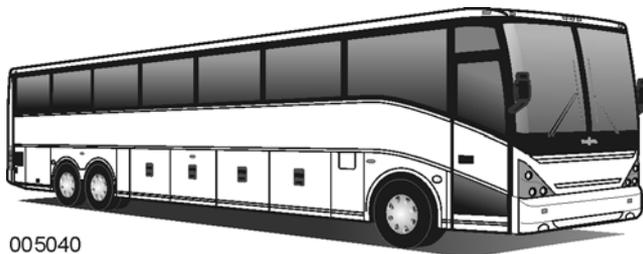


MANUAL PARTS

Introduction	0
Complete vehicle	1
Traction engine	2
Suspension	3
Driveline/Axle	4
Brakes.....	5
Transmission	6
Steering.....	7
Climate control.....	8
Occupant protection system	9
Body and body accessories.....	10
Control systems	11
Axles	12
Compressed-air feed system.....	13
Electrical	14
Indexes and lists	15

MAINTENANCE MANUAL



005040

COACH

C2045 E⁰⁴ CU

CONSTRUCTION Nos.
46104 - 46126

SPECIFICATIONS MODEL VERSION "04"

Engine:	CUMMINS ISM07
Transmission:	WT, ZF
Drive Axle:	DANA G171
Brakes:	D-Elsa 2
Multiplex:	V3

VANHOOL

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BELGIUM

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Publication No.: H0250en-US

EDITION 1

Table of contents

Introduction The table of contents of the manual lists the manual parts and chapters. For subdivisions of a manual part or chapter, see the list on the “Overview” page at the beginning of that part or chapter.

How to handle updating material Please note the identification marks which, in a revised table of contents, appear behind the date mark of a chapter:
 + : additional chapter; file into your manual according to the sequence shown in the contents table.
 x : chapter modified since the previous edition of the contents list; insert as a replacement of the outdated one.

Contents **This is edition 1**

Part Chapter	Number of pages	Chapter publication date
0 - Introduction		
0.1 Preface	8	19 September 2006
1 - Complete vehicle		
1.1 General	44	19 September 2006
2 - Traction engine		
2.6 Engine suspension	4	19 September 2006
2.10 Fuel system	10	19 September 2006
2.22 Air intake system	12	19 September 2006
2.30 Exhaust system	14	21 December 2007
2.34 Cooling system	26	19 September 2006
2.38 Lubrication system	8	19 September 2006
2.46 Accessory drive systems	24	19 September 2006
3 - Suspension		
3.6 Air suspension	18	19 September 2006
3.10 Front axle suspension	4	19 September 2006
3.14 Drive axle suspension	8	19 September 2006
3.18 Trailing axle suspension	4	19 September 2006
3.34 Wheels	10	19 September 2006

continued on next page

3.38	Tires	8	19 September 2006
4 - Driveline/Axle			
4.10	Propeller shaft	14	19 September 2006
5 - Brakes			
5.2	Control systems	16	19 September 2006
5.10	Compressed-air brakes	44	19 September 2006
5.14	Speed retarder	2	19 September 2006
6 - Transmission			
6.10	Transmission	28	19 September 2006
7 - Steering			
7.6	Front axle steering system	54	19 September 2006
8 - Climate control			
8.2	Control systems	38	19 September 2006
8.6	Airside systems	6	19 September 2006
8.10	Water circuit	10	19 September 2006
8.14	Refrigerant circuit	38	19 September 2006
9 - Occupant protection systems			
9.6	Safety belts	4	19 September 2006
10 - Body and body accessories			
10.1	General	16	19 September 2006
10.2	External lighting and signalling devices	10	19 September 2006
10.6	Interior lighting equipment	4	19 September 2006
10.62	Entrance and exit doors	16	19 September 2006
11 - Control systems			
11.1	Multiplex system	78	19 September 2006
11.2	ATC	6	19 September 2006
12 - Axles			
12.6	Front axle	38	19 September 2006
12.10	Drive axle	12	19 September 2006
12.14	Trailing axle	26	19 September 2006
13 - Compressed-air feed system			
13.1	Complete compressed-air system	4	19 September 2006
13.9	Air purifying devices	2	19 September 2006

continued on next page

13.13	Valves	6	19 September 2006
13.17	Tanks	4	19 September 2006
13.21	Pressure switches and pressure sensors	4	19 September 2006
13.25	Air lines	4	19 September 2006
14 - Electrical			
14.2	Electric power supply	18	19 September 2006
14.6	Junction boxes	2	19 September 2006
14.10	Wiring	12	19 September 2006
14.18	Electric circuit diagrams	16	19 September 2006

Part 0 - Introduction

Overview

Contents

Chapter	See page
Chapter 1: Preface	0.1-1

Chapter 1: Preface

Overview

Introduction

This chapter deals with the manual format and usage.

Number of pages

8

Chapter publication date

19 September 2006

Contents

Topic	See page
About this manual	0.1-2
Disclaimer	0.1-3
Manual structure	0.1-4
Illustrations and symbols	0.1-5
Special tools	0.1-6
Does your manual copy contain the latest additions and modifications?	0.1-7
Service bulletins	0.1-8

About this manual

What does this manual deal with?

This manual deals with information regarding the operation and the maintenance of the vehicle model mentioned on the title page. It also contains important safety instructions, technical data, component specifications and general troubleshooting instructions.

Other information

Activities that are not described in this manual, such as repair of drive line components and extensive tests of electronic units, are dealt with in the workshop instructions by Van Hool's suppliers. At request Van Hool acts as an intermediary to supply these publications.

There is also an operating manual available for the vehicle (publication number: replace the initial letter "H" of the maintenance manual publication number by a "B")

Who does this manual address?

The manual addresses experienced garage personnel which is familiar with the maintenance of heavy commercial vehicles and the general safety rules involved.

Read, before you begin

Everyone whose task it is to carry out work on the vehicle has to read the pages of this manual applicable to his job, before starting any activity. This applies in particular to the pages containing safety instructions at the beginning of chapter 1.1 and to all safety instructions contained in the text of other chapters.

Follow instructions

Carefully following the instructions in this manual is the prerequisite for traffic safety and operational reliability of your vehicle. Non-compliance with the instructions causes all warranty claims to expire.

How to order further copies?

Copies can be ordered from your Van Hool representative or directly from the Van Hool After Sales Department at Koningshooikt-Lier. Please mention the publication number of the manual as well as the number of copies required. The publication number is to be found in the bottom righthand corner of the title page. If the vehicle is built to the customer's own specifications, its construction number also appears on the title page. In this case, also mention that number when ordering.

Disclaimer

Differences from the product described

The data and illustrations in this manual are based upon the newest product information available at the time of printing. Van Hool reserves the right to make changes to its product without prior notice.

Inaccuracies or shortcomings

Great care has been observed in writing this manual. In spite of this fact, the Van Hool company does not accept any liability for damage or discomfort in any sense that could be attributed to errors or shortcomings contained in this manual.

Instruction not mentioned

Failure to mention maintenance instructions in this manual for certain comfort features does not automatically mean that said features require no maintenance. To the extent possible, separate documentation is supplied separately with the documents supplied with the vehicle.

Improper use of the vehicle

Van Hool is not liable for damage or accidents occurring as a result of improper use of the vehicle. This involves: operation under circumstances or for a purpose improper to the vehicle concept, or a driving style abnormal to bus or coach operation.

Spare parts

The use of accessories and spare parts not issued by Van Hool or which are not original Van Hool parts will result in the loss of all guarantee claims.

Manual structure

What is the structure based on?

The manual structure is based on the structure of the vehicle in terms of components and systems.

Parts

There are 16 parts (0 through 15). They are easily traceable by means of the blue cardboard divider sheets.

Chapters

Each manual part has been divided into chapters. The chapters are in numeric order within the manual part they come under. However, the numbers do not necessarily link up. Some numbers may be lacking in the sequence. However, this does not mean that your manual is incomplete. The reason is that your vehicle contains only part of the components the Van Hool numbering system reserves entries for.

Pages

Page numbering is restarted at the beginning of each chapter. All pages within a same chapter bear the same date: the chapter publication date.

Table of contents

Completely at the front, you will find the manual's table of contents. It lists all the parts and chapters present in the manual.

Overview pages

Each part and each chapter begins with an overview page.

The overview page of a...	lists...
part	the name and number of each chapter present in the corresponding part.
chapter	the title and the page number of each topic dealt with in the chapter.

Addenda

Behind the blue cardboard divider sheet "Addenda", you may come across documents that, for their different type of layout or page numbering, could not be fitted into the overall structure of the manual. These are mostly instruction sheets from Van Hool suppliers, presented in their original format.

Illustrations and symbols

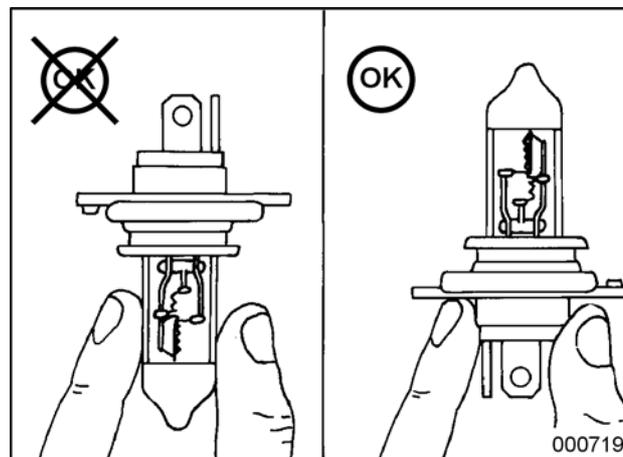
Applicability of the illustrations

Some of the illustrations in this manual are simplified or common. They will not look exactly like the component or equipment found on your vehicle. However, the procedures they illustrate do apply to your vehicle.

Symbols in illustrations

Illustrations may include symbols indicating an acceptable or a not acceptable condition or action.

Example:



Never hold halogen lamps at the bulb.

Danger symbols in the text

Certain areas of text in this manual include danger symbols.

	This symbol points to danger of personal injury, health or even death.
	This symbol points to a risk of damage to components or equipment.

Special tools

List of special tools

At the end of each chapter, you will find a list of all the special tools needed to perform the activities described in that chapter.

Ordering special tools

Tools for which....	you order...
Van Hool order numbers are stated	at our service department, in the same manner as spare parts.
other supplier's order numbers are stated	directly by the respective manufacturer, importer or representative in your country.

Does your manual copy contain the latest additions and modifications?

To check the status of your copy

Use the table of contents at the beginning of the manual.

Is your copy complete?

Your manual is complete when all the chapters listed in the table of contents are actually present and contain the number of pages stated behind the chapter title in the table of contents.

Is your copy up-to-date?

An edition number on the first page of the manual's table of contents indicates to which edition of your manual the table of contents belongs. In order to know whether a chapter has been updated to the level of that particular edition, compare the date mark in the chapter itself with the date given behind the chapter title in the table of contents.

Method of updating

All manual holders registered in our mailing list automatically receive the additions and modifications deemed necessary by Van Hool.

Updates are always supplied as complete chapters. You will recognise a modified chapter by its more recent date mark.

What does an updating package consist of?

An updating package consists of additional/replacement chapters, plus a new table of contents for the manual.

Service bulletins

Introduction

As an additional means of informing you on technical items, Van Hool from time to time sends you service bulletins.

How to treat service bulletins?

File service bulletins related to a subject treated in this manual in numerical order behind the blue cardboard divider sheet with the title "Service bulletins". Manually mark the page(s) involved with the service bulletin number. Thus you will be remembered of the bulletin you filed when you leaf through the manual.

Priority

The information passed on in service bulletins always takes priority over information that deviates from and is older than the service bulletin.

Part 1 - Complete vehicle

Overview

Contents

Chapter	See page
Chapter 1: General	1.1-1

Chapter 1: General

Overview

Introduction This chapter deals with general information about the vehicle.

Number of pages 44

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety instructions: general	1.1-2
Safety instructions: bodily harm or health damage	1.1-3
Safety instructions: damage to vehicle or equipment	1.1-6
Safety instructions: materials containing asbestos	1.1-7
Safety instructions: environmental protection	1.1-8
Vehicle identification	1.1-9
Vehicle characteristics	1.1-12
Access doors and controls at the outside of the C2045	1.1-13
Fluids and lubricants	1.1-21
Running-in service	1.1-24
Maintenance schedule	1.1-26
Maintenance schedule additional information	1.1-35
Maintenance schedule for the climate-control system	1.1-36
Lifting instructions	1.1-38
Towing instructions	1.1-40
To lift and tow vehicle with recovery vehicle equipped with under-arm lift	1.1-41
External cleaning of vehicle units	1.1-43

Safety instructions: general

Prevention of accidents and damage

To help prevent accidents and damage, a series of general customary safety rules for dealing with commercial vehicles is provided below. Special warnings have also been provided in various chapters of this manual, referring to work instructions to which they apply.

Read all these rules and warnings attentively, in both your own safety interest and that of the vehicle.

Competent staff

Using the vehicle described in this manual is safe on the condition that the personnel responsible for its operation and maintenance are adequately trained and follow the necessary precautions.

Responsibility

Inclusion of these safety rules does not mean that Van Hool is responsible for the compliance with them in your company. It must also be emphasized that Van Hool cannot possibly anticipate ALL situations or improper actions that could lead to an accident, damage or health problems.

Safety instructions: bodily harm or health damage

Introduction

Below you will find rules to prevent accidents causing bodily harm or health damage.

Before operation

Familiarize yourself with the location and the function of all controls, before you drive the vehicle for the first time.

To start the engine

Always make sure the parking brake has been applied and the transmission is in neutral, before starting the engine.

Exhaust emissions

Do not run the engine or operate the coolant heater in a confined space, unless a proper exhaust removing system is used.

Refueling

Due to fire risk refueling is allowed with the engine and the heating system switched off only (coolant heater!).

Working on the vehicle

- Make sure you have read and understood all applicable instructions before beginning any work.
- Before working on parts in the engine compartment, activate the starter-prevention switch (if present) to prevent anyone from turning on the engine. Put a warning on the steering wheel saying "DO NOT START: MAINTENANCE".
- As a rule, maintenance has to be performed, while the engine is not running. If you have to conduct checks, while the engine is running, keep distance from the moving parts (Caution: optical illusion may cause a running fan to look like it is not turning).
- Beware that the vehicle superstructure can suddenly drop over 3 in, if someone (intentionally or unintentionally) allows air to escape from the suspension air springs.
- Firmly support all heavy vehicle parts, before you unscrew fixing bolts or nuts.
- Except when adjusting tire pressure, always fill tires in a safety cage.

Tools

- For a number of activities the use of special tools is prescribed. If you use different tools in those cases, you do so at your own risk.
- Never use any tools without having learnt how to handle them first.
- Use tools in proper condition only. Worn-out nut wrenches, for example, can slip away dangerously and cause injury.

continued on next page

-
- Risks of burns**
- Do not touch with bare hands an engine, transmission or retarder that has been operating recently: danger of burns.
 - Beware of burns, when draining hot oil. Do not touch oil drain plugs and filters with bare hands. Make sure the catcher tray you place under the drain plug is big enough, so that it will not overflow (refer to chapter 1.1, "Fluids and lubricants").
 - Never open the engine cooling or interior heating system, while the coolant is hot. If this is necessary due to some obligatory reason, however, first release the pressure from the system as outlined in chapter 2.34.
-
- Systems under pressure**
- Do not tighten or loosen pipe or hose connections, while the pipe or hose is under pressure (fuel lines, lubricating oil, hydraulic fluid, compressed air, etc.).
 - Do not check pressurized lines for leaks with your hands.
 - Safely depressurize devices containing compressed air or liquid under pressure, before opening them.
 - Gas struts of body hatches contain gas under dangerously high pressure. Never drill through these struts or open them.
-
- Batteries**
- When disconnecting or connecting batteries, always disconnect the negative cable first and reconnect it last (so as to avoid short circuits).
 - Batteries contain highly corrosive acid; battery gas is explosive (refer to chapter 14.2 "Safety instructions relating to batteries").
-
- Jacking**
- Before jacking up the vehicle, make sure the brakes have been applied and the wheels remaining on the ground have been secured with wheel chocks.
 - Use faultless and suitable jack types only, with sufficient lifting power.
 - Never support the vehicle with hydraulic jacks only; always place chassis stands or support blocks, before working under a jacked-up vehicle.
-
- Hazardous substances**
- Beware of explosion danger, when draining fuel tanks.
 - Avoid any contact with the skin and eyes with corrosive substances or irritants. Wear protective clothing, gloves, safety goggles.
 - Avoid ingestion or inhalation and skin contact with toxic substances. Wear protective clothing and, if necessary, a suitable respiration mask.
 - If victims are injured in an accident with corrosive or toxic substances, call for a doctor immediately.

continued on next page

- Never keep vehicle liquids in packings that could be confused with beverage packings.
 - Make sure the workshop has "safety data sheets" at hand for all hazardous substances used. These sheets indicate the substance properties, precautionary measures in dealing with it and recommendations for first aid in the event of an accident. They are available from the supplier of the hazardous substance.
 - When working with parts containing asbestos, carefully follow the instructions stated under "Safety instructions: materials containing asbestos" later in this chapter.
-

Safety instructions: damage to vehicle or equipment

Introduction

Below you will find rules to prevent damage to the vehicle or equipment.

Defects

Make sure every defect that is identified is fixed as soon as possible to prevent greater damage.

Screws and nuts

- Screws and nuts may be replaced with those having the same part number (or equivalent) only, never use screws or nuts of a lower property class.
 - Observe the tightening torques specified in the various chapters of this manual, when tightening screws and nuts.
-

Electrical system

- Turn off the battery isolating switch, before working on the electrical system of the vehicle.
 - When the battery isolating switch is closed, never pull out the connectors of any electronic control unit (automatic transmission, ABS/ATC, E-GAS, EDC, speed-limiting device, cruise control, etc.).
-

Electric welding

Before carrying out electrical welding on the vehicle, first turn off the battery isolating switch and subsequently remove the connectors from all electronic control units. Secure the ground return cable of the welding device as close as possible to the part that is to be welded.

Engine encapsulation

When working on vehicles with engine encapsulation, make sure to check afterwards that no flammable substances are left on the bottom of the engine encapsulation (e.g. diesel fuel after bleeding the fuel system).

Jacking

Jack up the chassis frame under the jack support points provided for this purpose only. These points have been indicated in chapter 1.1, under "Lifting instructions".

Overheated engine

Never pour cold coolant into an overheated engine.

Safety instructions: materials containing asbestos

Introduction

Some parts of the vehicle (including brake and clutch linings, heat-resistant gaskets) may contain asbestos. Dust from these parts can cause dangerous lung diseases when inhaled. Spare parts containing asbestos, and possibly their packaging as well, include a warning label as shown in the figure.

As a general rule, you should prevent asbestos dust from being released into the air and being inhaled. Follow the instructions of regulations on working conditions.

The following tips apply in general.

Figure:
warning label
for materials
containing
asbestos



Work clothing

Wear work clothing that covers the entire body. Wear gloves and a respiratory mask suitable for asbestos dust.

Dealing with asbestos dust

- Remove asbestos dust from vehicle parts using a vacuum cleaner fitted with an appropriate filter. Wipe any remaining dust using a wet rag. Put used rags in plastic waste bags, before they dry.
- Never use compressed air or a brush to remove asbestos dust.
- Handle items that have asbestos dust on them carefully, so the dust is not disturbed and gets into the air.
- Do not sweep up dust that has fallen on the floor; do use a vacuum cleaner or dampen and scrape it up.
- When possible, work in the open air or in a well-ventilated working space.

Safety instructions: environmental protection

Introduction

Below you will find rules to prevent damage to environment we live in.

Toxins or pollutants

Do not dump any toxins or pollutants into the environment. Lubricants, anti-freeze, liquids for hydraulic systems, battery acid, batteries, fuel and oil filters, asbestos are "special waste" and may only be disposed of in a manner permitted by law. Check with the environmental protection authorities to find out applicable regulations in your country (or region).

Exhaust gas

Do not unnecessarily idle the vehicle engine. Exhaust emissions cause environmental pollution.

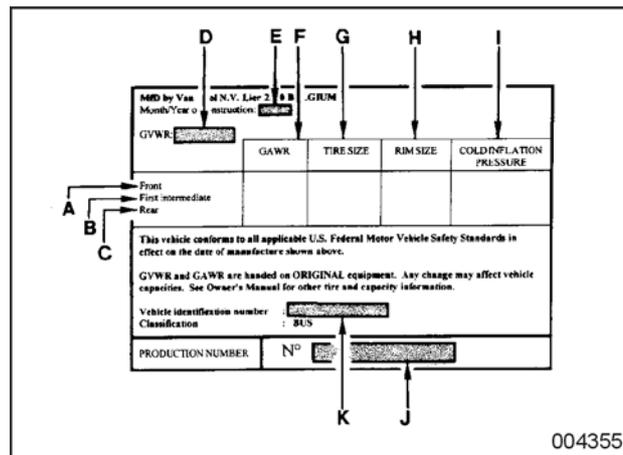
Vehicle identification

Vehicle identification plate

The vehicle identification plate is located in the step well of the vehicle.



Figure: vehicle identification plate

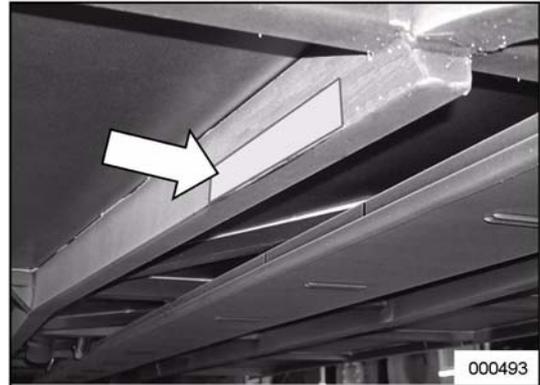


- A 1st axle
- B 2nd axle
- C 3rd axle
- D Gross vehicle weight rating
- E Manufacturing date
- F Gross axle weight rating
- G Tire size
- H Rim size
- I Tire inflation pressure (cold tires)
- J Production number
- K Chassis number

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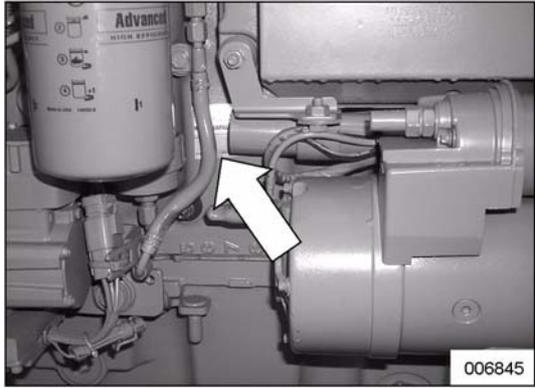
Chassis number

The chassis number has been stamped on the chassis side member behind the right-hand front wheel and is accessible from under the vehicle.



Engine identification plate

Engine	Location
Cummins	
Detroit Diesel	

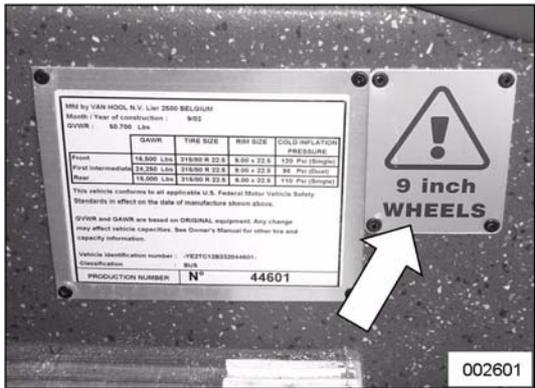
Engine	Location
Caterpillar	

Wheels



WARNING!

Never install wheels with a rim width of 8.25 inch on vehicles originally equipped with 9 inch rim-width wheels and vice versa.

<p>Vehicles originally equipped with 9 inch rim-width wheels have a "9 inch WHEELS" warning plate next to the vehicle identification plate.</p>	
---	--

Vehicle characteristics

Engine

Make	Cummins
Type	<ul style="list-style-type: none"> ISM07 450
Maximum power	<ul style="list-style-type: none"> 450 hp at 1 900 rpm
Maximum torque	<ul style="list-style-type: none"> 1 550 ft.lbf at 1 200 rpm

Brakes

Make	ArvinMeritor
Type	D-Elsa 2 disc brakes

Transmission

Allison	WTB500(R)
ZF	Astronic

Multiplex system

Make	Siemens VDO
Type	V3

Front axle

Make	Van Hool
Type	Independent wheel suspension

Drive axle

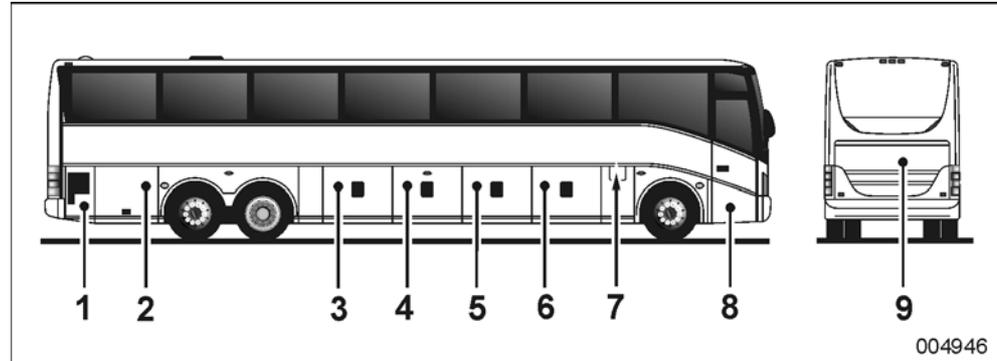
Make	Dana
Type	G171

Trailing axle

Make	Van Hool
Type	Independent wheel suspension

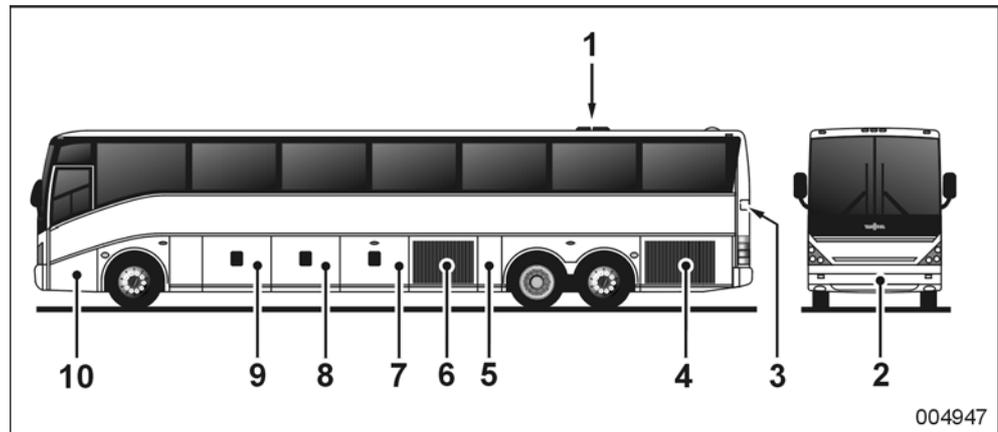
Access doors and controls at the outside of the C2045

Figure: right side view and rear view



- 1 Power steering fluid tank, waste water tank dump valve, toilet tank dump valve
- 2 Luggage compartment
- 3 Luggage compartment, access to engine junction box, access to box with compressed-air switches and sensors
- 4 Luggage compartment
- 5 Luggage compartment
- 6 Luggage compartment, access to main junction box
- 7 Fuel filler opening
- 8 Passenger door
- 9 Engine compartment

Figure: left side view and front view

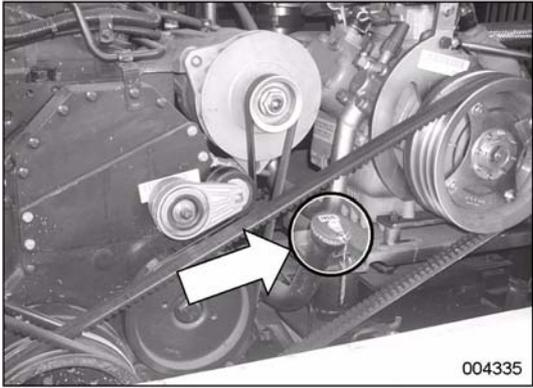
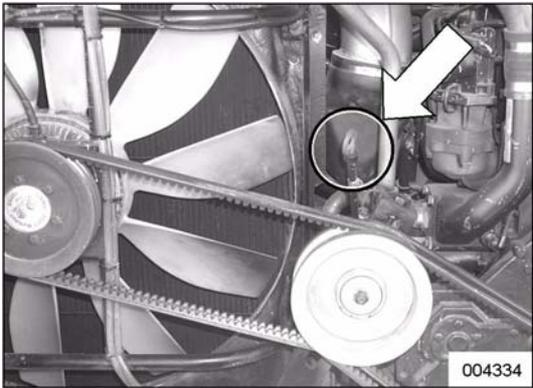
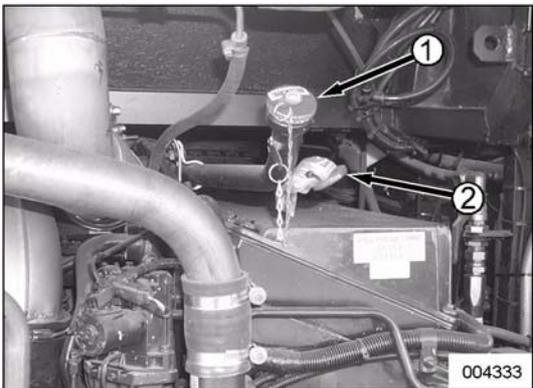


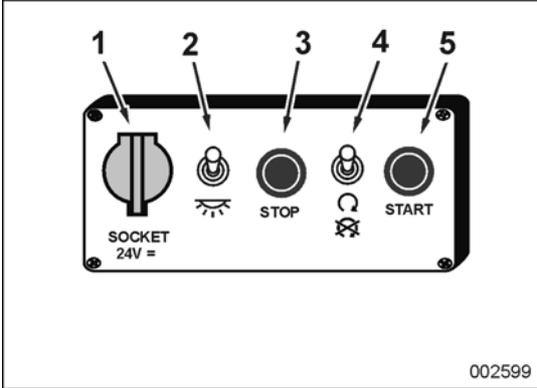
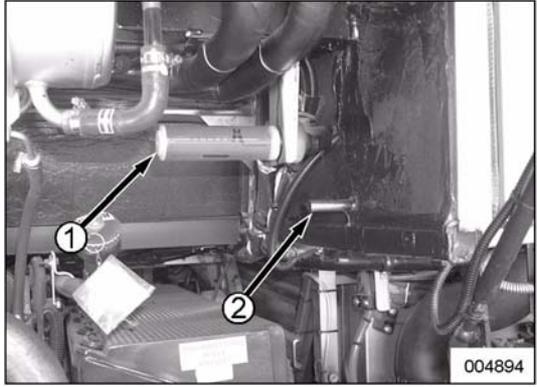
004947

- 1 Roof hatch
- 2 Spare wheel, compressed-air system fill connection
- 3 Coolant filler cap
- 4 Air filter, air-filter service indicator, batteries, mechanical battery isolating switch, access to battery junction box
- 5 Coolant heater, main shut-off valve in interior heating supply line, main shut-off valve in interior heating return line, interior heating valve block
- 6 Climate-control condensor compartment
- 7 Luggage compartment
- 8 Luggage compartment
- 9 Luggage compartment
- 10 Windshield washer tank, front-bumper release lever

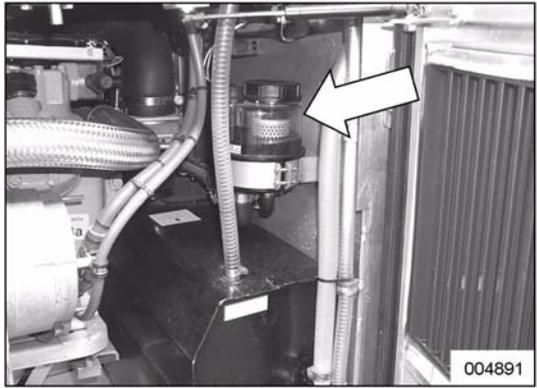
In engine compartment

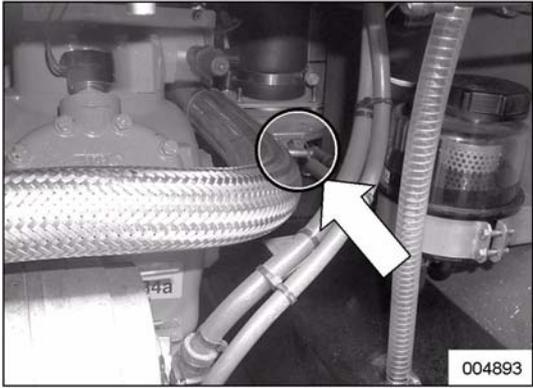
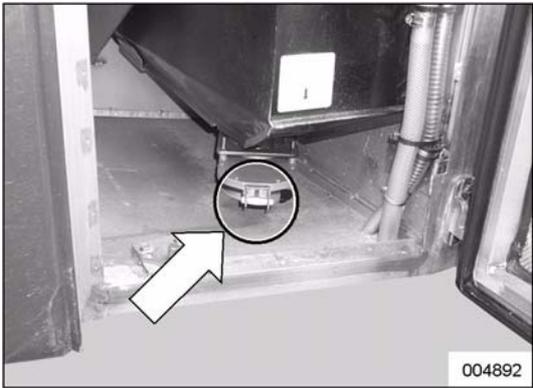
Element	Location
Coolant sight glass	

Element	Location
<p>Engine oil filler cap</p>	
<p>Engine oil dipstick</p>	
<p>Allison WTB500(R) transmission only</p> <p>1 Transmission oil filler cap</p> <p>2 Transmission oil dipstick</p>	

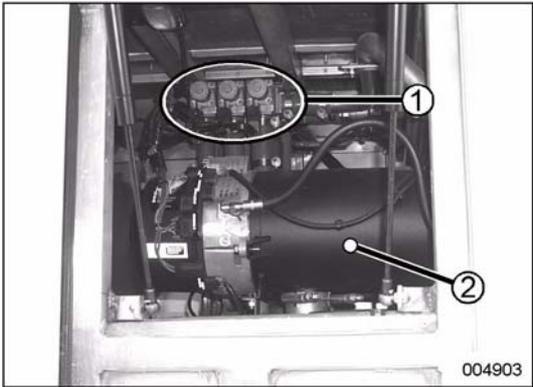
Element	Location
<p>Control panel</p> <ol style="list-style-type: none"> 1 Socket for portable lamp (24 volt) 2 Engine-compartment lighting switch 3 Engine stop button 4 Starting interlock switch 5 Engine start button 	 <p style="text-align: right;">002599</p>
<p>Jump-starting terminals</p> <ol style="list-style-type: none"> 1 "+" terminal 2 Ground terminal 	 <p style="text-align: right;">004894</p>

On right-hand side at very rear

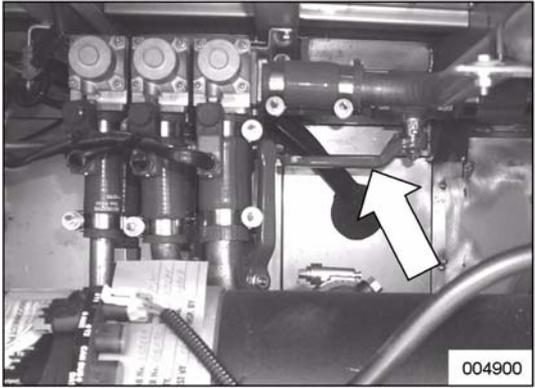
Element	Location
<p>Power steering fluid tank</p>	 <p style="text-align: right;">004891</p>

Element	Location
Toilet tank dump valve	
Waste-water tank dump valve	

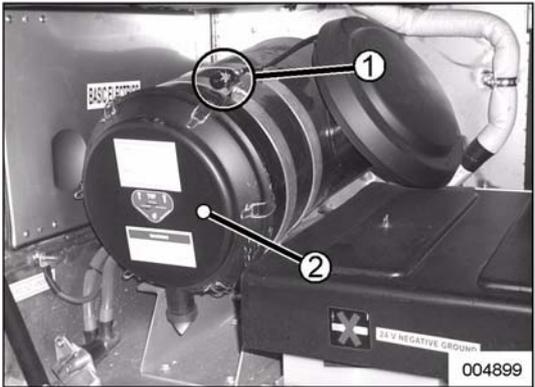
In front of left-hand wheel of drive axle

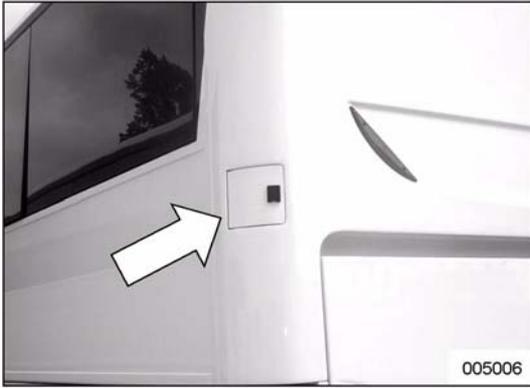
Element	Location
1 Interior heating valve block 2 Coolant heater	

continued on next page

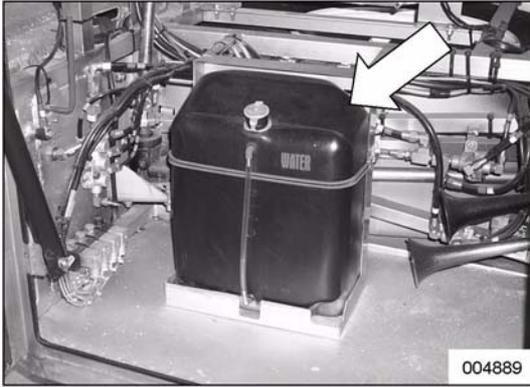
Element	Location
<p>Main shut-off valve in interior-heating return line</p> <p><i>NOTE: The main shut-off valve in the interior-heating supply line is located behind the coolant heater.</i></p>	

On left-hand side at very rear

Element	Location
<p>1 Air-filter service indicator</p> <p>2 Air filter</p>	
<p>Mechanical battery isolating switch</p> <p>1 Batteries disconnected</p> <p>2 Batteries connected</p>	

Element	Location
Access to coolant filler cap	 <p>005006</p>

On left-hand side at very front

Element	Location
Windshield washer tank	 <p>004889</p>
Front-bumper release lever	 <p>004888</p>

**In front of
right-hand
wheel of drive
axle**

Element	Location
<p>1 Engine junction box</p> <p>2 Box with compressed-air switches and sensors</p>	

**At the left,
behind front
bumper**

Element	Location
<p>Compressed-air system fill connection</p>	

Fluids and lubricants

Fuel tank

Capacity	Specifications ^a
approx. 238 gallons	ULSD-diesel oil ^b meeting ASTM D 975 No. 2D requirements

a. For more information, see Service Bulletin 3379001 by Cummins.

b. ULSD stands for "Ultra-Low Sulfur Diesel" (sulphur content not over 15 ppm)

Engine oil pan

Capacity	Specifications ^a
<ul style="list-style-type: none"> Maximum level: approx. 9 gallons Minimum level: approx. 8 gallons 	Motor oil meeting the requirements of "Cummins Engineering Specifications" CES 20081. Viscosity depending on outside temperature.

a. For more information, see Service Bulletin 3810340 by Cummins.

Transmission

Type	Capacity	Specifications
Allison WTB500(R) <ul style="list-style-type: none"> Refill after oil change Initial fill 	approx. 31 U.S. Qts approx. 40 U.S. Qts	CASTROL TranSynd
ZF Astronic	approx. 11.6 U.S. Qts	Oil to ZF lubricants list TE-ML 02, class 02E, 02H or 02L ^{ab} .

a. The ZF Astronic transmission has been factory filled with CASTROL Syntrans Max 75W-80.

b. On the "www.vanhool.be" website, under the "service" menu item, you will find links to lists with approved fluids and lubricants on the website of ZF.

continued on next page

Drive axle

Capacity	Specifications
approx. 4.5 gallons	Transmission oil meeting MIL-L-2105D requirements. ^a Viscosity depending on outside temperature <div style="text-align: center; margin-top: 10px;"> <p>005802im</p> </div>

a. The drive axle has been factory filled with SAE 85W-140 mineral oil.

Power steering system

Capacity	Specifications
approx. 9.5 U.S. Qts	Automatic transmission fluid, to ZF lubricants list TE-ML 09 ^a .

a. On the "www.vanhool.be" website, under the "service" menu item, you will find links to lists with approved fluids and lubricants on the website of ZF.

Engine cooling and interior heating system



CAUTION!

The use of antifreeze with "organic" corrosion inhibitors (OAT technology) is not allowed. This type of antifreeze attacks blue silicone hoses.

