123558

Ex Parte Meeting

Dion Casey
Attorney, Office of Chief Counsel, NHTSA

Docket NHTSA-2000-8572 -15

On February 27, 2001, NHTSA representatives met with representatives of BERU Corporation concerning the impending rulemaking on tire pressure monitoring systems required by the recently-enacted Transportation Recall Enhancement Accountability and Documentation (TREAD) Act.

NHTSA was represented by Dion Casey, George Soodoo, Joe Scott, Bruce Spinney, John Finnevan, Art Carter, and Barbara Faigin. BERU was represented by Gunter Schulze, Eduardo Vultorius, and Dr. Rainer Podeswa.

The BERU representatives gave a slide presentation on the BERU tire pressure monitoring system currently being used by several European vehicle manufacturers. That presentation is attached.

Technical Presentation

BERU Tire Pressure Monitoring System

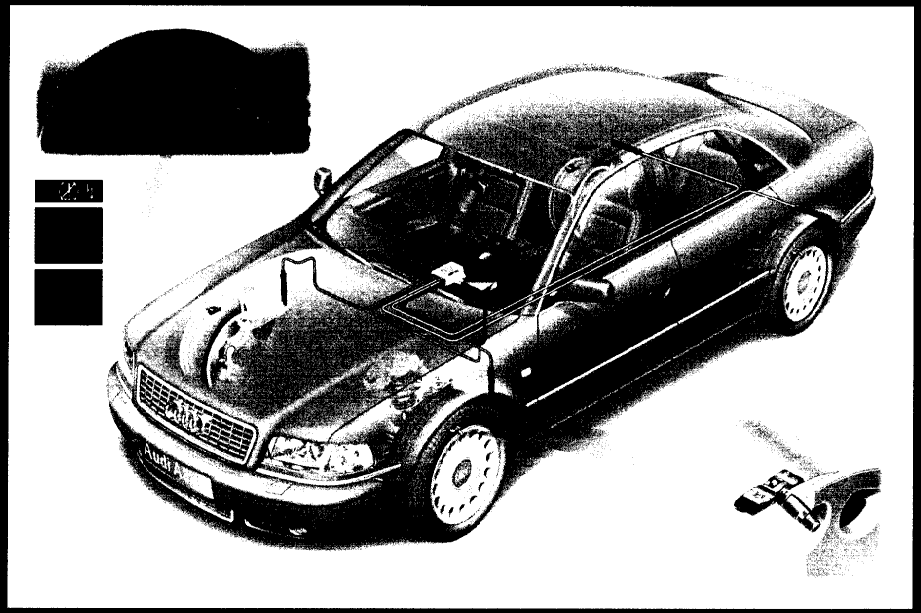
NHTSA

February 27, 2001

Contacts:
Eduardo Vultorius, BERU Corporation, Detroit
Dr. Rainer Podeswa, BERU AG Ludwigsburg, Germany

BERU Tire Pressure Monitoring System

- Customer Benefits
- Development History
- OE Customers
- Production Experience
- System Function
- Warning Features
- Warning Scenarios
- Wheel Electronic Highlights



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Customer Benefits

- **Mobility**
  - Avoids up to 80% of all tire and rim caused breakdowns
- **Safety**
  - Immediate alert when a tire puncture occurs
- **Comfort**
  - No need for standard pressure check, system informs the driver if an action is needed

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Development History

- 1988 BERU started TPMS feasibility studies
- 1992 Foundation of TPMS Taskforce by BMW, DaimlerChrysler, Porsche and VW/Audi
- 06/1995 TPMS Taskforce nominated BERU as system development partner
- 09/1995 Start of TPMS product development
- 06/1998 Start of TPMS series production

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OE Customers

- **Audi**
  - 09/99 Audi A8
  - 04/00 Audi A6 All Road
  - 04/02 Audi A4 & A6
- **Bentley**
  - 03/2002
- **BMW**
  - 06/98 BMW Series 7 & Series 5
  - 01/99 BMW Series 3
  - 08/00 BMW X5

OE Customers

- **DaimlerChrysler**
  - 06/99 DaimlerChrysler AMG
  - 09/99 DaimlerChrysler S-Class
  - 12/99 DaimlerChrysler S-Class Coupe
  - 07/01 DaimlerChrysler SL Roadster
  - 01/02 DaimlerChrysler E-Class
- **Ferrari / Maserati**
  - 06/01
- **Ford Premier Group**
  - 07/01 Land Rover L30

OE Customers

- **Porsche**
  - 03/02 Porsche Cayenne
  - 10/03 Boxter
  - 10/03 Porsche 911 Series
- **Volkswagen**
  - 09/01 VW Top Model
  - 03/02 VW Colorado
  - 10/02 VW Passat

Production Experience

- Volume production since 1998
- > 100,000 BERU TPMS systems on the road
- > 750,000 BERU wheel electronics produced
- Wheel electronics delivery quality 0 PPM, no field returns

