tahoe.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
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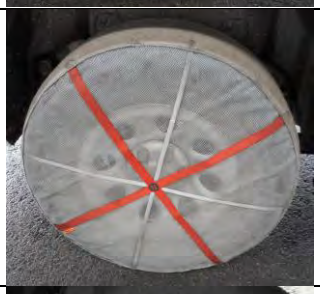
30				
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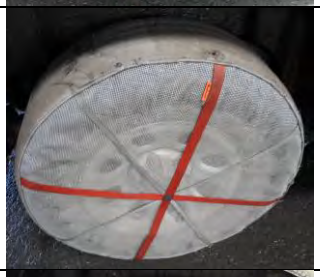
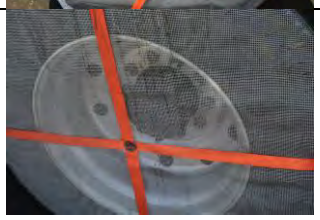
50				
58				
60				

First durability test for the Tractor.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10				
15				
20				

25				
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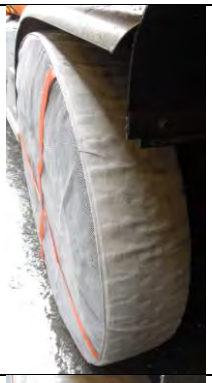
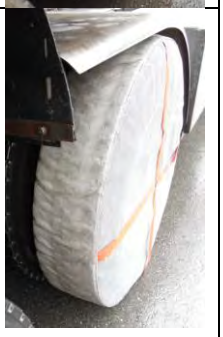
35				
40				

Second durability test for the Tractor.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
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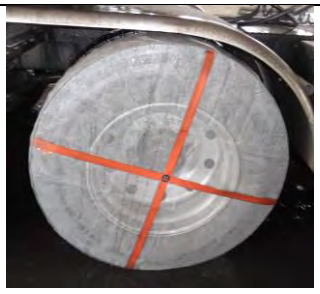
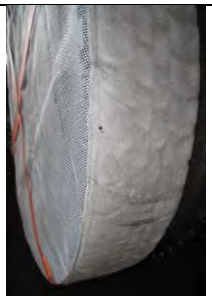
15				

20				
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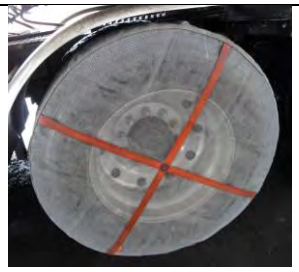
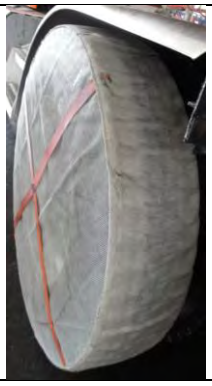
30				
35				

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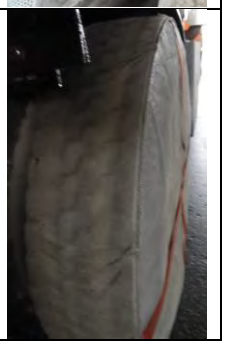
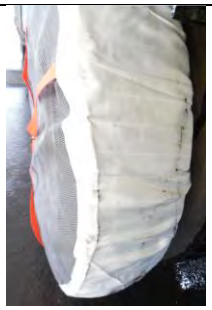
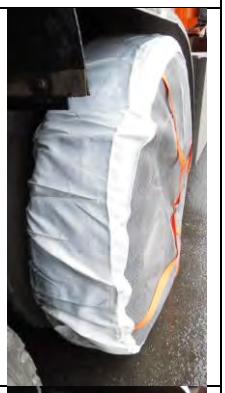
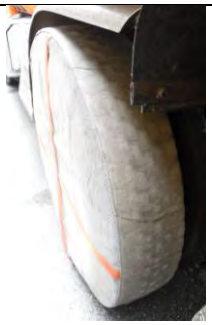
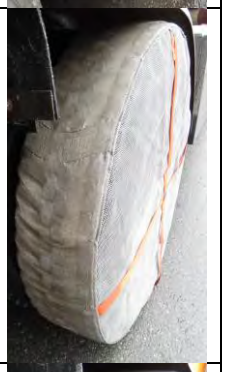
45				