Capacity	Specifications ^a
approx. 46 gallons	Year round: "fully formulated" ethylene glycol coolant according to "Cummins Engineering Standard 14603". "Fully formulated" coolant is a properly composed mixture of water, antifreeze and Fleetguard DCA4 additive.

a. For more information, see Service Bulletin 3666132 by Cummins.

continued on next page

Interior cooling system

Refrigerant R134a

Climate-control compressor oil pan

Capacity	Specifications
approx. 3.4 U.S. Qts	<ul style="list-style-type: none"> • CASTROL Icematic SW68 • MOBIL Eal Arctic 68 • ICI Emkerate RL68H

Windshield washer tank

Capacity	Specifications
approx. 5.3 gallons	Water with windshield-washer antifreeze

Greasing points

Application	Specifications
All lubricators for manual lubrication on chassis and body, unless otherwise stated.	Multipurpose grease: NLGI No. 2 consistence, lithium based, with EP and corrosion inhibiting additives, drop point not below 380 °F
Propeller shaft	Special high temperature grease: <ul style="list-style-type: none"> • SHELL Retinax LX 2 • FUCHS Renolit Duraplex GWB • RHENUS Norplex LKP 2
Front axle: king-pin bearings	FUCHS Renolit LX-OTP 2
Splash-water protective cover on steering-gear output shaft	Special grease: TEXACO Texando FO 20
Automatic passenger-door spindle	NLGI No. 2 high-temperature grease with molybdenum disulphide (MoS ₂)

Running-in service

This schedule applies to

Vehicles with:

Component	Make/type
Engine	<ul style="list-style-type: none"> Cummins ISM07 Detroit Diesel Series 60 DDEC VI Caterpillar C13 EPA2007
Transmission	<ul style="list-style-type: none"> Allison WTB500(R) ZF Astronic
Drive axle	Dana G171
Brakes	ArvinMeritor D-Elsa 2

Fluids and lubricants

Refer to "Fluids and lubricants" earlier in this chapter.

After first 30 miles

And again after the next 60 miles, retighten the wheel nuts with a torque wrench. Subsequent to this, take up slack every day, until finally tight.

After first 1 000 miles

Action	Component
Tighten	Wheel nuts
	Engine cooling system, interior-heating system: classic hose clamps (Do not retighten constant torque hose clamps!)
Check	V-belts: tension (with gauge)
	Engine: air intake ductings for security, damage, leakage
	Tires: pressure
	Air springs: height
	Emergency exits (emergency side windows and roof hatches): whether they can be opened, closed and latched properly.
	Starter motor, alternators, mass points: security of electrical connections
	Electrical cables: security of connections, attachment, chafing

continued on next page

After first 3 000 miles

Action	Component
Change	Drive axle: oil
Lubricate	Propeller shaft: universal joints
	Front axle steering: intermediate lever
	Climate-control compressor: compressor seat bearings
Tighten	Wheel nuts
	Propeller shaft: fixing bolts
Check	V-belts: tension (with gauge)
	Drive axle: breather for freedom of obstruction
	Air suspension: height, leakage
	Batteries: fluid level
	Brake chambers: damage, leakage
	Compressed-air valves of brake system: air tightness and exhaust function
	Engine and transmission: security in chassis
	Wheel suspensions: security of components
	Steering system: security of steering gear, rods and arms
	Compressed-air tanks: security
	Dashboard gauges and indicator lights: operation
Test	Service brake circuits: air tightness

After first 20 000 miles

Action	Component
Check	Caterpillar engine: adjustment of electronic injectors (adjust if necessary)
	Caterpillar engine: valve clearance (adjust if necessary)
	Caterpillar engine: operation of valve rotators
	Caterpillar engine: valve actuators (adjust if necessary)

Maintenance schedule

This schedule applies to

Vehicles with:

Component	Make/type
Engine	<ul style="list-style-type: none"> Cummins ISM07 Detroit Diesel Series 60 DDEC VI Caterpillar C13 EPA2007
Transmission	<ul style="list-style-type: none"> Allison WTB500(R) ZF Astronic
Drive axle	Dana G171
Brakes	ArvinMeritor D-Elsa 2

Fluids and lubricants

Refer to "Fluids and lubricants" earlier in this chapter.

Additional grease interval

After interim cleaning of the chassis with a steam cleaner, perform an additional greasing service at the following points:

- Propeller shaft universal joints;
- Front axle king-pin bearings;
- Intermediate lever of front axle steering.

Daily

Action	Component
Drain	Cummins engine: fuel filter
	Caterpillar engine: fuel-water separator

continued on next page

Action	Component
Check	Engine: oil level
	Engine: coolant level
	Engine: air-filter service indicator
	Engine: air intake ductings for security, damage and leakage (visually)
	Cummins engine: freedom of obstruction of crankcase breather duct
	Allison WTB500(R) transmission: oil level
	Front axle steering: fluid level
	V-belts: tension, wear
	All pipes and hoses for security, damage, chafing and leakage (also of the exhaust system)
	Presence of fluid leaks in engine compartment, wheel hubs, ...
	Tires: pressure, damage
	Wheel nuts: security (visually)
	Wheels for cracks and deformation
	Visually: body ground clearance (air suspension operation)
	Emergency side windows: whether they are closed and latched

**Every
7 500 miles**

Action	Component
Drain	Detroit Diesel engine: primary fuel filter
Tighten	Wheel nuts (with torque wrench)
Lubricate	Front axle steering: intermediate lever
	Climate-control compressor: compressor seat bearings

continued on next page

Action	Component
Check	Windshield washer: fluid level
	Drive axle: oil level
	Batteries: fluid level and charge, cleanliness of terminals
	Engine: adjustment of engine suspension rear mounts
	Engine: condition and security of the exhaust system
	Engine cooling system: mesh screen of radiator compartment (clean, if necessary)
	V-belts: tension, wear
	Air springs: height (measure)
	Compressed-air supply: compressed-air tanks for absence of moisture
	Wheel suspensions: security of components
	Tires: pressure (with tire pressure gauge)
	Emergency exits (windows and roof hatches): whether they can be opened, closed and latched properly.
	Indicator lights and gauges: operation

**Every
15 000 miles**

Action	Component
Change	Cummins and Detroit Diesel engines: oil ^a
Renew	Cummins and Detroit Diesel engines: oil filter ^b
	Cummins engine: fuel filter ^c
	Detroit Diesel engine: primary and secondary fuel filters ^d
Tighten	Engine cooling system, interior-heating system: classic hose clamps (Do not retighten constant torque hose clamps!)
Lubricate	Bodywork hinges and locks
	Windshield wipers: pivot points of linkage (with oil)

continued on next page

Action	Component
Check	Engine: calibration of air-filter service indicator
	Engine: cooling system antifreeze concentration ^e
	Engine: cooling system supplemental coolant additives (SCA) concentration ^f
	Detroit Diesel engine: crankshaft vibration damper
	Detroit Diesel engine: waterpump drain hole for freedom of obstruction
	Detroit Diesel engine: turbocharger
	ZF Astronic transmission: oil level
	Wheel suspension: exterior condition of air springs, air tightness
	Wheel suspension: shock absorbers for exterior damage and leakage
	Brakes: brake pad wear ^g
	Brakes: general condition ^h
	Brakes: brake chambers for damage, leakage
	Brakes: valves, lines and couplings for air tightness
	Brakes: foot brake valve operating mechanism
	Steering system: steering ball-joints for backlash, condition of ball-joint protection covers
	Steering system: security of steering gear, rods and arms
	Electricity: condition of the electrical wiring (insulation, loose or oxidised connections)
	Exterior lighting: operation
	Exterior lighting: headlamps adjustment
	Passenger door: operation and adjustment
Toilet: operation	
Windshield wipers: wiping area, wiper blades condition	

- a. At least every 6 months.
- b. At least every 6 months.
- c. At least every 6 months.
- d. At least every 6 months.
- e. At least every 6 months.
- f. At least every 6 months.
- g. At least every 6 months.
- h. At least once a year.

continued on next page

**Every
20 000 miles**

Action	Component
Change	Caterpillar engine: oil ^a
Renew	Caterpillar engine: oil filter ^b
	Caterpillar engine: fuel-water separator ^c
	Caterpillar engine: fuel filter ^d
Clean	Caterpillar engine: crankcase breather
Check	Engine: automatic belt tensioner position
	Caterpillar engine: ground stud of cylinder head (clean/tighten)
Carry out	Caterpillar engine: to take a coolant sample and have it analysed by Caterpillar
	Caterpillar engine: to take an engine oil sample and have it analysed by Caterpillar

- a. At least every 6 months.
b. At least every 6 months.
c. At least every 6 months.
d. At least every 6 months.

**Every
22 500 miles**

Action	Component
Lubricate	Propeller shaft: universal joints
	Passenger door: door spindle
	Passenger door: ball-joints of upper and lower guide arms
	Emergency side windows: unlatching mechanism
To install	Passenger door: vaseline on the locking cams
	Passenger door: silicone grease on rubber door seals ^a
Clean	Engine: radiator and charge-air cooler
Carry out	Compressed-air brakes: function test

continued on next page

Action	Component
Check	Engine: security
	Caterpillar engine: adjustment of electronic injector units (correct if necessary)
	Caterpillar engine: valve clearance (adjust if necessary)
	Caterpillar engine: adjustment of variable valve actuators (adjust if necessary)
	Transmission: security
	Transmission and drive axle: breather for freedom of obstruction
	Water hoses for signs of deterioration (change if necessary)
	Front wheels: toe
	Wheel suspension: leveling valves for wear and damage
	Emergency windows: force to operate unlatching lever (20 lbs)
	Compressed-air system: security of air compressor

a. Repeat monthly in winter

Every 45 000 miles

Action	Component
Lubricate	Front axle: king-pin bearings ^a
	Passenger door: door spindle
Clean	Caterpillar engine: ARD nozzle (ARD stands for "After-treatment Regeneration Device")

a. At least once a year.

Every 60 000 miles

Action	Component
Renew	Compressed-air dryer: cartridge ^a
	Steering system: filter in fluid tank
	Air suspension: line filters
Carry out	Propeller shaft: minor inspection ^b
Clean	Cummins and Detroit Diesel engines: crankcase breather

continued on next page

Action	Component
Check	Engine: turbocharger security
	Detroit Diesel engine: valve clearance and injectors height (adjust if necessary)
	Detroit Diesel engine: oil pressure ^c
	Detroit Diesel engine: crankcase pressure ^d
	Passenger door: locking cams wear
	Front axle: clearance between steering knuckle and axle end
	Compressed-air system: setting of overflow valves
	Alternator brushes

- a. At least once a year.
b. At least once a year.
c. At least every 2 years
d. At least every 2 years.

Every 75 000 miles

Action	Component
Renew	Caterpillar engine: filter of crankcase breather
	Allison WTB500 transmission: oil filters ("MAIN" and "LUBE" filters) ^a
Check	Caterpillar engine: ARD spark plug (ARD stands for "Aftertreatment Regeneration Device")

- a. At least every 3 years.

Every 96 000 miles

Action	Component
Change	Drive axle: oil ^a
	ZF Astronic with ZF Intarder: oil ^b
Renew	ZF Astronic with ZF Intarder: oil filter ^c

- a. At least once a year. The 96 000 miles interval applies to mineral oil. If a synthetic oil approved by Dana is used, the interval can be extended to 240 000 miles or every three years.
b. At least once a year. The 96 000 miles interval applies to class 02H oil as listed in ZF lubricants list TE-ML 02. If class 02L oil is used, the interval can be extended to 180 000 miles or two years. When using oil from class 02E, the interval can be prolonged to 330 000 miles or 3 years, on the condition that the transmission breather is connected to a dry compartment.
c. At least once a year.

continued on next page

**Every
120 000 miles**

Action	Component	Item no. on figure
Renew	Detroit Diesel engine: filter of crankcase breather	
Check	Cummins engine: valve clearance and injectors clearance (adjust if necessary)	
	Cummins engine: condition of EGR system hoses (EGR stands for "Exhaust Gas Recirculation")	
	Brakes: condition of pistons and guide sleeves dust boots ^a	
	Brakes: brake caliper sliding system ^b	
	Brakes: condition of brake disc, thickness of brake disc, run-out of brake disc ^c	

- a. At least once a year.
b. At least once a year.
c. At least once a year.

**Every
150 000 miles**

Action	Component
Renew	Cummins engine: filter element of crankcase breather
To exchange/to clean	Caterpillar engine: particulate filter of exhaust after-treatment system
Change	Allison WTB500 transmission: oil ^a
Lubricate	Passenger door: door spindle

- a. At least every 4 years.

**Every
180 000 miles**

Action	Component
Change	Engine cooling and heating circuit: coolant
Renew	Engine cooling system: filler cap and pressure relief cap of expansion tank
	Cummins and Detroit Diesel engines: engine cooling thermostats
	Compressed-air system: governor
To exchange/to clean	Cummins engine: particulate filter of exhaust after-treatment system

continued on next page

Action	Component
Clean	Vehicle understructure
Carry out	Propeller shaft: major inspection ^a
	Steering system: major inspection ^b (content: refer to "Maintenance schedule additional information" further in this chapter)
Overhaul	Service brake chambers (change diaphragm)
Check	Compressed-air system: air-compressor discharge line for carbon deposit
	Compressed-air system: condition of air-compressor unloader valves
	Cummins engine: crankshaft vibration damper
	Caterpillar engine: water pump

a. At least every 3 years.

b. First time after 480 000 km

Every 300 000 miles

Action	Component
Check	Caterpillar engine: security of air compressor
	Caterpillar engine: crankshaft vibration damper
	Caterpillar engine: turbocharger
	Caterpillar engine: adjustment of electronic injectors (adjust if necessary)
	Caterpillar engine: valve clearance (adjust if necessary)
	Caterpillar engine: valve actuators (adjust if necessary)

Every 390 000 miles

Action	Component
To change/to clean	Detroit Diesel engine: particulate filter of exhaust after-treatment system ^a

a. Change/clean the particulate filter also if "ENGINE WARNING" appears on the multifunctional display on the dashboard and if, when reading the fault memory, the active fault "Clean DPF" appears.

Maintenance schedule additional information

"Steering system major inspection" contains:

-
- To check maximum steering pump pressure.
 - To check steering pump flow.
 - To check/set hydraulic steering lock.
 - To check steering gear pressure.
 - To check steering gear for internal leakage.
 - To check return time of power steering valve.
 - To measure play on steering wheel.
 - To measure steering gear mesh load.
 - To check straight-ahead position of wheels.
 - To check steering lock angles.
 - To check steering column bearings for play.
 - To check universal joints and flex couplings.
-

Maintenance schedule for the climate-control system

General

- Have the climate-control system checked annually by a heating and refrigerating technician at the beginning of the hot season. All work listed under "Annual" must be carried out.
- Vehicles with coolant heater: have the coolant heater checked annually by a recognised Proheat technician at the start of the cold season.
- Vehicles with coolant heater: check the outlet of the coolant heater at every service. The outlet must be unobstructed, otherwise it will prevent proper operation of the coolant heater and could cause damage.

Preventative off-season operation

- Let the climate-control compressor run for 15 to 20 minutes once per month, even during the cold season, i.e. with the clutch engaged.
- Vehicles with coolant heater: let the heater run for about 10 minutes once per month, even during the hot season, while the engine is cold.

Fluids and lubricants

Refer to "Fluids and lubricants" earlier in this chapter.

Explanation of maintenance intervals

The letter...	stand for...
"A"	"Every 100 hours".
"B"	"Every 1000 hours".
"C"	"Annually, before the hot season".

Maintenance intervals

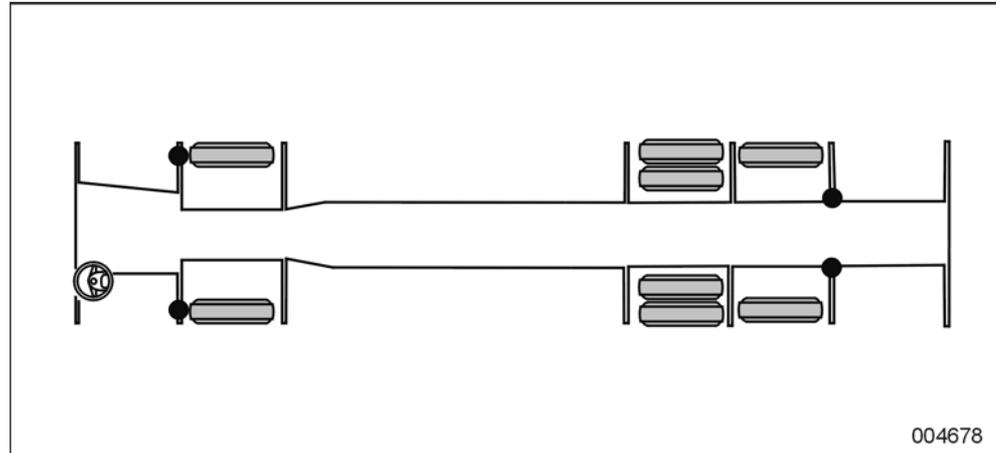
	Action	Interval		
		A	B	C
Airside systems	Check the air ducts for leaks.	x	x	x
	Clean/change the air filters.	x	x	x
	Check/clean the drain lines of the drain pans under the evaporators.		x	x
	Check/clean the fins of the convectors, radiators and evaporators.		x	x
	Check the operation of all fans.		x	x
	Check the operation and the tightness of the air flaps.		x	x

continued on next page

	Action	Interval		
		A	B	C
Water circuit	Check the operation of the circulating pumps.		X	X
	Check the condition of the water hoses.		X	X
Refrigerant circuit	Check operating pressures and performance.			X
	Check the compressor clutch bearing.		X	X
	Check/clean the condenser cooling fins.		X	X
	Check the condenser cooling fans.		X	X
	Check the operation of the high- and low-pressure switches.		X	X
	Change the filter/dryer.			X
	Check the refrigerant lines and line couplings. If necessary, tighten the coupling.			X
	Check the hoses for leaking compressor oil or refrigerant.		X	X
	Check the oil level in the compressor. Change the compressor oil.			X
	Check the sight-glass to see if the system has sufficient refrigerant.			X
	Check that the climate-control compressor is securely mounted.		X	X
	Control system	Check that the system can perform all of the basic functions.		
Carry out a complete function test.				X
Check the condition of the electrical cables, connectors and warning lights.				X
With compressed air, blow through the inside-air temperature sensor(s) by the openings in the housing.				X

Lifting instructions

Figure:
chassis-frame
jacking points



WARNING!

Never support the vehicle with hydraulic jacks only; always place chassis stands or support blocks, before working under a jacked-up vehicle.



WARNING!

Put the air suspension system in "lowered" position or depressurize it before you lift the vehicle.

To lift under chassis frame



CAUTION!

Disregarding the following instructions can cause serious damage to chassis sections:

- If the vehicle has to be raised by means of jacks under the chassis frame, position the jacking ram under the points indicated in the figure only.
- Always jack simultaneously at both front or both rear jacking points.
- Equally, when placing the vehicle on support stands (e.g. when lifting columns have been used to raise the vehicle), position the stands under the above mentioned points only.

continued on next page

To raise the vehicle with lifting columns



WARNING!

The four (or six) lifting columns have to move at the same speed, so that the vehicle remains level while it is being raised or lowered

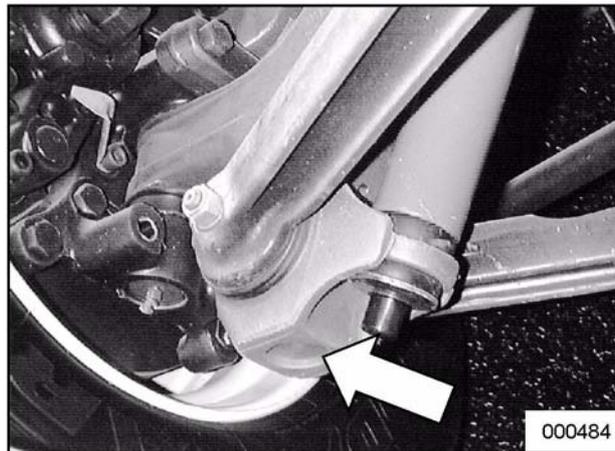
To raise the vehicle under the drive axle

If the drive axle has to be raised, it is best to place a central jack with a dished head under the middle of the axle banjo.

To raise the vehicle under the front axle

If an axle end of the front suspension has to be raised, place the jack inside the recess in the steering knuckle carrier, indicated on the figure.

Figure: recess for jack in steering knuckle carrier



To raise an axle end of the front suspension, place jack here.

Towing instructions

Guidelines

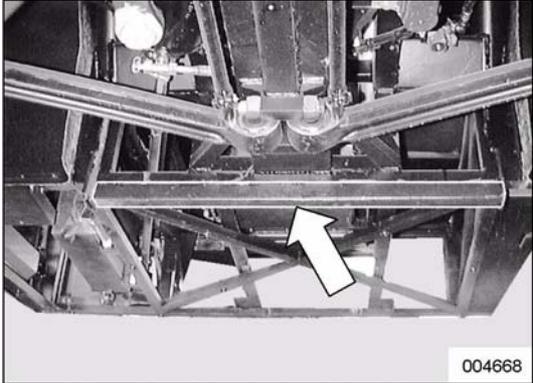
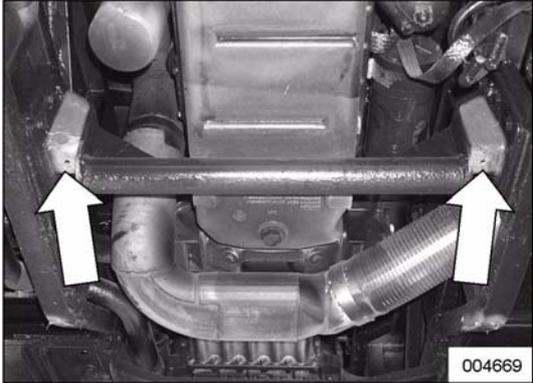
-
- Before towing, always disconnect the propeller shaft at the drive axle end or remove the two drive-axle half shafts. In case of damage inside the drive axle, the vehicle has to be towed from the back.
 - During the towing procedure, the vehicle air system can be supplied with compressed air by the towing vehicle through a hose coupling (refer to "To charge compressed-air tanks externally").
-

To lift and tow vehicle with recovery vehicle equipped with under-arm lift

Equipment condition

To read towing conditions (refer to "Towing instructions").

To lift where?

If you...	you have to place the lifting-system forks under...
lift the vehicle at the front	the reinforced cross beam in front of the front axle. 
lift the vehicle at the back	the anchor points under the reinforced cross beam under the engine. 

**WARNING!**

Do not carry out towing procedures that may be hazardous to other road users or that may cause damage to the vehicle.

**WARNING!**

Follow the legislation that applies to towed vehicles.

Procedure

Step	Action
1	Manoeuvre frame of under-arm lift under reinforced cross beam.
2	Lift the vehicle.

External cleaning of vehicle units

Introduction

The cleaning of vehicle units with a pressure washer and mains water to which a suitable cleaning agent has been added is permitted if you follow the instructions below.

NOTE: Instructions for cleaning the vehicle bodywork are given in chapter 10.1 "Care of the bodywork".

Cleaning equipment

Allowed	Not allowed
Pressure washers with flat-jet nozzle, 25° spray angle.	Power jets, rotary (turbo) jets and water cannons (equipment with very high flow rate, "fire-fighting" type).



WARNING!

To avoid accidents, read the safety precautions and instructions for use supplied by the manufacturer of the pressure washer.

Spraying distance

Minimum distance of spray lance nozzle to object: 20 in.

Operating pressure

Max. 725 psi at spray lance nozzle.

Water temperature

Unheated (cold) or max. 140 °F at spray lance nozzle.

NOTE: Cleaning takes less time with hot water because oil and grease dissolve better in water at high temperatures.

Cleaning agents

NOTE: Hard water can halve the effectiveness of cleaning agents.

Allowed	Not allowed
Neutral or slightly alkaline cleaners in a concentration of 1 to 5 %. pH-value of a 1 % solution: not higher than 9.5.	<ul style="list-style-type: none"> • "Cold cleaners" based on hydrocarbons (cleaning grade spirits, white spirit, kerosene) and other solvent-containing cleaning agents added to water. • Acidic or strongly alkaline agents.

continued on next page

**WARNING!**

To avoid health problems, read the safety precautions and instructions for use supplied by the manufacturer of the cleaning agent.

Do not point the spray lance of the pressure washer at ...

- opening(s) or flexible pipe joints of the engine air-intake system;
 - pump modules on diesel engines with Unit Pump System (UPS);
 - soft seals (dust caps and the like);
 - oil filler caps (of engine, transmission, etc.), especially not upwards from below;
 - breathers (on engine crankcase, transmission, drive axle, etc.);
 - bearings (of pulleys and belt tensioners, universal joints, steering system articulations, etc.);
 - lubricators;
 - radiator, charge-air cooler, climate-control condenser and other finned heat exchangers;
 - clutch and pressure switches (pressostats) of climate-control compressor;
 - electrical equipment such as batteries, starter motor, alternator(s), electronic control units, sensors, etc.;
 - ignition coils, distributor, sparkplugs (if vehicle with gas engine);
 - electrical connections (connectors, etc.)
-

Used cleaning water

Used cleaning water should be treated and disposed of in accordance with the environment regulations of your country or region (use an oil separator).

Part 2 - Traction engine

Overview

Contents

Chapter	See page
Chapter 6: Engine suspension	2.6-1
Chapter 10: Fuel system	2.10-1
Chapter 22: Air intake system	2.22-1
Chapter 30: Exhaust system	2.30-1
Chapter 34: Cooling system	2.34-1
Chapter 38: Lubrication system	2.38-1
Chapter 46: Accessory drive systems	2.46-1

Chapter 6: Engine suspension

Overview

Introduction This chapter deals with the engine suspension.

Number of pages 4

Chapter publication date 19 September 2006

Contents

Topic	See page
To check engine security	2.6-2
To check adjustment of rear engine mounts	2.6-3
Technical data: engine suspension	2.6-4

To check engine security

Tightening torques

Refer to "Technical data" at the end of this chapter.

To check adjustment of rear engine mounts

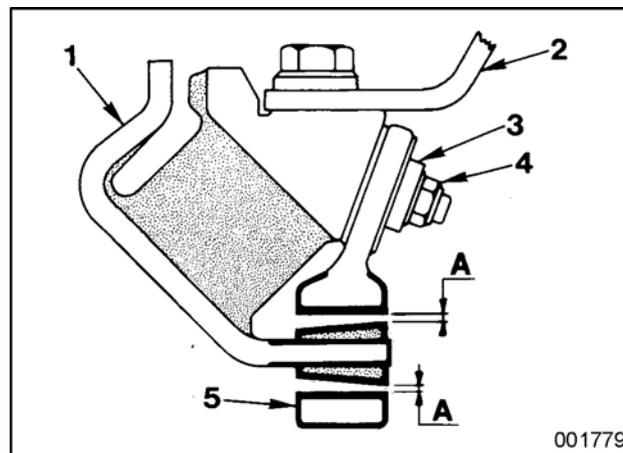
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

To check what?

Measure the distances "A" indicated in the figure. The distance "A" between engine mount (1) and stop (5) must be the same on top and underneath (approximately 0.1 in).

Figure: rear engine mount



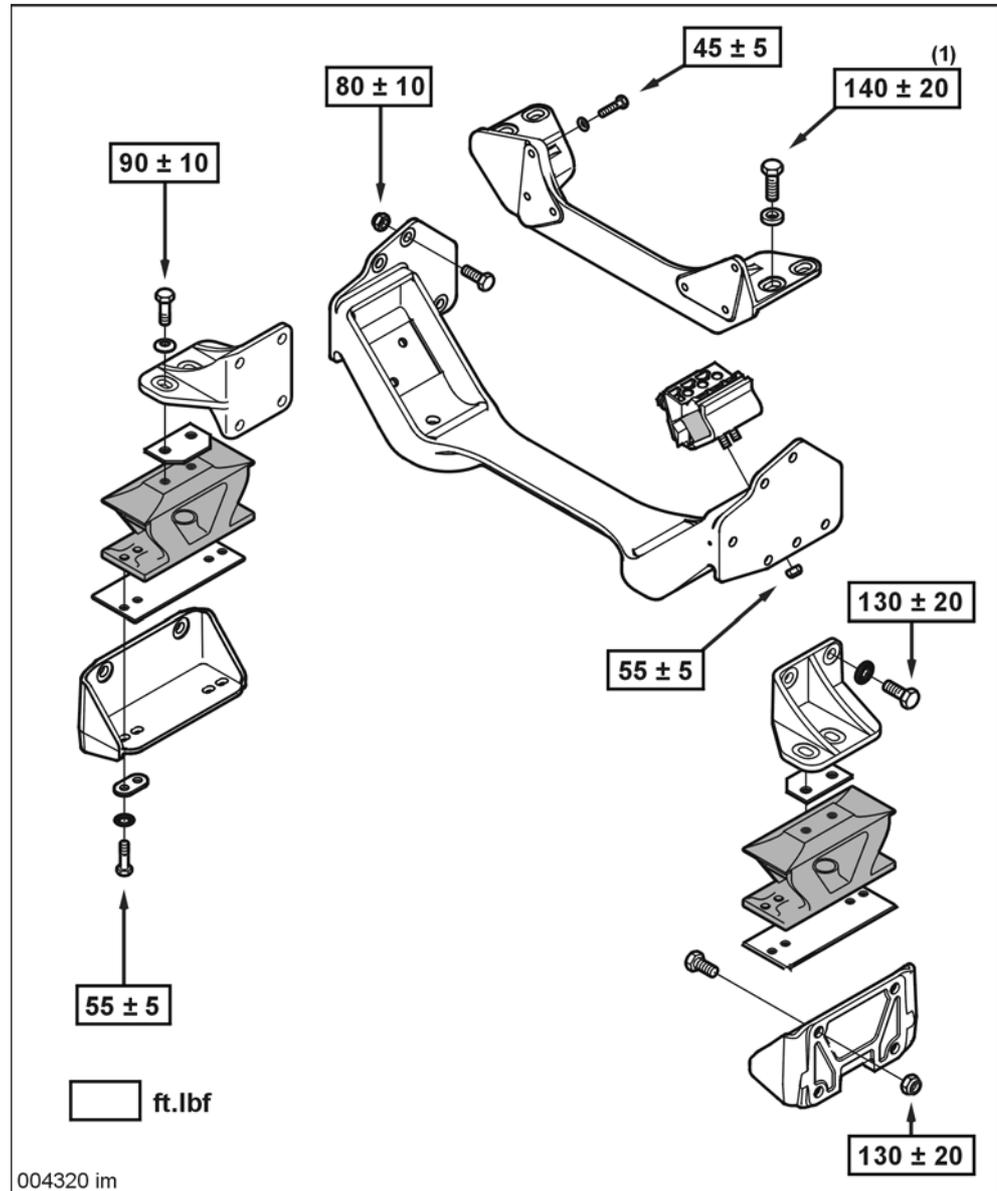
- 1 Engine mount
- 2 Engine bracket
- 3 Washer
- 4 Self-locking nut
- 5 Stop

How to adjust?

Step	Action
1	Loosen nuts (4).
2	Pull stop (5) down.
3	Slide a feeler gauge with a thickness of 0.1 in between stop (5) and mount (1) underside.
4	Push stop (5) up and tighten nuts (4).
5	Remove feeler gauge.

Technical data: engine suspension

Figure:
tightening
torques



Security of engine.

(1) Screws locked with Loctite 243 or equivalent

Chapter 10: Fuel system

Overview

Number of pages

10

Chapter publication date

19 September 2006

Contents

Topic	See page
EDC system: self-diagnosis	2.10-2
EDC system: fault reproduction	2.10-3
EDC system: to read out fault memory using flash code	2.10-5
To drain fuel filter	2.10-8
To change fuel filter	2.10-9

EDC system: self-diagnosis

Introduction

The electronic control unit contains a self-diagnostic feature. The electronics constantly monitor the correct operation of the system and faults are stored in a memory. The self-diagnosis feature makes troubleshooting easier.

How to read fault memory?

You can read the fault memory using:

- the engine diagnostics lamps on the diagnostics panel in the front junction box;
 - a special diagnostic tool from Cummins (refer to Cummins service literature).
-

EDC system: fault reproduction

Active fault

An active fault is a fault that exists during diagnostics.

Engine diagnostic lamps

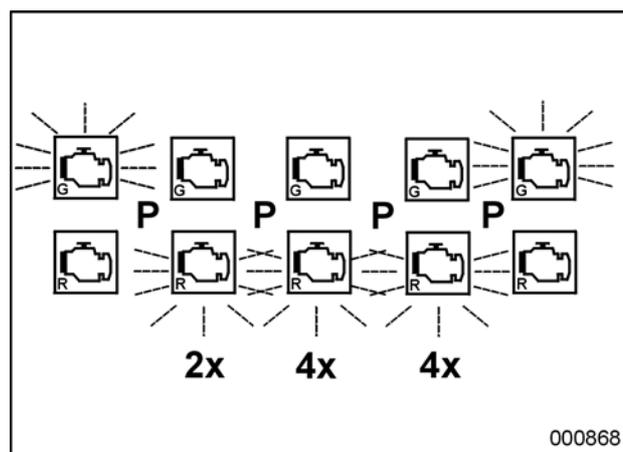
On request, the engine diagnostic lamps on the diagnostics panel in the front junction box show the active faults through a flash code.

What does a flash code look like?

The code will flash in the following sequence:

- one flash of the "ENGINE WARNING" lamp;
- a 1 to 2 second pause;
- one or more flashes of the "STOP ENGINE" lamp (= first figure of the fault code);
- a 1 to 2 second pause;
- one or more flashes of the "STOP ENGINE" lamp (= second figure of the fault code);
- a 1 to 2 second pause;
- one or more flashes of the "STOP ENGINE" lamp (= third figure of the fault code);
- a 1 to 2 second pause;
- one flash of the "ENGINE WARNING" lamp.

Figure: fault code example



Fault code 244

G "ENGINE WARNING" lamp

R "STOP ENGINE" lamp

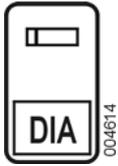
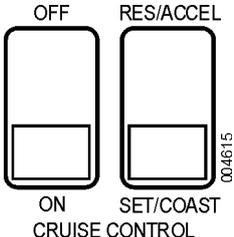
2.10

Traction engine
Fuel system



EDC system: to read out fault memory using flash code

Dash switches

Switch	Function
	To start engine diagnostics
	To switch cruise control on/off

Active fault

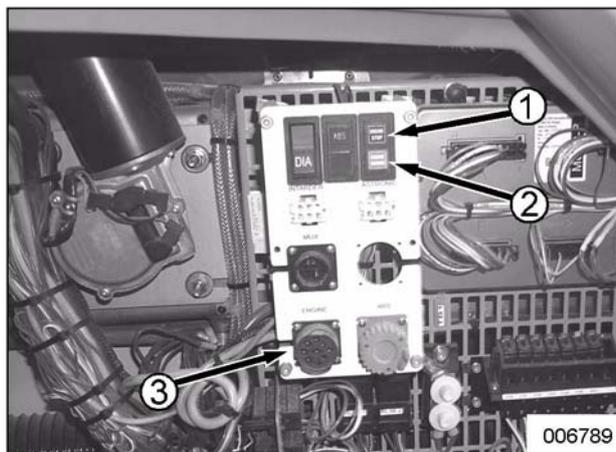
As to the meaning of an "active fault", refer to "EDC system: fault reproduction".

Engine diagnostic lamps

The engine diagnostics lamps are located on the diagnostics panel in the front junction box. Upon request, they show the active faults of the fault memory by means of a flash code.

continued on next page

Figure:
components
for engine
diagnostics



Diagnostics panel in front junction box (EKF)

- 1 "STOP ENGINE" lamp
- 2 "ENGINE WARNING" lamp
- 3 Engine diagnostic socket

To call up flash code

Step	Action
1	Switch on on-board voltage.
2	<p>Unlock the diagnostics switch on the dashboard and press it.</p> <p>The diagnostics lamps show the contents of the fault memory.</p> <ul style="list-style-type: none"> • In the case of an active fault: both diagnostics lamps come on momentarily, then the fault code is shown ("ENGINE WARNING" lamp (2) flashes once, then "STOP ENGINE" lamp (1) gives the flash code). • If there are no active faults: "ENGINE WARNING" lamp (2) and "STOP ENGINE" lamp (1) come on and remain lit.

Several active faults

Each fault code is shown three times. After that, the following code is shown.

If you want to call the ... yourself	put the...
next code	"RES/ACCEL-SET/COAST" switch on the dashboard momentarily in the "RES/ACCEL" position.
previous code	"RES/ACCEL-SET/COAST" switch on the dashboard momentarily in the "SET/COAST" position.

continued on next page

**List with fault
codes**

Refer to Cummins literature.

To drain fuel filter

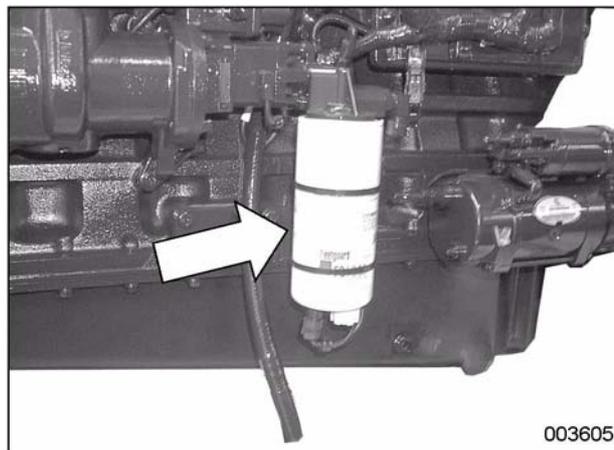
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Engine stopped

Figure: fuel filter



WARNING!

The water in the filter is toxic and carcinogenic. Avoid contact with skin. Drain the fuel filter into a container and dispose of the water in accordance with environmental regulations.

Procedure

Step	Action
1	Open the drain valve at the bottom of the filter and allow the water to drain.
2	Close the drain valve as soon as nothing but clean fuel comes out.

To change fuel filter

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

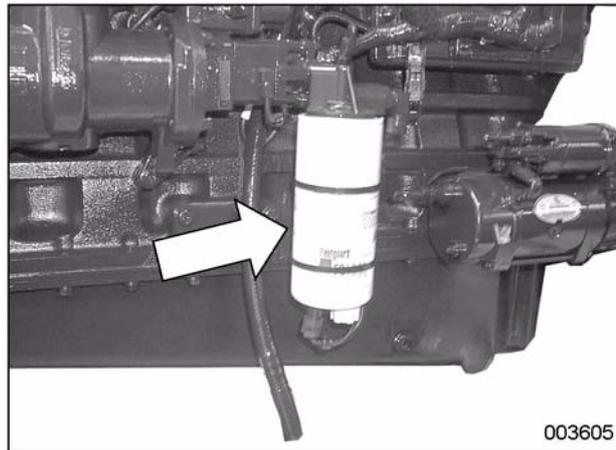
Consumables

Filter element	Cummins No. 3329289
----------------	---------------------

Equipment condition

Area around filter holder cleaned

Figure: fuel filter



To change fuel filter

Step	Action
1	Open the drain valve at the bottom of the filter for 5 seconds. This will prevent fuel from running over the top edge of the filter element upon removal.
2	Disconnect the water-in-fuel sensor at the bottom of the filter.
3	Unscrew and remove the filter element using a strap wrench.
4	 WARNING! Dispose of the fuel from the old filter element in accordance with environmental regulations. Empty the old filter element into a bowl.
5	Wet the sealing-ring of the new filter element with lubricating oil.

continued on next page

Step	Action
6	Fill the new filter element with clean fuel.
7	Screw the new filter in place. Follow the instructions from the filter manufacturer.
8	Reconnect the "water-in-fuel" sensor.
9	Start the engine and check for leaks.

Chapter 22: Air intake system

Overview

Introduction This chapter deals with the air intake system.

Number of pages 12

Chapter publication date 19 September 2006

Contents

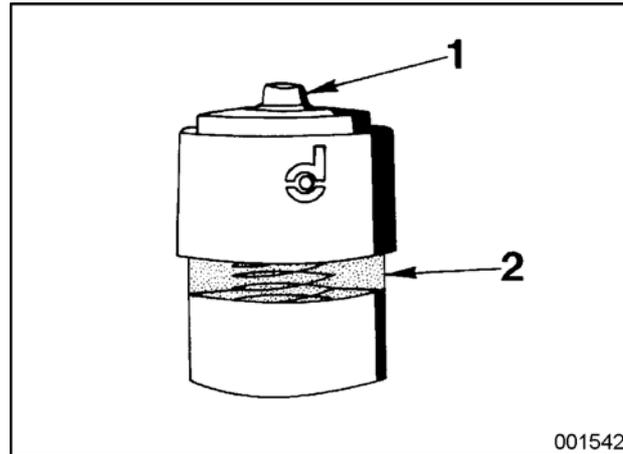
Topic	See page
To check air filter condition	2.22-2
To check air-filter service indicator	2.22-3
To check air-filter dust evacuation valve	2.22-5
To change air-filter element	2.22-6
To clean exterior of charge-air cooler	2.22-8
Technical data: air intake system	2.22-10
Special tools: air intake system	2.22-11

To check air filter condition

To be carried out when?

Before commencing daily service.

Figure: air-filter service indicator



1 Reset button

2 Window

Procedure

Check the condition of the air filter by observing the service indicator.

If...	then ...
, with the engine off, the red plunger appears in window (2),	the air-filter element should be changed as soon as possible.