System Function - Measurement

- Precise measurement of pressure & temperature, no indirect method
- Pressure measurement range suitable for all vehicle classes: Passenger Car, SUV, Light Truck
- Real time pressure measurement and display
- Data transmission at all vehicle speeds as well as during standstill,
  even while ignition is switched off

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System Function - Evaluation

- Pressure evaluated with respect to:
  - Internal temperature inside the wheel
  - External temperature
  - Speed
  - Carried load
  - History – Seasonal climatic influence on pressure and temperature

System Function - Warning

Warning immediately when loss of pressure is detected

- after "ignition on"
  or
- during driving

- Soft warning: small loss of pressure
- Hard warning: dangerous loss of pressure
- All warnings at any driving conditions, independent of speed, road surface, maneuvers, load, towing

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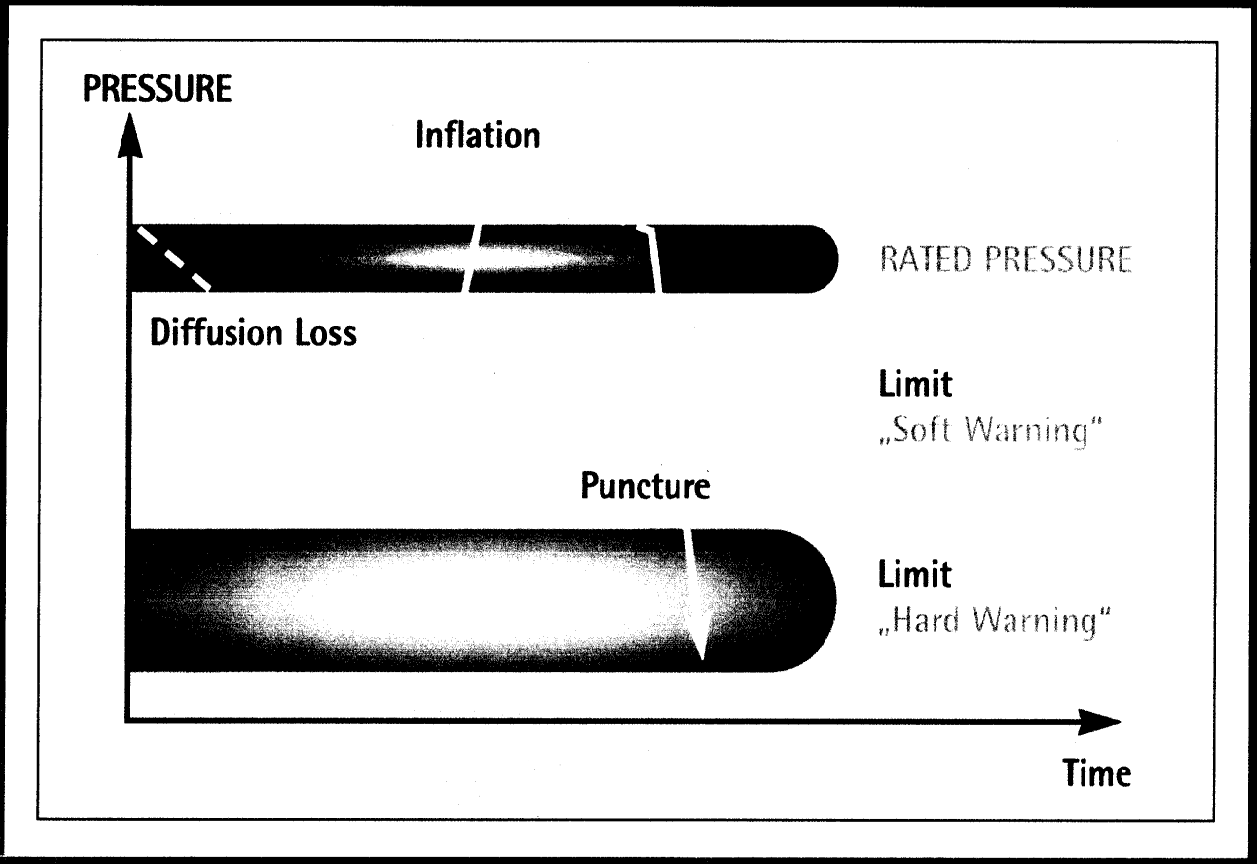
System Function - Warning



Static Warning Levels

- **Soft warning limit** 
  2.8 psi (0.2 bar) below nominal pressure p_{nom}
- **Hard warning limit** 
  5.7 psi (0.4 bar) below p_{nom} or $p < 0.84 * p_{nom}$
- p_{nom} calculated with respect to actual internal temperature T
- Limits defined by VDA TPMS-Taskforce (BMW, Daimler-Chrysler, Porsche, VW/Audi), accepted by ETRTO (European Tire and Rim Technical Organization)