Third durability test for the Tractor.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
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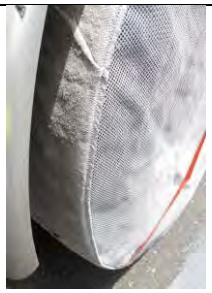
15				

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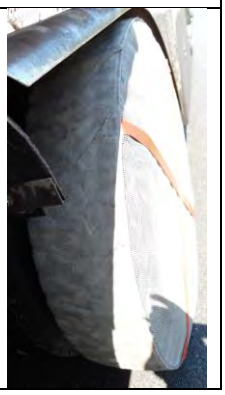
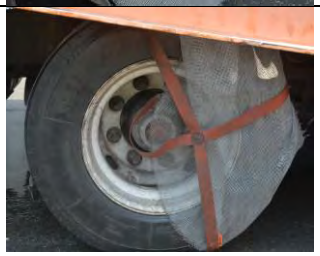
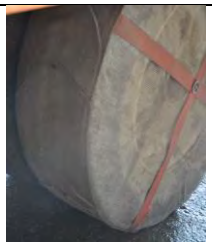
25				

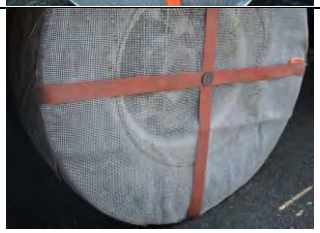
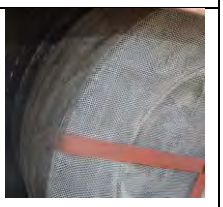
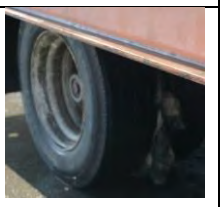
First durability test for the trailer.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10				

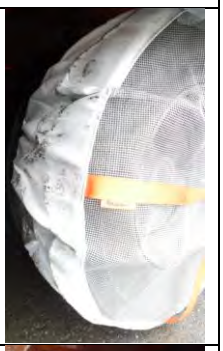
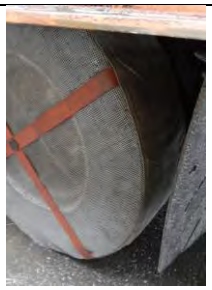
Second durability test for the trailer.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10				

Third durability test for the trailer.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10				

Fourth durability test for the trailer.

Distance (in Miles)	Driver's Side Wheel Side View	Driver's Side Wheel	Passenger's Side Wheel Side View	Passenger's Side Wheel
0				
5				
10			REMOVED	REMOVED
15			REMOVED	REMOVED

APPENDIX G – TIRE TRACTION CONTROL DURABILITY TEST PLAN

1. Researcher will write their name on the data sheet used for the test.
2. Air temperature and pavement temperature will be recorded at time of test (and every hour after initial recording).
3. Photo of traction control device box/packaging to note which device is being used for the test run. This will ensure that the wear photos of the traction control device will correspond with the device.
4. Traction control device will be weighed and noted on data sheet.
5. Brand new traction control device installed on test vehicle per manufacturer's instructions.
6. Photo of traction control device on wheel before operation.
    a. Driver's side wheel side.
    b. Driver's side wheel surface.
    c. Passenger's side wheel side.
    d. Passenger's side wheel surface.
7. Test vehicle is operated at a maximum speed of 30 mph (for car or SUV) or 20 mph (for tractor trailer) for one mile after which the traction control device is adjusted/retightened as necessary.
8. Test vehicle is then operated at a maximum speed of 30 mph (for car or SUV) or 20 mph (for tractor trailer) for 5 miles.
9. Every 5 miles the vehicle will be stopped for inspection of the cloth traction control device on the tire.
    a. Photo of the traction control device will be taken.
        i. Driver's side wheel side.
        ii. Driver's side wheel surface.
        iii. Passenger's side wheel side.
        iv. Passenger's side wheel surface.
10. Step 9 is continued until traction control device failure or 100 miles is reached. If the traction control device fails, the vehicle shall be stopped and the mileage shall be noted and recorded. Device failure is the point where the manufacturer recommends that the device is no longer safe and should be replaced or no longer on the tire due to breakage, whichever comes first.
11. Traction control device is weighed after failure or end of test and recorded.
12. Interview the driver on ride comfort, vehicle handling, preferred operating speed (if any) and impressions for each device.