To check air-filter service indicator

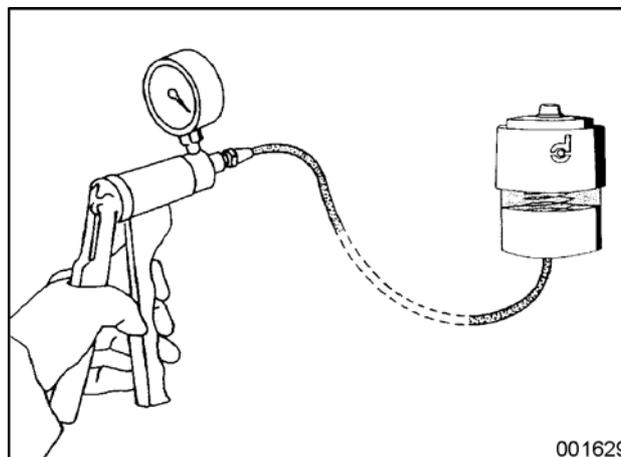
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking values

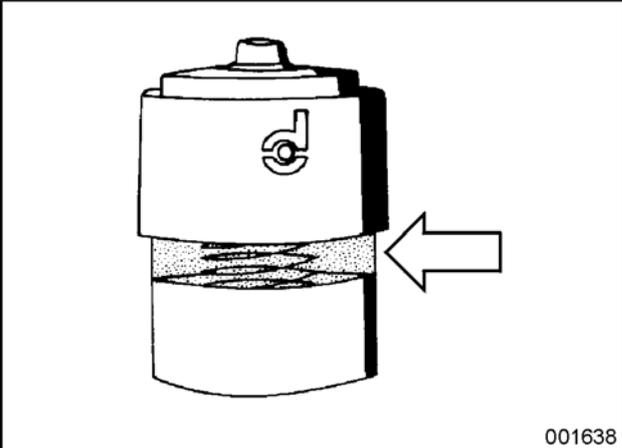
Refer to "Technical data" at the end of this chapter.

Figure: to check air-filter service indicator



Procedure

Step	Action
1	Disconnect the hose of air-filter service indicator at the air-filter outlet.
2	Connect the hose end to a small vacuum pump (available from retail trade).

Step	Action
3	<p>Actuate the pump until the pressure gauge of the pump registers the pressure indicated in the technical data.</p> <p>A red plunger should rise in the window of the service indicator.</p> <div style="text-align: center;"><p>001638</p></div>
4	<p>Disconnect the vacuum pump. The atmospheric pressure is restored at the service indicator.</p> <p>The red plunger should stay in the window.</p>
5	<p>Change indicator, if red plunger responds too soon, too late or not at all.</p> <p><i>NOTE: The field in the window must not be red anymore when the service indicator is put back into service after checking. Press the service indicator reset button to clear the window again as necessary.</i></p>

To check air-filter dust evacuation valve

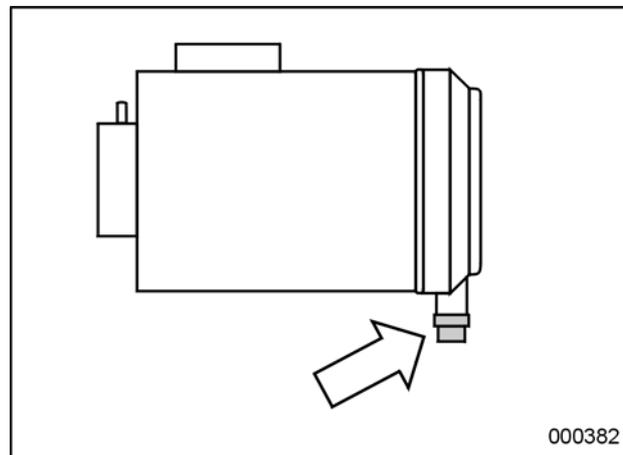
To be carried out when?

Regularly

Function of dust evacuation valve

The dust evacuation valve automatically expels the dust collected in the filter while the engine is running.

Figure: air-filter dust evacuation valve



Procedure

Squeeze the rubber valve by hand regularly to open the evacuation slot. This way you prevent the slot from sticking shut due to air humidity.

To change air-filter element

To be carried out when?

When the air restriction indicator's red signal remains visible after engine shutdown. The element should be discarded in any case after 1 year.

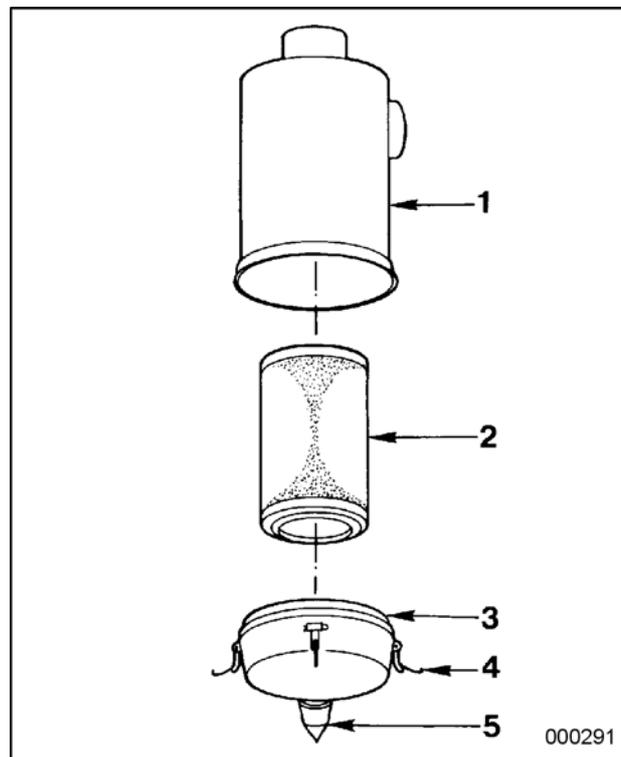
Consumables

Air-filter element	Van Hool No. 11064358
--------------------	-----------------------

Equipment condition

Engine stopped

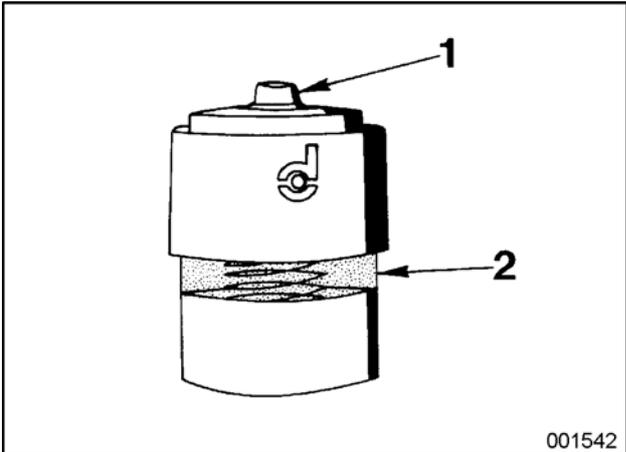
Figure: air filter



- 1 Filter housing
- 2 Filter element
- 3 Dust pan
- 4 Toggle clips
- 5 Dump valve

continued on next page

Procedure

Step	Action
1	Release toggle clips (4) and remove dust pan (3).
2	<p><i>NOTE: Detaching and removing the filterelement have to be done with great care, so that no dust is released in the air. Do not knock the element against the air-filter housing.</i></p> <p>Sometimes the rubber O-ring of the filter element sticks somewhat to the filter housing. To detach the O-ring, turn the filter element alternately to the left and to the right. Pull the element off the outlet tube and remove it from the air-filter housing.</p>
3	Check the old filter element. A stripe of dust at the inside of the element means that there is something wrong. In that case, first determine the cause before mounting a new element.
4	Clean the inside of the air-filter housing and outlet tube with a damp cloth.
5	 <p>CAUTION!</p> <p>Apply pressure at the reinforced outer rim of the element only, not in the centre.</p> <p>Inspect new element for damage. Install element in air-filter housing and push it onto outlet tube.</p>
6	Install the dust pan onto the filter housing so that dump valve (5) is pointing downward and close toggle clips (4).
7	<p>Press button (1) to make the red plunger inside window (2) disappear.</p>  <p style="text-align: right;">001542</p>

To clean exterior of charge-air cooler

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Cleaning product

Detergent P3-Grato 12 by Henkel, or similar product

Special tools

Cleaning tool	Van Hool No.10527208
---------------	----------------------



WARNING!

Wear a dust mask, when cleaning with compressed air.

Nature of dirt

Nature of dirt	Cleaning medium
Dry dust or sand	Compressed air (approximately 115 psi)
Tenacious dirt	Water + detergent. <i>NOTE: Van Hool recommend the use of P3-Grato 12 by Henkel.</i>

To use P3-Grato 12

Mix a quantity of P3-Grato 12 with a similar volume of water. Follow the instructions on the packaging.

NOTE: According to its manufacturer this detergent contains neither corrosive nor toxic agents.

Procedure

Step	Action
1	Carry out steps 1 up to and including 5, as mentioned in chapter 2.34 "To clean exterior of radiator".
2	Insert T-headed cleaning tool (with holes towards charge-air cooler, this means to front of vehicle) into gap between radiator and charge-air cooler.

continued on next page

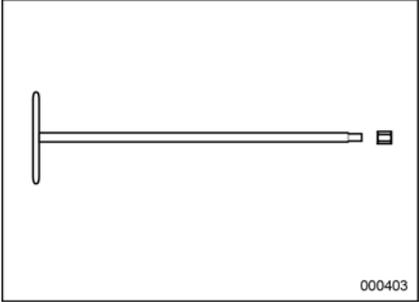
Step	Action
3	 CAUTION! If the cleaning tool is not flat against the radiator surface when you open the pressure supply, the reaction force of the pressure jets will make the tool lash backward and the radiator will be damaged. Hold tool flat against front of radiator and open pressure supply.
4	Move the cleaning tool back and forth while holding it flat against the radiator.

Technical data: air intake system

**Air-filter
service
indicator**

Preset restriction limit	25 in H ₂ O
--------------------------	------------------------

Special tools: air intake system

Ordering number	Description	Figure
Van Hool 10527208	Cleaning tool for radiator and charge-air cooler	

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Chapter 30: Exhaust system

Overview

Number of pages

14

Chapter publication date

21 December 2007

Contents

Topic	See page
Exhaust aftertreatment system: CRT principle	2.30-2
Exhaust aftertreatment system: to regenerate particulate filter (DPF)	2.30-4
Exhaust aftertreatment system: to change particulate filter (DPF)	2.30-8
Technical data exhaust system	2.30-13

Exhaust aftertreatment system: CRT principle

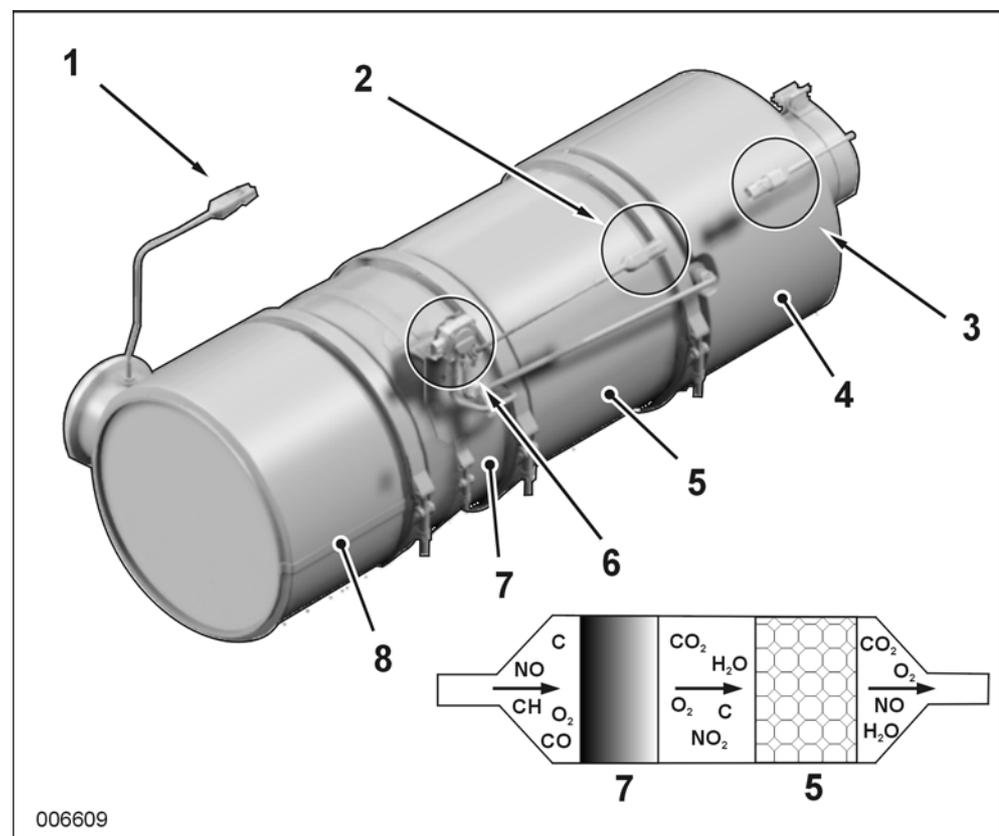
CRT?

The vehicle has been equipped with an exhaust aftertreatment system. "CRT" stands for "Continuously Regenerating Trap".

Parts

The exhaust aftertreatment system consists of an oxidation catalyst (DOC) and a particulate filter (DPF). The device has been equipped with three temperature sensors and a differential pressure sensor checking its operation.

Figure: CRT exhaust after-treatment system (example)



- 1 Temperature sensor
- 2 Temperature sensor
- 3 Temperature sensor
- 4 Outlet module
- 5 Particulate filter module
- 6 Differential pressure sensor
- 7 Catalyst module
- 8 Inlet module

continued on next page

**Oxidation
catalyst (DOC)**

Consists of a ceramic structure on which a noble metal has been vaporized. The noble metal serves as a catalyst for the hydrocarbons (CH) and the carbon monoxide (CO). Together with the oxygen in the excess air, the noble metal starts up a chemical reaction. Hence the name oxidation catalyst.

In the oxidation catalyst, the following transformations take place,

- $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
- $2\text{CO} + \text{O}_2 \rightarrow 2\text{CO}_2$
- $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$

**Particulate
filter (DPF)**

Most of the soot particles containing carbon and ash are captured in the particulate filter.

What happens with the carbon?

Once the self-cleaning temperature is reached (approx. 570°F), the carbon reacts with the nitrogen dioxide and burns to become carbon dioxide. This process is called regeneration.

- $2\text{NO}_2 + \text{C} \rightarrow 2\text{NO} + \text{CO}_2$

What happens with the ash?

The ash particulates can only be removed by cleaning the filter. To this end, the manufacturer of the exhaust aftertreatment system works with an exchange system. The contaminated filter module is exchanged for a cleaned unit at a certain cost.

Exhaust aftertreatment system: to regenerate particulate filter (DPF)

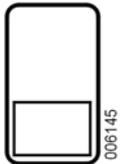
What is regeneration?

Refer to "Exhaust aftertreatment system: CRT principle".

Messages on multifunctional display

Symbol	Message
	DPF regeneration required Also appears for a few seconds when ignition is switched on.
	High exhaust temperature. The fact that this symbol appears does not mean that there is an engine problem. It only warns you of a high exhaust temperature due to a regeneration. Make sure the exhaust pipe is not directed toward a surface that will burn or melt at high temperature (grass, ..., asphalt!) <i>NOTE: Only appears at low vehicle speed.</i> Also appears for a few seconds when ignition is switched on.
DPF REGENERATION ACTIVE	The particulate filter goes through a stationary regeneration
DPF REGENERATION INHIBITED	DPF regeneration switch in regeneration inhibited position

Dash switch

Switch	Function
	DPF regeneration switch <ul style="list-style-type: none"> • Upper part pressed: regeneration inhibited • Middle position: off • Lower part pressed: to request a stationary regeneration

continued on next page

When to regenerate?

If the particulate filter...	then ...
reaches the self-cleaning temperature while driving	regeneration takes place automatically. You don't have to take any action yourself.
does not reach the self-cleaning temperature while driving (e.g. due to frequent stopping)	the "DPF regeneration" symbol will appear after a while. This means that you have to intervene to start the regeneration.

"DPF regeneration" symbol: warning phases

There are four warning phases:

- Phase 1: The "DPF regeneration" symbol appears to indicate that the particulate filter has to be regenerated at the next opportunity.
- Phase 2: The "DPF regeneration" symbol flashes to indicate that regeneration has to be performed immediately.
- Phase 3: The "DPF regeneration" symbol flashes together with the "ENGINE WARNING" message. Regeneration has to be performed immediately. Engine power is reduced automatically.
- Phase 4: If you wait any longer, the "STOP ENGINE" message appears. Switch off engine and ask for technical assistance.

How to start regeneration?

- Go for a ride maintaining a high speed for at least 20 minutes (highway) or...
- perform a stationary regeneration.

To perform a stationary regeneration**WARNING!**

During a stationary regeneration, engine speed can increase up to 1 000 to 1 500 rpm.

NOTE: Only perform stationary regeneration with warm engine (coolant temperature above 185°F).

Step	Action
1	Select an appropriate location to park the vehicle. Refer to "Appropriate location for stationary regeneration".
2	Apply the parking brake.
3	Make sure the transmission is in neutral position.
4	Put chocks in front of and behind the wheels.

continued on next page

Step	Action
5	Set up a safety area around the exhaust. Refer to "Safety area around exhaust".
6	<p>Carry out the actions below within a 35 seconds time limit:</p> <ul style="list-style-type: none"> • Release the parking brake and reapply it. • Put transmission from N to D and back to N. • Press the lower part of the DPF regeneration switch during 5 to 10 seconds. <p>The stationary regeneration is initiated. The engine speed increases and the "DPF-regeneration" symbol disappears.</p>
7	<div style="display: flex; align-items: center;"> <p>WARNING!</p> </div> <p>If an unsafe situation occurs, stop the regeneration process immediately by pushing the brake pedal or by switching off the engine. Regeneration is also stopped if you put the "DPF regeneration" switch in the "INHIBIT REGEN" position.</p> <p>Observe the vehicle and its immediate surroundings during regeneration.</p> <p>The regeneration process takes 20 to 40 minutes. The regeneration has succeeded if the engine speed automatically returns to idling speed and if the "DPF regeneration" symbol does not reappear.</p> <p>If the "DPF regeneration" symbol reappears, the regeneration process has failed. In that case, ask for technical assistance.</p>

To inhibit/ interrupt regeneration

If regeneration causes hazardous situations (e.g. at a stop), you can inhibit/ interrupt the regeneration process. To this end, press the upper part of the DPF regeneration switch.

Appropriate location for stationary regeneration

- Surface that will not start to burn or to melt under high temperatures (such as clean concrete; no grass or asphalt!);
- Away from anything that can burn, melt or explode;
- Not near gas or vapors that can ignite, explode or contribute to a fire (such as LPG, diesel vapors, ...).

Safety area around exhaust

- If bystanders can access the area, set up barriers at least 5 ft away from the exhaust.

continued on next page

- If regeneration takes place in a confined space, connect an exhaust gas evacuation system to the exhaust pipe. The evacuation system has to resist temperatures of at least 1500°F.
 - Keep a fire extinguisher nearby.
-

Exhaust aftertreatment system: to change particulate filter (DPF)

Application Vehicles with Cummins ISM07 engine

To be carried out when? Refer to chapter 1.1, "Maintenance schedule".

Consumables

Particulate filter module	Cummins no. 4965244 NX
Gasket (2x)	Cummins no. 3684079

Tightening torques Refer to "Technical data" at the end of this chapter.

Equipment condition Exhaust aftertreatment device cold



WARNING!

Handle the exhaust aftertreatment device with care. It contains fragile ceramic material.



WARNING!

The material captured in the particulate filter may contain elevated concentrations of metals, zinc and molybdenum, and possibly also polynuclear aromatic hydrocarbons subject to regulation. This material should be handled and removed in accordance with local regulations.

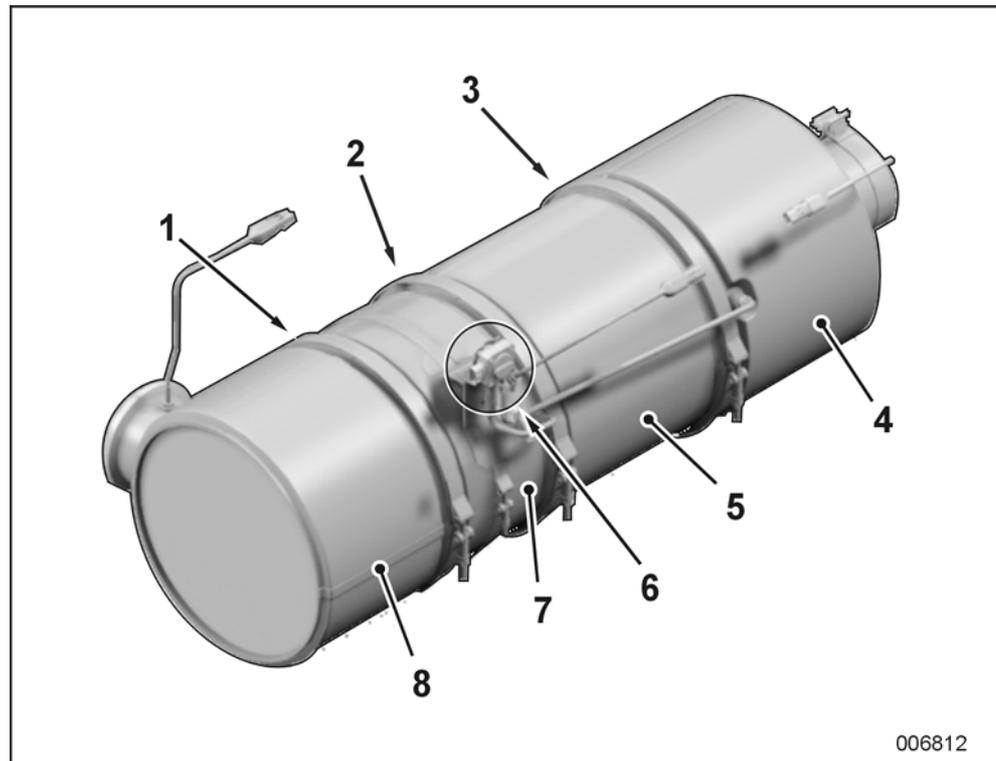


WARNING!

The exhaust aftertreatment device weighs more than 50 lbs (depending on the type up to 150 lbs). Use a lifting device for removing/installing.

continued on next page

Figure:
exhaust after-
treatment
device



- 1 V-band clamp with gasket
- 2 V-band clamp with gasket
- 3 V-band clamp with gasket
- 4 Outlet module
- 5 Particulate filter module
- 6 Differential pressure sensor
- 7 Catalyst module
- 8 Inlet module

**To remove the
particulate
filter**

Step	Action
1	Remove the exhaust aftertreatment device entirely from the vehicle.
2	Mark the position of the modules and the V-band clamps. To this end, draw a line over the full length of the device, on the modules as well as on the V-band clamps.

Step	Action
3	 <p>CAUTION!</p> <p>If the hoses of the tubes on the differential pressure sensor are hard to loosen, it is best to cut them loose and replace them. Rotating and bending the hoses can damage the sensor.</p> <p>Mark the tubes on the differential pressure sensor (to avoid confusion when reconnecting them later on). Disconnect the tubes at the differential pressure sensor.</p>
4	 <p>CAUTION!</p> <p>Do not use compressed-air tools to remove the nuts of the V-band clamps. The use of such equipment will damage the thread of the fixing bolts. Apply a drop of oil to the thread of the fixing bolt before removing the nut.</p> <p>Loosen the V-band clamps that secure the particulate filter module to the catalyst module and outlet module. Remove the V-band clamps.</p>
5	Bring the contaminated particulate filter module to a Cummins shop where, at a certain cost, you can exchange it for a clean one

To mount the particulate filter

Step	Action
1	 <p>CAUTION!</p> <p>Do not use a grinder to remove the residual gasket material on the mounting flanges of the modules. The grinder can damage the mounting flanges causing the connection to leak.</p> <p>Discard the used gaskets. Using a scraper, remove all the dirt from the mounting flanges of the particulate filter module, the catalyst module and the outlet module. Inspect the mounting flanges for damage.</p>
2	Inspect the tubes of the differential pressure sensor for clogging. Procedure, refer to "To check the tubes of the differential pressure sensor" further in the text.
3	Inspect the V-band clamps for damage (deformation, damaged thread). If necessary, replace the clamps.

continued on next page

Step	Action
4	Apply Never-Seez to the thread of the V-band clamps.
5	Install new gaskets and secure the particulate filter module to the catalyst module and the outlet module. Pay attention to the arrow stamped on the cleaned particulate filter housing. The arrow must point in the direction of the exhaust flow. Align the various modules and V-band clamps (use the line drawn during removal as a reference).
6	 <p>CAUTION!</p> <p>Do not use a compressed-air tool to mount the nut of the V-band clamp. The use of such equipment will damage the thread of the fixing bolt.</p> <p>Slightly tighten the nuts of the V-band clamps so that final aligning of the differential pressure tubes remains possible.</p>
7	Secure the tubes of the differential pressure sensor. Pay attention to the marks applied during removal. Tighten the nuts of the tubes to the prescribed torque.
8	Tighten the nuts of the V-band clamps to the prescribed torque.
9	Mount the whole of the exhaust aftertreatment device. Reconnect the electrical sensor connectors.
10	Start the engine and check the exhaust system for leaks.
11	Carry out a stationary regeneration. This ensures that the value stored in the ECU memory for ash fouling is reset.

To check the tubes of the differential pressure sensor

Step	Action
1	Remove the tubes of the differential pressure sensor at the catalyst module and at the outlet module.
2	Clean the inside as well as the outside of the tubes with a safe solvent. If the tube is partially clogged, it may be necessary to put the tube in a bath filled with safe solvent. After that, use a tube cleaner to clear the inside.
3	Remove the dirt at the ends of the tubes but be careful not to damage the tubes. If the tube is completely clogged or unfit to clean, install a new tube. Dry the tube with compressed air. Check the tube for cracks and damaged thread. Replace the tube if it is damaged.
4	Inspect the thread of the tapped holes on the catalyst and outlet modules that have to receive the differential pressure sensor tubes. Remove the dirt but be careful not to damage the thread.

continued on next page

Technical data exhaust system

Tightening torques

Exhaust aftertreatment device: V-band clamps	15 ft.lbf
Exhaust aftertreatment device: tubes of differential pressure sensor to catalyst module and outlet module	13 ft.lbf

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Chapter 34: Cooling system

Overview

Introduction This chapter deals with the cooling system.

Number of pages 26

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety instructions relating to cooling system	2.34-2
Coolant for Cummins engine	2.34-4
To check coolant level	2.34-6
To check DCA4-concentration	2.34-8
To change DCA4 element	2.34-9
To check/clean radiator compartment mesh screen	2.34-11
To clean radiator exterior	2.34-12
To check condition of water hoses	2.34-14
Hose clamp types	2.34-15
To check hose clamps tightening torque	2.34-16
Fan clutch types	2.34-17
Fan clutch operation	2.34-18
To determine remaining service life span of fan clutch	2.34-21
Technical data: cooling system	2.34-24
Special tools: cooling system	2.34-26

Safety instructions relating to cooling system

**WARNING!**

Antifreeze and coolant with antifreeze contain the toxic chemical ethylene glycol. Hazardous for ingestion or inhalation of fumes. Causes irritation upon contact with the eyes. In the event of ingestion, have a first-aider cause the victim to vomit (if conscious); in the event of inhalation, move the victim into the open air. Seek medical assistance in both cases. In the event of contact with the eyes, rinse the eyes with ample water. If eye irritation develops, consult an eye doctor.

**WARNING!**

Fleetguard DCA4 contains alkaline. Take care that it does not get into your eyes. In the event of contact with the eyes, rinse the eyes with ample water for at least 15 minutes. Seek medical assistance. Avoid prolonged or repeated contact with the skin. In the event of contact, wash the skin with soap and water immediately. Keep out of children's reach.

**WARNING!**

Never open the coolant expansion tank filler cap or pressure relief cap if the coolant temperature gauge indicates more than 122 °F. The pressure could cause hot water to squirt outward and cause scalds.

**WARNING!**

If the filler cap or pressure relief cap of the coolant expansion tank has to be opened with hot engine, first turn it carefully counterclockwise to the first stop and let the pressure escape. Then continue to turn it to the second stop and remove the cap.

**CAUTION!**

Never add cold coolant, when the engine is hot. The sudden cooling could cause parts of the engine block to crack.

Coolant for Cummins engine

**WARNING!**

Coolant contains the toxic chemical ethylene glycol. Hazardous for ingestion or inhalation of fumes. Causes irritation upon contact with the eyes. In the event of ingestion, have a first-aider cause the victim to vomit (if conscious); in the event of inhalation, move the victim into the open air. Seek medical assistance in both cases. In the event of contact with the eyes, rinse the eyes with ample water. If eye irritation develops, consult an eye doctor.

Which coolant to use?

Refer to chapter 1.1, "Fluids and lubricants".

Antifreeze concentration

NOTE: Fresh fully formulated coolant contains 50% antifreeze. This concentration protects against frost to approximately -25 °F. If you expect exterior temperature to drop below -25 °F, increase antifreeze concentration according to the instructions given by Cummins. Antifreeze concentrations higher than 60% are not allowed.

To protect the system against corrosion and deposits, at least 40% of the coolant volume has to consist of antifreeze, both in winter and summer. This concentration protects against frost up to -12 °F.

How to measure antifreeze concentration?

To measure the concentration, use a refractometer (Fleetguard No. C2800).

Fleetguard DCA4

Fleetguard DCA4 is a coolant additive that provides added protection for the engine and metal parts of the cooling and heating system.

**WARNING!**

Fleetguard DCA4 contains alkaline. Take care that it does not get into your eyes. In the event of contact with the eyes, rinse the eyes with ample water for at least 15 minutes. Seek medical assistance. Avoid prolonged or repeated contact with the skin. In the event of contact, wash the skin with soap and water immediately. Keep out of children's reach.

DCA4 concentration

The effectiveness of the Fleetguard protection system depends on the correct quantity of DCA4 in the coolant system. Regularly check the concentration level using the Fleetguard CC2626 test kit.

When to change coolant?

- Because, when in use, antifreeze loses its protective qualities over time, you need to check the coolant annually to determine if it needs to be changed. Contact Cummins for further information.
- All coolant (engine circuit and interior heating) must also be changed, after a new engine, radiator or water-cooled retarder has been installed. The reason is that only fresh coolant contains sufficient additives to create an effective basic protective layer on new metal parts.

To dispose of coolant

Antifreeze, DCA4 or coolant must not be disposed of through the sewer.

To check coolant level

To be carried out when?

Before commencing daily service.

Equipment conditions

Cold engine

**WARNING!**

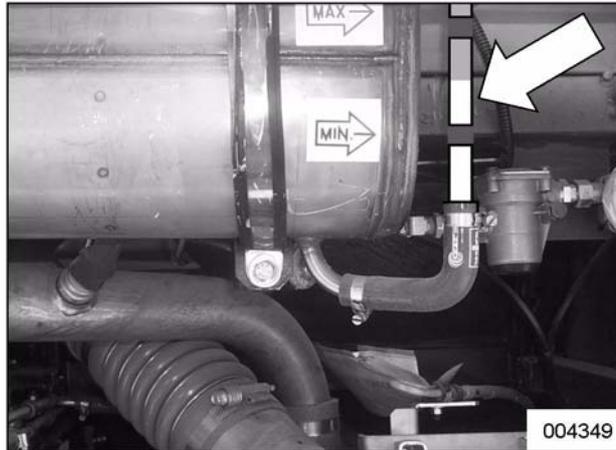
Never open the filler cap if the coolant thermometer indicates more than 122 °F. The pressure could cause hot water to squirt outward and cause scalds.

**WARNING!**

If the filler cap has to be opened with a warm engine, first carefully turn it counterclockwise to the first stop and let the pressure escape. Then turn to the second stop and remove the cap.

**CAUTION!**

Never pour cold coolant in the expansion tank when the engine is hot. The sudden cooling could cause parts of the engine block to crack.

**Figure:
coolant level**

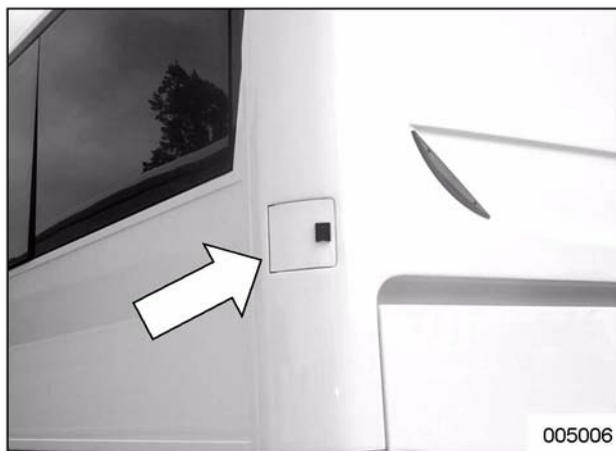
The coolant expansion tank is located in the engine compartment.

**Proper coolant
level**

The coolant level is correct if it is between the "MIN" and "MAX" marks of the expansion tank.

**To top up with
coolant**

To top up, always use fully formulated ethylene glycol coolant according to "Cummins Engineering Standard 14603". If you add "pure" water, the concentration of the protective agents in the system would be reduced, thus increasing the risk of deposits, corrosion and freezing.

**Figure: access
to expansion
tank filler cap**

The filler cap can be reached through the exterior access door on the far back left side.

To check DCA4-concentration

Introduction

The coolant is a mixture of water, antifreeze and Fleetguard DCA4. Fleetguard DCA4 is an additive that provides added protection for the engine and metal parts of the cooling and heating system.

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Special tools

Test kit for measuring the DCA4-concentration	Fleetguard No. CC2602
---	-----------------------



CAUTION!

Inadequate concentration of DCA4 can bring about major corrosive damage to metal components of the cooling system. On the other hand, overconcentration may result in the formation of a "gel". This gel causes restriction and blockages in coolant lines, or overheating.

Procedure

Follow the instructions supplied with the test kit.

Interpreting the measurement

DCA4 concentration	Evaluation	What to do?
Less than 1.2 units per gallon	Too low	Change the DCA4-element and add 1/4 gallon of liquid DCA4 for each 8 gallons of coolant.
Between 1.2 and 5 units per gallon	Good	Change the DCA4 element.
Higher than 5 units per gallon	Too high	Wait to replace the DCA4 element, until the concentration falls below 5 units per gallon.

To change DCA4 element

To be carried out when?

Refer to "To check DCA4 concentration".

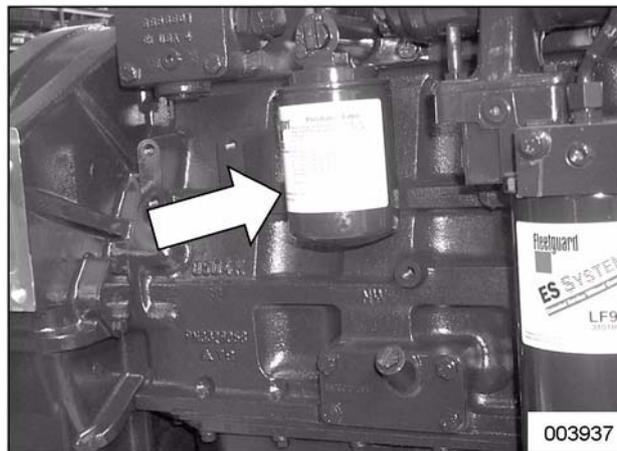
Consumables

DCA4 element	
--------------	--

Equipment condition

- Cold engine
- Area around filter holder cleaned

Figure: DCA4 element



On left side of engine



WARNING!

Never open the filler cap if the coolant thermometer indicates more than 122 °F. The pressure could cause hot water to squirt outward and cause scalds.

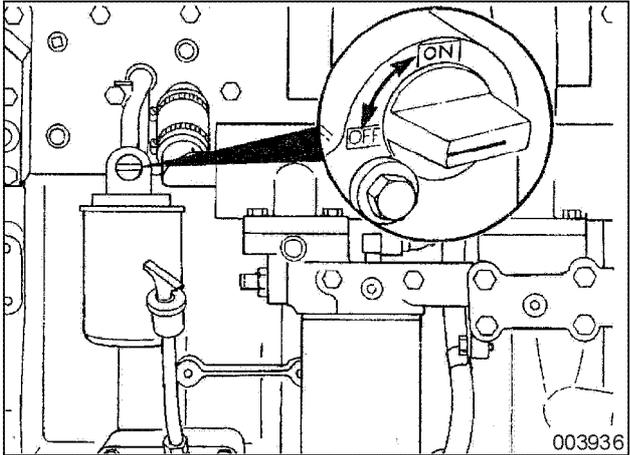


WARNING!

If the filler cap has to be opened with a warm engine, first carefully turn it counterclockwise to the first stop and let the pressure escape. Then turn it to the second stop and remove the cap.

continued on next page

Procedure

Step	Action
1	Remove the filler cap from the coolant expansion tank.
2	Turn the knob of the valve on the DCA4 element holder to the "OFF" position. 
3	Unscrew the DCA4 element from its holder using a strap wrench. Clean the element seat on the holder.
4	 <p>CAUTION! Make sure no engine oil gets into DCA4 element. Oil will damage DCA4.</p> <p>Apply a light film of engine oil to the sealing-ring of the new DCA4 element.</p>
5	 <p>CAUTION! Do not use any tools to tighten DCA4 element. Overtightening of the element can distort the threads or the holder.</p> <p>Screw the DCA4 element onto the holder until tight. Turn the element another 1/2 to 3/4 turn to seal it, or follow the filter manufacturer's instructions.</p>
6	Turn the knob of the valve on the DCA4 element holder to the "ON" position.
7	Screw the filler cap onto the coolant expansion tank.
8	Start the engine and check for leaks.

To check/clean radiator compartment mesh screen

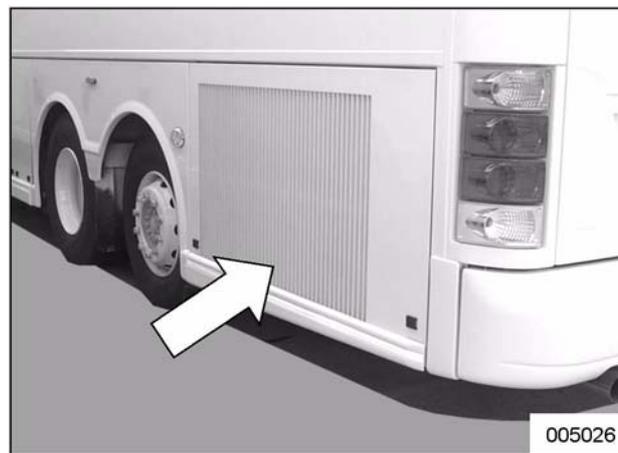
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Function of mesh screen

The mesh screen prevents bigger dirt particles from being sucked in by the fan.

Figure: mesh screen



WARNING!

Wear a dust mask, when cleaning mesh screen with compressed air.

How to clean?

Depending on dirt nature, clean mesh screen with vacuum cleaner, with compressed air or with water or steam jet.

To clean radiator exterior

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Cleaning product

Detergent P3-Grato 12 by Henkel, or similar product

Special tools

Cleaning tool	Van Hool No. 10527208
---------------	-----------------------



WARNING!

Wear a dust mask, when cleaning with compressed air.

Nature of dirt

Nature of dirt	Cleaning medium
Dry dust or sand	Compressed air (approximately 116 psi)
Tenacious dirt	Water + detergent <i>NOTE: Van Hool recommend the use of P3-Grato 12 by Henkel.</i>

To use P3-Grato 12

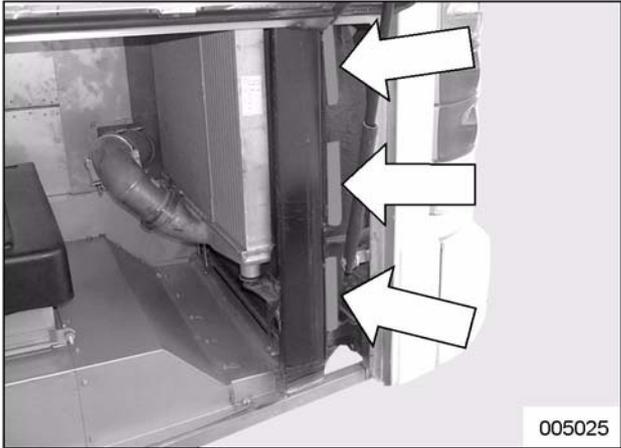
Mix a quantity of P3-Grato 12 with a similar volume of water. Follow the instructions on the packaging.

NOTE: According to its manufacturer this detergent contains neither corrosive nor toxic agents.