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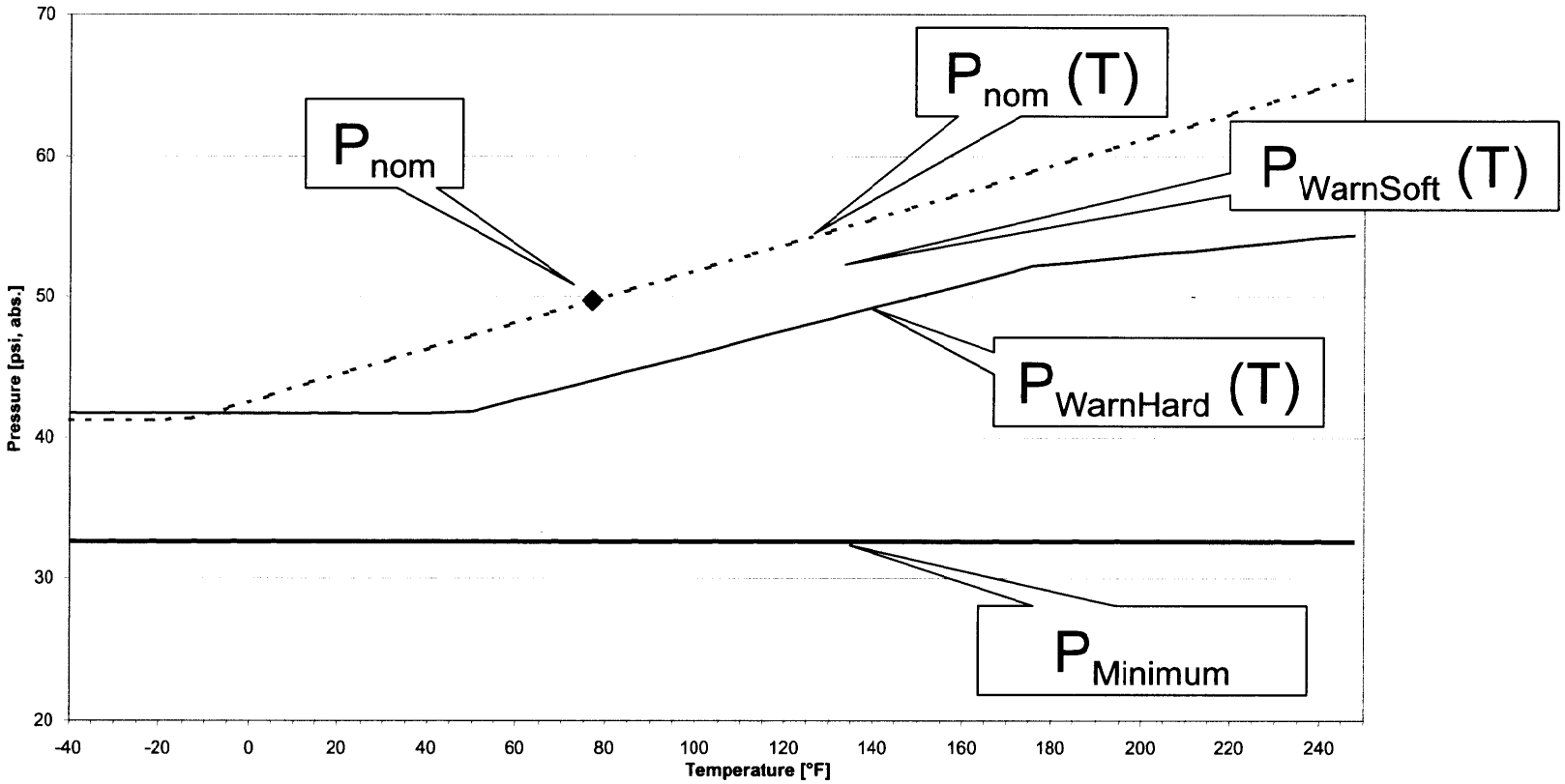
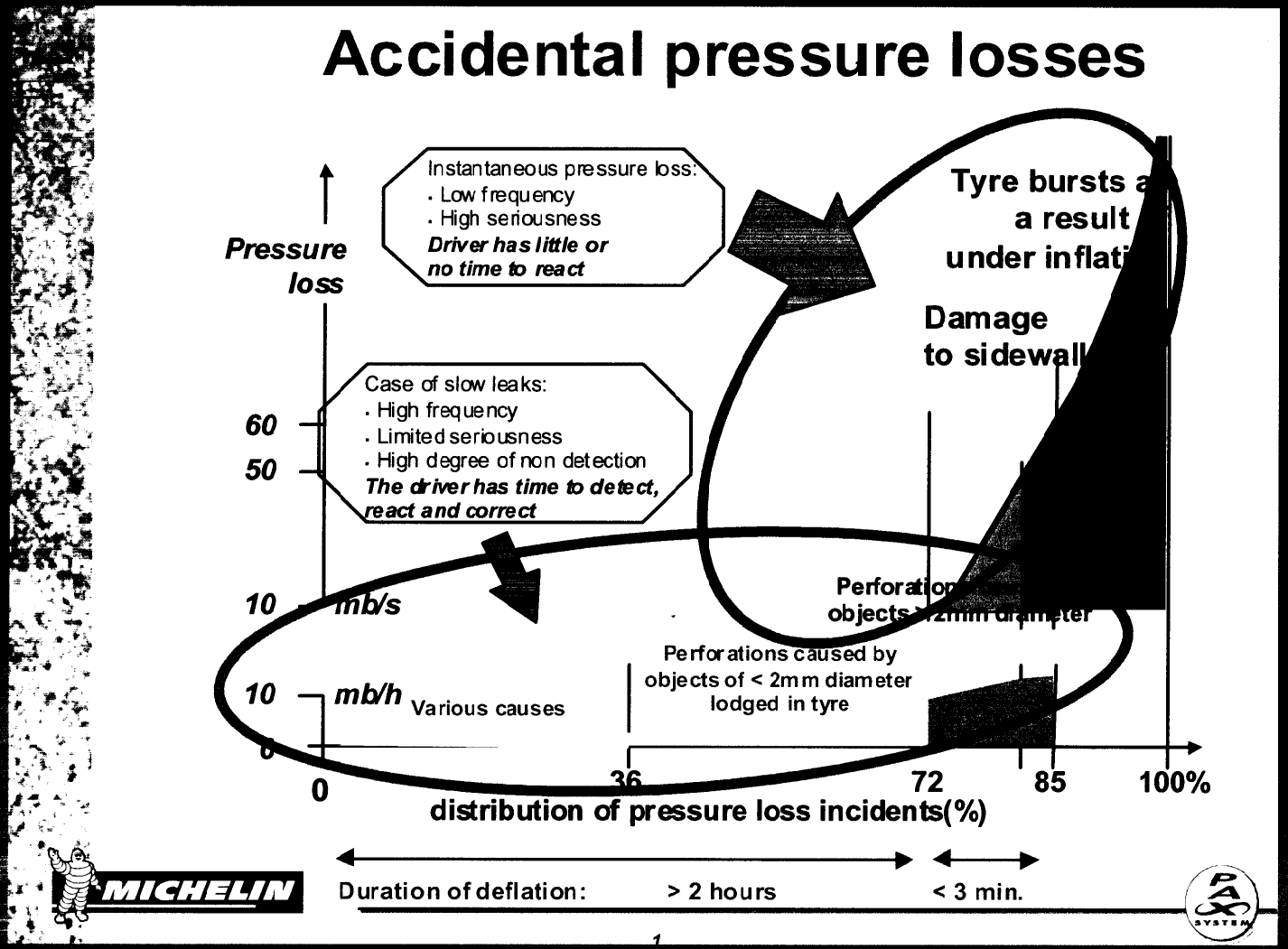
Influence of Pressure vs.Temperature