APPENDIX H – WASHINGTON ADMINISTRATIVE CODE 204-24

The following excerpt of the Washington Code was found on the website
http://apps.leg.wa.gov/WAC/default.aspx?cite=204-24&full=true

204-24-005
Promulgation.

1. By authority of RCW 46.37.005 and 46.37.420, the Washington state patrol adopts the following standards for tire chains and traction devices.

204-24-010
Scope.

1. These standards apply to tire chains and traction devices designed for and used upon a public roadway.

204-24-015
Definitions.

1. "All wheel drive" means a vehicle which has four-wheel drive capability and may be driven with all wheels in gear.
2. "Alternative traction device (ATD)" means pneumatically driven chains which, when engaged, spin under the drive wheels automatically as traction is lost or a traction device differing from metal chains in construction, material or design but capable of providing traction equal to or exceeding that of such metal chains under similar conditions.
3. "Automatic tire chain" means an air-operated centrifugal force system which deploys short lengths of chain underneath the drive wheels.
4. "Cable laid rope" means a compound laid rope consisting of several ropes or several layers of strands laid together into one rope.
5. "Cable tire chains" means any ladder-type cable tire chain assemblies designed for use on tires that have been manufactured in accordance with the standards of the Tire & Rim Association, Inc.; 3200 West Market Street; Akron, Ohio 44313.
6. "Cross cable fastener" means any suitable fastener used to attach each cross cable to the side cable. The fastener must be constructed and assembled to prevent accidental detachment.
7. "Cross cable traction reinforcement sleeves" means a device that is constructed of the manufacturer's specified material and of suitable length and width to maximize traction, braking, cornering and longevity.

8. "Fastener" means any suitable connecting device, secured to one end of a side cable constructed so that it can connect to the opposing end and be easily closed (engaged or fastened) and be readily opened (released) by hand.
9. "Link tire chains" means tire chains which consist of at least two chain loops, one on each side of the tire, connected by evenly spaced metal cross chains across the tire tread.
10. "Reinforced cross cables" means stranded cable wrapped or covered to provide increased resistance to abrasive wear. This covering may be either a hard drawn spring wire, a high-carbon steel wire or nylon type 6 or 12. The wrapped or covered cable must be enclosed by traction reinforcement sleeves covering said cable essentially from side connector to side connector. Cross cable must be of specified length and provide proper drape over the tire tread.
11. "Side cable" means stranded cable to complete one full circumference along the tire sidewall.

204-24-020
Standards for tire chains.

1. Link tire chains must meet the National Association of Chain Manufacturers Tire Chain Specifications NACM-5179(TC).
2. Cable tire chains must be designed for use on tires mounted in accordance with specifications in Society of Automotive Engineers (SAE) Recommended Practice J1232, Class S, and SAE Informational Report J683a. Oversized tires, snow tires, special service, or special traction tires, etc., may require chains of a larger size.
    a. Classifications. Cable tire chains described in this specification must be of the following types as specified for regular and restricted clearances:
        i. Passenger car;
        ii. Single light truck;
        iii. Heavy truck;
        iv. Special police and emergency vehicle.
    b. Requirements:
        i. Components. Cable tire chain assemblies must consist of two side cables, or two outer and one inner side cable, with reinforced cross cables, cross cable fastener, and fasteners necessary to form a complete assembly.
        ii. Material.
            1. Stranded side and stranded cross cable wire must be constructed of preformed galvanized high-carbon steel with a minimum of 450 pounds breaking strength with seven wires per strand and seven strands per cable. The lay must be a right hand lay.