Procedure

Step	Action
1	Open the exterior door on the left-hand side at the very rear.
2	Use compressed air to blow all leaves, paper and other debris from the spaces between the radiator and the charge-air cooler.

continued on next page

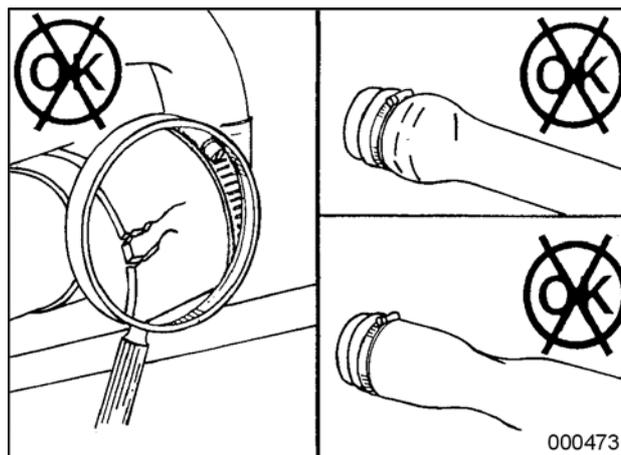
Step	Action
3	<p>Connect cleaning tool to an air hose or a high-pressure cleaner, depending on dirt nature and severity.</p> <p><i>NOTE: If you have to clean with water, set high-pressure cleaner to 140 to 176 °F and make sure pressure does not exceed 1450 psi.</i></p>
4	<p>Insert T-headed cleaning tool with holes towards radiator (this means towards vehicle front) into the gaps in the fan shroud. Move the cleaning tool back and forth.</p> <div style="text-align: center;">  </div>
5	<p>Remove dirt from the space between radiator and charge-air cooler.</p>
6	<p>Clean the charge-air cooler, refer to "To clean exterior of charge-air cooler" in chapter 2.22.</p>
7	<p>Insert T-headed cleaning tool into gap between radiator and charge-air cooler, so that the holes are directed towards the radiator (i.e. the back of the vehicle).</p>
8	<div style="display: inline-block;">  </div> <p>CAUTION!</p> <p>When opening the pressure supply, the cleaning tool must be placed flat against the charge-air cooler, otherwise the reaction force of the pressure jets will cause the tool to lash backward and damage the charge-air cooler.</p> <p>Hold tool flat against back of charge-air cooler and open pressure supply.</p>
9	<p>Move the cleaning tool back and forth while holding it flat against the charge-air cooler.</p>
10	<p>If necessary, repeat the procedure until all air passages are open.</p>

To check condition of water hoses

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: faulty water hoses



When to change water hoses?

Change cracked, cut, bulging or collapsed hoses (see figure).

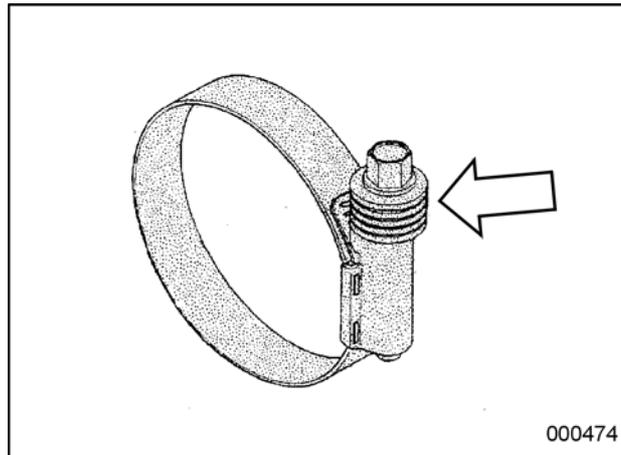
Hose clamp types

Introduction

The hose clamp types used on your vehicle are the standard screw and the constant torque.

A constant torque clamp can be identified by the spring washers under the screw head

Figure: constant torque hose clamp



The arrow points out the spring washers

To check hose clamps tightening torque

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Tightening torques

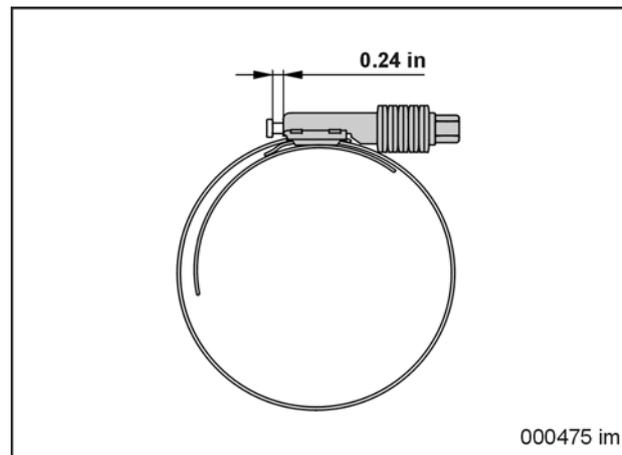
Refer to "Technical data" at the end of this chapter.

Retorque constant torque hose clamps?

Constant torque hose clamps keep their sealing pressure, when the hose swells or shrinks. Therefore they need not be retorqued after installation.

Visual torque check: the screw tip of a properly torqued constant torque clamp extends approximately 0.24 in beyond the housing.

Figure: checking value of constant torque hose clamps



Fan clutch types

What clutch type on your vehicle?

Your vehicle can be equipped with a 2-speed (one step) or 3-speed (two step) clutch.

Clutch type	Identification
2-speed	One single connector on the clutch unit.
3-speed	Two connectors on the clutch unit (one for each clutch step).

Fan clutch operation

Introduction

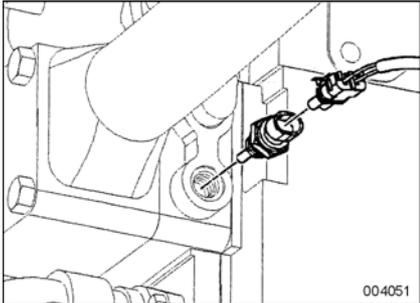
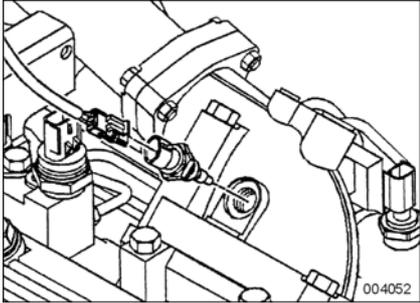
The fan clutch switches in and out according to:

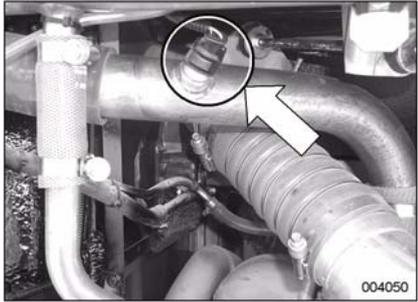
- coolant temperature and...
- intake air temperature.

Coolant temperature as well as intake air temperature are measured by sensors of the engine management system. It is the control unit of the engine management system that switches on the fan clutch if the temperature becomes too high.

NOTE: Vehicles with an Allison WTB500R or ZF Astronic transmission have a supplementary temperature switch in the water pipe to the radiator.

Location of temperature sensors/temperature switch

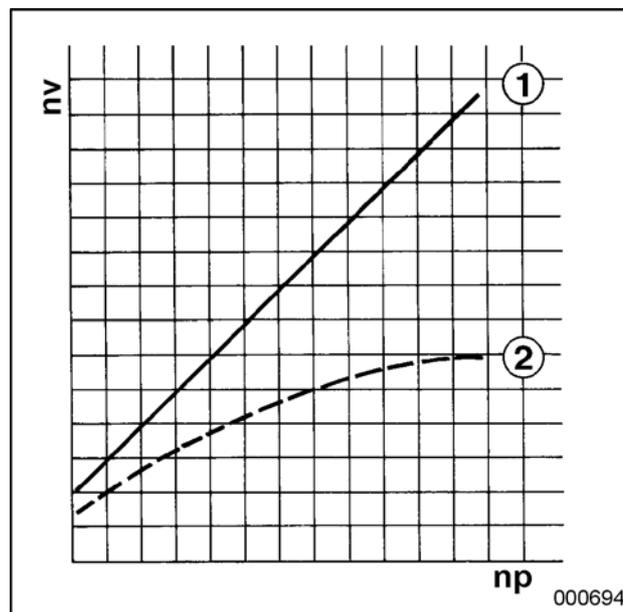
Element	Location
Coolant temperature sensor of engine management system	 <p><i>In thermostat housing of the engine.</i></p>
Intake air temperature sensor of engine management system	 <p><i>In air-intake manifold of the engine.</i></p>

Element	Location
Coolant temperature switch	 <p><i>In the water pipe to the radiator.</i></p>

Operation

If...	then ...
the electrical circuit of the clutch is dead	the fan will be taken along by the permanent magnetic force of the drive part of the clutch. There is no mechanical connection (eddy current system). Fan speed is lower than drive pulley speed due to slip between clutch parts.
the electrical circuit of the magnet coils closes	the clutch parts will be pressed together, forming a rigid mechanical drive. In this condition the fan speed equals the drive pulley speed.

Figure:
diagram of
operation



Relation between fan speed and fan drive speed.

1 Clutch closed

2 Clutch open

n_v fan speed

n_p drive pulley speed

To determine remaining service life span of fan clutch

Introduction

As the Linnig clutch wears progressively, the air gap between the clutch plates will become larger. The larger the air gap, the stronger the magnetic field – and therefore the higher the voltage – needed to bring the plates together. The remaining service life span of the fan clutch unit can be determined by measuring this cut-in voltage.

Clutch types

Refer to 'Fan clutch types'.

Tools

DC electrical power supply with a voltage range of 10 to approx. 30 V and an amp rating of at least 3 A.

Procedure for 2-speed clutch

Step	Action
1	Disconnect connector of fan clutch.
2	Connect power supply to fan clutch.
3	Set adjustable power supply to 10 V.
4	As you are turning the fan to and fro by hand, slowly increase voltage, until at one particular point you feel the fan clutch impede or lock the fan (clutch engaged with an audible clicking).
5	Take note of cut-in voltage value and look up remaining service life span (in percentage) in table.
6	Calculate remaining life span in miles (see example).

Procedure for 3-speed clutch

Step	Action
1	Disconnect both connectors on fan clutch.
2	Connect power supply to connector of coupling 1 (first step).
3	Carry out steps 3, 4 and 5 of "Procedure for 2-speed clutch".
4	Connect power supply to connector of coupling 2 (second step).
5	Carry out steps 3, 4 and 5 of "Procedure for 2-speed clutch".
6	Calculate remaining service life span in miles for both couplings. The coupling showing most wear is indicative of the remaining service life-span of the clutch unit.

continued on next page

Table: relation between cut-in voltage and service life span

The table below shows the remaining service life span (in percentage) of the fan clutch according to cut-in voltage, both with a cold clutch and with clutch at operating temperature.

Cut-in voltage measured with		Remaining service life of fan clutch
cold ^a clutch	clutch at operating temperature ^b	
10 V	12 V	100%
11 V	13 V	88%
12 V	14 V	80%
13 V	15 V	72%
14 V	16 V	64%
15 V	17 V	56%
16 V	18 V	48%
17 V	19 V	40%
18 V	20 V	32%
19 V	21 V	24%
20 V	22 V	16%
21 V	23 V	8%
22 V	24 V	0%

a. Clutch at temperature between 50 and 86 °F.

b. Engine at operating temperature, or clutch which has been energised at 24 V-voltage for about 15 to 20 minutes.

Calculation example

Suppose you measure a cut-in voltage of 17 V with a coldclutch. In such case you will learn from the table that the clutchstill has 40 % of total service life to go (meaning clutch is 60% worn). For example: if the vehicle has travelled 240 000 km withthe clutch, it will last for another

Suppose you measure a cut-in voltage of 17 V with a cold clutch. In such case you will learn from the table that the clutch still has 40 % of total service life to go (meaning clutch is 60 % worn). For example: if the vehicle has travelled 150 000 miles with the clutch, it will last for another

150 000 miles x (40:60)= 100 000 miles approximately

Change clutch when?

Change clutch if cut-in voltage is approximately 28 V with running engine, in an emergency situation you may keep clutch in operation for another while, as long as cut-in voltage is between 24 V and 28 V.

continued on next page

**No new clutch
available
immediately?**

As on-board voltage is approximately 28 V with running engine, in an emergency situation you may keep clutch in operation for another while, as long as cut-in voltage is between 24 V and 28 V.

Technical data: cooling system

Thermostats

Vehicles with Allison WTB500 transmission.

Make	Cummins
Number	1
Start to open at	180 ± 2 °F
At least 0.435 in open at	202 °F

Thermostats

Vehicles with Allison WTB500R or ZF Astronic transmission.

Make	Wahler
Number	2
Start to open at	174 ± 3 °F
At least 0.315 in open at	194 °F

Expansion tank pressure-relief cap

Valve opens at 8.7 psi overpressure

Expansion tank filler cap

Valve opens at 14.5 psi overpressure

Thermal fan drive clutch

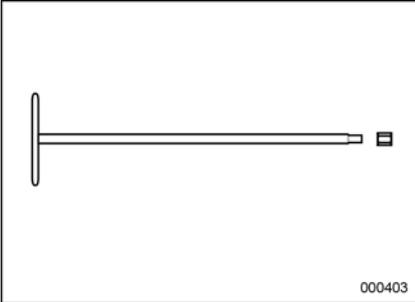
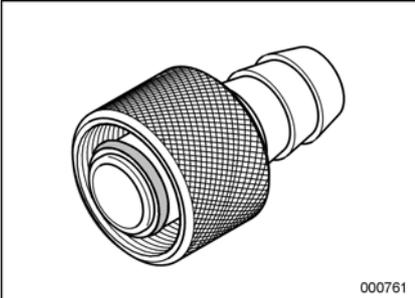
Make/type	Linnig 2 speed
Temperature switch cut-in (only vehicles with an Allison WTB500R and ZF Astronic transmission)	200 °F coolant temperature

Tightening torques

Standard hose clamps, clamping range up to 0.9 in dia.	2.2 ± 0.4 ft.lbf
Standard hose clamps, clamping range up to 1.06 in dia.	3.3 + 0.4 ft.lbf
Constant torque hose clamps (manufacturer "Breeze"), with four conical spring washers	5.2 ± 0.4 ft.lbf
Constant torque hose clamps (manufacturer "Breeze"), with five conical spring washers	6.6 + 0.7 ft.lbf

continued on next page

Special tools: cooling system

Ordering number	Description	Figure
Fleetguard CC2606	Test kit for measuring the DCA4-concentration	 <p>003786</p>
Van Hool 10527208	Cleaning tool for radiator and charge-air cooler	 <p>000403</p>
Van Hool 10772040	Coupling for drain nipple on water pipe of engine cooling system	 <p>000761</p>

Chapter 38: Lubrication system

Overview

Introduction

This chapter deals with the lubrication system.

Number of pages

8

Chapter publication date

19 September 2006

Contents

Topic	See page
To check engine oil level	2.38-2
To change oil	2.38-4
To change oil filter	2.38-6
Technical data: lubrication system	2.38-8

To check engine oil level

To be carried out when?

Before commencing daily service.

Oil type

Refer to chapter 1.1, "Fluids and lubricants".

Equipment condition

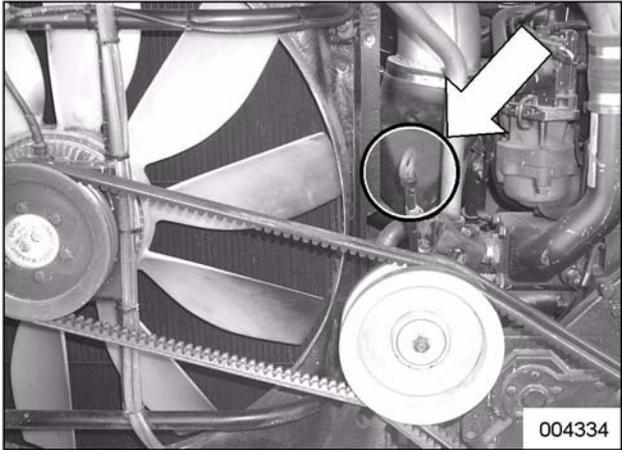
- Vehicle on level ground
- Engine should have been off for at least 10 minutes to give the oil time to return to the oil pan.

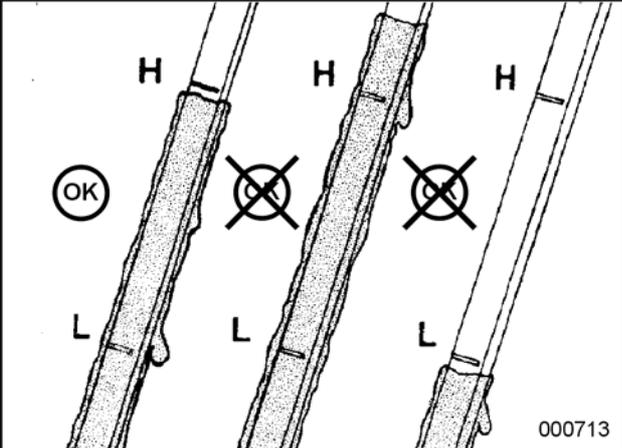
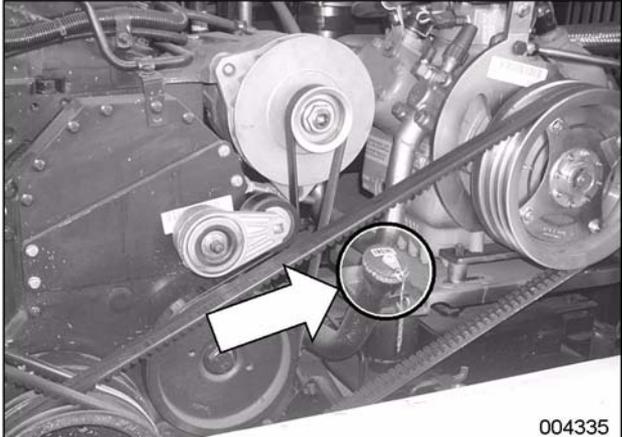


CAUTION!

Never operate the engine with the oil level below the "L" (Low) mark or above the "H" (High) mark on the dipstick.

Procedure

Step	Action
1	Pull out dipstick. 
2	Wipe the dipstick clean with a cloth and reinsert it.

Step	Action
<p>3</p>	<p>Pull out dipstick.</p> <p>The oil level should be between the "L" (Low) and the "H" (High) marks on the dipstick.</p>  <p>000713</p>
<p>4</p>	<p>If oil level is too low, top up oil through filler tube.</p>  <p>004335</p>

To change oil

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Oil type

Refer to chapter 1.1, "Fluids and lubricants".

Consumables

Sealing-ring for engine oil drain plug	
--	--

Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

Warm engine (coolant temperature 140 °F)



WARNING!

Used engine oil is toxic and carcinogenic. Avoid prolonged contact with the skin and inhalation of the fumes.



WARNING!

Hot oil flowing out of the oil pan can cause scalds. Avoid contact with the skin.

Procedure

Step	Action
1	<p>WARNING! Dispose of the used engine oil in accordance with environmental regulations.</p> <p>Remove the drain plug from the oil pan and allow oil to drain.</p>

continued on next page

Step	Action
2	Clean the drain plug. Screw the drain plug with a new sealing-ring back into the oil pan and tighten to the prescribed torque.
3	Change the oil filter (refer to "To change oil filter").
4	Fill oil pan with clean oil through filler tube, until "H" (High) mark on dipstick is reached.
5	Start the engine.
6	Check the drain plug and oil filter for leaks.
7	<p>Stop the engine. Wait a few minutes and check the oil level with the dipstick. If necessary, add oil, until the level reaches "H" (High) mark on the dipstick.</p> <div style="text-align: center;"> <p>000713</p> </div>

To change oil filter

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

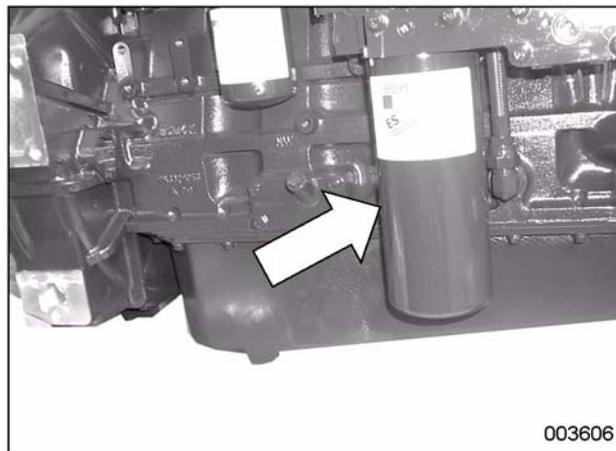
Consumables

Filter element	Cummins No. 3101869
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Equipment condition

- Cold engine
- Area around filter holder cleaned

Figure: oil filter



Procedure

Step	Action
1	Unscrew and remove the filter using a strap wrench.
2	<i>NOTE: The sealing ring of the filter element may be stuck to the holder. Make sure it is removed before installing the new filter element.</i> Clean the contact surface on the filter holder.
3	Fill the new filter element with clean lubricating oil.
4	Apply a light film of lubricating oil to the sealing ring of the new filter element.

continued on next page

Step	Action
5	 CAUTION! Overtightening the filter element can distort the threads or damage the sealing ring. Install filter element on the holder. Follow the instructions from the filter manufacturer.

Technical data: lubrication system

Minimum oil pressure

At 1 200 rpm	30 psi
At idle speed	10 psi

Tightening torques

Drain plug in engine oil pan	65 ft.lbf
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Chapter 46: Accessory drive systems

Overview

Introduction This chapter deals with the accessory drive systems.

Number of pages 24

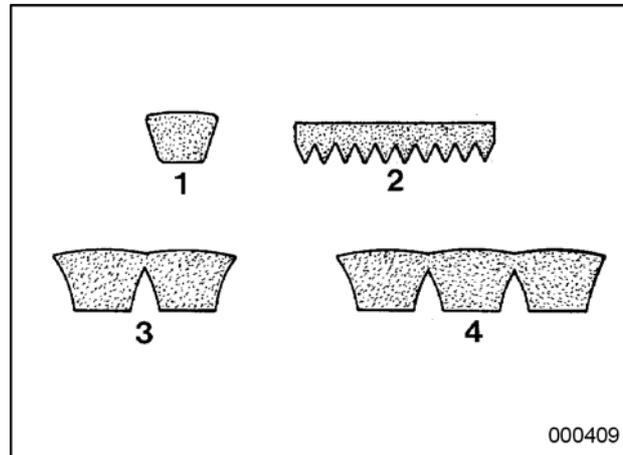
Chapter publication date 19 September 2006

Contents

Topic	See page
Belt types	2.46-2
To check belt tension	2.46-3
To check condition of V-belts	2.46-5
To check condition of V-ribbed belt	2.46-6
Climate-control compressor: operation of tensioning system	2.46-7
Climate-control compressor: to adjust belt	2.46-9
Climate-control compressor: to replace belt	2.46-10
Climate-control compressor: to check/adjust stops of compressor seat	2.46-12
Climate-control compressor: to grease compressor seat bearings	2.46-13
Fan: to adjust belts	2.46-14
Fan: to replace belts	2.46-15
Alternator secured to engine block: to adjust tension arm of automatic belt tensioner after installing a new belt	2.46-16
Alternator secured to engine block: to replace belt	2.46-18
Alternator secured to climate-control compressor: to adjust belt	2.46-20
Alternator secured to climate-control compressor: to replace belt	2.46-22
Technical data: accessory drive systems	2.46-23
Special tools: accessory drive systems	2.46-24

Belt types

Figure: belt types



Most common belt types on Van Hool vehicles

- 1 *Single V-belt*
- 2 *V-ribbed belt*
- 3 *Dual V-belt*
- 4 *Triple V-belt*

To check belt tension

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

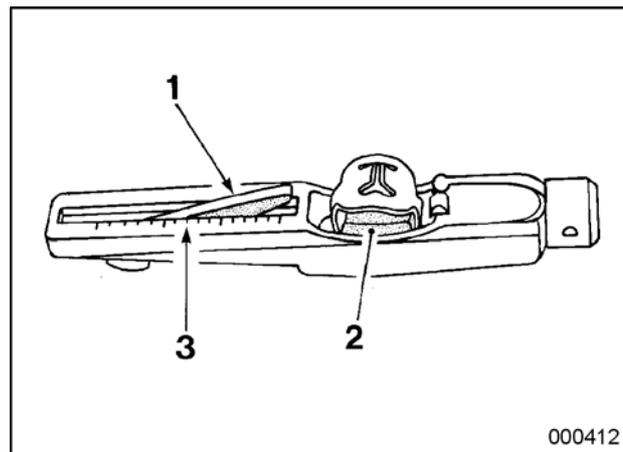
Special tools

Tension gauge	Gates No.	For use on
Krikit I	740100071	Single V-belts
Krikit II	740100072	V-ribbed belts or multi-V-belts

Checking values

Refer to "Technical data" at the end of this chapter.

Figure: "Krikit I"

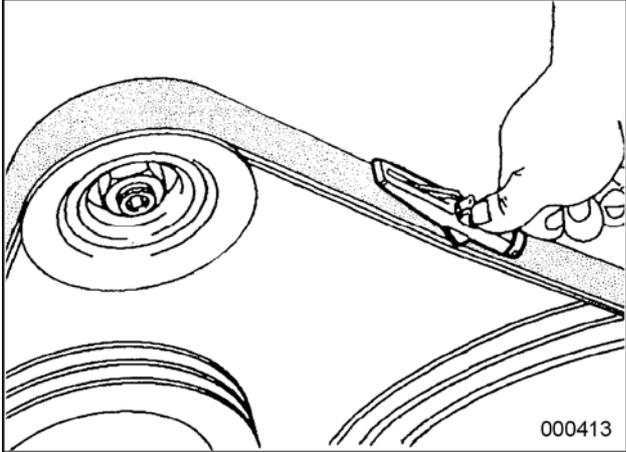


- 1 Indicator arm
- 2 Pressure pad
- 3 Tension scale

Which belts should be checked?

Measure the tension of each belt of each drive.

Procedure

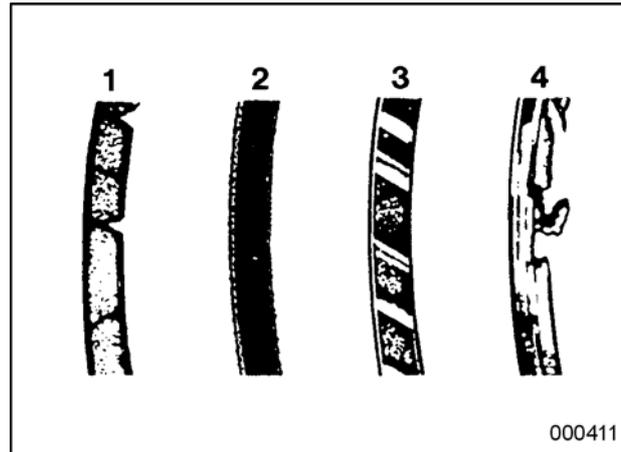
Step	Action
1	Adjust the tension gauge to zero by pushing the indicator arm (1) down as far as possible.
2	Place the gauge on the belt, halfway between the pulleys. 
3	Now slowly push the pressure pad (2) at a right angle towards the belt surface, until the gauge makes a click sound. Do not keep pushing after hearing this click sound, otherwise the gauge will provide an incorrect reading. Note that the indicator arm (1) must stay in position until step 4 has been completed.
4	Read the tension value at the point where the top part of the indicator arm crosses the Newton (or kilogram) Scale. Arrow (3) in the figure indicates the crossing point.
5	Compare this read value to the prescribed tension.

To check condition of V-belts

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: belt damage



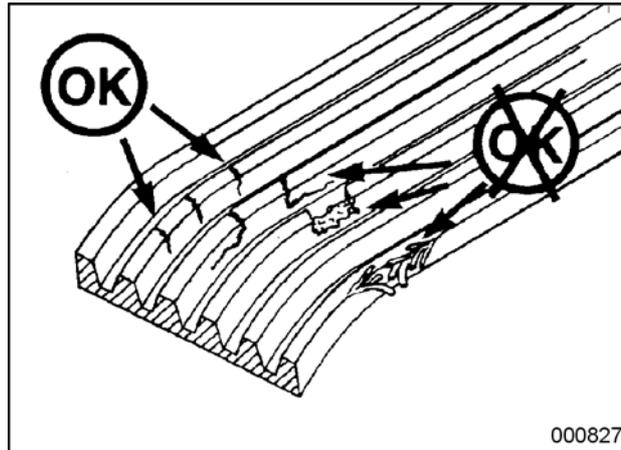
- 1 Cracks in sides or bottom
 - 2 Soft, sticky sides; sometimes flaking. Swollen profile (rubber affected by grease or oil)
 - 3 Glazed (burnt) sides
 - 4 Cuts or tears
-

To check condition of V-ribbed belt

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: belt defects



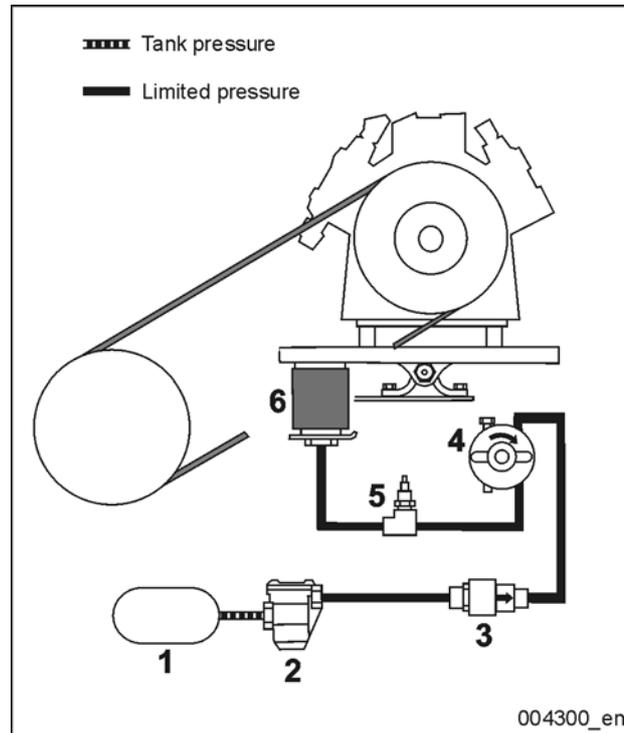
Allowable or not allowable?

Check belt for cracks and damage. Use table below to evaluate whether you should change the belt.

Wear pattern	Evaluation
Cracks across the width	Allowed
Cracks in the direction of the length that intersect the cracks across the width	Not allowed
Fraying belt	Not allowed
Torn out pieces	Not allowed

Climate-control compressor: operation of tensioning system

Figure:
tensioning
system



The figure shows the tensioning system in the running position

- 1 Accessories air tank
- 2 Pressure reducing valve
- 3 Single check valve
- 4 Cock
- 5 Test fitting
- 6 Air bag

Running position

The tensioning system is in the running position if the handle of cock (4) is fully turned counterclockwise.

Service position

The tensioning system is in the service position if the handle of cock (4) is turned fully clockwise. Air bag (6) is connected to the atmosphere through cock (4). This is the position to change the belts.

Operation in running position

In the running position the air bag (6) receives compressed air from the accessories air tank, through pressure reducing valve (2), check valve (3), and cock (4). The pressure reducing valve ensures that the pressure in the air bag remains constant. This way the belt tension is kept constant as well.

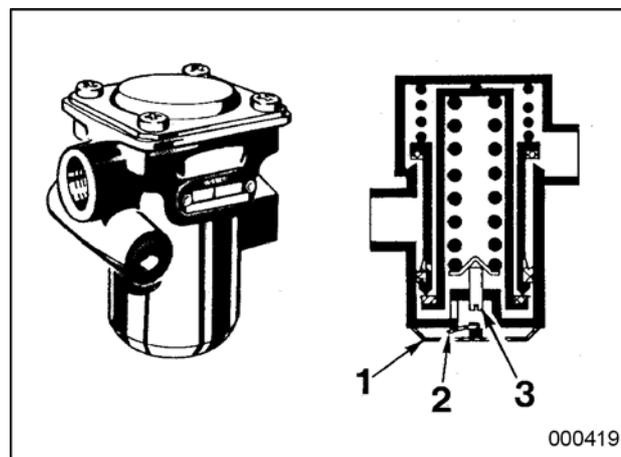
Climate-control compressor: to adjust belt

Setting values Refer to "Technical data" at the end of this chapter.

Equipment condition

- Air system charged to maximum operating pressure
- Handle of cock in compressed-air line of tensioning system turned fully counterclockwise (running position).

Figure:
pressure
reducing valve



- 1 Protection cover
2 Exhaust valve
3 Adjusting screw

Procedure

Step	Action
1	Turn protection cover (1) until the attachments inside are free. Remove the cover of the pressure reducing valve.
2	Turn adjusting screw (3), until prescribed belt tension is reached: <ul style="list-style-type: none"> • to increase tension: clockwise. • to diminish tension: counterclockwise.
3	Check if rubber exhaust valve (2) is positioned correctly.
4	Re-install cover (1).

Climate-control compressor: to replace belt

To be changed when?

Replace the belt if it looks frayed (worn out), or if you notice a defect (refer to "To check condition of V-belts").

Consumables

Dual V-belt	Van Hool No. 10969729
-------------	-----------------------

Equipment condition

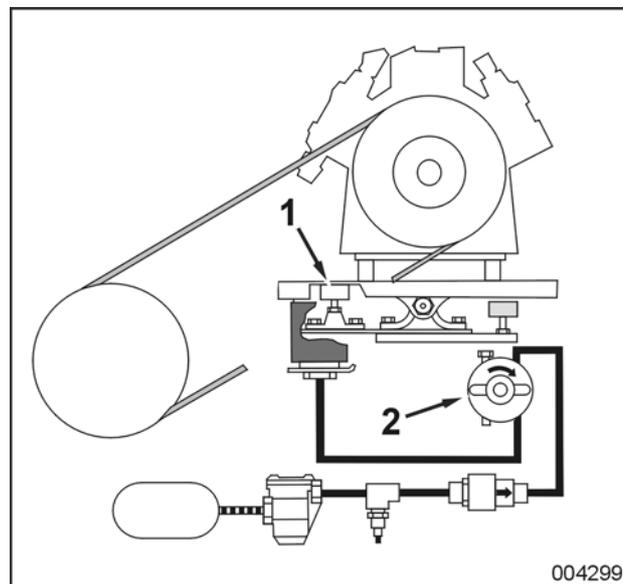
System charged to maximum operating pressure



CAUTION!

Never twist or roll a belt over the edge of the pulley. Even if this action does not cause immediate visible damage, it does shorten belt life.

Figure: tensioner



1 Rubber stop

2 Cock

Procedure

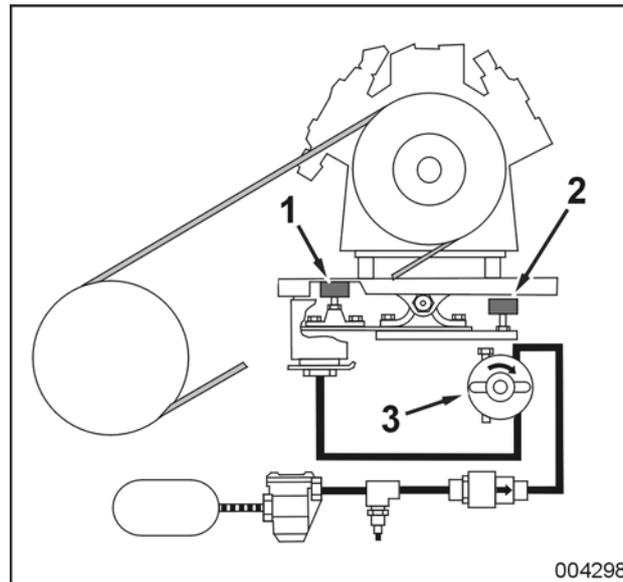
Step	Action
1	Screw rubber stop (1) down as far as it will go.
2	Turn the handle of cock (2) fully clockwise. The air bag of the tensioning system is now without pressure.
3	Remove belt.
4	Install the new belt.
5	Turn the handle of cock (2) fully counterclockwise (running position).
6	Adjust the height of rubber stop (1), refer to "Climate-control compressor: to check/adjust stops of climate-control compressor seat".

Climate-control compressor: to check/adjust stops of compressor seat

To check when?

Immediately after replacing the belt(s), and then a few times during the next 6 000 mi.

Figure: compressor set-up



- 1 Rubber stop
- 2 Rubber stop
- 3 Cock

Equipment condition

- System charged to maximum operating pressure;
- Cock (3) turned fully counterclockwise (running position).

How to check/adjust rubber stop (1)?

Rubber stop (1) is properly adjusted if it touches the bottom of the compressor seat without applying any pressure to it. If necessary, adjust by screwing in or out the rubber stop.

How to check/adjust rubber stop (2)?

Rubber stop (2) is set correctly if there is a play of approximately 0.4 in between the top of the rubber stop and the bottom of the compressor seat. If necessary, adjust by fastening or unfastening the rubber stop.

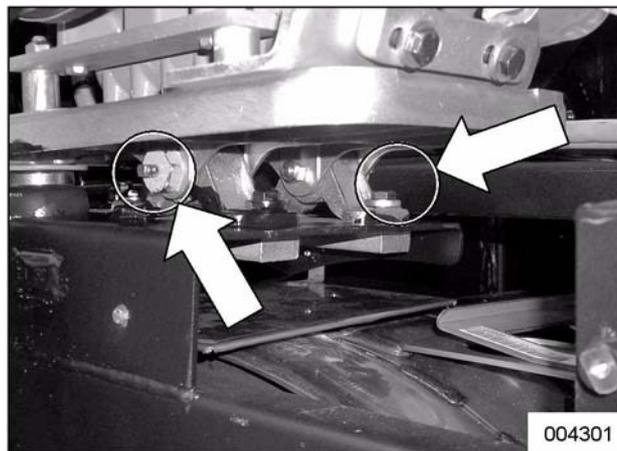
Climate-control compressor: to grease compressor seat bearings

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Grease type

Refer to chapter 1.1, "Fluids and lubricants".

Figure: grease nipples

Procedure

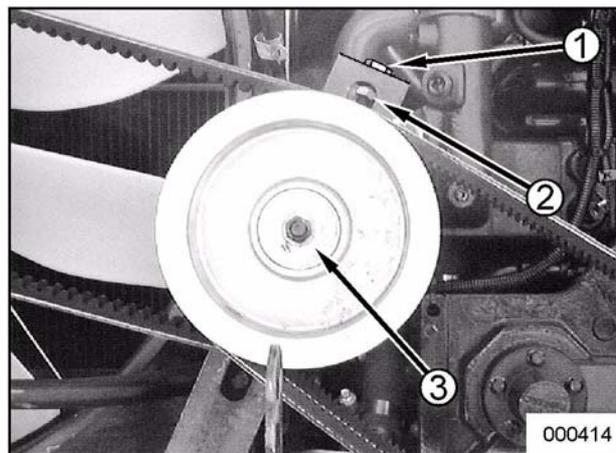
Push grease in the grease nipples until new grease escapes.

Fan: to adjust belts

Setting values Refer to "Technical data" at the end of this chapter.

Tightening torques Refer to "Technical data" at the end of this chapter.

Figure:
tensioning
system



- 1 Adjusting hexagon
- 2 Locknuts
- 3 Nut

Where to measure? Measure the tension of the fan drive belts between the tensioning idler and the fan pulley.

Procedure

Step	Action
1	Loosen nut (3) of the tensioning idler.
2	Loosen both locknuts (2) of tensioning idler.
3	Turn adjusting hexagon (1), until prescribed tension is reached. <ul style="list-style-type: none"> • to increase belt tension: turn clockwise • to decrease belt tension: turn counterclockwise
4	Retighten nuts (2) and (3).

Fan: to replace belts

Consumables

Set of two single V-belts between the engine crankshaft pulley and tensioning idler	Van Hool No. 639602001
Set of two single V-belts between tensioning idler and fan pulley	Van Hool No. 639602001

To be changed when?

Replace the belts if they look frayed (worn out), or if you notice a defect (refer to "To check condition of V-belts").



CAUTION!

Never twist or roll the belt over the edge of the pulley. Even if this action does not cause immediate visible damage, it does shorten belt life.

Procedure

Belts of the same drive must always be changed as a pair.

Step	Action
1	Slacken the tensioning system as far as possible; refer to "Fan: to adjust belts".
2	Remove the belts.
3	Install the new belts.
4	Set the belt tension, refer to "Fan: to adjust belts".

Retensioning

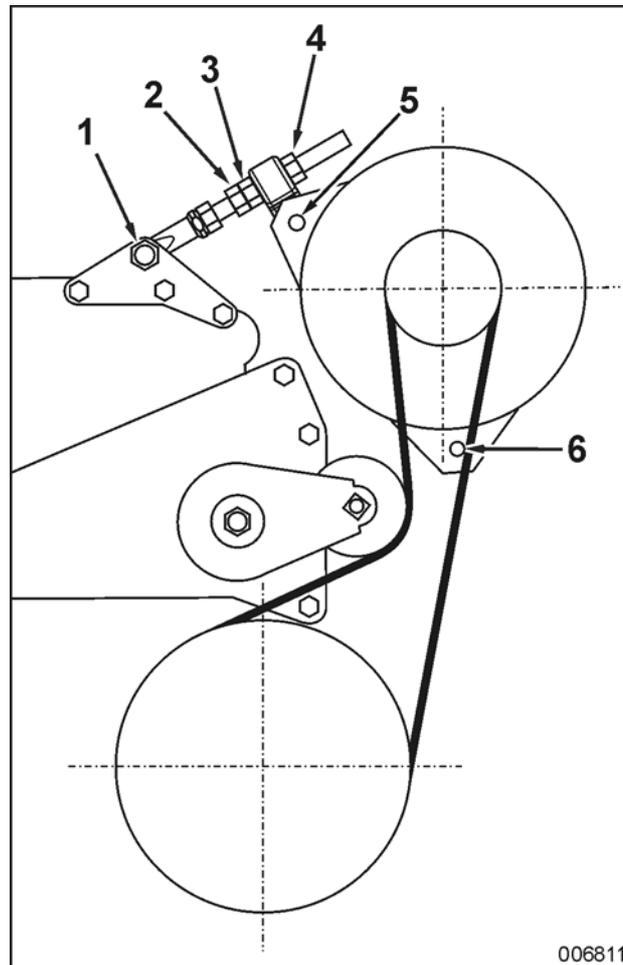
During run-in, a part of the tension will be lost because the new belts will stretch and fall deeper in the grooves of the pulleys. Therefore, re-adjust belt tension to its initial value after the first 20 minutes of operation.