- Example Diagram for
  P_{nom} = 50 psi (abs) set @ T_{fill} = 77 °F (25 °C)

Pressure Loss Scenarios



Pressure Loss Scenarios

- **Typical scenario 1:**
  - Slow pressure loss due to diffusion (normal for all cars)
  - Typically 0.05 to 2 psi per month simultaneously at all wheels
  - Detection during standstill
  - Soft warning at „ignition on“ to remember driver to correct pressure

Pressure Loss Scenarios

➢ Typical scenario 2:

- Slow pressure loss due to small leakage (80% of defects)
- Typically 5 to 20 psi per day
- Detection during standstill (most probably) or during driving
- Hard warning at „ignition on“ before car is driven with deflated tire

Pressure Loss Scenarios

- **Typical scenario 3:**
  - Rapid pressure loss while driving (20% of defects)
  - Occurs during driving as result of damage to sidewalls, bursts as a result of under-inflation or when a perforating object, which has punctured the tire is removed by centrifugal force
  - Typically 0.1 to 1 psi per second
  - Data acquisition & transmission designed to warn within < 5 sec after pressure limit of hard warning is reached

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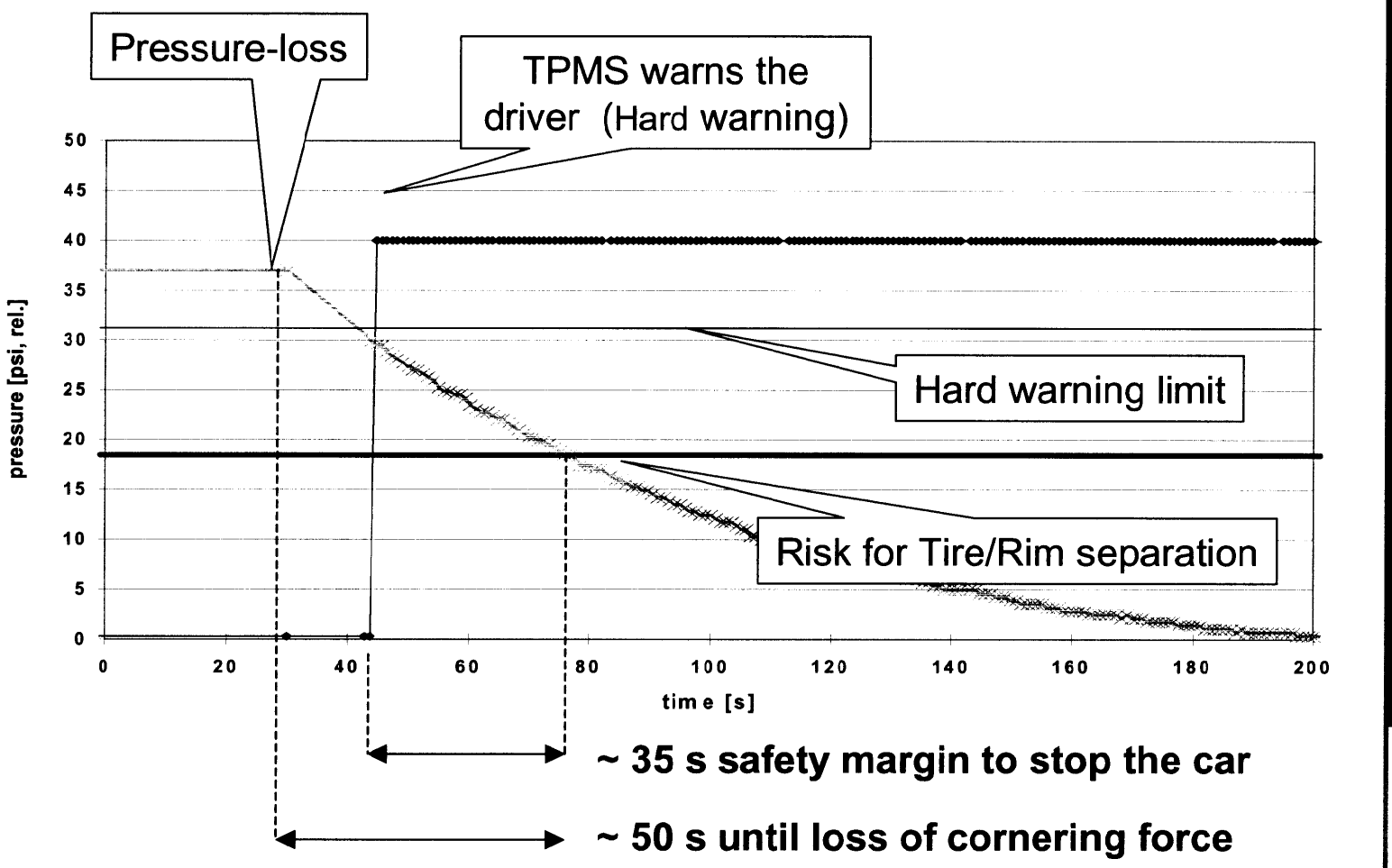
Dynamic Response to Extremely Rapid Pressure Loss