2. Wire covering stranded cable must be constructed of high-carbon plow steel wire with a minimum tensile strength of 230,000 pounds per square inch.
3. Spring wire covering stranded cable must be constructed of harddrawn spring wire with a minimum tensile strength of 200,000 pounds per square inch.
4. Cables, spring, and plow wire must be manufactured in conformance to SAE Recommended Practice J113.
5. Cross cable fasteners must be constructed of open hearth, electric furnace, or basic oxygen process steel.
6. Metallic cross cable traction reinforcement sleeves must be constructed of open hearth, electric furnace, or basic oxygen process steel and shall comply with the following American Society for Testing Materials (ASTM) standards: Standard E6 - Bend Test, Standard E8 - Tension Test, Standard E18 - Test Methods for Rockwell Hardness, and Standard A568 - Table of Chemical Content of Steel.
7. Nonmetallic cross cable traction reinforcement sleeves shall be constructed of "Zytel" ST-801 nylon or its equivalent.
8. All side cable fasteners are to be constructed of material that will allow easy installation and removal.

iii. Spacing of cross cable. The first cross cable must be attached to that point of each side cable nearest the fastener that will permit the fastener to lie in the proper plane when the assembled cable tire chain is applied to the tire. On single cable tire chains, the remainder of the cross cables must be attached to the side cable at intervals designed to provide for at least one cross cable in contact with the roadway at all times. On dual-triple tire chains, the remainder of the cross cable shall be attached to the outer side cables at like intervals and to the inner side chain with opposing cross cables staggered at the same intervals.

iv. Tolerances.

1. Cross cable length. The inside length of all cross cable, including fasteners held in the same plane, must be within a tolerance of minus 1/8 inch to plus 1/8 inch of the specified length indicated by the chain manufacturer's specifications. The length shall be measured by hanging the cross cable vertically on a horizontal pin and measuring the inside to inside length. The number of traction reinforcement sleeves in a cross cable may not vary from the number specified by the manufacturer.

2. Side cable length. The length of all side cables must be within tolerance of minus 1/8 inch to plus 1/2 inch of the length indicated by the chain manufacturer's specifications.
3. Stranded cable size. Stranded cable size must be subject to the following tolerances:
    a. Material up to and including .094 inch (2.4 mm) diameter shall not be less than the designated diameter and shall not exceed .010 inch (.25 mm) over the specified diameter.
    b. Material over .094 inch (2.4 mm) diameter shall not be less than the specified diameter and shall not exceed .014 inch (.36 mm) over the specified diameter.
4. Component dimensions. The dimensions of manufactured components may vary, but the assembled cable chains must meet the tolerances specified in (b)(iv)(A), (B), and (C) of this subsection.
5. Finish. All cable tire chains must have a rust-resistant finish for protection in transit and storage.
6. Identification. Each half set of cable tire chains must be permanently marked with the manufacturing company's name, initials or trademark in order that it may be easily identified when not in the original container.

3. Automatic tire chain system must:
    a. Consist of:
        i. A switch or button located within reach of the driver in the vehicle cab;
        ii. An air valve; and
        iii. An air cylinder and chain wheel with units mounted on the rear suspension in order to apply the chain to make contact with the inside wheel.
    b. Be periodically inspected by the operator for proper mechanical conditions;
    c. Display a sign with letters at least one inch high indicating the vehicle is equipped with the automatic tire chain. The design of the sign must be approved by the manufacturer of the automatic tire chain.

204-24-030
Standards for studded tires.

Studded tires must meet the following specifications:

1. Studs must be metal, tipped with tungsten carbide.
2. Metal studs must be inserted only in a new tire or a newly-recapped tire which has molded in the tread the "pin-holes" into which metal studs are to be inserted. Studs

must not be inserted in any new tire or newly-recapped tire after it has been driven on a vehicle.