Alternator secured to engine block: to adjust tension arm of automatic belt tensioner after installing a new belt

Equipment condition

Engine stopped

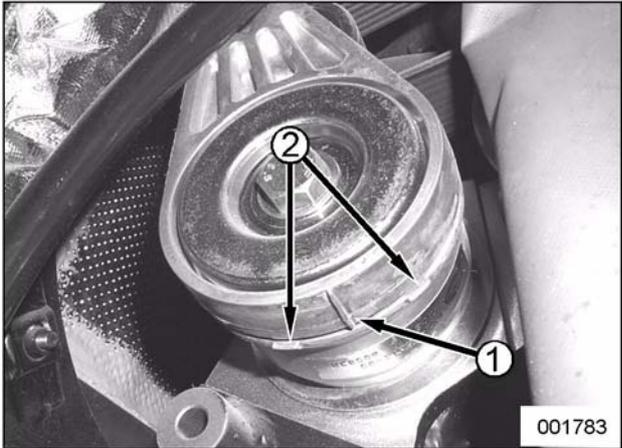
Figure:
adjusting system



- 1 Bolt
- 2 Jam nut
- 3 Adjusting nut
- 4 Nut
- 5 Bolt
- 6 Pivot fasteners

Procedure

The alternator drive is fitted with an adjuster which enables you to change the position of the tension arm of the automatic belt tensioner.

Step	Action
1	Loosen front and rear pivot bolts (6) of the alternator.
2	Loosen screw (1) and bolt (5).
3	Loosen screw (2) and nut (4).
4	Turn the adjusting nut of the adjusting system, until the arm of the automatic belt tensioner is in the middle of its adjustment range. This means that mark (1) is across the middle of the arc between cams (2).
	
5	Tighten screw (2) and nut (4).
6	Tighten screw (1) and bolt (5).
7	Tighten alternator pivot fasteners (6).

Retensioning

During the run-in period the belt will stretch, which will cause the arm of the automatic belt tensioner to change position. Therefore, recheck the position of the tension arm after approximately 20 minutes of operation.

Alternator secured to engine block: to replace belt

To be changed when?

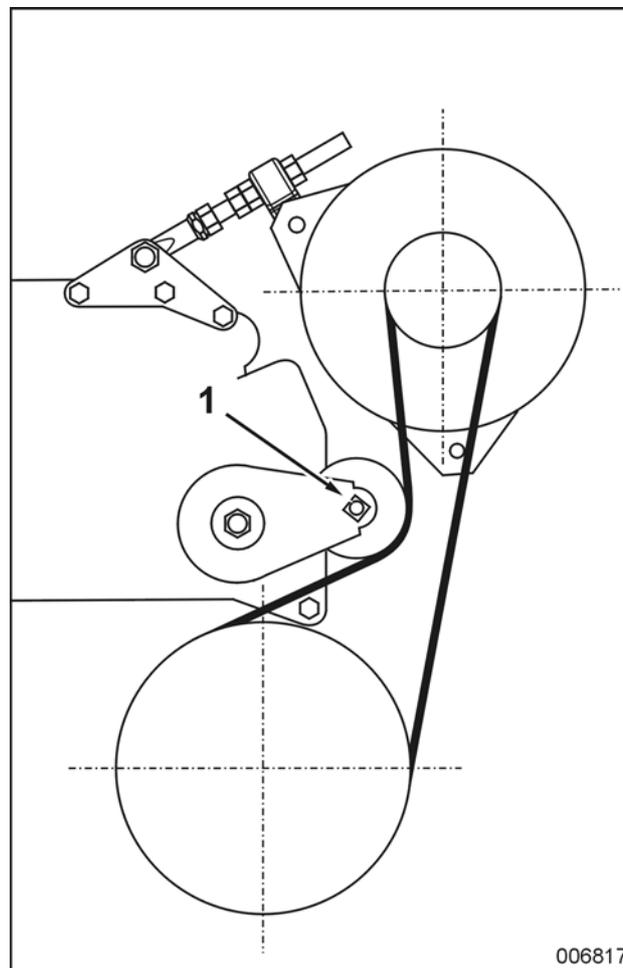
Refer to "To check condition of V-ribbed belt".

Consumables

V-ribbed belt

Van Hool No. 10851824

Figure: belt loop



1 Hole in automatic belt tensioner for ratchet wrench

**CAUTION!**

Never twist or roll the belt over the edge of a pulley. Even if this action does not cause immediate visible damage, it does shorten belt life.

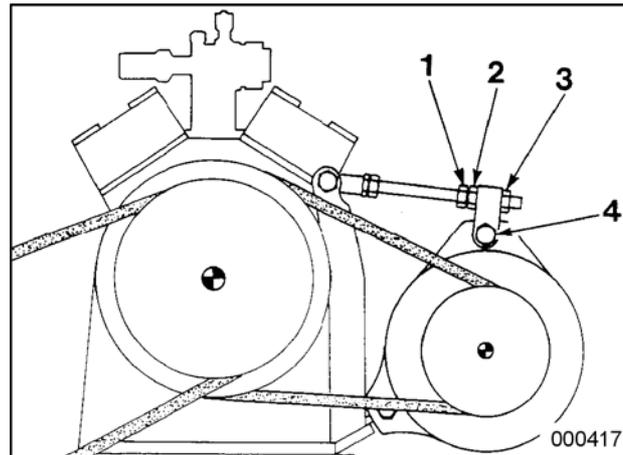
Procedure

Step	Action
1	Insert a ratchet wrench with 1/2 inch square drive into hole (1) of the automatic belt tensioner.
2	Relieve the belt tension by turning the ratchet wrench in the opposite direction to the spring tension of the automatic belt tensioner.
3	Remove the belt. Carefully let the automatic belt tensioner spring back to the stop.
4	Check all pulleys for damage.
5	Loop the new belt over the alternator pulley.
6	Tighten the automatic belt tensioner. Loop the belt over the drive pulley. Carefully release the automatic belt tensioner against the new belt.
7	Check that the belt rides in the grooves of all the pulleys.
8	Adjust the position of the automatic belt tensioner (refer to "Alternator secured to engine block: to adjust tension arm of automatic belt tensioner after installing a new belt").

Alternator secured to climate-control compressor: to adjust belt

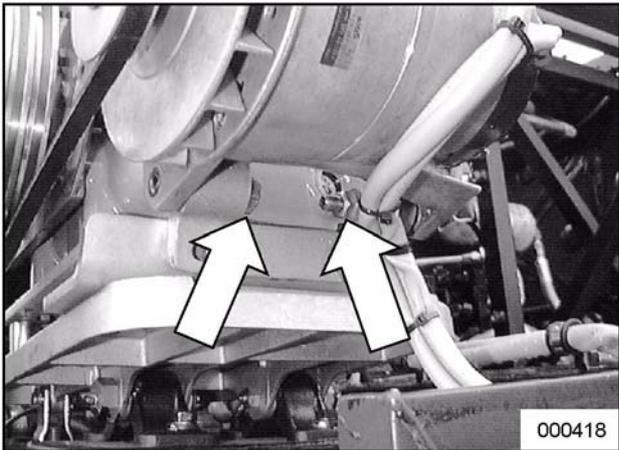
Setting values Refer to "Technical data" at the end of this chapter.

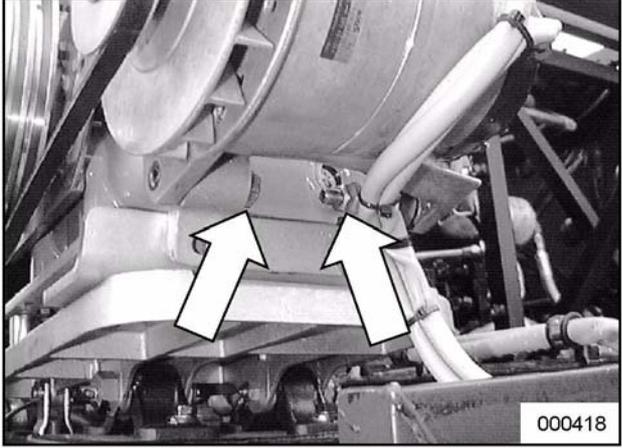
Figure:
tensioner



- 1 Locknut
- 2 Adjusting nut
- 3 Locknut
- 4 Bolt

Procedure

Step	Action
1	Loosen the pivot fasteners.  000418
2	Loosen bolt (4).

Step	Action
3	Loosen locknuts (1) and (3).
4	Tighten adjusting nut (2), until required tension is reached.
5	Tighten locknuts (1) and (3) and bolt (4).
6	Tighten the pivot fasteners. 

Alternator secured to climate-control compressor: to replace belt

To be changed when?

Replace the belt if it looks frayed (worn out), or if you notice a defect (see under "To check condition of V-belts").

Consumables

Single V-belt	Van Hool No. 639601600
---------------	------------------------



CAUTION!

Never twist or roll the belt over the edge of the pulley. Even if this action does not cause immediate visible damage, it does shorten belt life.

Procedure

Step	Action
1	Slacken the tensioning system as far as possible; refer to "Alternator secured to climate-control compressor: to adjust belt".
2	Remove the belt.
3	Install the new belt.
4	Set the belt tension; refer to "Alternator secured to climate-control compressor: to adjust belt".

Retensioning

During the run-in period the belt will stretch, which will cause the arm of the automatic belt tensioner to change position. Therefore, recheck the position of the tension arm after approximately 20 minutes of operation.

Technical data: accessory drive systems

Belt tension

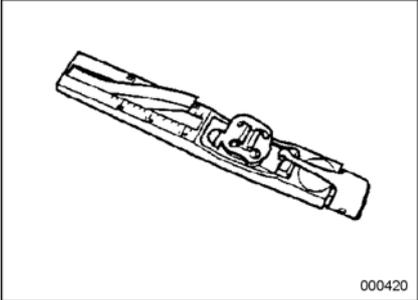
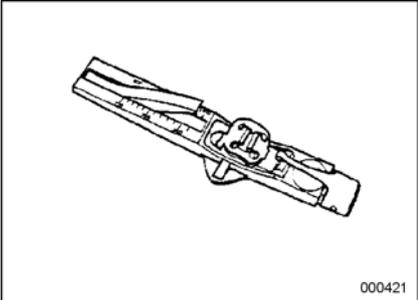
The table below shows the tension per belt.

Drive	Tension of a new belt	Tension at routine checks according to maintenance schedule
alternator secured to engine block	Automatic belt tensioner	
alternator secured to climate-control compressor	100 ± 10 lbf	90 ± 10 lbf
fan	100 ± 10 lbf	90 ± 10 lbf
climate-control compressor		
<ul style="list-style-type: none"> in the case of two single V-belts 	110 ± 10 lbf	110 ± 10 lbf
<ul style="list-style-type: none"> in the case of a dual V-belt 	220 ± 20 lbf	220 ± 20 lbf

Tightening torques

Nut on shaft of fan belts tensioner pulley	50 ± 7 ft.lbf
--	---------------

Special tools: accessory drive systems

Ordering number	Description	Figure
Gates 740100071	Belt tension gauge "Krikrit I"	 000420
Gates 740100072	Belt tension gauge "Krikrit II"	 000421

Part 3 - Suspension

Overview

Contents

Chapter	See page
Chapter 6: Air suspension	3.6-1
Chapter 10: Front axle suspension	3.10-1
Chapter 14: Drive axle suspension	3.14-1
Chapter 18: Trailing axle suspension	3.18-1
Chapter 34: Wheels	3.34-1
Chapter 38: Tires	3.38-1

Chapter 6: Air suspension

Overview

Introduction This chapter deals with the air suspension.

Number of pages 18

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety precautions concerning compressed air	3.6-2
Air line color codes	3.6-3
Visual identification: air suspension components	3.6-4
Location of air suspension components	3.6-8
To check operation of air suspension visually.	3.6-9
To check air spring height	3.6-10
To adjust air spring height	3.6-11
To check air bag condition	3.6-13
To check air springs for leaks	3.6-14
To check leveling valve	3.6-15
To clean/change line filters	3.6-16
Technical data: air suspension	3.6-18

Safety precautions concerning compressed air

**Cross-
reference**

Refer to chapter 13.1, "Complete compressed-air system".

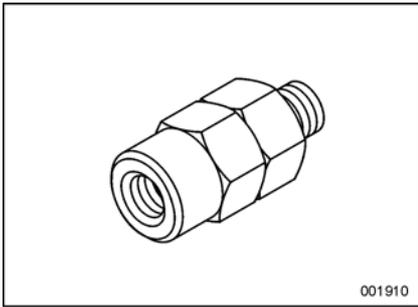
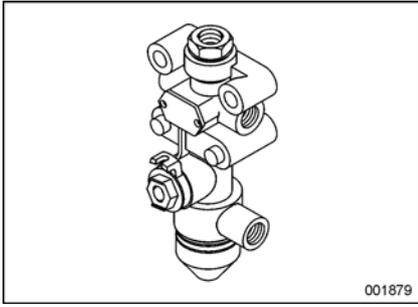
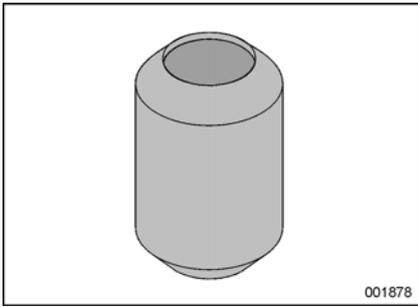
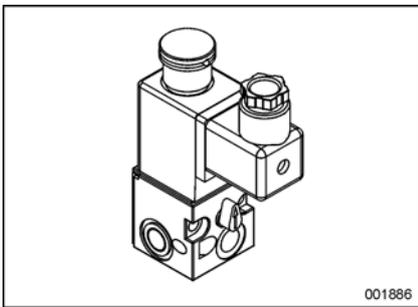
Air line color codes

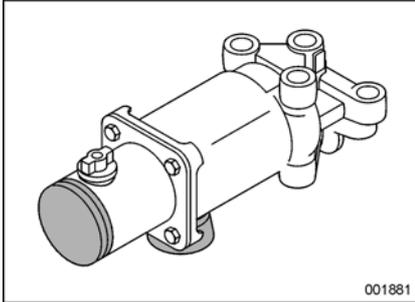
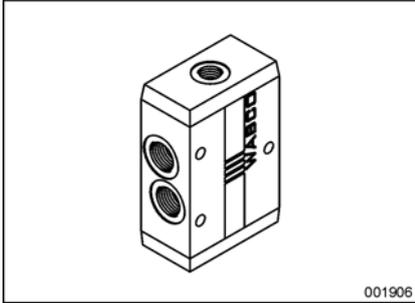
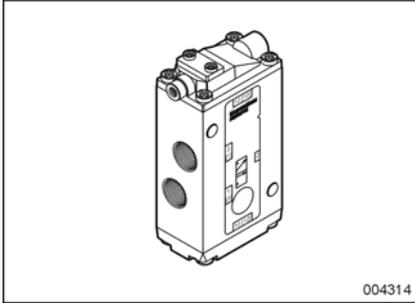
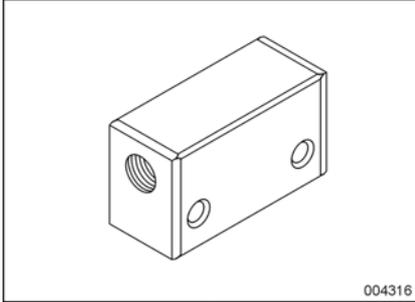
**Cross-
reference**

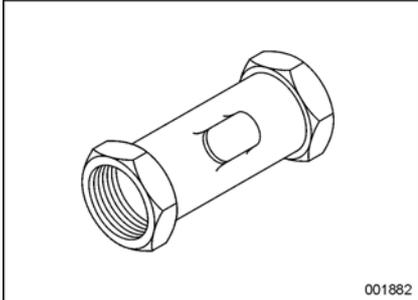
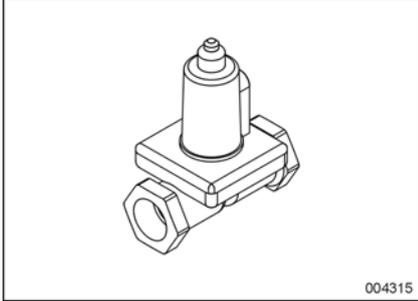
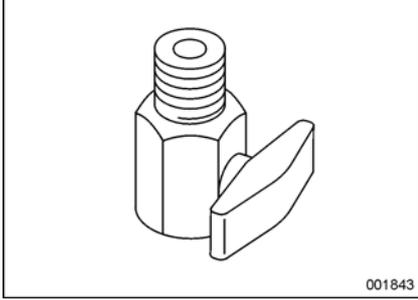
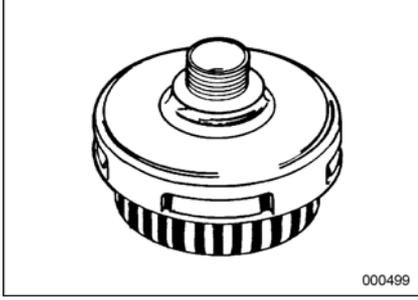
Refer to chapter 13.25, "Air lines".

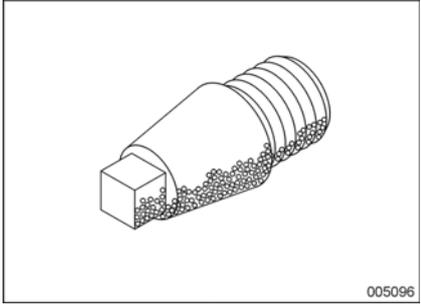
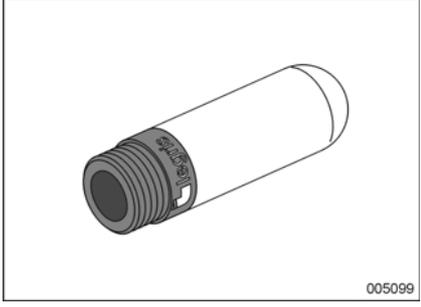
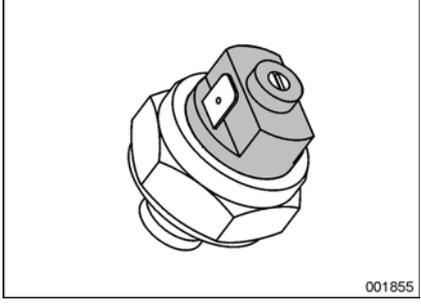
Visual identification: air suspension components

Components

Name	Figure
Line filter	 <p>001910</p>
Leveling valve	 <p>001879</p>
Air bag	 <p>001878</p>
3/2-way valve, electrically operated	 <p>001886</p>

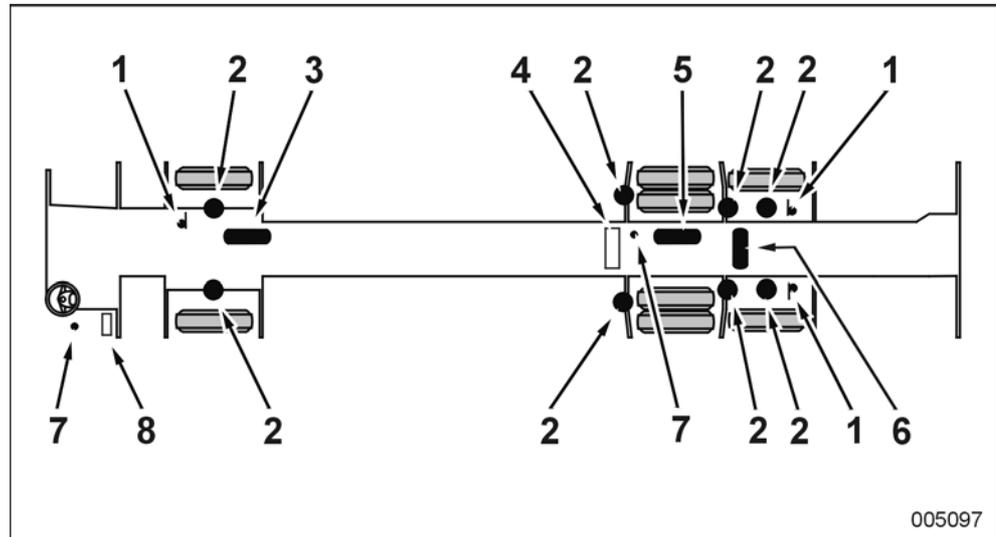
Name	Figure
4/2-way valve, electrically operated	 <p style="text-align: right;">001881</p>
3/2-way valve, pneumatically operated (Wabco)	 <p style="text-align: right;">001906</p>
3/2-way valve, pneumatically operated (Mannesmann Rexroth)	 <p style="text-align: right;">004314</p>
Double check valve	 <p style="text-align: right;">004316</p>

Name	Figure
Single check valve	 <p style="text-align: right;">001882</p>
Overflow valve with limited return	 <p style="text-align: right;">004315</p>
Compressed-air tank drain valve	 <p style="text-align: right;">001843</p>
Muffler	 <p style="text-align: right;">000499</p>

Name	Figure
Muffler	 <p>005096</p>
Muffler	 <p>005099</p>
Pressure switch	 <p>001855</p>

Location of air suspension components

Figure:
location of air
suspension
components



- 1 Leveling valve
- 2 Air spring
- 3 Kneeling system compressed-air tank
- 4 Compressed-air valves of raising system, lowering system and rear raising system
- 5 Accessories compressed-air tank
- 6 Rear raising system compressed-air tank
- 7 Line filter
- 8 Compressed-air valves of kneeling system

To check operation of air suspension visually.

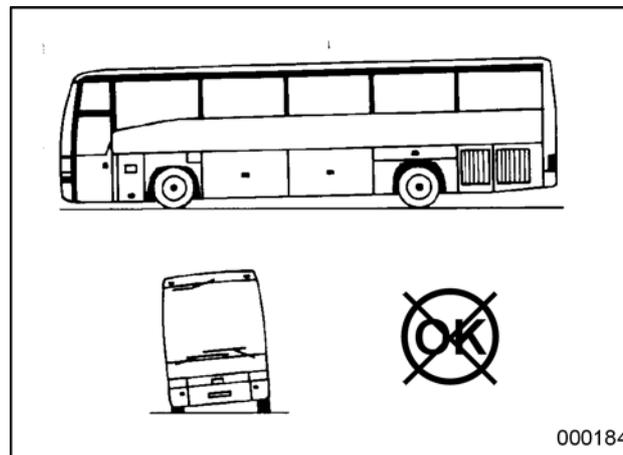
To be carried out when?

Before commencing daily service.

Equipment condition

- Normal operating pressure in the air system
- Vehicle on level ground

Figure: to check air suspension



Procedure

Visually check that normal body ground clearance is maintained at both ends and sides of the vehicle: the body should not lean over.

To check air spring height

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking values

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Empty vehicle on a flat level surface, over an inspection pit
 - Tires equally worn and at the correct inflation pressure
 - Air system charged to maximum operating pressure (let the engine idle)
 - Vehicles equipped with a kneeling, raising or lowering system: air suspension in normal "ride" position
-

Which air springs should be checked?

Check:

- height of left air spring front suspension, and...
 - height of left and right rear air springs of drive axle suspension.
-

Procedure

It is essential to hold the gauge parallel to the spring axis (refer to the figures in "Technical data" at the end of this chapter).

To adjust air spring height

Introduction

Air spring height is adjusted by altering the effective length of the leveling valve control rod. Any adjustment is to be made from "low" to "high". This means that the air bag is first deflated, then re-inflated, until the prescribed height is achieved.

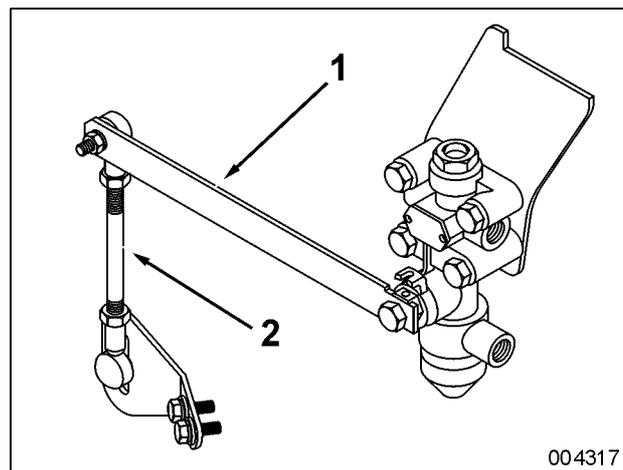
Setting values

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Empty vehicle on a flat level surface, over an inspection pit
- Air system charged to maximum operating pressure (let the engine idle)

Figure: leveling valve



1 Valve actuating lever

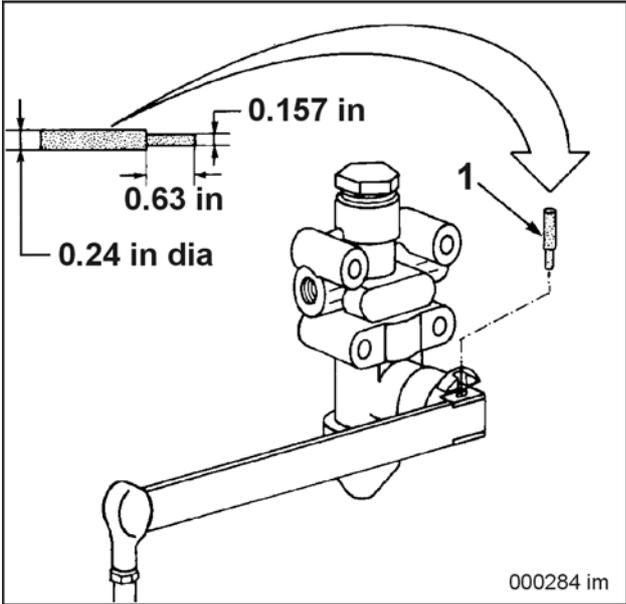
2 Connection rod between valve and axle assembly

Procedure

NOTE: The setting value listed under "Technical data" applies to the air spring in normal drive position: if your vehicle is equipped with a raising/lowering system, this system should not be activated.

Step	Action
1	Disconnect connection rod of its bottom attachment bracket.
2	Lower the body by pulling the rod downward, which will deflate the air bag.
3	Slowly move the rod up to reinflate the air bag. As soon as correct height setting is obtained, instantly return leveling valve actuating lever to its horizontal position to stop inflation.

continued on next page

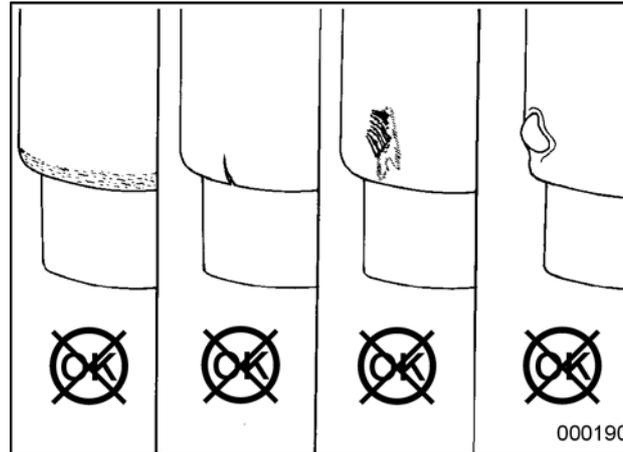
Step	Action
4	<p>While retaining the valve actuating lever in a horizontal position, secure the connection rod to the bottom attachment bracket.</p> <p><i>NOTE: You can use a pin (1) to block the valve actuating lever in a horizontal position (position without inflation or deflation) while you detach or attach the connection rod. Move pin in between the lugs on the valve housing and insert it into the valve shaft hole. Do not forget to remove pin before driving vehicle!</i></p>  <p>The diagram shows a valve assembly with a horizontal lever. Dimensions are provided: 0.157 in for the distance from the lever's pivot to the connection point, 0.63 in for the distance from the lever's pivot to the valve shaft hole, and 0.24 in dia for the diameter of the valve shaft hole. A pin labeled '1' is shown inserted into the valve shaft hole. A curved arrow indicates the lever's movement.</p> <p style="text-align: right;">000284 im</p>
5	<p>Test drive the vehicle on a curvy track and readjust, if necessary, the height of the air springs.</p>

To check air bag condition

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: air bag failure



When to change the air bag?

Air bag should be changed, if:

- torque cracks on "down-rolling" part down to casing fabric;
 - cuttings damage down to casing fabric;
 - chafings damage down to casing fabric;
 - blisters occur.
-

To check air springs for leaks

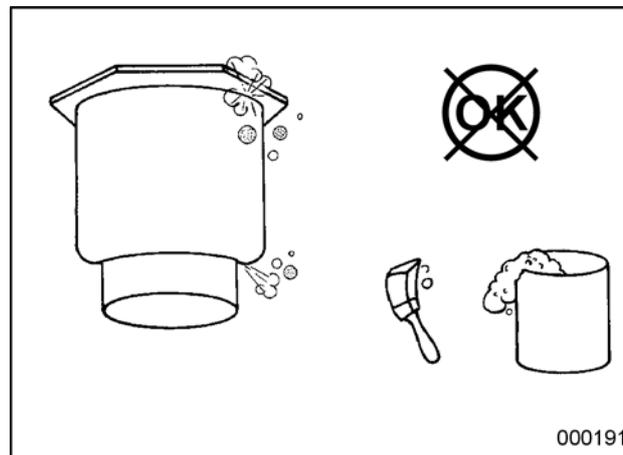
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Air system charged to maximum operating pressure

Figure: checking air spring for leaks



Procedure

Coat the bag beads and sidewalls with a soap solution to check the airtightness of the bags. No soap bubbles should appear. Demount leaking bags from the suspension for further inspection.

To check leveling valve

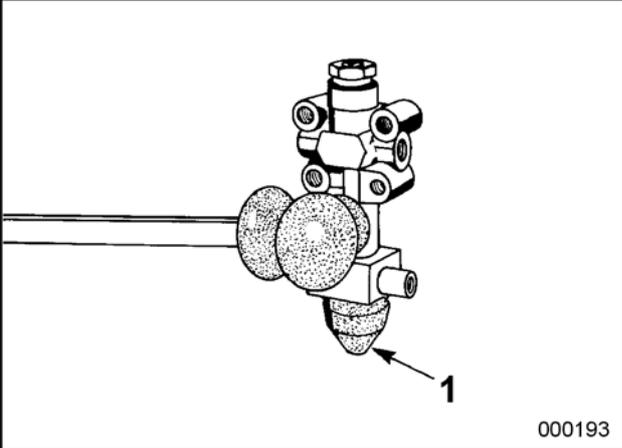
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

A pressure of 115 to 130 psi in the air tanks

Procedure

Step	Action
1	<p>Clean the rubber protection cover (1) on the exhaust of the valve, and brush soapy water on it. Look for soap bubbles.</p> <div style="text-align: center;">  <p>The diagram shows a mechanical leveling valve assembly. It consists of a main body with several ports and a central vertical rod. A rubber protection cover, indicated by the number '1' and an arrow, is attached to the lower part of the valve. The cover has a textured, circular surface. The number '000193' is printed in the bottom right corner of the diagram area.</p> </div>
2	If the valve leaks, remove it for repair.

To clean/change line filters

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

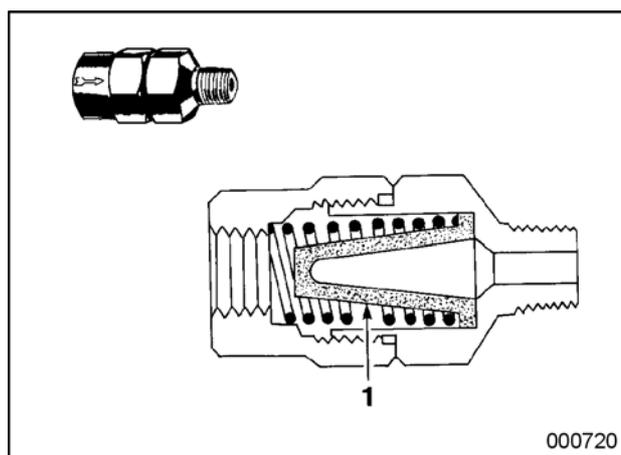
Consumables

Screen	Bendix No. 236562
Gasket	Bendix No. 234972
Special grease	Bendix No. BW-204-M

Location of line filters

Refer to "Location of air suspension components".

Figure: line filter



1 Screen



WARNING!

Do not remove the filter with the air system pressurized.

Procedure

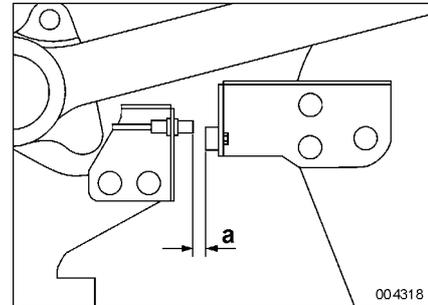
Step	Action
1	Release pressure from air system by actuating drain valve on accessories air tank. For the location of the air tanks refer to "Location of air tanks" in chapter 13.17.
2	Disconnect air lines from filter body and remove filter.
3	Disassemble filter body in vise.
4	Clean or change filter screen.
5	Reassemble new or cleaned filter screen into filter body. Apply thin film of special grease to new gasket.
6	Re-install filter in air lines.

Technical data: air suspension

Kneeling system

Sensor adjustment:

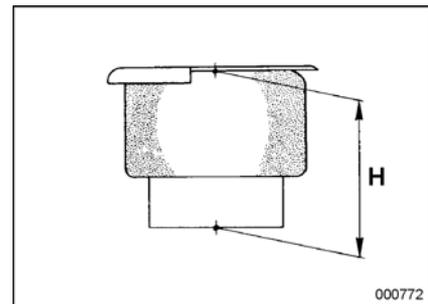
- $a = 0.3 \text{ à } 0.4 \text{ in}$



Air spring

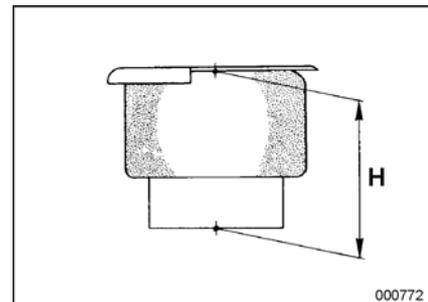
Air spring height on front axle

$H = 11 + 0.4 \text{ in}$



Air spring height on drive axle

$H = 11 + 0.4 \text{ in}$



Chapter 10: Front axle suspension

Overview

Introduction This chapter deals with the front axle suspension.

Number of pages 4

Chapter publication date 19 September 2006

Contents

Topic	See page
To check security of suspension components	3.10-2
To check shock absorbers for damage and leakage	3.10-3
Technical data: front axle suspension	3.10-4

To check security of suspension components

Tightening torques

Refer to “Technical data” at the end of this chapter.

Procedure

Visually check those bolts, screws and nuts that are locked by means of a cotter pin, a locking plate or locking adhesive (Loctite). The security of all others must be checked mechanically. Retighten, if necessary.



WARNING!

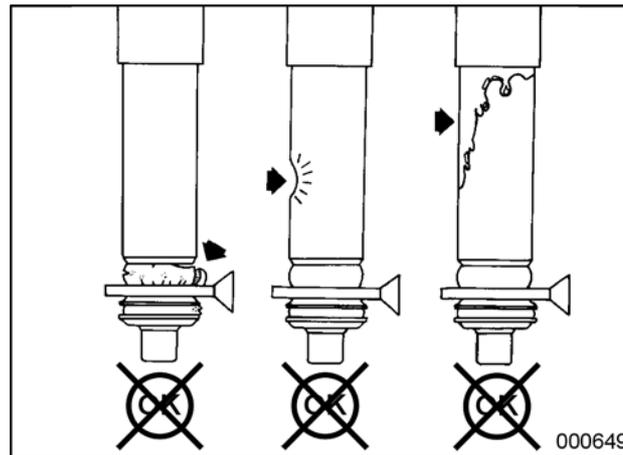
Never retighten bolts, screws or nuts that are fitted with locking adhesive, as this would destroy locking properties.

To check shock absorbers for damage and leakage

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: shock absorber failure



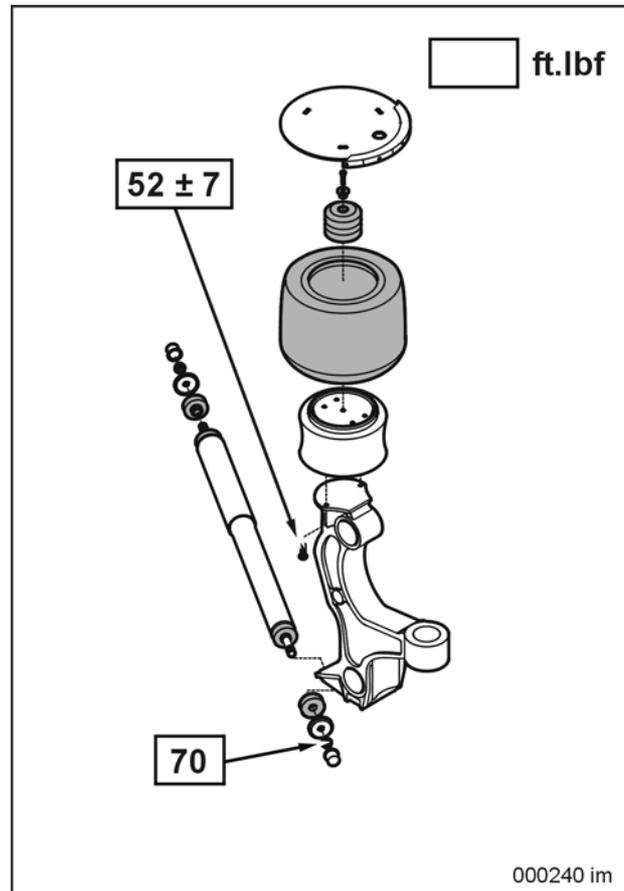
What to check?

Check the shock absorber for:

- fatigue cracks on rubbers;
- damage at housing;
- oil leaks.

Technical data: front axle suspension

Figure:
tightening
torques



Security of air bag piston and shock absorber.

Chapter 14: Drive axle suspension

Overview

Introduction This chapter deals with the drive axle suspension.

Number of pages 8

Chapter publication date 19 September 2006

Contents

Topic	See page
To check security of suspension components	3.14-2
To work on or nearby the leaf spring	3.14-3
To check shock absorbers for damage and leakage	3.14-4
Technical data: drive axle suspension	3.14-5

To check security of suspension components

Tightening torques

Refer to "Technical data" at the end of this chapter.

Procedure

Visually check those bolts, screws and nuts that are locked by means of a cotter pin, a locking plate or locking adhesive (Loctite). The security of all others must be checked mechanically. Retighten, if necessary.



WARNING!

Never retighten bolts, screws or nuts that are fitted with locking adhesive, as this would destroy locking properties.

To work on or nearby the leaf spring



WARNING!

The leaf spring is made of high-carbon steel which makes it extremely vulnerable to chipping, impact and high temperatures. Do not weld, grind or drill. Never use a hammer to dismantle or install. When welding or grinding in the vicinity, protect against welding particles or accidental grinding deviations. The spring leaves should remain bare: do not apply any sprayed or painted coatings (protect, when spraying underbody with rust preventer). A leaf spring accidentally chipped or affected by welding particles should be replaced immediately to avoid breakage.



CAUTION!

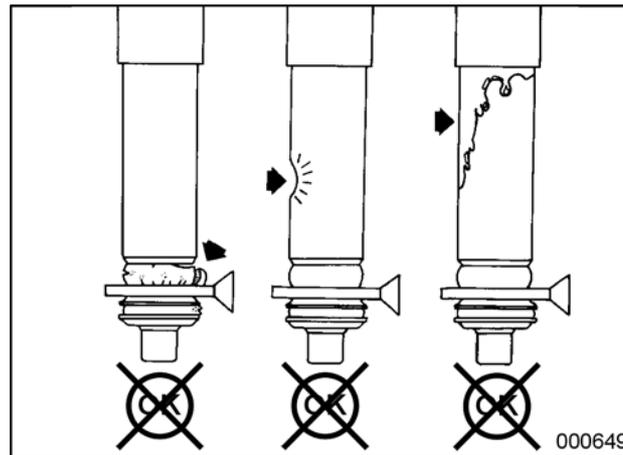
Do not spray lubricant on or between the spring leaves. Lubricants and grease damage the rubber of the spring carrier arms.