Puncture diameter 0.08 inch



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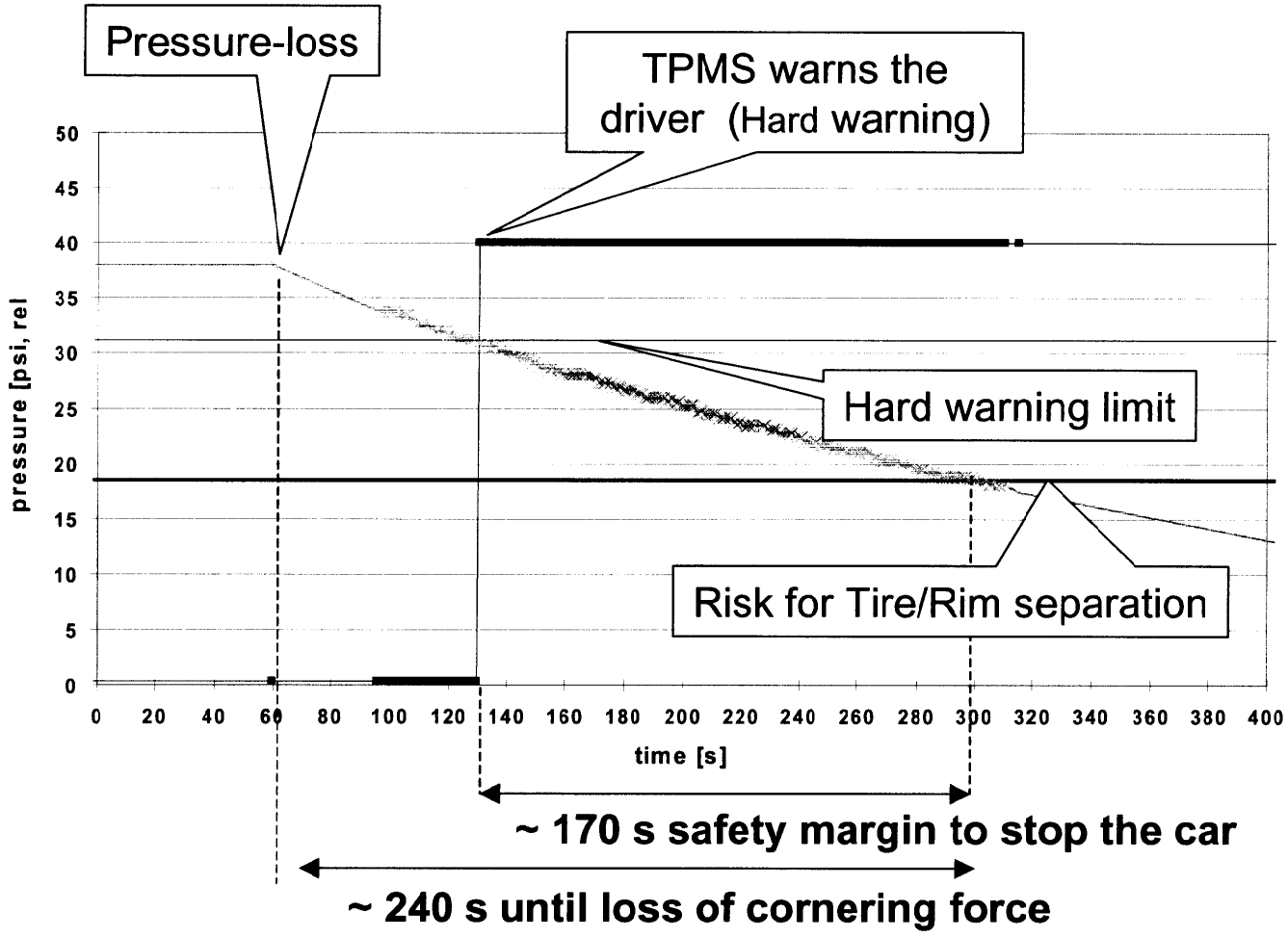
Dynamic Response to Rapid Pressure Loss