3. Metal studs may be installed only by the tire manufacturer, or by a tire dealer or tire jobber who shall install the metal studs in conformance with the manufacturer's specifications.
4. When a tire is sold or offered for sale as a studded tire or when studs are installed in a new tire or a newly recapped tire, there must be a minimum of seventy metal studs evenly spaced around the tread of the tire.
5. A tire must contain a minimum of fifty-six metal studs at all times in order to qualify as a "studded tire" or as an approved traction device.
6. Metal studs must not be installed in any tire of a vehicle which has a gross vehicle weight of ten thousand pounds or over.
7. School buses and fire department equipment tires are exempt from subsection (6) of this section.

204-24-035
Standards for alternative traction devices.

1. In order for an alternative traction device to be considered approved:
    a. The alternative traction device must be tested in accordance with a recognized standard on vehicles certified by its manufacturer as complying with the United States Federal Motor Vehicle Safety Standards. The testing will:
        i. Be conducted using USDOT approved summer tires.
        ii. For passenger vehicles, at minimum:
            1. Be done on both front and rear wheel drive vehicles with the device mounted on only the drive tires.
            2. Include the following tests:
                a. Durability testing of the product;
                b. Acceleration on both snow and ice;
                c. Deceleration on both snow and ice; and
                d. Traction force of the product on snow.
        iii. For vehicle combinations over 10,000 pounds as outlined in WAC 204-24-050(2), at minimum:
            1. Be done on a five axle vehicle with the device on one tire on each side of each drive axle and one tire on the last axle of the last trailer or semi-trailer, if seeking approval for a combination with five or less axles.
            2. Be done on a five axle vehicle with the device mounted on all tires on one drive axle and one tire on the last axle of the last trailer or semi-trailer, if seeking approval for a combination with five or more axles.

3. Include the following tests:
    a. Durability testing of the product;
    b. Acceleration on snow and/or ice;
    c. Deceleration on snow and/or ice; and
    d. Traction force of the product on snow.

iv. Be done in comparison to a tire chain when tested using the same standard to show that the alternative traction device meets or exceeds the standard as compared to the results of the referenced tire chain approved for use in the state of Washington under this chapter.

b. Alternative traction devices must cooperate well with any given electronic driving support such as ABS, ESP, and ASR.
c. Alternative traction devices should be resistant to UV light, corrosion, water, fuels, spreading salts and alcohols typically used to clear roads during winter.
d. The following information must be provided to the Washington state patrol:
    i. The testing standard used, in English.
    ii. Documentation of the testing results, which must include the data produced for each test comparing the alternative traction device to the referenced tire chain. Except that durability testing is not required to be provided for the referenced tire chain.
    iii. A certified statement from the company or manufacturer outlining what measurable indicator of wear can be used by an officer to indicate when the product will no longer provide adequate traction equivalent to a chain.
    iv. Review and approval by a third-party testing agency that the tests were conducted according to the published standard. If testing cannot be done according to the published standard, companies may self-certify any supplemental tests necessary to comply with the requirements in this section, provided that the data from the tests is confirmed by a third-party testing agency. The patrol may request that the data be provided by the third-party testing agency directly.
    v. Provide certification of the test results, which must contain the following statement "I certify that the test methods, conditions and results reported are accurate and complete" and bear the signature of the tester.