To check shock absorbers for damage and leakage

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: shock absorber failure



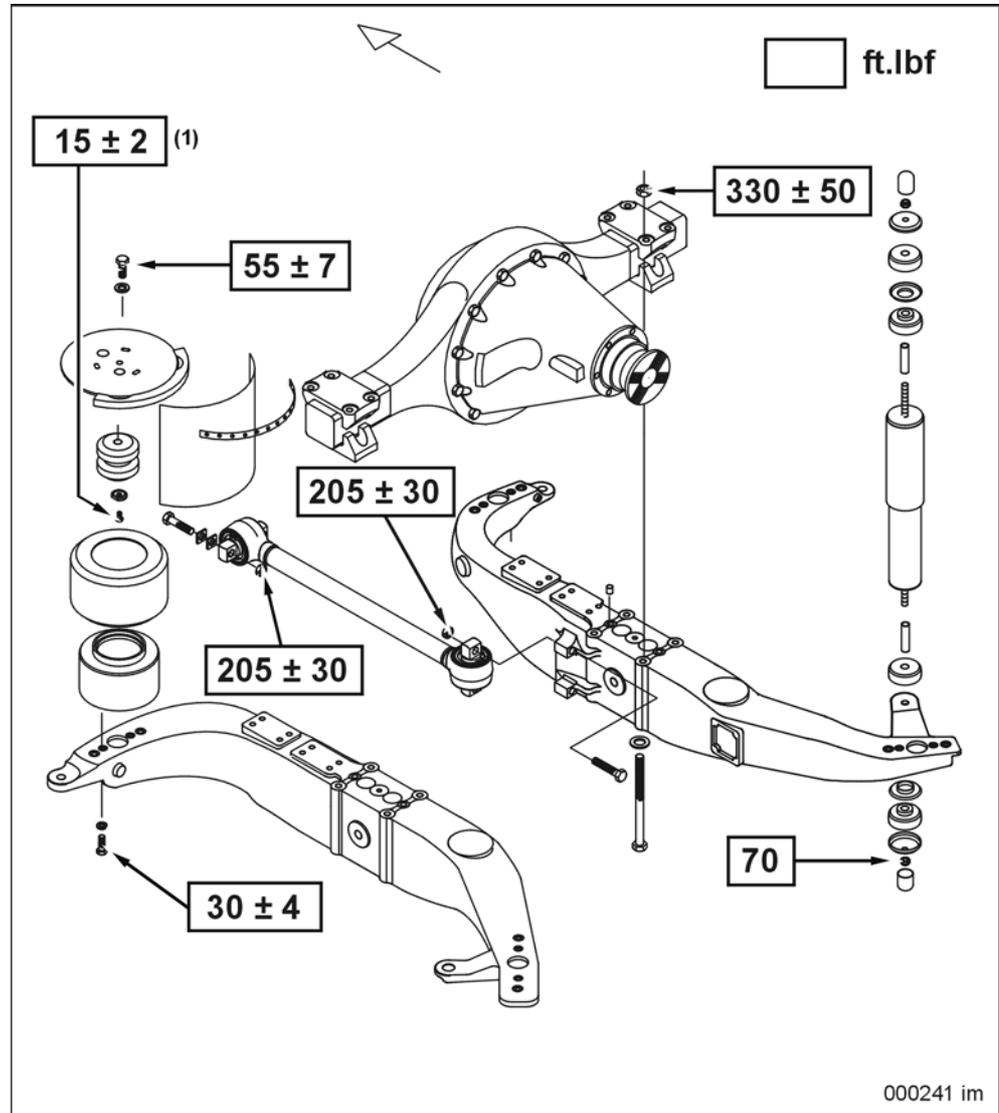
What to check?

Check the shock absorber for:

- fatigue cracks on rubbers;
- damage at housing;
- oil leaks.

Technical data: drive axle suspension

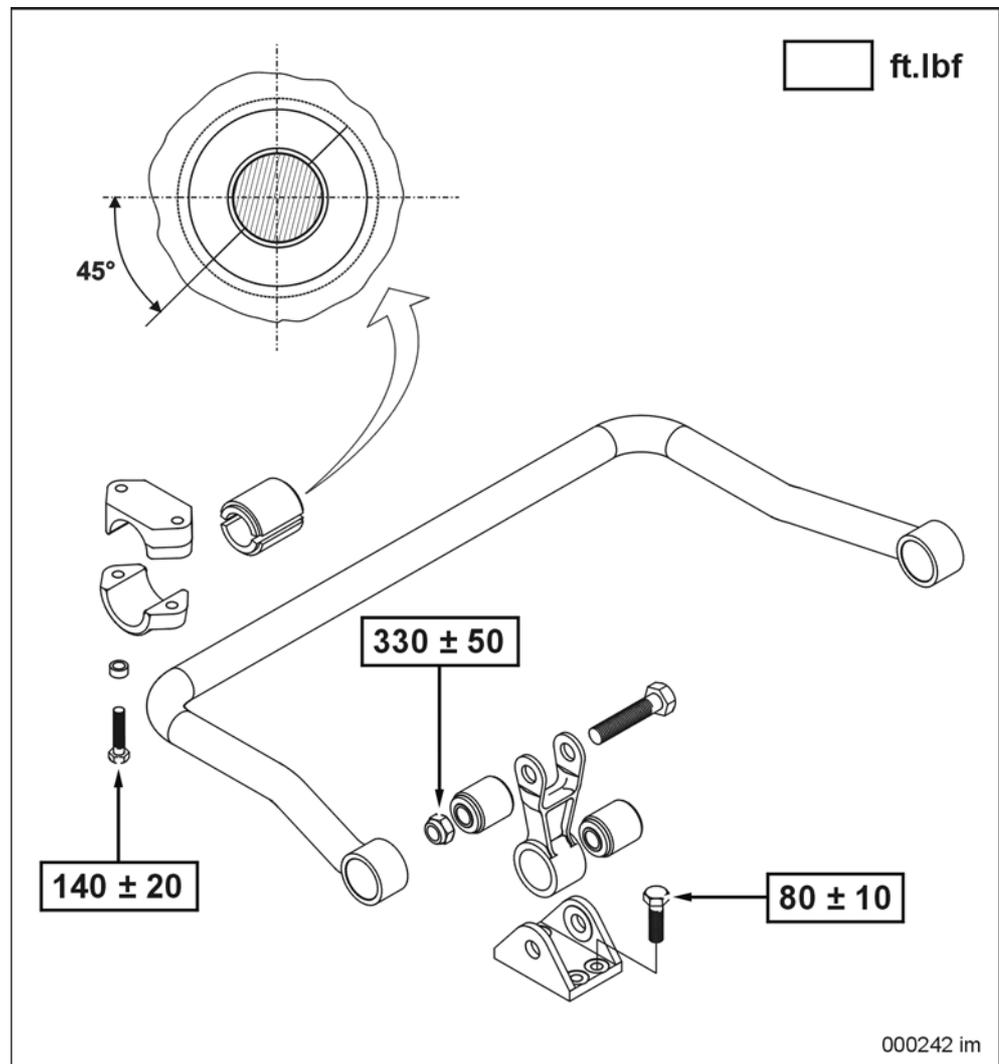
Figure:
tightening
torques



Security of beams.

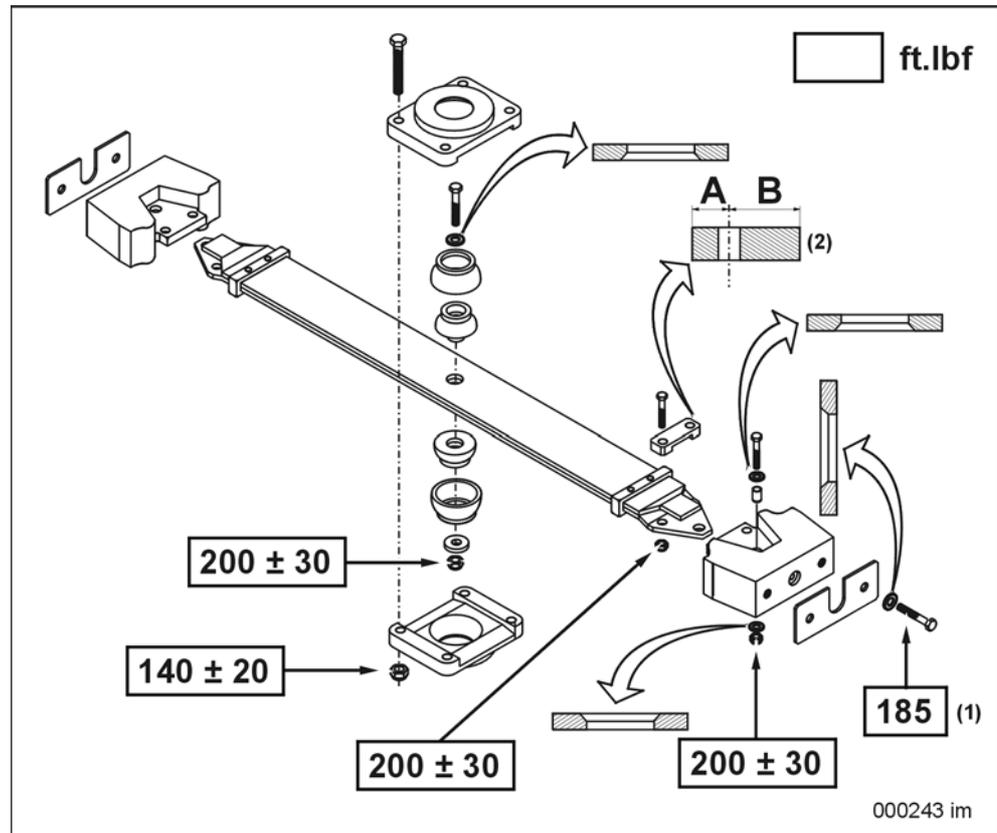
(1) Screws locked with Loctite 243 or equivalent

Figure:
tightening
torques



Security of sway bar

Figure:
tightening
torques



Security of leaf spring.

(1) Screws locked with Loctite 243 or equivalent

(2) "B" must be positioned at the spring carrier arm side.

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Chapter 18: Trailing axle suspension

Overview

Introduction

This chapter deals with the trailing axle suspension.

Number of pages

4

Chapter publication date

19 September 2006

Contents

Topic	See page
To check security of suspension components	3.18-2
To check shock absorbers for damage and leakage	3.18-3
Technical data: trailing axle suspension	3.18-4

To check security of suspension components

Tightening torques

Refer to "Technical data" at the end of this chapter.

Procedure

Visually check those bolts, screws and nuts that are locked by means of a cotter pin, a locking plate or locking adhesive (Loctite). The security of all others must be checked mechanically. Retighten, if necessary.



WARNING!

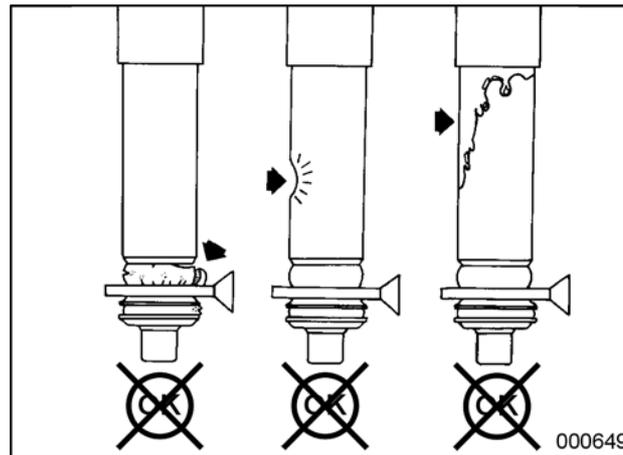
Never retighten bolts, screws or nuts that are fitted with locking adhesive, as this would destroy locking properties.

To check shock absorbers for damage and leakage

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: shock absorber failure



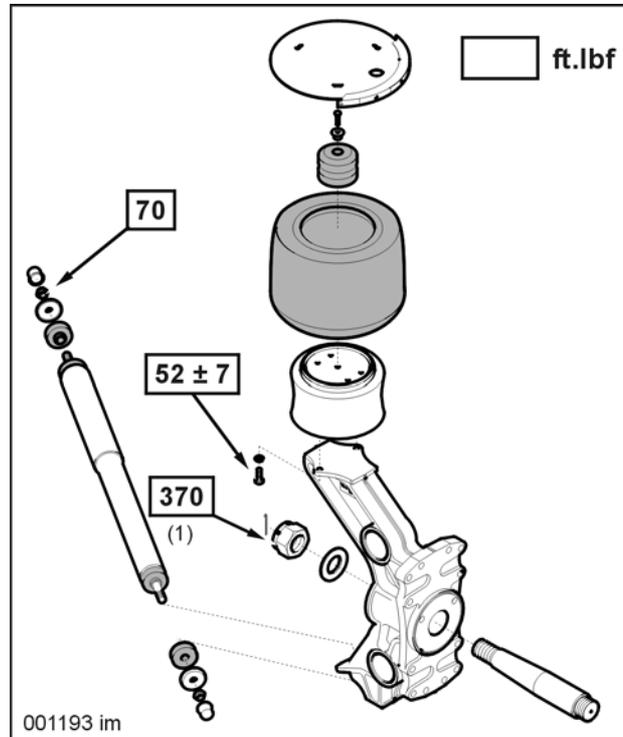
What to check?

Check the shock absorber for:

- fatigue cracks on rubbers;
- damage at housing;
- oil leaks.

Technical data: trailing axle suspension

Figure:
tightening
torques



Security of air bag piston and shock absorber.

- (1) *If necessary, tighten the nut a little further until you can install the cotter pin.
Never turn back to install the cotter pin.*

Chapter 34: Wheels

Overview

Introduction This chapter deals with the wheels.

Number of pages 10

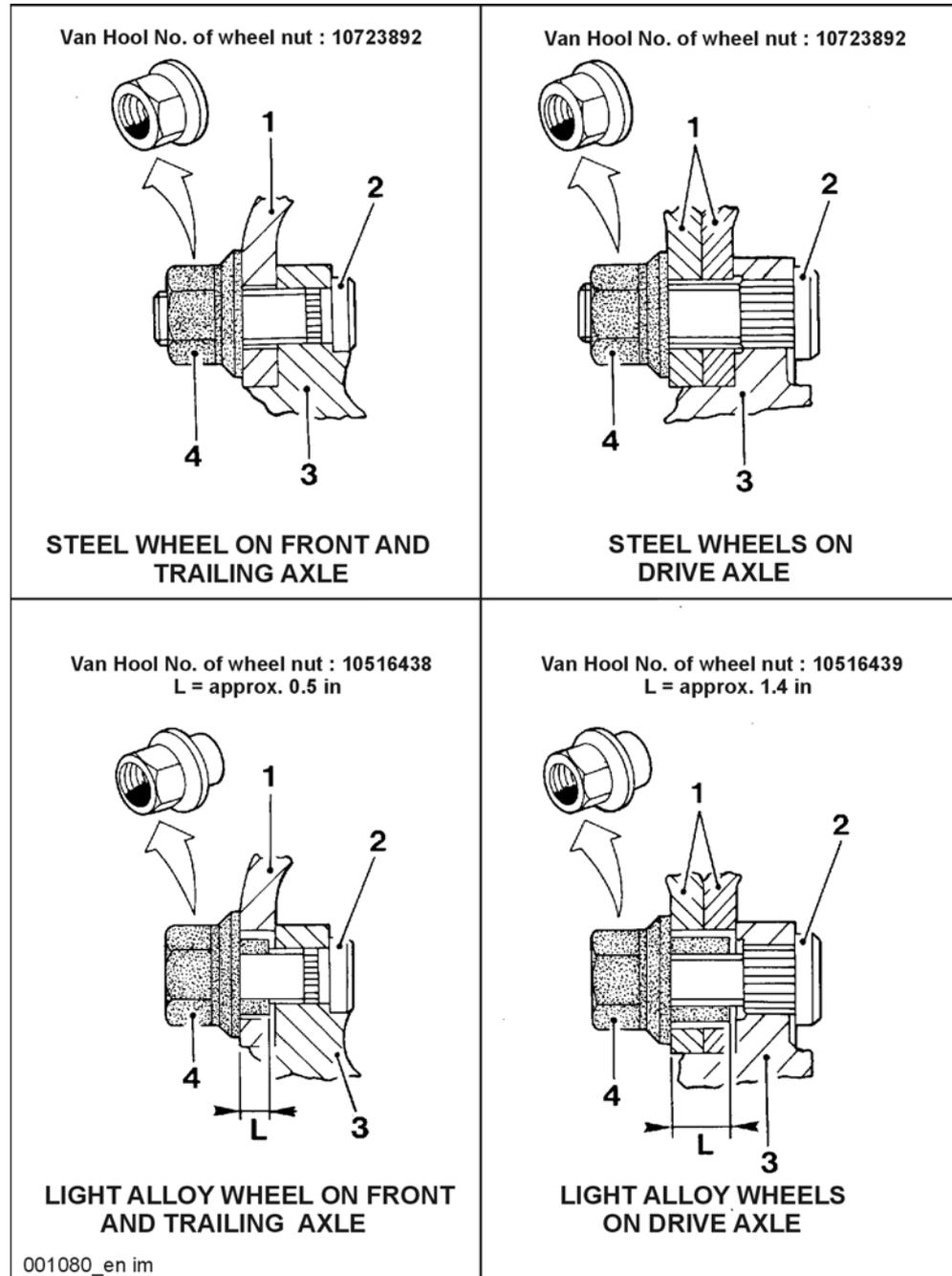
Chapter publication date 19 September 2006

Contents

Topic	See page
Wheel mounting systems	3.34-2
To change wheel	3.34-4
Technical data: wheels	3.34-7
Special tools: wheels	3.34-8

Wheel mounting systems

Figure: wheel mounting system



- 1 Wheel
- 2 Wheel bolt
- 3 Wheel hub
- 4 Wheel nut

Hub piloting

Van Hoof applies the so-called "hub piloting" to its vehicles. the wheel disc center hole fits a machined spigot (or a number of pads) on the hub precisely.

Hub-piloting characteristics:

- Wheels with cylindrical bolt holes;
 - Wheel nuts with flat, rotary but non-removable washers.
-

**WARNING!**

Only use wheels and wheel nuts suitable for hub piloting.

To change wheel

Wheel nut tightening torque

Refer to "Technical data" at the end of this chapter.

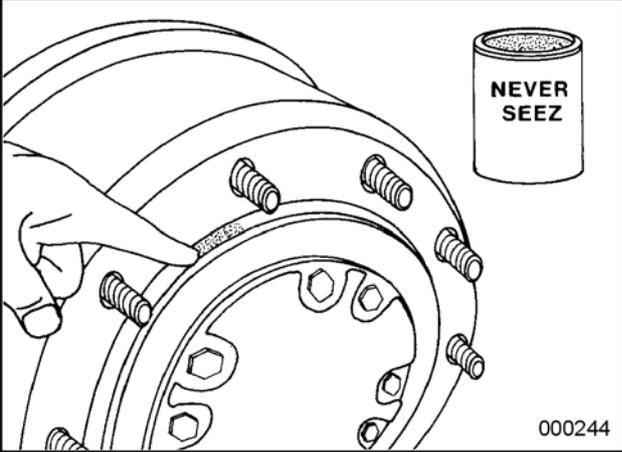
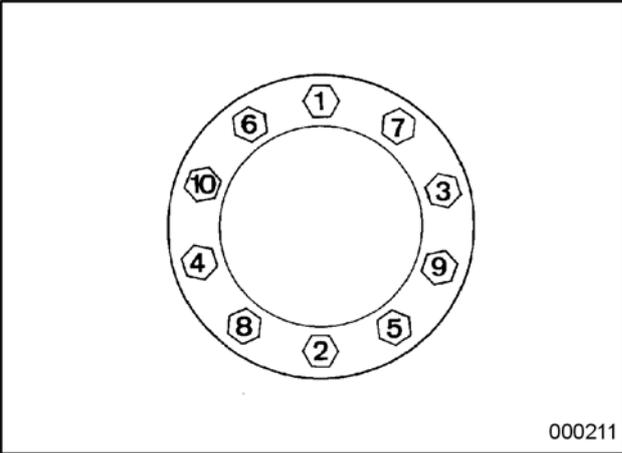
Precautions at wheel installation

- Before mounting a wheel, remove burrs, rust, dirt and paint runs from the contact surfaces. These are the areas of the wheel disc that touch the hub (or the other wheel in a double assembly), as well as the wheel nut contact areas.
- The contact areas (see above) may only be painted very thinly. Total coat thickness may not exceed 0.002 in. Only mount the wheel after the paint has hardened completely. Too thick a coat of paint or wheel mounting, when the paint is not fully hard yet, can cause wheel nut slackening.
- Before installing a wheel, always check wheel bolts for damage. Also check that bolts are well-secured in hub bolt-holes.
- After fitting a new tire, the wheel has to be balanced again.

Procedure

Step	Action
1	Using a socket wrench, remove the wheel nut caps, if present, by turning them counterclockwise until they are loose.
2	If necessary, clean wheel bolt ends with a stiff brush.
3	Slacken all wheel nuts by half a turn.
4	Jack up vehicle.
5	Remove wheel nuts and wheel.

continued on next page

Step	Action
6	<p>Clean hub pilot and wheel disc center hole. Smear pilot lightly with "Never-Seez".</p> 
7	<p>Clean wheel bolts with steel brush.</p>
8	<p>Locate wheel on hub. In case of a double mounting, make sure the valve of the inner wheel is accessible through hand holes.</p>
9	<p>Fit wheel nuts and tighten them according to sequence given in figure. Tighten wheel nuts evenly by alternately turning every nut progressively further each time, until specified torque is reached.</p> 
10	<p>If necessary, reinstall the wheel nut caps, as described under "To install wheel nut caps".</p>

To install wheel nut caps

Step	Action
1	<p>Install the wheel nut cap loosely on the wheel nut.</p>

continued on next page

Step	Action
2	 CAUTION! Only use a socket wrench to tighten the wheel nut caps. Using a socket wrench, turn the wheel nut caps clockwise until you sense a slight clamping.

**To retighten
wheel nuts**

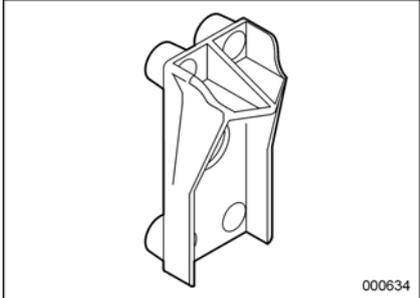
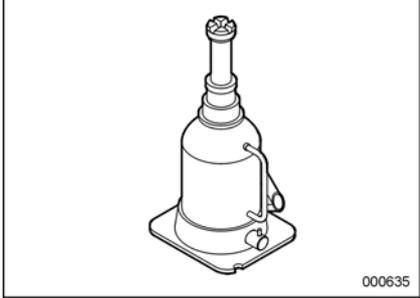
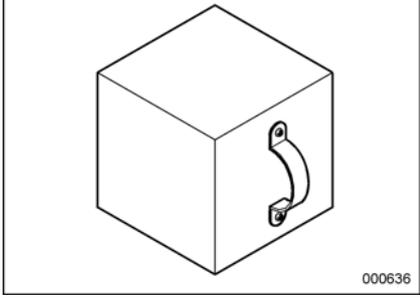
When a wheel has been changed, retighten wheel nuts with torque wrench after 30 miles and again after the next 60 miles. Subsequently check torque daily, until nuts are finally tight. Wheel nut slackening is explained by the fact that the fasteners set, so that part of the original torque is lost.

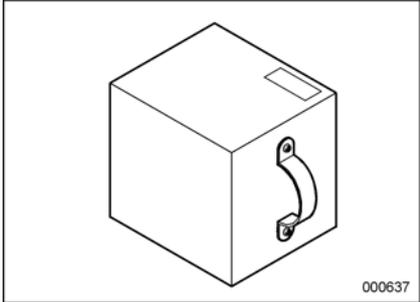
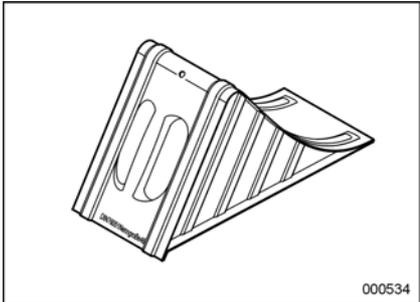
Technical data: wheels

Tightening torques

Wheel nuts	445 ± 15 ft.lbf
------------	-----------------

Special tools: wheels

Ordering number	Description	Figure
Van Hool 619900160	Lifting bracket (for steel wheels)	
Van Hool 10627455	Lifting bracket (for light alloy wheels)	
Van Hool 10583382	Hydraulic jack	
Van Hool 10581561	Wooden supporting block for jack	

Ordering number	Description	Figure
Van Hool 10581556	Wooden supporting block for steering knuckle carrier	
Van Hool 10545507	Wheel chock	

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Chapter 38: Tires

Overview

Introduction This chapter deals with the tires.

Number of pages 8

Chapter publication date 19 September 2006

Contents

Topic	See page
Tire selection	3.38-2
To check tires for inflation pressure and damage	3.38-3
To inspect tires	3.38-4
What to check with dual tires?	3.38-6
To change tires	3.38-7
Technical data: tires	3.38-8

Tire selection

**WARNING!**

Do not fit tires of size or construction other than the original ones without prior consent by Van Hool. Never fit tires with lower load or speed ratings.

Dimensions

Refer to "Technical data" at the end of this chapter.

**Load and
speed ratings**

Refer to "Technical data" at the end of this chapter.

To check tires for inflation pressure and damage

To be carried out when?

Before commencing daily service.

Tire inflation pressure

Refer to "Technical data" at the end of this chapter.



CAUTION!

If pressure is found to drop more than normal over a period of time, remove and inspect the tire to determine the cause.

Tire damage

Remove any stones or similar which have become embedded in the tread. They may cause damage in the long run.

Change the tire, if you encounter any of the following signs of damage:

- bumps, bulges or knots;
 - tread cuts, snags or side wall cracks deep enough to expose the casing cords;
 - any exposed casing material.
-

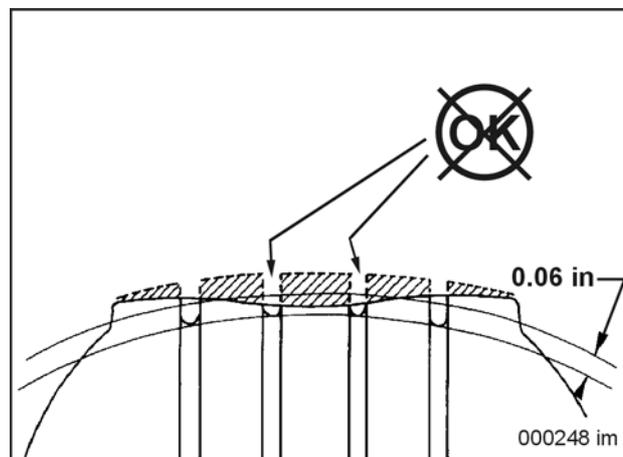
To inspect tires

To measure tread depth

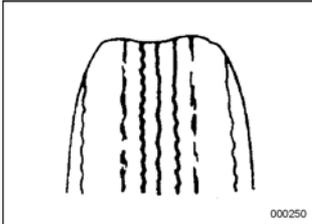
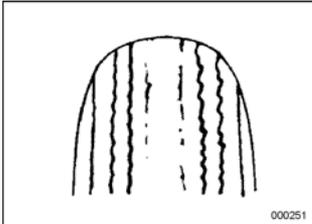
Measure the depth of the main tread grooves. Driving with a tread depth of less than 0.06 in is legally prohibited. One had better not wait, until the legal minimum has been reached, but replace the tire at a tread depth of 0.1 to 0.08 in already. The risk of skidding on wet and slippery roads increases, when tread is below this value.

NOTE: Tires of recent date have wear indicators.

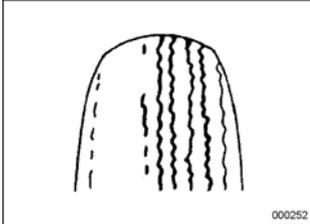
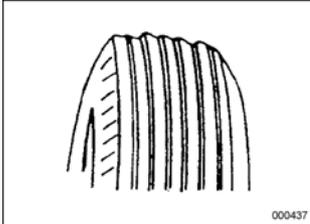
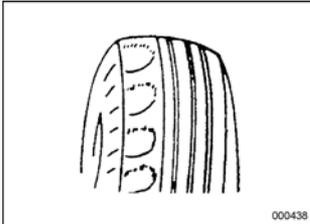
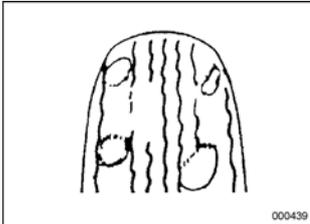
Figure: tread depth



Abnormal tread wear

Type of wear	Cause	Figure
Shoulder wear	Surface is "dished" due do underinflation.	
Center wear	Surface is "domed" due to overinflation.	

continued on next page

Type of wear	Cause	Figure
<p>Severe wear on one side of the tread</p>	<p>Excessive camber. Sometimes also misalignment.</p>	 <p>000252</p>
<p>Feather edging When you run your hand across the tread, you feel sharp edges in one direction (burrs).</p>	<p>Wheel alignment is incorrect.</p>	 <p>000437</p>
<p>Cupping</p>	<p>Usually poor shock absorbers. Sometimes unbalanced wheels. Occasionally also incorrect wheel alignment.</p>	 <p>000438</p>
<p>Bald spots</p>	<ul style="list-style-type: none"> • Unbalanced wheels. • Wheel run-out. • Excessive play in wheel bearings. • Incorrect wheel alignment in combination with loose steering joints. • Braking problems 	 <p>000439</p>

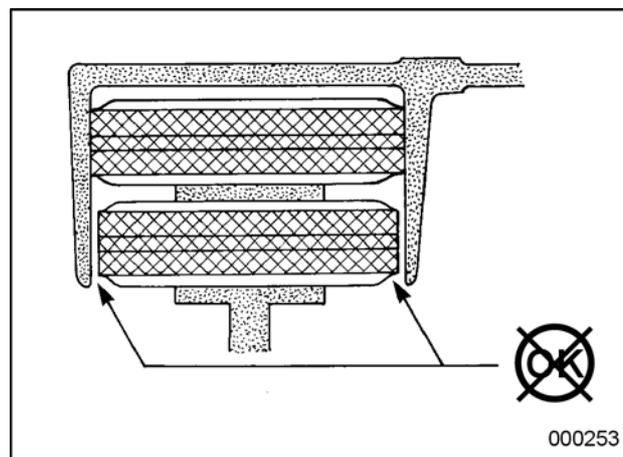
What to check with dual tires?

What to check?

To prevent overloading (and therefore damaging) one of dual tires, take care that:

- in mounted, inflated condition, the diameter difference (see figure) between both tires does not exceed 0.24 in;
- pressure in both tires is identical.

Figure: to check difference in diameter between tires



To change tires

To remove/ mount tires

To change a tire on this vehicle, follow the normal procedure for tubeless tires and drop-center rims.

NOTE: Always change the tires on each side of the axle at the same time.

Technical data: tires

Which tires should be on the vehicle?

Dimensions	Load and speed ratings
315/80 R22.5	156/150 L

Tire inflation pressure

The tire inflation pressure is mentioned on the vehicle identification plate in the step well of the passenger door.

The pressure values given in the table apply to cold tires, i.e. after at least 1 hour of standstill.

Under extreme operating conditions or, if tire wear gives cause to do so, tire inflation pressure should be adapted after consulting the tire manufacturer and Van Hool.

Part 4 - Driveline/Axle

Overview

Contents

Chapter	See page
Chapter 10: Propeller shaft	4.10-1

Chapter 10: Propeller shaft

Overview

Introduction

This chapter deals with the propeller shaft.

Number of pages

14

Chapter publication date

19 September 2006

Contents

Topic	See page
To carry out minor inspection of propeller shaft	4.10-2
To lubricate propeller shaft universal joints	4.10-7
To carry out major inspection of propeller shaft	4.10-8
To install propeller shaft	4.10-11
Technical data: propeller shaft	4.10-13

To carry out minor inspection of propeller shaft

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

Vehicle over an inspection pit or on a lifting device



CAUTION!

Never clean the propeller shaft with a high-pressure or steam cleaner. If in doubt whether someone has done so lately, regrease propeller shaft universal joints, until new grease escapes from bearing seals.

Minor inspection

The minor inspection contains the following points:

- To check flange bolts/screws for security;
- To check for wear;
- To check balance weights;
- To check universal joint bearings;
- To check seals;
- To check synthetic resin-coating of sliding joint;
- To check shaft for damage.

If the propeller shaft is damaged, parts are missing or excessive wear is found, remove the shaft for repair in an authorized workshop.

To check security of flange bolts/screws

Check security of flange bolts/screws at transmission side with torque wrench. At drive axle side you can find one of following fixation types:

If mating flange has...	then ...
tapped holes to receive screws locked with Loctite,	you may not retorque screws, otherwise locking properties of adhesive will be destroyed. Visually check whether screw heads contact flange.

continued on next page

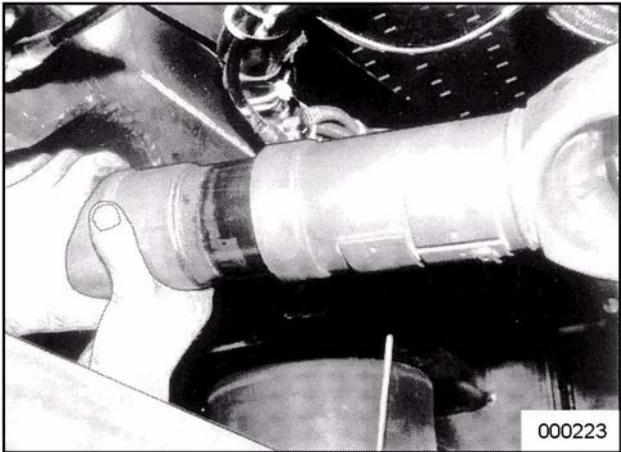
If mating flange has...	then ...
holes to receive bolts,	you have to check security with torque wrench.

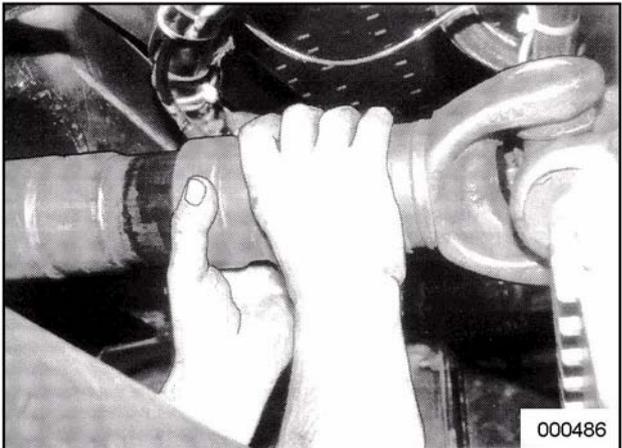


CAUTION!

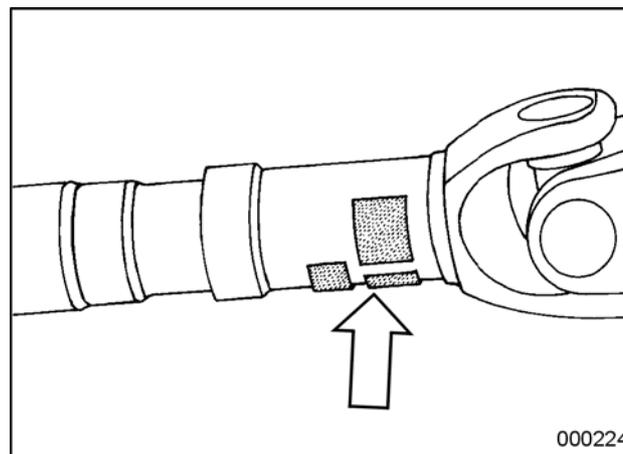
Do not attempt to turn the propeller shaft by means of a lever inserted through a universal joint. This may cause damage to seals and grease nipple.

To check for wear

Step	Action
1	<p>Try to move shaft up and down by hand: any movement indicates lash in sliding joint.</p> 

Step	Action
2	<p><i>NOTE: Check for looseness in universal joints, before re-lubricating them..</i></p> <p>Try to twist shaft by hand: any movement of shaft main section in relation to flange yoke indicates play in universal joint.</p> 

**Figure:
balance
weights**

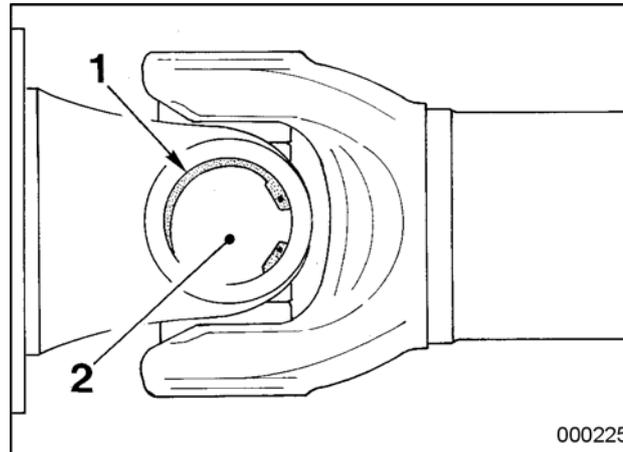


**To check
balance
weights**

Check whether all balance weights are secure. Look for traces of missing balance weights. Remove all build-up of foreign matter, which can cause an out-of-balance condition from shaft tube.

continued on next page

Figure:
universal joint



- 1 Snap ring
2 Universal joint bearing

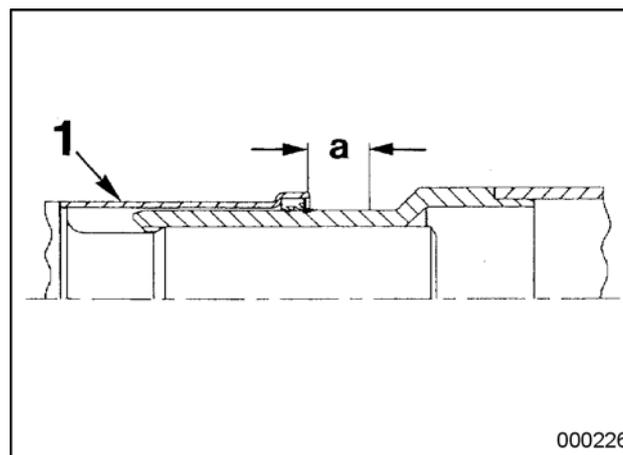
**To check
universal joint
bearings**

Check whether all bearings are secured with a snap ring (1). Check bearing cup (2) for signs of overheating (blue discoloration).

To check seals

Visually check condition of universal joint bearing seals and sliding joint seal. A damaged seal will result in excessive grease loss. This will soon lead to breakdown of the shaft.

**Figure: detail
of sliding joint**



- 1 Protection sleeve
2 Synthetic resin-coated area

**To check
synthetic
resin-coating**

Check condition of synthetic resin-coating at outer diameter of slip stub shaft (where protective sleeve seal will slide). The coating may not show signs of any damage or abrasion.

**To check shaft
for damage**

Visually check shaft tube for flaked paint, cracks and dents. Also check protection sleeve (1) of sliding joint for eccentricity.

To lubricate propeller shaft universal joints

To be carried out when?

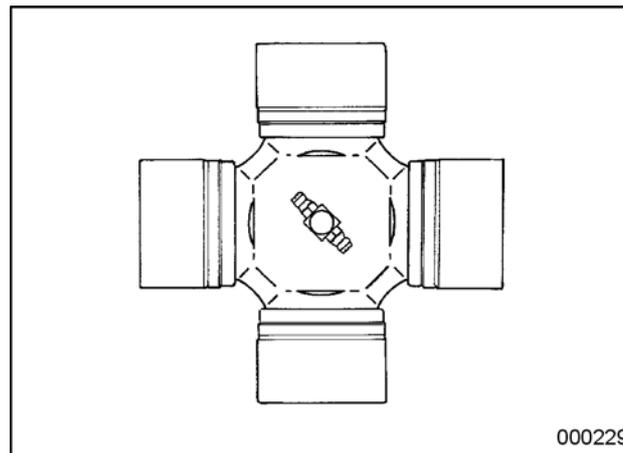
Refer to chapter 1.1, "Maintenance schedule".

Grease type

Refer to chapter 1.1, "Fluids and lubricants".

**CAUTION!**

Avoid pressure surges at lubrication. Maximum allowable grease gun pressure: 200 psi.

Figure: grease nipple on universal joint

Procedure

Use a grease gun to apply lubricant through the T-nipple on each trunnion. Check that old grease escapes from all bearing seals.

Grease will not pass through?

If no grease escapes from the bearing seal during lubrication, the bearing can be considered damaged. If such a bearing is found, remove the propeller shaft for repair in an authorized workshop. There they will change both shaft trunnions for safety reasons.

To carry out major inspection of propeller shaft

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Propeller shaft removed



CAUTION!

Never clean the propeller shaft with a high-pressure or steam cleaner. If in doubt whether someone has done so lately, regrease propeller shaft universal joints, until new grease escapes from bearing seals.

Major inspection

The major inspection contains the following points:

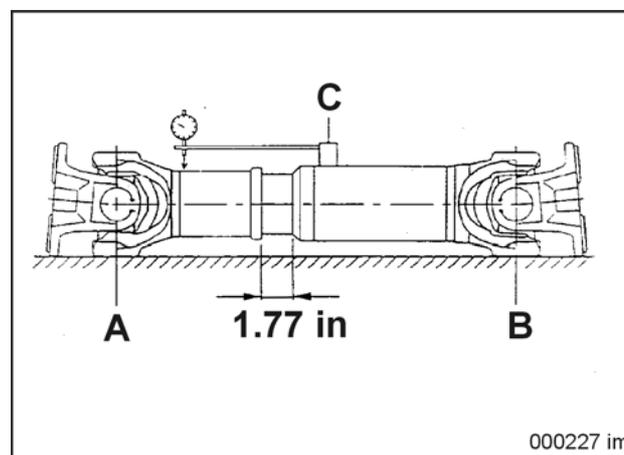
- To check universal joint bearings;
- To check lash in sliding joint;
- To check the dismantled sliding joint visually.

If the inspection reveals damage or excessive wear, bring the shaft to an authorized workshop for repair.

To check universal joint bearings

Manoeuvre universal joints by hand in all directions to check whether they are free of play or "tight spots" (e.g. hooking).