Puncture diameter 0.04 inch



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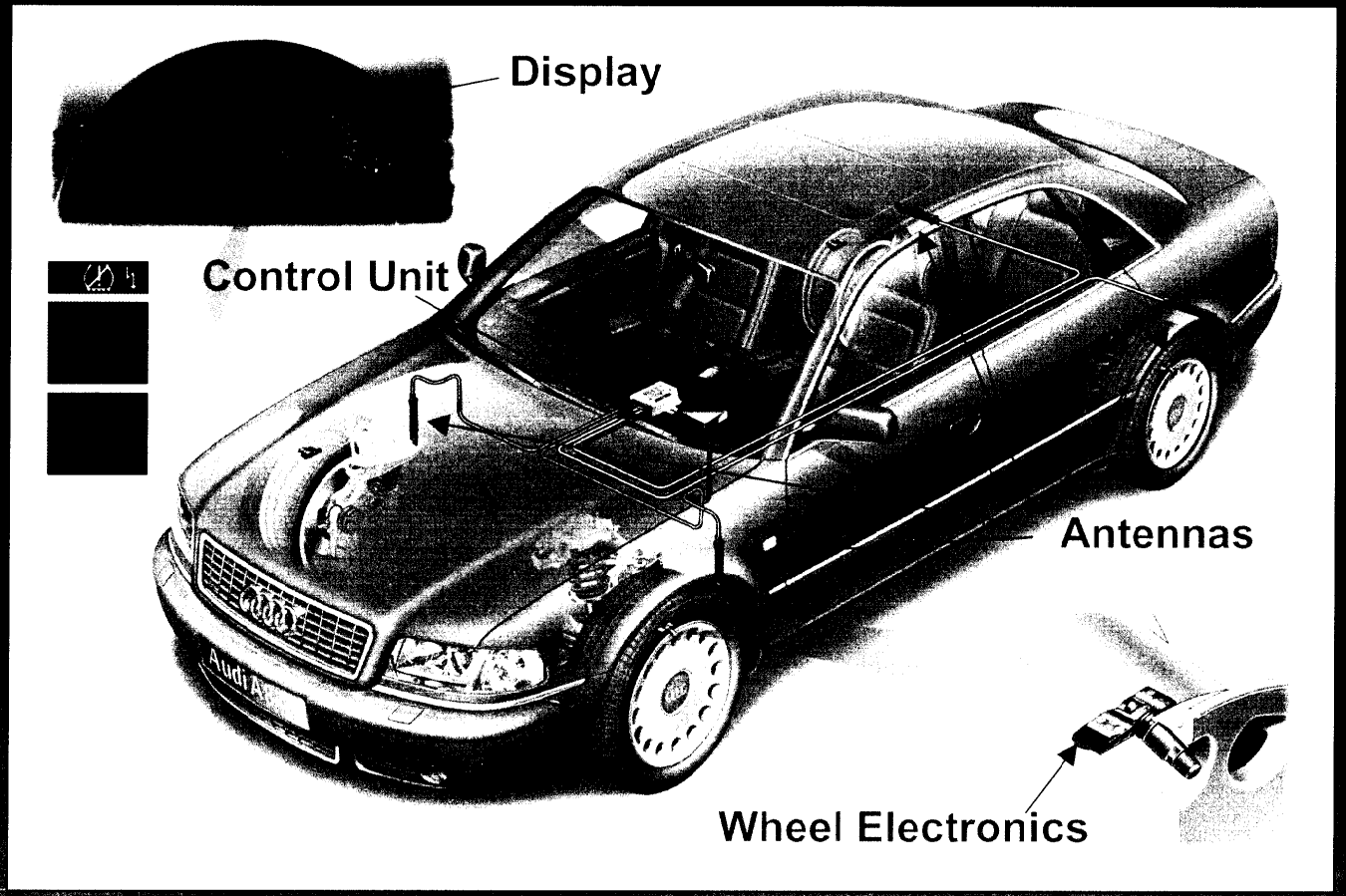
System Function - Comfort features