2. The patrol may suspend or revoke approval for an alternative traction device upon receiving evidence that the device has failed to comply or no longer complies with any requirement or provision of law or this chapter. The following process will be used:
    a. The patrol will give the applicant or manufacturer notice of the action and an opportunity to be heard as prescribed in chapter 34.05 RCW, prior to suspension or revocation of the approval, except as provided in subsection (3) of this section.

b. Upon receiving notice of the action, the applicant or manufacturer may request an administrative hearing to contest the decision. A request for administrative hearing must:
    i. Be made in writing and mailed to the Washington State Patrol Equipment and Standards Section, P.O. Box 42600, Olympia, WA 98504-2600; and
    ii. Be received by the patrol's equipment and standards section within twenty business days after the date of the notice of action.
c. Failure to request a hearing or failure to appear at a hearing, a prehearing conference, or any other stage of adjudicative proceeding may constitute default and result in the entry of a final order under RCW 34.05.440.
d. Administrative proceedings consistent with chapter 34.05 RCW for revocation or other action will be promptly instituted and determined. The patrol must give notice as practicable to the applicant or manufacturer.
e. Unless the patrol finds the immediate revocation is necessary or unless the applicant or manufacturer timely requests a hearing as provided under this section, a decision to revoke or suspend will be effective thirty days from the date of the notice of action decision unless that patrol finds that immediate revocation is necessary.

3. The patrol may, without prior notification suspend or revoke approval for a device if it finds that there is danger to the public health, safety, or welfare that requires immediate action. For every summary suspension of a letter of approval, an order signed by the patrol must be entered in accordance with the provisions of RCW 34.05.479.

204-24-040
Traction devices.

The following equipment items are approved by the state patrol for use as traction devices wherever traction devices are required by the department of transportation:

1. Tire chains meeting the standards in WAC 204-24-020.
2. Studded tires meeting the standards in WAC 204-24-030.
3. Approved traction tires. An approved traction tire must have the following tread characteristics:
    a. A minimum of 4/32 inch tread, measured in the center portion of the tire at three locations equally spaced around the circumference of the tire.
    b. A relatively aggressive tread pattern designed primarily to provide additional starting, stopping, and driving traction on snow or ice. The tread must have ribs, lugs, blocks or buttons the edges of which are at an angle greater than thirty degrees to the tire circumferential centerline.

c. On at least one side of the tread design, the shoulder lugs protrude at least 1/2-inch in a direction generally perpendicular to the direction of travel.
d. Tires manufactured to meet these specifications must:
    i. Be permanently labeled on at least one sidewall with the words "mud and snow" or any contraction using the letters "M" and "S" (e.g. MS, M/S, M-S, M & S, etc.); or
    ii. Be permanently labeled on at least one side wall with the mountain/snowflake symbol.

4. Alternative traction devices. Any alternative traction device approved under this chapter must be used in accordance with the manufacturer's recommendations concerning proper use of the product. The list of approved devices will be maintained on the patrol's web site. Upon suspension or revocation of an approval for an alternative traction device, the device will be removed from the list of approved devices on the patrol's web site.

204-24-050
Use of tire chains or other traction devices.

1. Vehicles under 10,000 pounds gross vehicle weight.
When traffic control signs are posted by the department of transportation it will be unlawful for any vehicle to enter the controlled area without having mounted on its drive tires the traction device specified by the sign, which must also meet the requirements of WAC 204-24-040.
    a. Exception for all wheel drive vehicles. When "chains required" signs are posted, all-wheel drive vehicles will be exempt from the chain requirement when all wheels are in gear and are equipped with approved traction devices as specified in WAC 204-24-040 provided that tire chains for at least one set of drive tires are carried in the vehicle.
    b. Alternative traction devices listed on the patrol's web site as being approved for passenger vehicles as outlined in this chapter will be considered approved for use when "chains required" signs are posted.
        i. Vehicles or combinations of vehicles over 10,000 pounds gross vehicle weight rating (GVWR).
2. When traffic control signs marked "chains required" are posted by the department of transportation it will be unlawful for any vehicle or combination of vehicles to enter the controlled area without having mounted on its tires, tire chains as follows: Provided, That highway maintenance vehicles operated by the department of transportation for the purpose of snow removal and its ancillary functions are exempt from the following requirements if such vehicle has sanding capability in front of the drive tires.
    a. Vehicles or vehicle combinations with two to four axles including but not limited to trucks, truck-tractors, buses and school buses: For vehicles with a single drive

axle, one tire on each side of the drive axle must be chained. For vehicles with dual drive axles, one tire on each side of one of the drive axles must be chained. For vehicle combinations including trailers or semi-trailers; one tire on the last axle of the last trailer or semi-trailer, must be chained. If the trailer or semi-trailer has tandem rear axles, the chained tire may be on either of the last two axles.