Figure: set-up for checking lash in sliding joint



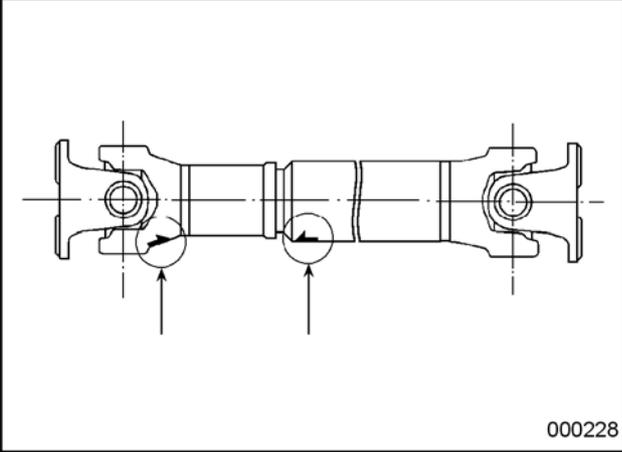
**To check lash
in sliding joint**

Step	Action
1	Lay complete shaft on flat surface, lugs of inner yokes resting on surface (points A and B). Extend sliding joint by approximately 1.77 in.
2	Mount dial indicator with magnetic base next to weld of sliding yoke (point C). Position stylus of dial indicator against protective sleeve, as close as possible to weld of latter.
3	Lift propeller shaft (approximately in its center of gravity), until inner yokes become free of flat surface.
4	Read variation shown by dial indicator. The maximum allowable value is 0.0067 in.

**To check
dismantled
sliding joint**

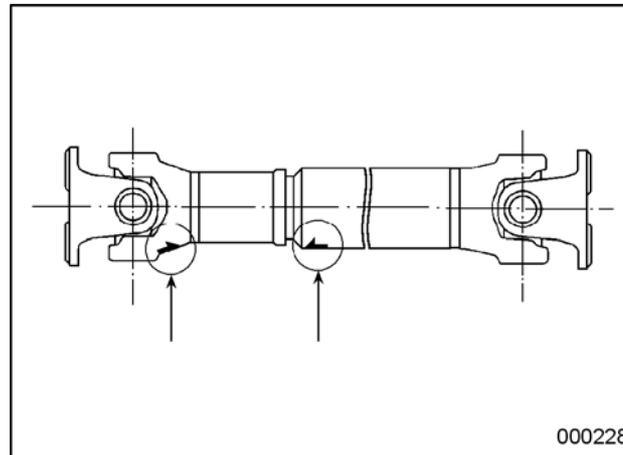
Step	Action
1	 <p>CAUTION! Do not damage synthetic coating of sliding joint. Do not use solvents; they can affect the synthetic coating.</p> <p>Withdraw slip stub shaft from sliding yoke.</p>
2	Examine sliding joint for damage on inside and outside of sliding yoke and at splines of slip stub shaft.
3	Check condition of protective sleeve seal.
4	If sliding joint is undamaged, regrease splines and seal. For grease type refer to chapter 1.1, "Fluids and lubricants".

continued on next page

Step	Action
5	<p>Push slip stub shaft into sliding yoke, making sure alignment marks (arrows) are in line.</p> <div><p>000228</p></div>

To install propeller shaft

Figure:
alignment
marks on shaft
members



**Installation
marks on shaft
members
aligned?**

Before mounting, check the relative position of the sliding joint members: the arrows (see figure) on the sliding yoke and the slip stub shaft should be aligned.

**Flanges clean
and
degreased?**

The mounting surfaces should be cleaned carefully on beforehand. Remove any traces of rust preventer, paint and lubricant with a suitable solvent.

NOTE: In the case of flanges with a toothed mounting surface you do not have to remove the rust preventer fitted on the toothing by the manufacturer.

**Before
installing
bolts/screws**

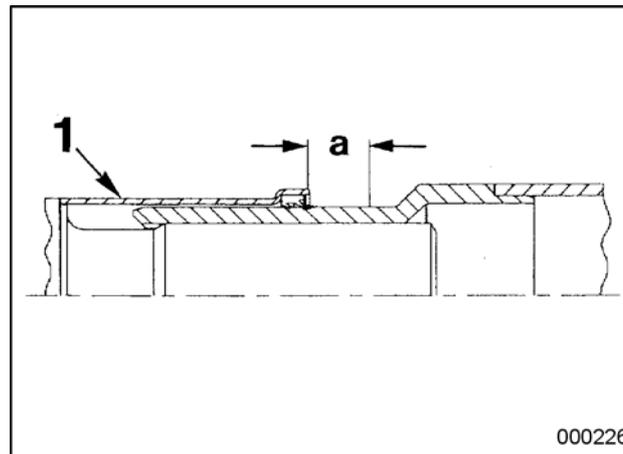
Screw or bolt	Treatment
Screw (without nut) to be used in tapped holes	Apply liquid adhesive Loctite 243 to screw threads.
Bolt (with nut) to be used in untapped holes	Slightly oil bolt threads. <i>NOTE: Do not use lubricants containing molybdenum disulphide (MoS₂).</i>

**To tighten
screws and
nuts**

Cross-tighten the screws and nuts of the flanges gradually, until the prescribed tightening torque is reached (refer to "Technical data" at the end of this chapter). Only use self-locking screws according to DIN 980, quality 10.

continued on next page

**Figure: detail
of sliding joint**



1 Protection sleeve

a Synthetic resin-coated area

When painting

During painting operations the synthetic resin-coated plain section of the sliding yoke, where the protective sleeve seal will slide, has to be protected.

Technical data: propeller shaft

Tightening torques flange fasteners

The tightening torque depends on the fasteners type.

The following table gives you an overview of all propeller shaft fasteners used on Van Hool vehicles. With toothed propeller shaft flanges, these are fasteners available in regular retail trade; with smooth propeller shaft flanges, you have to use the special fasteners mentioned in the Van Hool spare parts manual.

Flange type	Fastener (quality 10.9)	Tightening torque
With a toothed flange	M12 x 1.75	74 ± 11 ft.lbf
	M12 x 1.5	77 ± 11 ft.lbf
	M14 x 2	118 ± 15 ft.lbf
	M14 x 1.5	133 ± 18 ft.lbf
With a smooth flange	M10	52 ± 4 ft.lbf
	M12	89 ± 6 ft.lbf
	M14	140 ± 10 ft.lbf
	M16	218 ± 15 ft.lbf

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Part 5 - Brakes

Overview

Contents

Chapter	See page
Chapter 2: Control systems	5.2-1
Chapter 10: Compressed-air brakes	5.10-1
Chapter 14: Speed retarder	5.14-1

Chapter 2: Control systems

Overview

Introduction This chapter deals with the control systems.

Number of pages 16

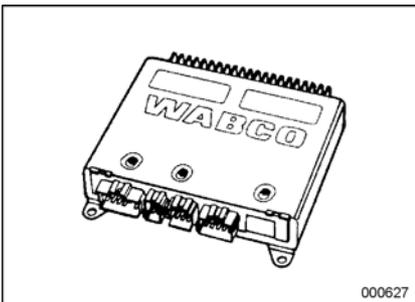
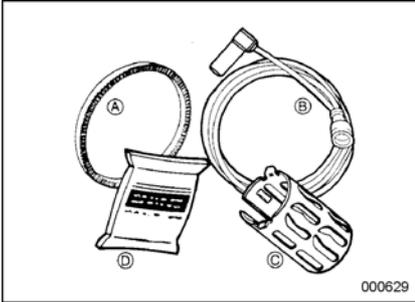
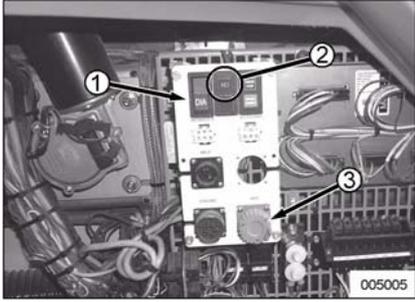
Chapter publication date 19 September 2006

Contents

Topic	See page
ABS: visual identification of components	5.2-2
ABS: fault reproduction	5.2-3
ABS: troubleshooting with diagnostic switch	5.2-5
To test the ABS with "MSPI Pro-Link 9000"	5.2-9
ABS: to check power supply	5.2-10
To check ABS valve	5.2-11
To check ABS wheel-speed sensors	5.2-13
To install ABS wheel-speed sensor	5.2-15
Special tools: control systems	5.2-16

ABS: visual identification of components

Components

Name	Figure
Electronic control unit	 <p>000627</p>
ABS valve	 <p>000628</p>
Wheel-speed sensor kit + pulse ring <i>A Pulse ring</i> <i>B Wheel-speed sensor</i> <i>C Spring sleeve</i> <i>D Special grease</i>	 <p>000629</p>
Diagnostics panel in front junction box 1 Diagnostic switch 2 ABS diagnostic lamp 3 ABS diagnostic socket	 <p>005005</p>

ABS: fault reproduction

Introduction

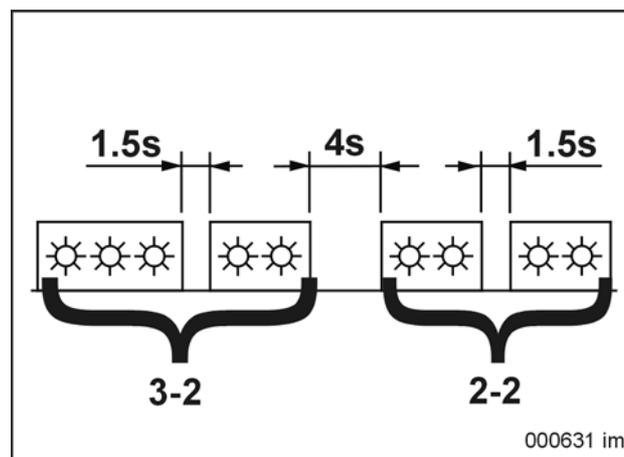
The electronic control unit contains a self-diagnostic feature. The electronics constantly monitor the correct operation of the system and fault findings are stored in a memory. Upon request, the ABS lamp on the diagnostic panel in the front junction box shows fault memory contents in the form of a flash code.

What does a flash code look like?

The fault code consists of two sets of flashes with each set separated by a 1.5 seconds pause.

If there are more fault findings in the memory, their flash codes are separated by a 4 seconds pause.

Figure: example of fault codes



Fault codes 3-2 and 2-2

Types of faults

Type of fault	What is it?
Active fault	<ul style="list-style-type: none"> Fault that exists during the reading of the diagnostic memory <p><i>NOTE: An active fault must be repaired, before you can display additional faults.</i></p>
Stored fault	<ul style="list-style-type: none"> A repaired fault that has not been cleared from the diagnostic memory, or... a fault that has disappeared spontaneously.

continued on next page

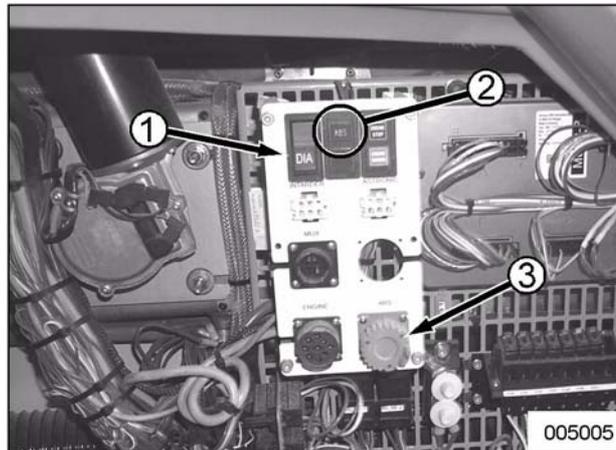
Fault reproduction according to fault type

The reproduction of the fault code is different for "active" and for "stored" faults.

In the case of...	the diagnostic lamp displays...	and...
an active fault	one fault code, even if there are more fault messages in the memory	repeats this code, as long as vehicle ignition is switched on.
a stored fault	successively the codes of all stored fault messages	does this one time only. <i>NOTE: If you want to look at the codes again, press the diagnostic push-button a second time.</i>

ABS: troubleshooting with diagnostic switch

Figure:
components
for ABS diag-
nostics



Diagnostics panel in front junction box (EKF)

- 1 Diagnostic switch
- 2 ABS lamp
- 2 ABS diagnostic socket

Does diagnostic memory contain fault messages?

Switch on the ignition and look at what the ABS lamp is doing.

If the lamp...	then ...
illuminates momentarily,	there is no fault code in the memory. No action required.
does not illuminate,	there is probably a fault in the wiring to the lamp.
illuminates and stays on,	there are fault codes in the memory.

To read fault codes

Step	Action
1	Switch the vehicle ignition on.
2	Press and hold diagnostic switch for 1 second.
3	Release the switch. The ABS lamp starts to flash. Count and note number of flash series, refer to "ABS: fault reproduction".
4	Compare code with figures in table "Fault code explanation".
5	Repair fault.

continued on next page

Step	Action
6	<ul style="list-style-type: none"> In the case of an active fault: repeat steps 2 up to 5, until you receive code "1-1". This means the system is OK. In the case of stored faults: note fault codes. If these faults appear repeatedly, you have to repair the fault.
7	Clear fault codes from memory, refer to "To clear fault codes from diagnostic memory".

To clear fault codes from diagnostic memory

Even after the fault has disappeared spontaneously or has been repaired, the lamp in the ABS diagnostic switch will stay on and the fault code will remain in the memory, until you clear the memory manually.

Step	Action
1	Switch the vehicle ignition on.
2	<p>Press and hold the diagnostic switch for at least 3 seconds.</p> <p>The ABS lamp starts to flash.</p> <ul style="list-style-type: none"> Lamp flashes eight times, after 4 seconds followed by one or two flashes. This code will be repeated, until the ignition is switched off. This means all fault codes have been cleared successfully. Lamp flashes one or two time(s). This means there are still active faults. Repeat steps 1 up to 7 under "To read fault codes".

Fault code explanation

Number of flashes series 1	Number of flashes series 2	Explanation
1	1	No fault codes found
2	1	ABS valve of RH front wheel
2	2	ABS valve of LH front wheel
2	3	ABS valve of RH drive axle wheel
2	4	ABS valve of LH drive axle wheel
2	5	ABS valve of RH trailer/trailing axle wheel
2	6	ABS valve of LH trailer/trailing axle wheel
3, 4, 5	1	Wheel-speed sensor of RH front wheel
3, 4, 5	2	Wheel-speed sensor of LH front wheel
3, 4, 5	3	Wheel-speed sensor of RH drive axle wheel

continued on next page

Number of flashes series 1	Number of flashes series 2	Explanation
3, 4, 5	4	Wheel-speed sensor of LH drive axle wheel
3, 4, 5	5	Wheel speed sensor RH trailer/trailing axle wheel
3, 4, 5	6	Wheel speed sensor LH trailer/trailing axle wheel
6	1	Pulse ring of RH front wheel
6	2	Pulse ring of LH front wheel
6	3	Pulse ring of RH drive axle wheel
6	4	Pulse ring of LH drive axle wheel
6	5	Pulse ring of RH trailer/trailing axle wheel
6	6	Pulse ring of LH trailer/trailing axle wheel
7	1	J1922 or J1939 data connection
7	2	ATC valve
7	3	Retarder (auxiliary brake) relay
7	4	ABS lamp
7	5	ATC configuration
7	6	Reserve
8	1, 2, 3, 4, 5	Electronic control unit

To be checked after fault diagnostics

Flash code	Problem	Action required
2-1, 2-2, 2-3, 2-4, 2-5, 2-6	ABS valve wiring interrupted or shorted to "ground" or "plus".	Check wiring.
3-1, 3-2, 3-3, 3-4, 3-5, 3-6	Output signal wheel-speed sensor too low.	<ul style="list-style-type: none"> • Push wheel-speed sensor manually against pulse ring. • Check wiring and connectors of wheel-speed sensor. • Check wheel bearing end-float and pulse ring run-out.
4-1, 4-2, 4-3, 4-4, 4-5, 4-6	Wheel-speed sensor wiring interrupted or shorted to "ground" or "plus".	Check wiring.

continued on next page

Flash code	Problem	Action required
5-1, 5-2, 5-3, 5-4, 5-5, 5-6	Output signal of wheel-speed sensor irregular.	<ul style="list-style-type: none"> • Check wiring and connectors of wheel-speed sensor. • Check pulse ring for damage.
6-1, 6-2, 6-3, 6-4, 6-5, 6-6		Check pulse ring for damage.
7-1		Contact Van Hool or an ArvinMeritor agent.
7-2	ATC valve wiring interrupted or shorted to "ground" or "plus".	Check wiring.
7-3		Check wiring to retarder.
7-4		Check the ABS lamp wiring
7-5		Contact Van Hool or an ArvinMeritor agent.
7-6	Output interrupted, or shorted to "ground" or "plus"	Check wiring.
8-1	Power supply sometimes too low	Check power supply and fuses.
8-2	Power supply longer than 5 seconds too high	Check power supply.
8-3		Change electronic control unit, if fault occurs repeatedly.
8-4		Contact Van Hool or an ArvinMeritor agent.
8-5		Check ground connections of electronic control unit and common valve wires.

To test the ABS with "MSPI Pro-Link 9000"

Special tools

MSPI Pro-Link 9000	Kent-Moore
"Meritor Wabco D" cartridge, version 4.0 or higher	Kent-Moore

Equipment condition

- Parking brake applied
- Wheels chocked
- Ignition off

Procedure

Step	Action
1	Slide the cartridge into the "Pro-Link".
2	Connect the "Pro-Link" to the diagnostic socket. For the location of the diagnostic socket, refer to "Location of components".
3	Switch the vehicle ignition on. The "Pro-Link" screen powers up.

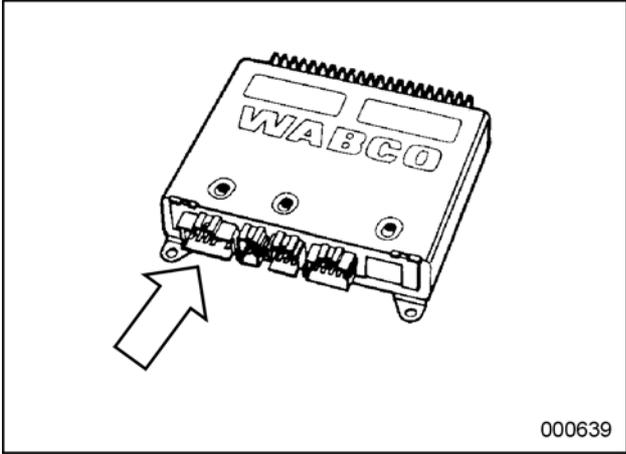
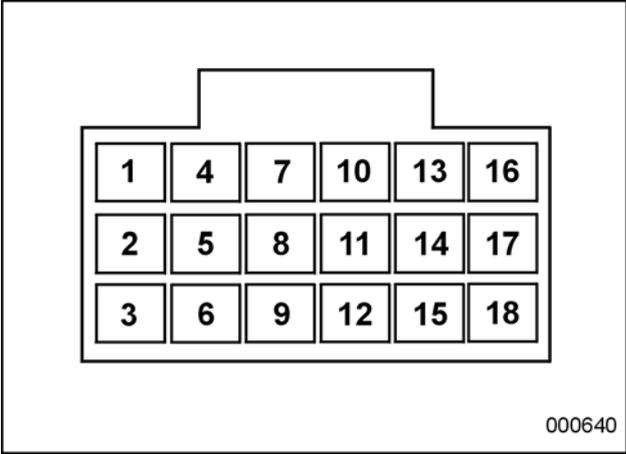
Test instructions

Refer to the "Pro-Link" manual.

ABS: to check power supply

Correct value Power supply has to be between 18 and 30 Volts.

Procedure

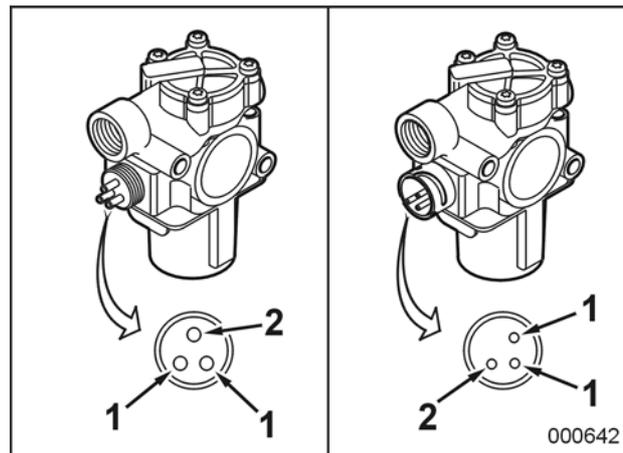
Step	Action
1	Switch off master switch on dashboard.
2	Disconnect 18-pin connector from electronic control unit.  <p style="text-align: right;">000639</p>
3	Switch on master switch on dashboard and turn on ignition.
4	Measure voltage between pins 7 and 10, 8 and 11, and 9 and 12 of the 18-pin connector. The numbers in the figure are to be considered from wire input side.  <p style="text-align: right;">000640</p>

To check ABS valve

Location of ABS valves

Refer to "Schematic" previously in this chapter.

Figure: ABS valve terminals



Left: ABS valve with screw socket; right: ABS valve with bayonet socket

- 1 Solenoid coil terminals
- 2 Ground terminal

Procedure

Step	Action
1	Switch off master switch on dashboard.
2	Disconnect connectors from electronic control unit.
3	Measure resistance of ABS valve and wiring as one unit. Measure resistance at pins indicated further on under "Measuring points". Reading should be between 11.0 and 21.0 Ohms.
4	<ul style="list-style-type: none"> • Resistance greater than 21.0 Ohms: clean electrical terminals of ABS valve. • Resistance infinite (=interruption): disconnect connector from ABS valve. Measure resistance straight at ABS valve, between each solenoid coil terminal and ground terminal.
5	<ul style="list-style-type: none"> • If resistance is still infinite, you have to change ABS valve. • If resistance is no more infinite, you know interruption is located in wiring between electronic control unit and ABS valve.

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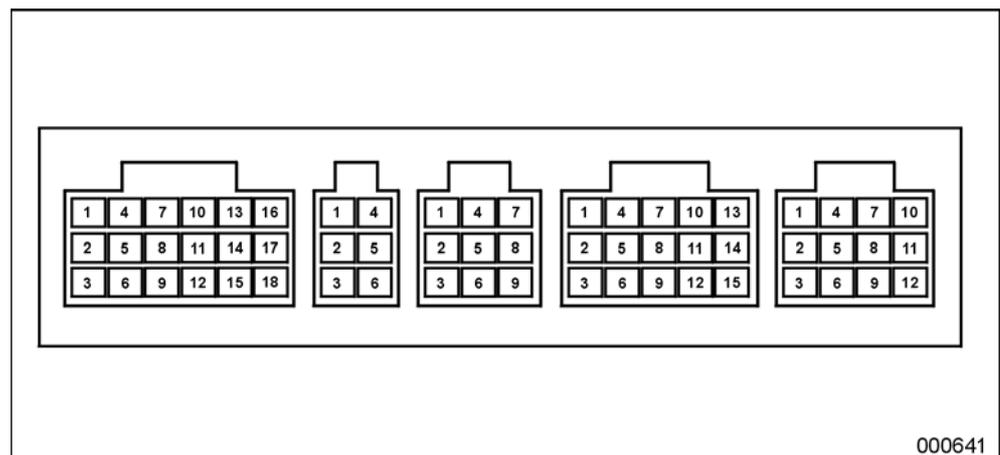
12-pin connector at electronic control unit

The 12-pin connector is to be found on vehicles with three axles only.

Measuring points at connectors of electronic control unit

ABS valve	Connector	Measure between pins
LH front wheel	6-pin	1 and 3 2 and 3
RH front wheel	9-pin	7 and 9 8 and 9
LH drive axle wheel	15-pin	1 and 3 2 and 3
RH drive axle wheel	15-pin	10 and 12 11 and 12
LH trailer/trailing axle wheel	12-pin	1 and 3 2 and 3
RH trailer/trailing axle wheel	12-pin	10 and 12 11 and 12

Figure: pin numbering of connectors on electronic control unit



Connectors as seen from wire input side.

To check ABS wheel-speed sensors

Location of wheel-speed sensors

Refer to "Schematic" previously in this chapter.

Electric resistance of sensor

500 to 2 000 ohms

Output voltage of sensor

At least 0.2 Volts AC at 30 rpm.



CAUTION!

The pins of the connector used in the ABS system are very fragile.

To measure sensor resistance

Step	Action
1	Switch off master switch on dashboard.
2	Disconnect connectors from electronic control unit.
3	Measure resistance of wheel-speed sensor and wiring as one unit. Measure resistance at pins indicated further on under "Measuring points".
4	If resistance is infinite (= interruption): disconnect connector from wheel-speed sensor and measure straight at sensor wiring.

To measure output voltage of sensor

Step	Action
1	Switch off master switch on dashboard.
2	Disconnect connectors from electronic control unit.
3	Rotate wheel by hand with speed of 30 rpm (one revolution every 2 seconds) and measure output voltage of wheel-speed sensors at connectors of electronic control unit. Measure voltage at pins indicated further on under "Measuring points".

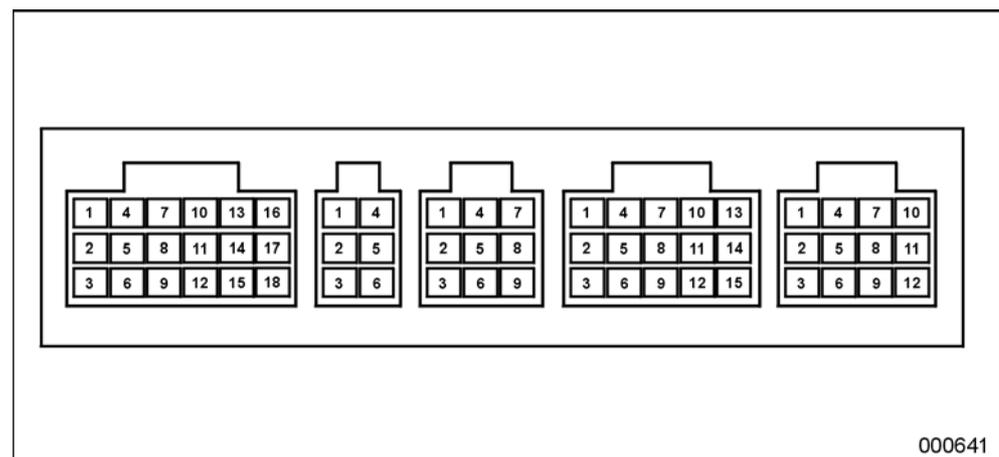
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**12-pin
connector at
electronic
control unit**

The 12-pin connector is to be found on vehicles with three axles only.

**Measuring
points at
connectors of
electronic
control unit**

Wheel-speed sensor	Connector	Measure between pins
LH front wheel	6-pin	4 and 5
RH front wheel	9-pin	4 and 5
LH drive axle wheel	15-pin	5 and 6
RH drive axle wheel	15-pin	8 and 9
LH trailer/trailing axle wheel	12-pin	5 and 6
RH trailer/trailing axle wheel	12-pin	8 and 9

**Figure: pin
numbering of
connectors on
electronic
control unit**

Connectors as seen from wire input side.

To install ABS wheel-speed sensor

Consumables

Special high temperature grease	Van Hool No. 10610096
"Blue seal" vaseline	Van Hool No. 660852700

Procedure

Step	Action
1	Apply special high temperature grease to clamping bush and sensor.
2	Push clamping bush into place.
3	Push sensor into place by hand, until it contacts pulse ring. The necessary gap between the sensor and the pulse ring will develop automatically, when the vehicle starts moving, at the first revolutions of the wheel.
4	<i>NOTE: In order to prevent the ingress of water, fill wheel-speed sensor connector with "Blue seal" vaseline.</i> Connect wheel-speed sensor to chassis wiring.

Special tools: control systems

Ordering number	Description	Figure
Kent-Moore	MSPI Pro-Link 9000 + "Meritor Wabco D" cartridge, version 4.0 or higher	 002626

Chapter 10: Compressed-air brakes

Overview

Introduction This chapter contains the compressed-air brakes.

Number of pages 44

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety precautions concerning compressed air	5.10-3
Air line color codes	5.10-4
To test service-brake circuits for air-tightness	5.10-5
To check and lubricate the operating mechanism of the foot brake valve	5.10-8
To inspect brake chambers on front axle	5.10-10
To inspect brake chambers on drive axle	5.10-11
To inspect brake chambers on trailing axle	5.10-13
To check quick release valve of front wheel brakes	5.10-14
To check quick release double check valve of parking brake	5.10-15
To check relay valve of drive axle service brake	5.10-16
To check relay valve of trailing axle brakes	5.10-17
Safety precautions to be taken when exposed to brake dust	5.10-18
To check condition of brake pads	5.10-19
To check brake clearance	5.10-20
To check adjusting mechanism operation	5.10-21
To check brake disc condition	5.10-22
To check brake disc run-out	5.10-24
To check the brake caliper sliding system	5.10-25
To remove brake pads	5.10-30
To install brake pads	5.10-33
To remove brake caliper/brake carrier	5.10-37
To install brake caliper/brake carrier	5.10-39

continued on next page

Topic	See page
Technical data: compressed-air brakes	5.10-42
Special tools: compressed-air brakes	5.10-43

Safety precautions concerning compressed air

**Cross-
reference**

Refer to chapter 13.1, "Complete compressed-air system".

Air line color codes

**Cross-
reference**

Refer to chapter 13.25, "Air lines".

To test service-brake circuits for air-tightness

To be carried out when?

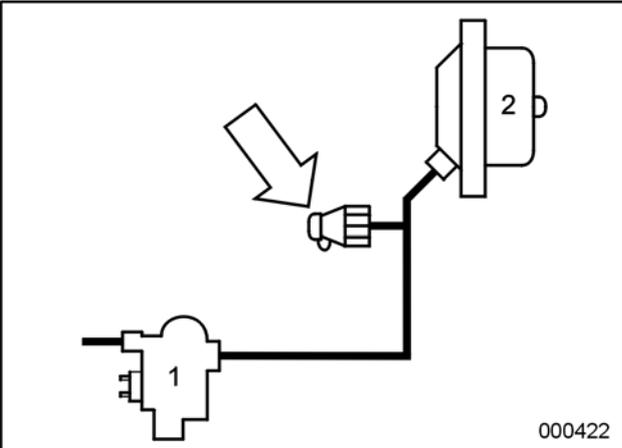
Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

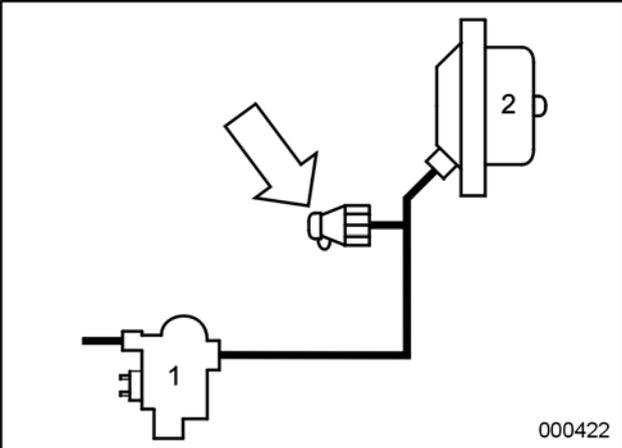
A pressure of 115 to 130 psi in the air tanks

Procedure

Test the three service-brake circuits for air-tightness as follows:

Step	Action
1	<p>Connect a class 0.6 pressure gauge with a range of 145 psi to the test fitting in air line to right-hand front wheel brake chamber. The test fitting is located between ABS valve (1) and brake chamber (2).</p>  <p style="text-align: right;">000422</p>

Step	Action
<p>2</p>	<p>Watch pressure gauge, as an assistant fully applies and holds brake pedal.</p> <p>The leakage rate with full brake application after 5 minutes must not exceed 4.34 psi.</p> <div style="border: 1px solid black; padding: 5px;"> </div>
<p>3</p>	<p>Repeat test, this time having connected pressure gauge to test fitting in air line to drive axle RH service brake chamber.</p> <p>The test fitting is located between ABS valve (1) and brake chamber (2).</p> <div style="border: 1px solid black; padding: 5px;"> </div>

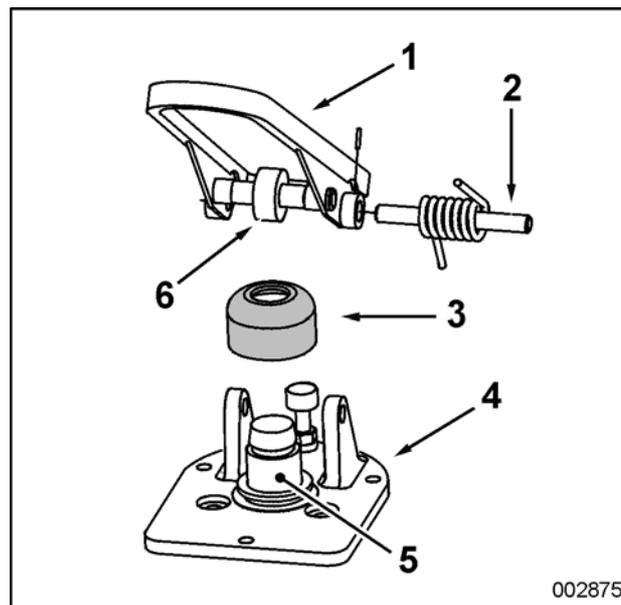
Step	Action
4	<p>Repeat test, this time having connected pressure gauge to test fitting in air line to trailing axle RH brake chamber.</p> <p>The test fitting is located between ABS valve (1) and brake chamber (2).</p> <div></div>
5	<p>If the pressure drop exceeds the permitted rate, locate the air leaks with an electronic detector or by coating the suspected spots in the circuit with a soap solution.</p>

To check and lubricate the operating mechanism of the foot brake valve

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: foot brake valve operating mechanism



- 1 Threadle
- 2 Hinge pin with return spring
- 3 Plunger dust boot
- 4 Mounting plate
- 5 Plunger
- 6 Threadle roller

Procedure

Step	Action
1	Remove the accumulated dirt, dust, gravel and grease from the heel of threadle (1), plunger (5), plunger dust boot (3) and mounting plate (4).
2	Check the plunger rubber dust boot (3) for damage. Change if necessary.
3	Check threadle (1) and mounting plate (4) for damage, wear and corrosion. Change if necessary.

Step	Action
4	Apply 2 to 4 drops of oil between plunger (5) and mounting plate (4). Do not use too much oil!
5	Lubricate threadle roller (6), threadle roller pin and hinge pin (2) with thin oil.

To inspect brake chambers on front axle

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Maximum pressure (115 to 130 psi) in the air tanks

Procedure

Step	Action
1	Clean the outside of the brake chamber and look for visible damage.
2	Brush soapy water to vent hole (2) and clamping ring (1). <div> <p>000444</p> </div>
3	Watch for bubbles while an assistant applies the brakes. No leakage whatsoever should be noticeable at the vent hole. On the clamping ring only a little foam should be formed.
4	If the chamber is damaged, or leaking, remove it for further inspection and repair.

To inspect brake chambers on drive axle

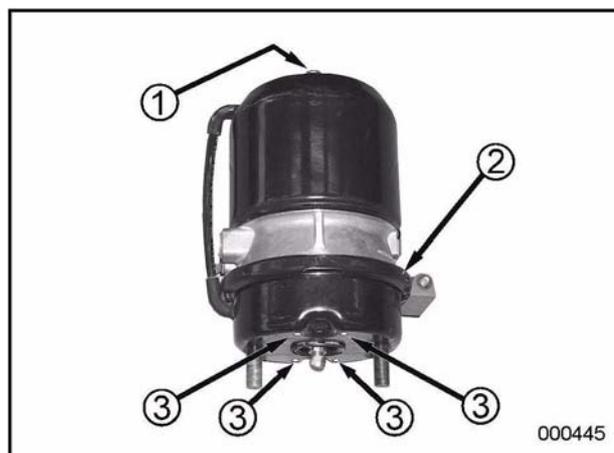
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

- Maximum pressure (115 to 130 psi) in the air tanks
- Wheels chocked

Figure: brake chambers on the drive axle



- 1 Emergency release bolt
2 Clamping ring
3 Vent holes

Procedure

Step	Action
1	Clean the outside of the brake chamber and look for visible damage.
2	Brush soapy water to vent holes (3) and clamping ring (2).
3	Watch for bubbles while an assistant applies the brakes. No leakage whatsoever should be noticeable at the vent holes. On the clamping ring only a little foam should be formed.
4	Release the parking brake.
5	Brush soapy water around the emergency release bolt (1) there where it sticks through the chamber wall. Look for soap bubbles. Only a little foam is allowed to show.
6	If the chamber is damaged, or leaking, remove it for further inspection and repair.

continued on next page

To inspect brake chambers on trailing axle

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Maximum pressure (115 to 130 psi) in the air tanks

Procedure

Step	Action
1	Clean the outside of the brake chamber and look for visible damage.
2	Apply soapy water to vent hole (2) and the clamping ring (1). <div> <p>The diagram shows a side view of a brake chamber. It is a cylindrical component with a clamping ring around its middle. Two arrows point to specific features: arrow 1 points to the clamping ring, and arrow 2 points to a small hole (the vent hole) located near the bottom of the chamber. The number 000444 is printed in the bottom right corner of the diagram area.</p> </div>
3	Watch for bubbles while an assistant applies the brakes. No leakage whatsoever should be noticeable at the vent hole. On the clamping ring, only a little foam is allowed to show.
4	If the chamber is damaged, or leaking, remove it for further inspection and repair.

To check quick release valve of front wheel brakes

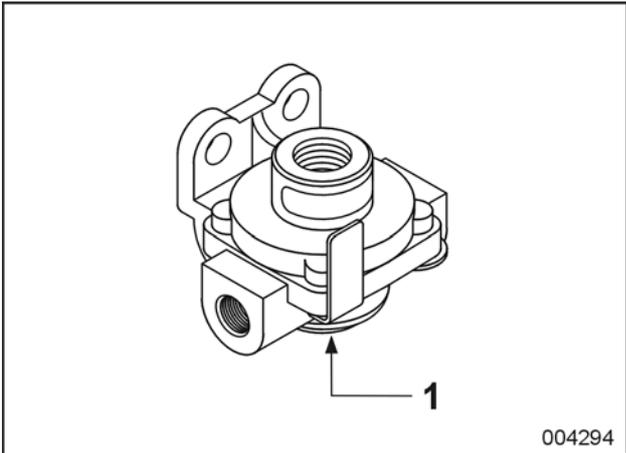
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Maximum pressure (115 to 130 psi) in the air tanks

Procedure

Step	Action
1	Temporarily remove muffler of the valve, if present.
2	Clean the exhaust opening (1) and brush soapy water on it. Watch for bubbles while an assistant fully applies the brakes (leakage check). <div style="text-align: center;">  <p>004294</p> </div>
3	Check whether the valve exhausts quickly and without hesitation when the pedal is released.
4	If the valve leaks or fails to exhaust properly, remove it for repair.

To check quick release double check valve of parking brake

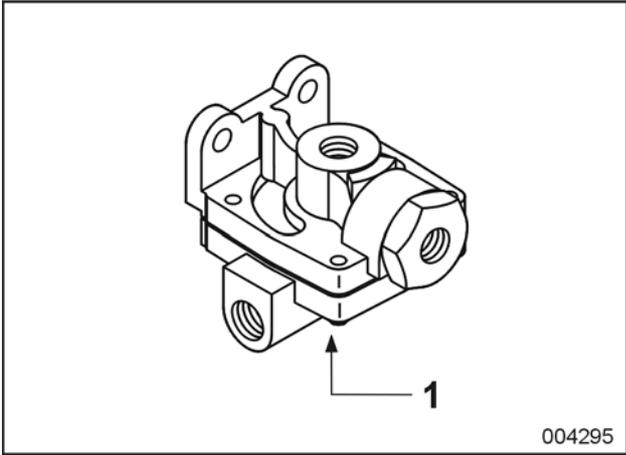
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

- Maximum pressure (115 to 130 psi) in the air tanks
- Wheels chocked

Procedure

Step	Action
1	Temporarily remove the muffler of the valve, if present.
2	Clean the exhaust opening (1) and brush soapy water on it. Check for bubbles while an assistant releases the parking brake (leakage check). <div style="text-align: center;">  </div>
3	Check whether the valve exhausts quickly and without hesitation when the parking brake is applied.
4	If the valve leaks or fails to exhaust properly, remove it for repair.

To check relay valve of drive axle service brake

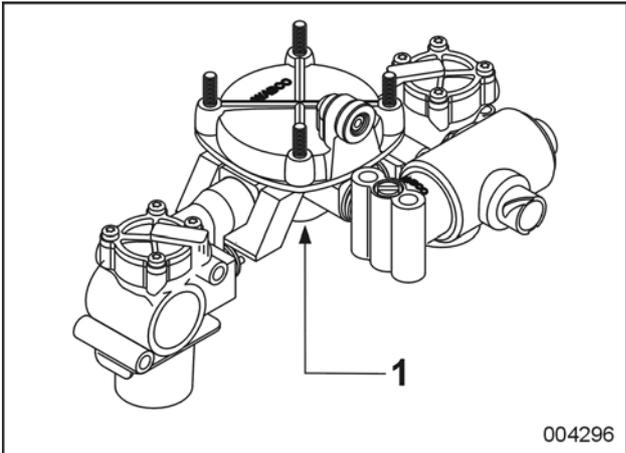
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Maximum pressure (115 to 130 psi) in the air tanks

Procedure

Step	Action
1	Temporarily remove the muffler of the valve, if present.
2	Clean the exhaust opening (1) and brush soapy water on it. Watch for bubbles while an assistant fully applies the brakes (leakage check).
 <p style="text-align: right;">004296</p>	
3	Check whether the valve exhausts quickly and without hesitation when the pedal is released.
4	If the valve leaks or fails to exhaust properly, remove it for repair.