- Automatic recognition of wheels mounted to vehicle
- Automatic detection of new wheels mounted to vehicle
- Automatic detection of wheel mounting position
- Automatic detection of wheels carried in the trunk

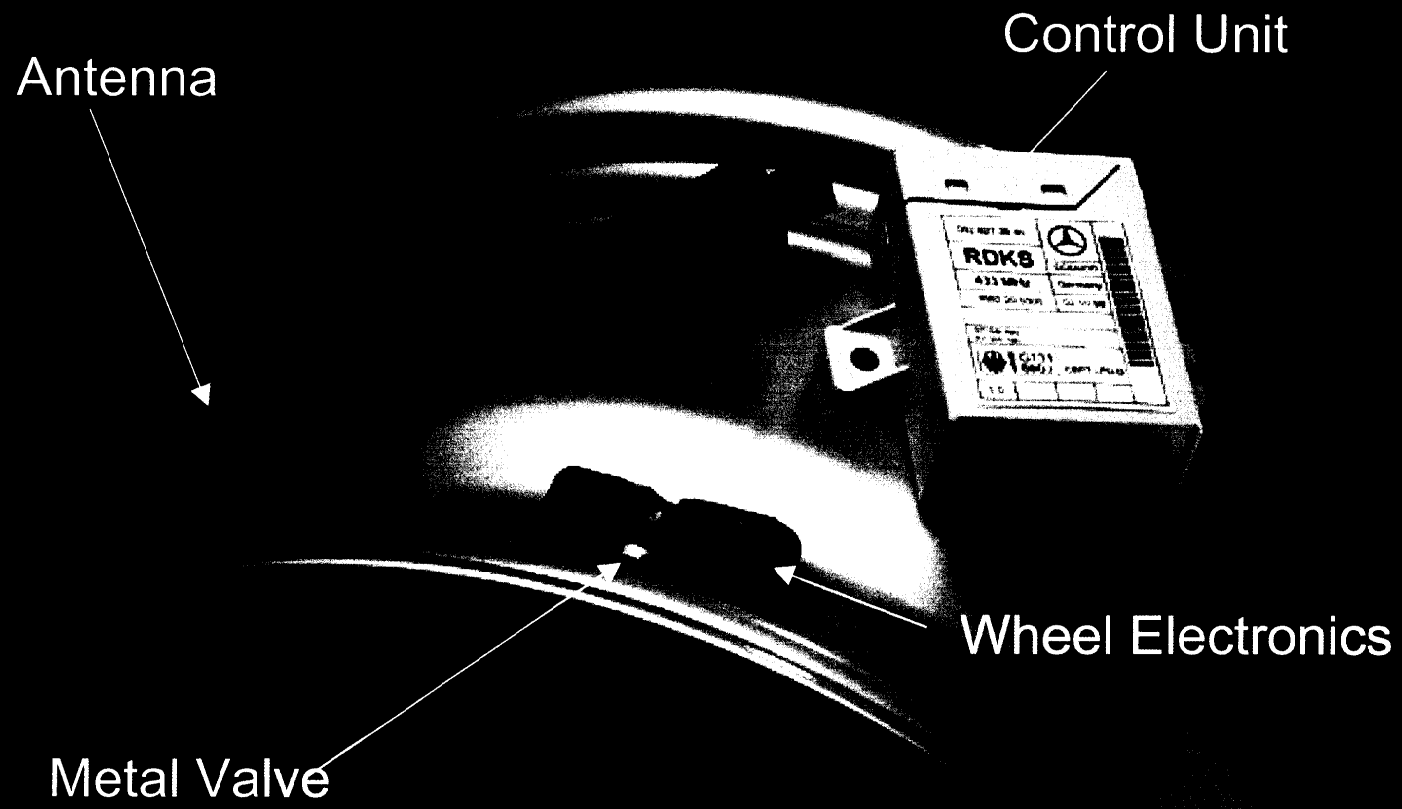
System Function - Pressure Display

- TPMS Display DaimlerChrysler S-Series

Principle of Operation



System Components



Wheel Electronic Highlights

- Designed to withstand extreme environmental conditions (temperature, shock, vibration, centrifugal force, humidity)
- Operating temperature
  -40 °F (-40°C) to + 245 °F (+120 °C)
- Peak temperature resistance +340 °F (+170 °C)
- Package compatible with all wheel rims
- Reliable FM RF transmission