b. Automobile transporters are any vehicle combination designed and used specifically for the transport of assembled (capable of being driven) highway vehicles. For vehicles with single drive axles, one tire on each side of the drive axle must be chained. For vehicles with dual drive axles, one tire on each side of each of the drive axles must be chained. For vehicle combinations including trailers or semi-trailers, one tire on the last axle of the last trailer or semi-trailer must be chained. If the trailer or semi-trailer has tandem rear axles, the chained tire may be on either of the last two axles.
c. Vehicle combinations with five axles consisting of a truck tractor with dual drive axles and a tandem axled semi-trailer; all tires on one drive axle may be chained or one tire on each side of each of the drive axles may be chained. Chains must be applied to a minimum of four tires on the drive axles. On the tandem axle semi-trailer, the chained tire may be on either of the last two axles.
d. Vehicle combinations with five axles, consisting of a truck and trailer, or truck tractor and semi-trailer with a single drive axle, or truck tractor, semi-trailer and full trailer: For vehicles with a single drive axle, all tires on the drive axle must be chained. For vehicles with dual drive axles, all tires on one of the drive axles must be chained. For vehicle combinations including trailers or semi-trailers, one tire on the last axle of the last trailer or semi-trailer must be chained. If the trailer or semi-trailer has tandem rear axles, the chained tire may be on either of the last two axles.
e. Vehicle combinations with six or more axles, including but not limited to truck and trailer or truck tractor and semi-trailer or truck tractor semi-trailer and full trailer: For vehicles with a single drive axle, all tires on the drive axle must be chained. For vehicles with dual drive axles where traffic control signs marked "approved traction tires required" are posted, all tires on one of the drive axles must be chained. For vehicles with dual drive axles where traffic control signs marked "chains required" are posted, all tires on one of the drive axles must be chained. In addition, one tire on each side of the additional drive axle must be chained. For vehicle combinations including trailers or semi-trailers, one tire on the last axle must be chained. For vehicles with tandem axle trailers or semi-trailers, the chained tire may be on either of the last two axles.
f. All vehicles over 10,000 pounds gross vehicle weight rating (GVWR) must carry a minimum of two extra chains for use in the event that road conditions require

the use of more chains or in the event that chains in use are broken or otherwise made useless.

g. Approved chains for vehicles over 10,000 pounds gross vehicle weight rating (GVWR) must have at least two side chains to which are attached sufficient cross chains of hardened metal so that at least one cross chain is in contact with the road surface at all times. Plastic chains will not be allowed.

h. If automatic tire chains are used, the vehicle must carry regular tire chains for use on the outside tires of the drive axle of all axles equipped with the automatic tire chain.

i. On the following routes all vehicles and combinations of vehicles over 10,000 gross vehicle weight rating (GVWR) pounds must carry sufficient tire chains to meet the requirements of this chapter from November 1 to April 1 of each year or at other times when chains are required for such vehicles:

   i. I-90 - Between North Bend (MP 32) and Ellensburg (MP 101).
   ii. SR-97 - Between (MP 145) and Junction SR-2.
   iii. SR-2 - Between Dryden (MP 108) and Index (MP 36).
   iv. SR-12 - Between Packwood (MP 135) and Naches (MP 187).
   v. SR-97 - Between the Columbia River (MP 0.00) and Toppenish (MP 59.00).
   vi. SR-410 - From Enumclaw to Naches.
   vii. SR-20 - Between Tonasket (MP 262) and Kettle Falls (MP 342); and SR-20 between Newhalem (MP 120) and Winthrop (MP 192).
   viii. SR-155 - Between Omak (MP 79) and Nespelem (MP 45).
   ix. SR-970 - Between (MP 0) and (MP 10).
   x. SR-14 - Between Gibbons Creek (MP 18.00) and (MP 108.40) intersection of Cliffs Road.
   xi. SR-542 - Mt. Baker highway between (MP 22.91) and (MP 57.26).
   xii. I-82 - Between Ellensburg Exit 3 (MP 3.00) and Selah Exit 26 (MP 26.00).

   Vehicles making local deliveries as indicated on bills of lading and not crossing the mountain pass are exempt from this requirement if operating outside of a chain required area.

3. For the purpose of this section, chained will mean that the tire has either a tire chain approved for use under chapter 204-24 WAC or an alternative traction tire device listed on the patrol's web site as approved for the type of vehicle combination listed in this section.
4. The Washington state department of transportation or Washington state patrol may prohibit any vehicle from entering a chain/approved traction device control area when it is determined that the vehicle will experience difficulty in safely traveling the area.

204-24-070
Approval of tire chains or traction devices.

1. Any tire chain, wheel chains, or studded tires meeting the standards in this chapter or certified under one of the following:
    a. Conformance to Federal Motor Vehicle Safety Standards, or, if none,
    b. Conformance to current standards and specifications of the Society of Automotive Engineers will be considered as an approved type chain, or studded tire.
2. Links to the Code of Federal Regulations are available on the Washington state patrol web site at www.wsp.wa.gov. Copies of the C.F.R. may also be ordered through the United States Government Printing Office, 732 N. Capitol Street, N.W., Washington, D.C. 20401. Copies of the SAE standards are available for review at the Washington State Patrol, 210 11th Avenue, Olympia, WA 98504, and may also be ordered from the Society of Automotive Engineers International, 400 Commonwealth Drive, Warrendale, PA 15096.

204-24-080
Hearing procedure.

1. Hearings under this chapter will be pursuant to chapters 34.05 RCW and 10-08 WAC as supplemented by this section.
2. A presiding officer will conduct a hearing and any prehearing conference(s).
3. The burden of proof in any hearing will be on the applicant seeking approval, or on the person or agency seeking the suspension or revocation of approval or other action by the patrol.
4. Oral proceedings must be recorded by the method chosen by the patrol and such recording will become part of the hearing record.
5. The following process applies to administrative hearings under this chapter:
    a. The patrol will notify the assistant attorney general of the petitioner's request for an administrative hearing.
    b. The assistant attorney general will draft an administrative complaint and send it to the petitioner and to the office of administrative hearings.
    c. The office of administrative hearings will schedule a hearing date, and will notify the petitioner, assistant attorney general, and patrol in writing of the hearing date, time, and location.
    d. The hearing will be conducted by an administrative law judge assigned by the office of administrative hearings.
    e. At the hearing, the assistant attorney general will present witnesses and other evidence on behalf of the patrol.
    f. At the hearing, the petitioner may be represented by an attorney or may choose to represent himself or herself. The petitioner or his/her attorney will be allowed to present witnesses and other evidence.

g. Nothing in this section will prevent the parties from resolving the administrative matter by settlement agreement prior to conclusion of the administrative hearing.

6. Initial and final order. At the conclusion of the hearing, the administrative law judge will prepare an initial order and send it to the petitioner and the assistant attorney general.
    a. Either the petitioner or the assistant attorney general, or both, may file a petition for review of the initial order with the patrol within twenty days of the date of service of the initial order. A petition for review must:
        i. Specify the portions of the initial order to which exception is taken;
        ii. Refer to the evidence of record which is relied upon to support the petition; and
        iii. Be filed with the patrol within twenty days of the date of service of the initial order.
    b. A party on whom a petition for review has been served may, within ten days of the date of service, file a reply to the petition. Copies of the reply must be mailed to all other parties or their representatives at the time the reply is filed.
    c. The administrative record, the initial order, and any exceptions filed by the parties will be submitted to the patrol for review. Following this review, the patrol will enter a final order that is appealable under the provisions of chapter 34.05 RCW.