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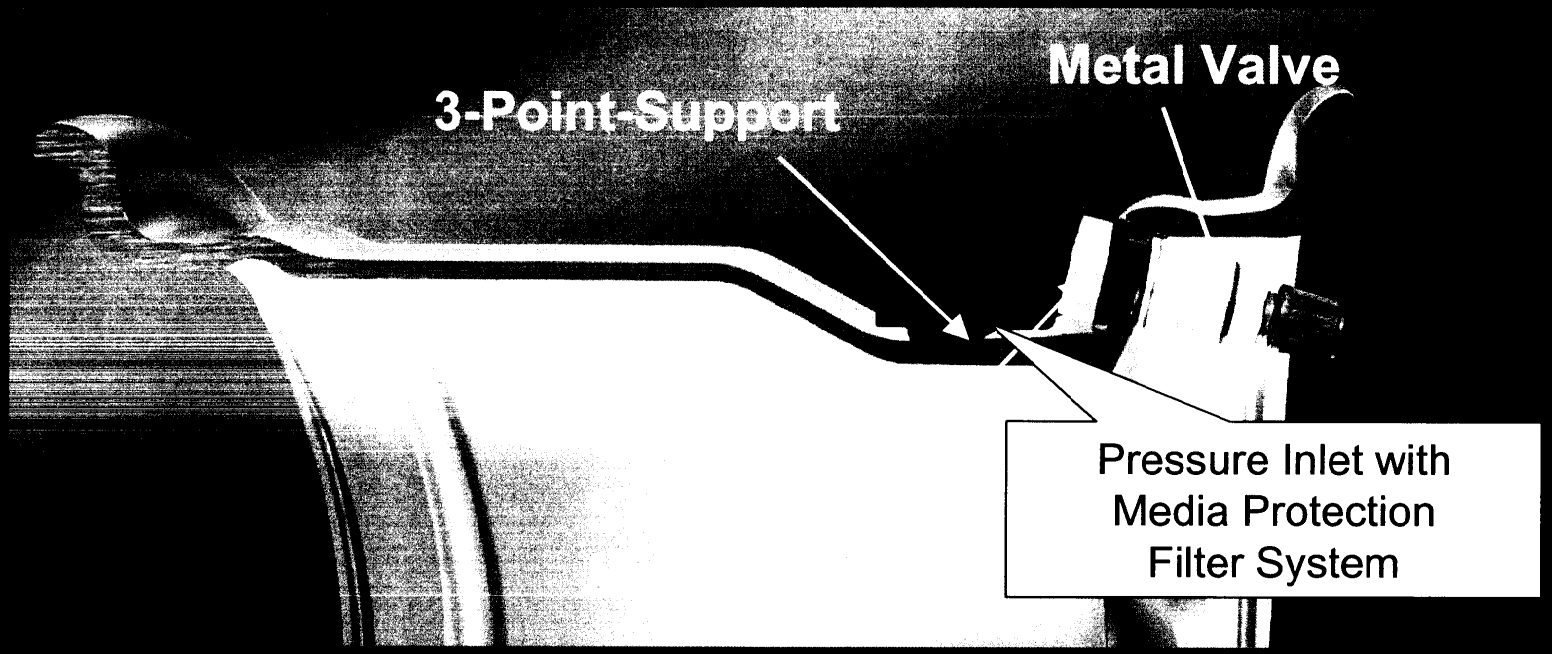
Wheel Electronic Mounting Position



- Universal applicability for various wheel rims and valve types using a metal-valve as a standard universal mounting method
- Use of only one wheel electronic design across all vehicle platforms and wheel rim type combinations

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TPMS Reliable FM Transmission

RF-Signal 0 dB	max RF-Disturbance level at Bit Error Rate 10^{-3}		
	Carrier without Modulation	FM 22.5 kHz Deviation	AM 100% Modulation
FM 22.5 kHz Deviation	-2 dB	-3 dB	+1 dB
AM 100% Modulation	-12 dB	-4 dB	-9 dB

- AM needs ~ 10 dB more signal level to reach same bit error rate compared to FM

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