To check relay valve of trailing axle brakes

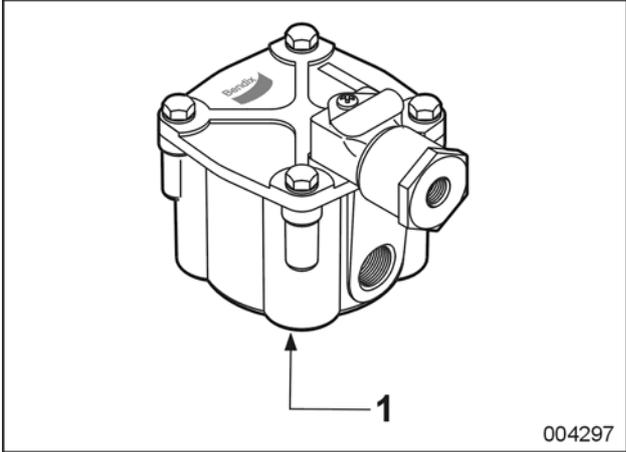
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Maximum pressure (115 to 130 psi) in the air tanks

Procedure

Step	Action
1	Temporarily remove the muffler of the valve, if present.
2	Clean the exhaust opening (1) and brush soapy water on it. Watch for bubbles while an assistant fully applies the brakes (leakage check). <div style="text-align: center; margin-top: 10px;">  <p style="text-align: right; margin-right: 20px;">004297</p> </div>
3	Check whether the valve exhausts quickly and without hesitation when the pedal is released.
4	If the valve leaks or fails to exhaust properly, remove it for repair.

Safety precautions to be taken when exposed to brake dust

Introduction

Consult the technical data in order to find out whether or not the brake pads are fitted with asbestos linings. Asbestos fibers cause cancer and asbestosis (a dangerous lung disease). The asbestos fibers are released into the air through brake lining wear. The instructions mentioned below are meant to prevent the creation of airborne brake dust and inhalation.

Experts do not agree on the harmless nature of asbestos-free brake linings. Therefore, it is recommended to observe the safety instructions, even when working with brakes containing non-asbestos material.



WARNING!

To remove dust from brake parts or from the floor, use an industrial vacuum cleaner designed for this type of work. Do not use brushes or compressed air!



WARNING!

Before removing a road wheel, vacuum the wheel disc first. After removing the wheel, vacuum around the brake caliper. Any remaining dust should be wiped using a wet rag. Used rags should be put in plastic waste bags, while still wet. Dust fallen on the floor should be removed immediately by means of a vacuum cleaner. Do not use brushes to sweep up dust. If necessary, wet the dust thoroughly and scrape it up.



WARNING!

Asbestos-containing waste should be collected and transported in special sealed containers bearing warning labels.

To check condition of brake pads

When should it be carried out?

Refer to chapter 1.1, "Maintenance schedule".

Checking values

Refer to "Technical data" at the end of this chapter.

Brake lining thickness

The brake pads are fitted with electric wear indicators. A message will appear on the multifunctional display in the driver's cab to indicate that the brake pads need replacing.

NOTE: Regardless of the presence of electric wear-indicators, it is recommended to visually check brake lining thickness. To perform this check you have to remove the wheels. The brake pads should be changed at the latest when their lining has worn down to the minimum permissible thickness.

To check brake linings for damage

Remove the brake pads and check their lining for damage. Replace the pads if large pieces of lining are missing.

To check brake clearance

Equipment condition

- Chocks in front of and behind the wheels that will remain on the ground;
- Vehicle raised so that the wheels of the axle that will be worked upon clear the ground;
- Road wheel removed;
- If drive axle brakes have to be checked: parking brake released.

Checking values

Refer to "Technical data" at the end of this chapter.

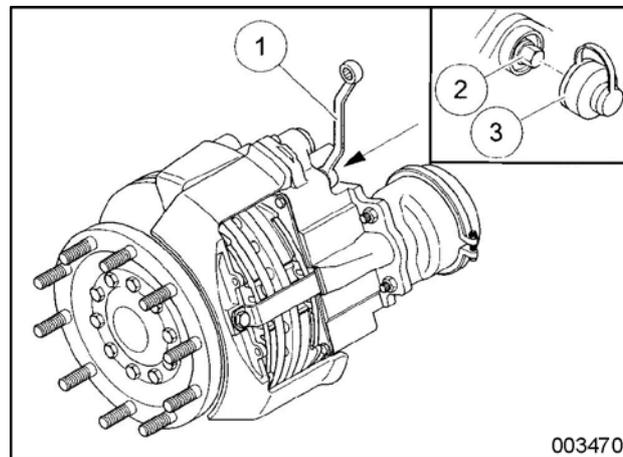
Procedure

Step	Action
1	Slide brake caliper inboard as far as it will go.
2	Use a suitable tool to push the inboard brake pad away from the piston heads.
3	Measure between the back plate of the inboard brake pad and the piston heads with a feeler gauge.

If the clearance is larger or smaller than the value mentioned in the technical data, check the operation of the adjusting mechanism. See further on under "To check operation of adjusting mechanisms".

To check adjusting mechanism operation

Figure: to check adjusting mechanism operation



- 1 Box wrench
- 2 Adjuster stem
- 3 Protective cap

Procedure

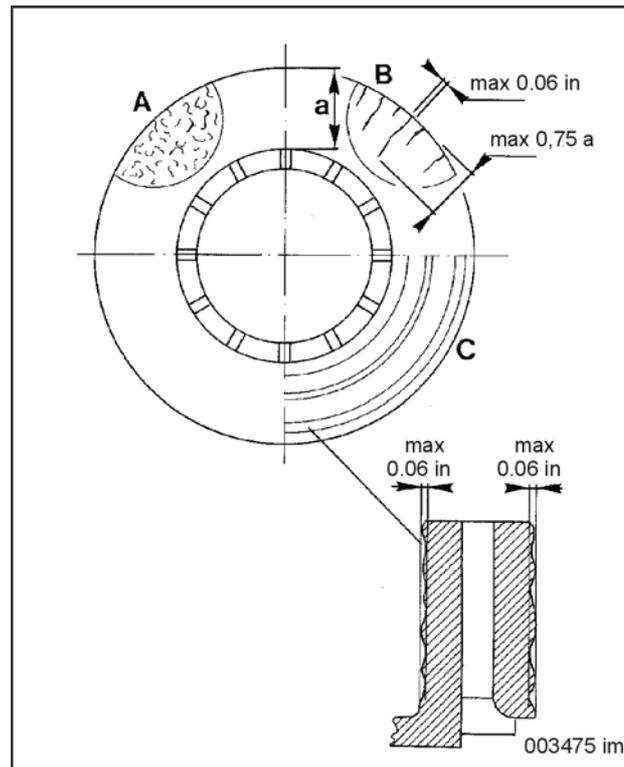
Step	Action
1	Remove protective cap from adjuster stem.
2	Using a 10 mm box wrench, turn the adjuster on the brake caliper half a turn back. Leave the wrench on the adjuster stem.
3	While assistant makes series of foot applications, check whether wrench turns slightly (some degrees) in opposite direction of step 2. If the wrench does not turn, or moves to and fro, the adjusting mechanism is faulty and the complete brake caliper should be replaced.
4	Set running clearance as explained under "To install brake pads".
5	Remove the box wrench.
6	Fill the protective cap of the adjuster stem with grease.
7	Push the adjuster stem protective cap onto the brake caliper.

To check brake disc condition

Equipment condition

Road wheel removed

Figure: brake disc wear-pattern



Cracks and grooves

Check brake disc for cracks and grooves. Use the table below to evaluate whether the brake disc should be replaced.

Wear pattern	Evaluation
Small cracks (A) spreading across the disc surface in a web-like pattern	Allowable
Cracks (B) in the direction of the hub center	Allowed, if they are: <ul style="list-style-type: none"> not wider or deeper than 0.06 in and not longer than 3/4 (=0.75 times) the height of the pad contact surface (a)
Grooves (C) on the brake pad contact surface (a)	Allowed up to a depth of 0.06 in

continued on next page

**Brake disc
thickness**

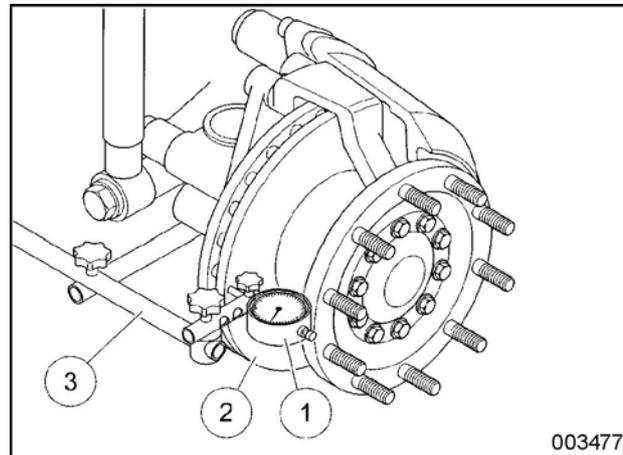
Measure brake disc thickness. Change the disc at the latest when the wear limit specified in the technical data has been reached.

**WARNING!**

Always change the brake discs on both axle ends at the same time.

To check brake disc run-out

Figure: dial indicator set-up



- 1 Dial indicator
- 2 Brake disc
- 3 Support

Procedure

Step	Action
1	Place a dial indicator with a magnetic support on the tie rod arm.
2	Place the indicator stylus square to the brake disc. Set the dial indicator to zero.
3	Rotate the wheel hub and read the total variation on the dial indicator. This is the brake disc run-out. Maximum permissible run-out: 0.002 in. If the run-out is more, the brake disc should be remachined or changed.



WARNING!

Always change the brake discs on both axle ends at the same time.

To check the brake caliper sliding system

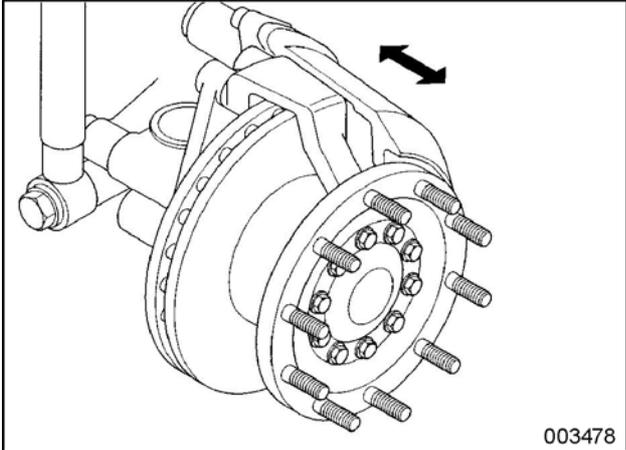
Special tools

Fitting for torque meter	Van Hool No. 11066326
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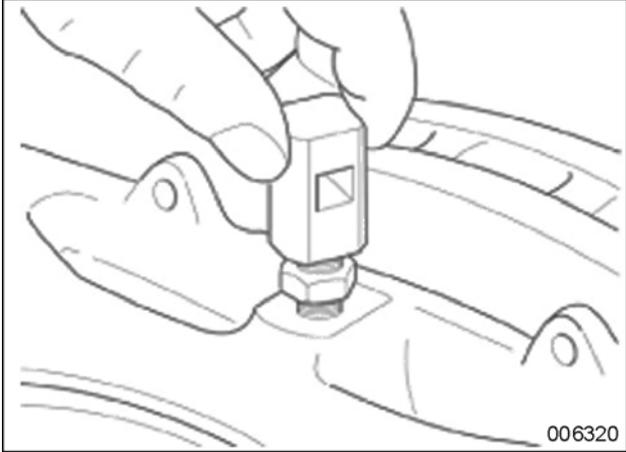
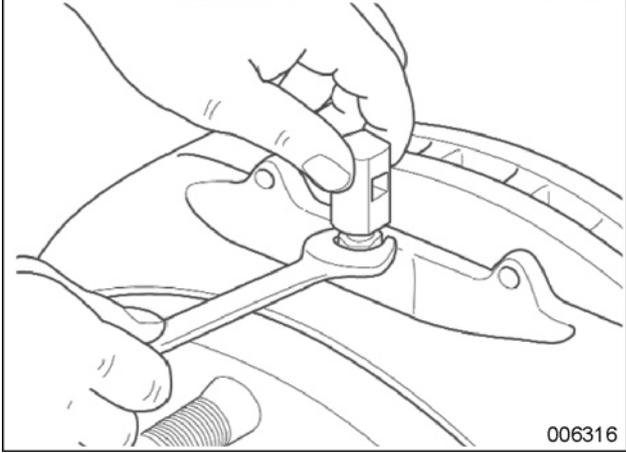
Equipment condition

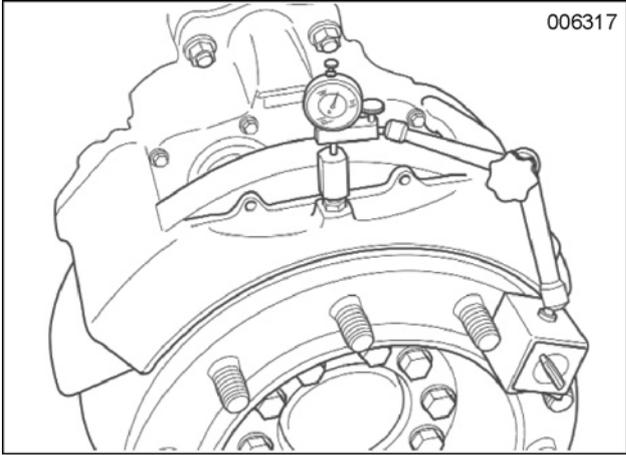
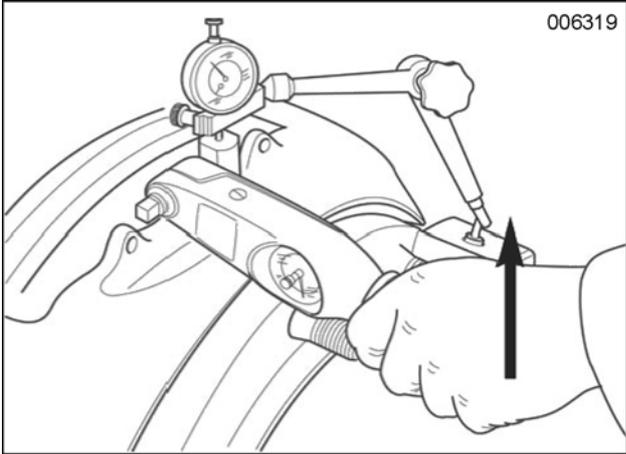
Brake pads removed, refer to "To remove brake pads".

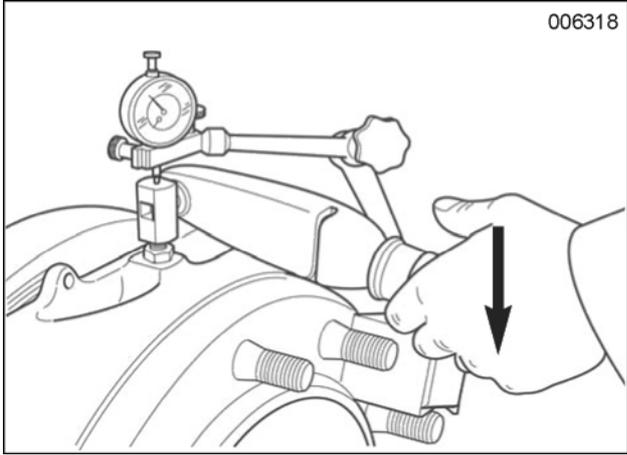
To check brake caliper for easy sliding

Step	Action
1	 <p>WARNING! In order to prevent injury, the brake caliper should only be handled from the outside. Hold the brake caliper on the outside.</p>
2	<p>Move the brake caliper back and forth (in the direction of the arrows) and check whether the caliper slides easily on the guide pins. If necessary, replace the guide sleeves and bushes.</p>  <p style="text-align: right;">003478</p>

**To check
brake-caliper
radial play**

Step	Action
1	<p>Screw the special fitting in the tapped hole for screw of brake-pads retaining plate.</p>  <p style="text-align: right;">006320</p>
2	<p>Turn the fitting until its opening is parallel to the brake disc as indicated in the figure and tighten the locknut.</p>  <p style="text-align: right;">006316</p>
3	<p> WARNING! In order to prevent injury, the brake caliper should only be handled from the outside. Pull the brake caliper outboard as far as it will go.</p>

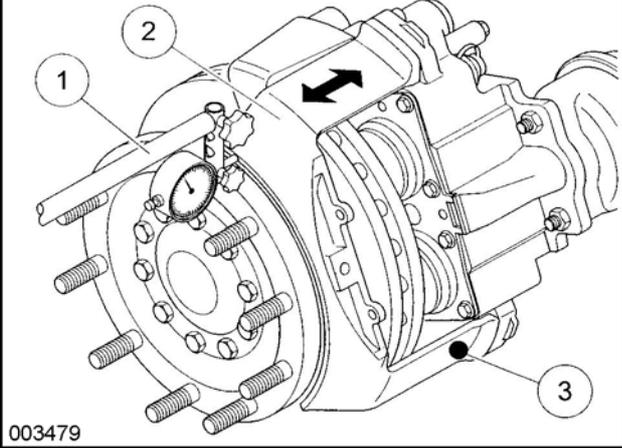
Step	Action
4	<p>Attach a dial indicator support to the wheel hub. Position dial stylus against the head of the fitting as indicated in the figure. Make sure the wheel hub is not free to turn. Set the dial indicator to zero.</p>  <p>006317</p>
5	<p>Introduce the square drive of a torque meter in the opening of the fitting as indicated in the figure. Pull up the torque meter by 18 ft.lbf without sliding the brake caliper. Note displacement shown by dial indicator.</p>  <p>006319</p>

Step	Action
6	<p>Introduce the square drive of the torque meter at the other side in the opening of the fitting.</p> <p><i>NOTE: Do not reset the dial indicator!</i></p> <p>Pull down the torque meter by 18 ft.lbf without sliding the brake caliper. Note displacement shown by dial indicator.</p> 
7	Add up the two displacements. The total should not exceed 0.08 in.
8	If this value is exceeded, change the guide sleeves and bushes.
9	Remove the fitting.

To check brake-caliper tangential play

Step	Action
1	 <p>WARNING!</p> <p>In order to prevent injury, the brake caliper should only be handled from the outside.</p> <p>Pull the brake caliper outboard as far as it will go.</p>

continued on next page

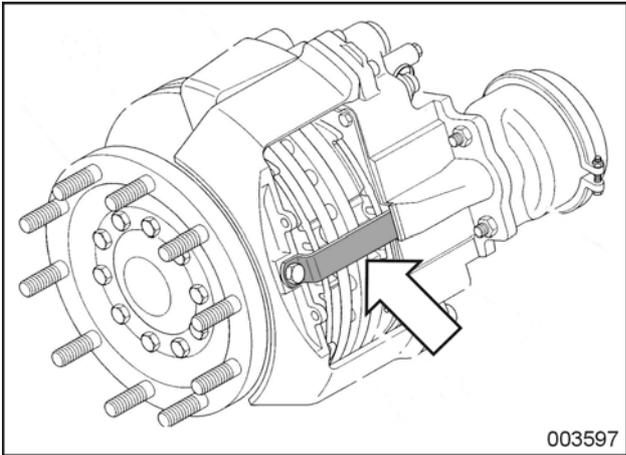
Step	Action
2	<p>Attach a dial indicator support (1) to the wheel hub. Place the dial indicator stylus squarely on the brake caliper and in line with the center line of short guide sleeve (2). Set the dial indicator to zero.</p> 
3	<p>Hold the brake caliper firmly by the side with long guide sleeve (3) so that it will not slide during the following step.</p>
4	<p>With the other hand, hold the brake caliper by the side of short guide sleeve (2) and tip it in the direction of the arrows shown in the above figure. Do not allow brake caliper to slide! Read off the total displacement. Maximum permissible variation: 0.12 inch.</p>
5	<p>If this value is exceeded, change the guide sleeves and bushes.</p>

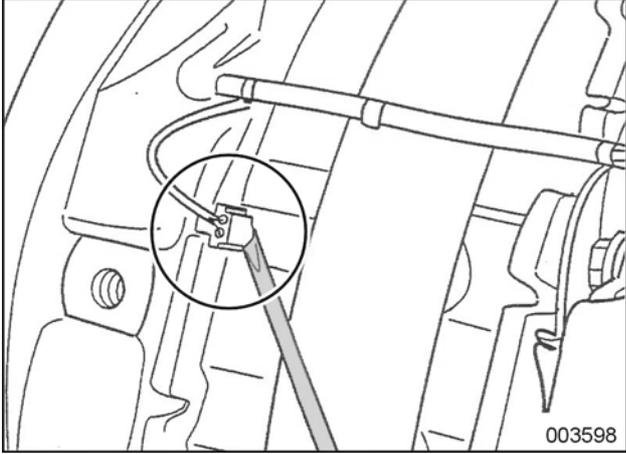
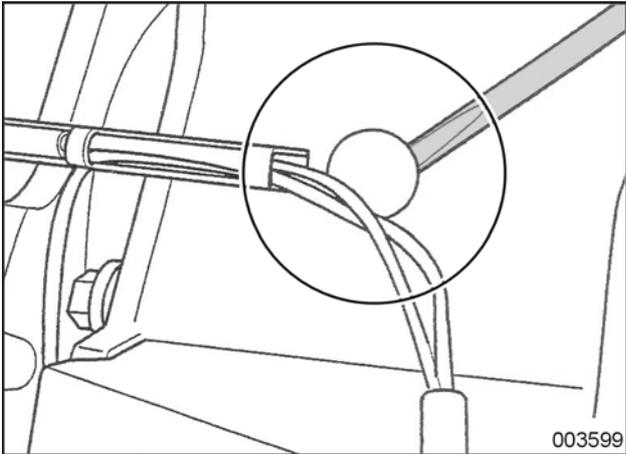
To remove brake pads

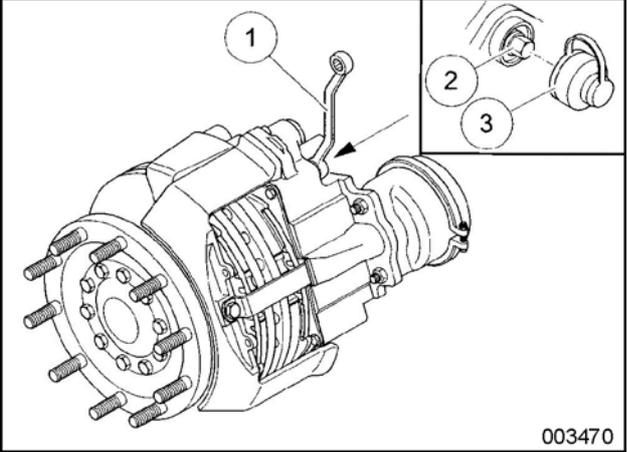
Equipment condition

- Chock vehicle by putting blocks in front of and behind the wheels remaining on the ground;
- Vehicle raised so that the wheels of the axle that will be worked upon clear the ground;
- Road wheel removed;
- If drive axle brake-pads have to be removed: parking brake released.

Procedure

Step	Action
1	Remove the brake pad retaining plate. <div style="text-align: center;">  <p style="text-align: right; margin-right: 20px;">003597</p> </div>
2	Remove the brake pad hold-down springs.

Step	Action
3	<p>Using a flat-bladed screwdriver, pry the wear indicators out of the brake pads.</p>  <p>003598</p>
4	<p>Undo the wear indicator connecting plugs.</p>
5	<p>Using a flat-bladed screwdriver, pry the plastic rivet out of the brake caliper and remove the wear indicators.</p>  <p>003599</p>

Step	Action
6	Remove protective cap (3) of adjuster stem (2) on the brake caliper.  003470
7	Using a 10 mm box wrench, turn the adjuster stem on the brake caliper back to increase the clearance between the piston heads and the brake pads.
8	Remove the brake pads from the brake caliper.

To install brake pads

Consumables

Set of brake pads (four brake pads + four brake pad springs)	Van Hool No. N508206051 (Ferodo 4568)
Wear indicator set (two wear indicators + wire clip)	Van Hool No. 10929328

Setting values

Refer to "Technical data" at the end of this chapter.

Tightening torques

Refer to "Technical data" at the end of this chapter.



CAUTION!

Do not use brake pads with lining material different from that specified in the technical data.



CAUTION!

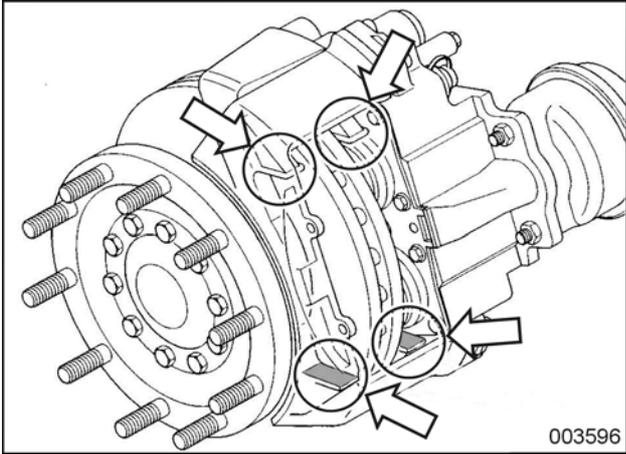
Always change the brake pads on both axle ends at the same time.



CAUTION!

When changing brake pads, always fit new brake pad hold-down springs and pad wear indicators.

Preliminary operations

Step	Action
1	Using a flat scraper, clean the faces of the brake carrier over which the pads slide.  <p style="text-align: right;">003596</p>
2	Turn the adjuster stem on the brake caliper until the dust boots of the pistons are visible. Check the piston and the guide sleeve dust boots for possible damage. If necessary, change the dust boots.
3	Check the caliper sliding system, refer to "To check brake caliper sliding system".
4	Check the brake disc, refer to "To check condition of brake disc" and "To check brake disc run-out".

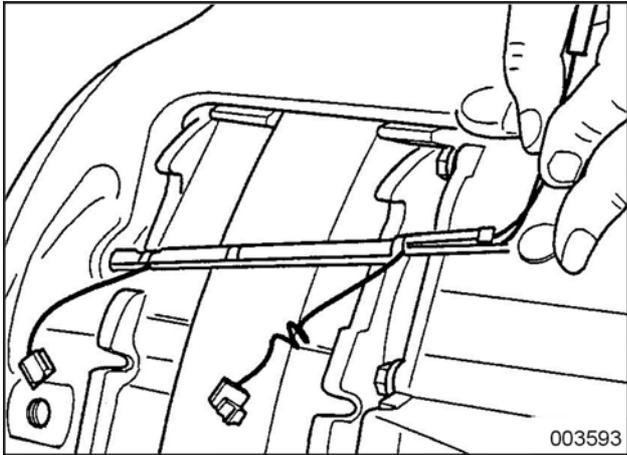
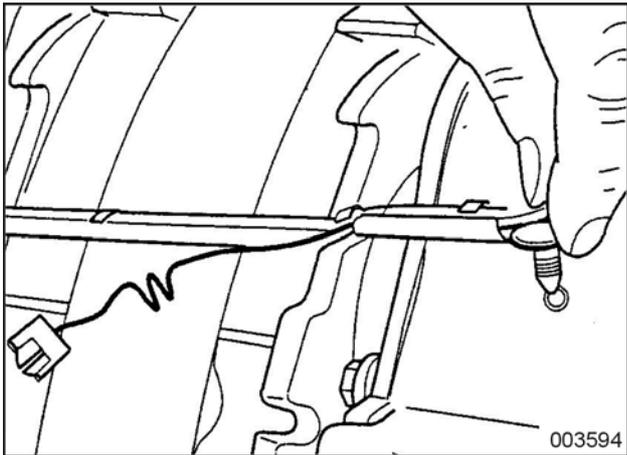
To install brake pads

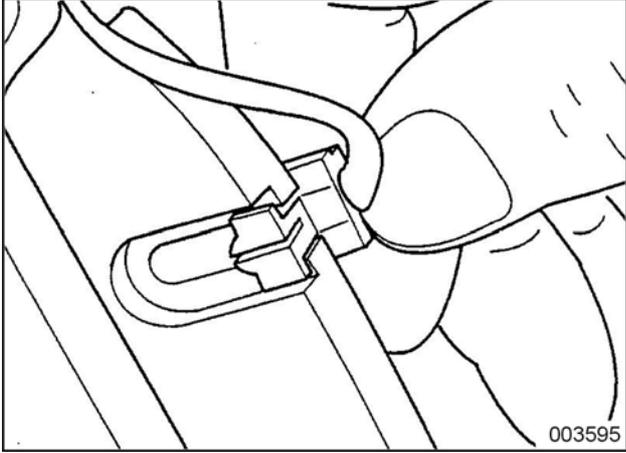
Step	Action
1	Move pistons back using the adjuster stem on the brake caliper.
2	Push the brake caliper inboard until there is enough room to install the new brake pad. Fit the inboard brake pad.
3	Slide the brake caliper back until the pad makes full contact with the brake disc. Fit the outboard brake pad.
4	Set lining-to-disc clearance, refer to "To set lining-to-disc clearance".
5	Install the new wear indicators, see "To fit the wear indicators".
6	Fit new brake pad hold-down springs.
7	Fit the brake pad retaining plate. Tighten the screw of the retaining plate to the prescribed torque.
8	Charge the air system. Apply the brake pedal several times.

continued on next page

Step	Action
9	Check for correct lining-to-disc clearance. If necessary, adjust the lining-to-disc clearance. Check that the wheel hub is free to rotate.
10	Push the adjuster stem protective cap onto the brake caliper.
11	Fit the road wheel and perform a brake operation test.

To fit the wear indicators

Step	Action
1	Slide the end of the wire clip into the hole of the brake caliper.  003593
2	Press the plastic rivet into the brake caliper.  003594

Step	Action
3	Slide the wear indicator into the back plate of the brake pads. 
4	Plug in the connector.

To set lining-to-disc clearance

Step	Action
1	Turn the adjuster stem until both brake pads are in contact with the brake disc.
2	Turn the adjuster stem back half a turn.
3	Measure the piston-to-brake pad clearance using a feeler gauge.
4	If necessary, turn the adjuster stem in the appropriate direction to achieve correct clearance.
5	Check that the brake disc is free to rotate.

To run in brake pads

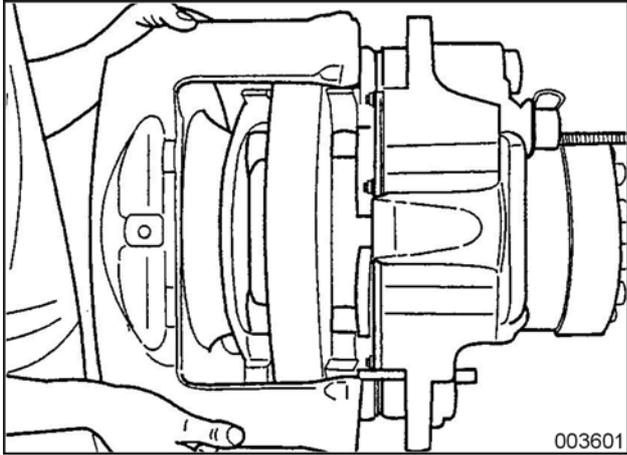
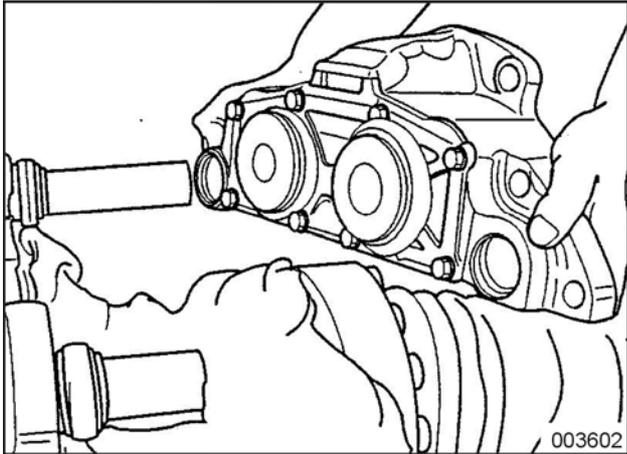
Avoid severe or long braking, if possible, during the first 200 kilometers.

To remove brake caliper/brake carrier

Equipment condition

Brake pads removed, refer to "To remove brake pads".

Procedure

Step	Action
1	Remove the nuts and washers securing the brake chamber to the brake caliper. Move the brake chamber out of the way.
2	Remove the screws attaching the brake caliper bridge to the brake caliper housing and remove the bridge. 
3	Slide the brake caliper housing carefully off the guide sleeves. 
4	Remove the screws securing the brake carrier to the axle end.
5	Remove the brake carrier.

5.10

Brakes
Compressed-air brakes



To install brake caliper/brake carrier

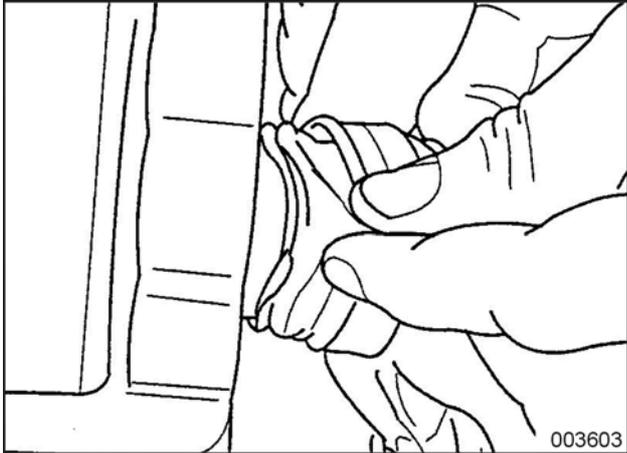
Tightening torques

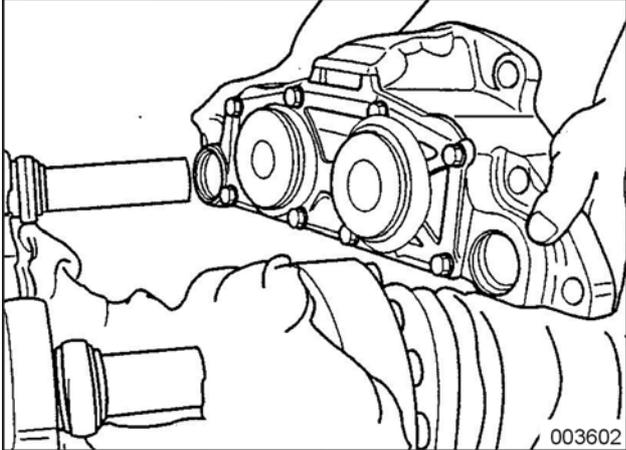
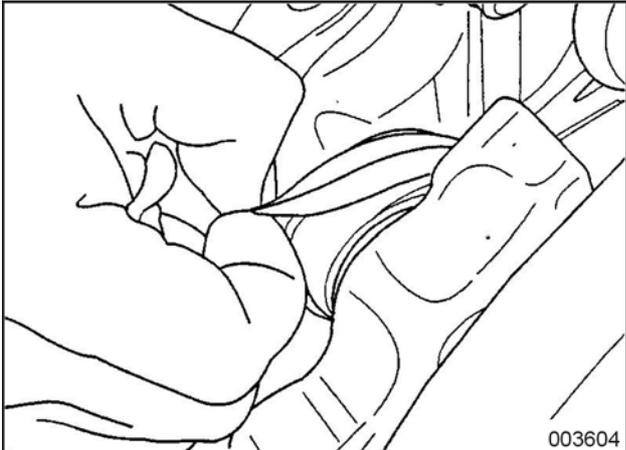
Refer to "Technical data" at the end of this chapter.

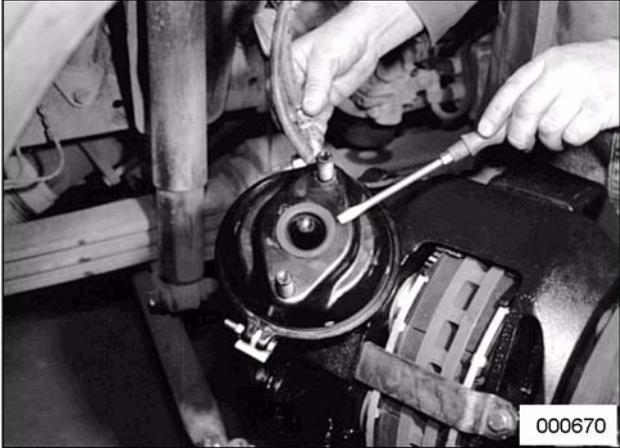
Grease type

- Fuchs Unitemp 2 or ...
- Castrol Optitemp TT1EP

Procedure

Step	Action
1	Clean the brake carrier and the guide pins thoroughly. Check the brake carrier and the guide pins for damage and wear. Replace damaged or worn parts if necessary.
2	Check the guide pins dust boots for damage. Replace the boots if necessary.
3	Secure the brake carrier with six screws to the axle end. Tighten the screws to the prescribed torque.
4	Lubricate the inside of the dust boots of the guide pins sparingly with grease. Slide the boots over the guide pins, then work them over the edge of the brake carrier.  003603
5	Grease the guide pins.

Step	Action
6	<p>Slide the brake caliper housing carefully onto the guide pins.</p> 
7	<p>Work the guide pin boots carefully over the edge of the brake caliper housing.</p> 
8	<p>Clean the contact surfaces of the brake caliper bridge. These are the parts of the brake caliper bridge that contact the caliper housing.</p>
9	<p>Fix the brake caliper bridge to the caliper housing with four new screws. Tighten the screws to the prescribed torque.</p>

Step	Action
10	<p>Check the seal at the bottom of the brake chamber for damage. Replace the seal if necessary.</p> 
11	<p>Secure the brake chamber to the brake caliper with two washers and two nuts. Tighten the nuts to the prescribed torque.</p>
12	<p>Install the brake pads as explained under "To install brake pads".</p>

Technical data: compressed-air brakes

Brake assembly

Make	ArvinMeritor
Type	D-Elsa 2
Brake clearance (brake pad-to-piston)	0.02 to 0.03 in

Brake disc

Diameter	17 in
Maximum permissible run-out, when installed	0.002 in
Thickness, new	1.77 in
Discard when worn to...	1.46 in

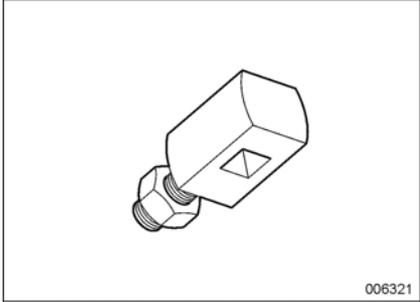
Brake pad

Lining thickness, new	0.87 in
Minimum permissible lining thickness	0.08 in
Lining material	Ferodo 4568 (asbestos free)

Tightening torques

Brake carrier fixing screws	300 ft.lbf
Brake caliper guide sleeve fixing screws	148 ft.lbf
Brake pad retaining plate fixing screw	30 ft.lbf
Screws securing brake caliper bridge to caliper housing	240 ft.lbf
Brake chamber to brake caliper	145 ft.lbf
Front and trailing axles: screws securing brake disc and wheel flange to hub unit	300 ft.lbf

Special tools: compressed-air brakes

Ordering number	Description	Figure
Van Hool 11066326	To check the brake caliper sliding system: fitting for torque meter	 <p>006321</p>

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Chapter 14: Speed retarder

Overview

Introduction This chapter deals with the speed retarder.

Number of pages 2

Chapter publication date 19 September 2006

Contents

Topic	See page
ZF retarder: maintenance	5.14-2

ZF retarder: maintenance

To check oil level

Refer to "ZF Astronic transmission with ZF retarder: to check oil level" in chapter 6.10.

To change oil

Refer to "ZF Astronic transmission with ZF retarder: to change oil" in chapter 6.10.

To change oil filter

Refer to "ZF Astronic transmission with ZF retarder: to change oil filter" in chapter 6.10.

Part 6 - Transmission

Overview

Contents

Chapter	See page
Chapter 10: Transmission	6.10-1

Chapter 10: Transmission

Overview

Introduction This chapter deals with the transmission.

Number of pages 28

Chapter publication date 19 September 2006

Contents

Topic	See page
Allison WTB500(R) transmission: to check oil level with cold transmission	6.10-2
Allison WTB500(R) transmission: to check oil level with warm transmission	6.10-4
Allison WTB500(R) transmission: to call up oil level with transmission selector	6.10-6
Allison WTB500(R) transmission: to change oil	6.10-8
Allison WTB500(R) transmission: to change oil filters	6.10-10
ZF Astronic transmission: troubleshooting	6.10-13
ZF Astronic transmission with ZF retarder: to check oil level	6.10-15
ZF Astronic transmission with ZF retarder: to change oil	6.10-17
ZF Astronic transmission with ZF retarder: to change oil filter	6.10-20
ZF Astronic transmission: to check breather	6.10-24
ZF Astronic transmission: to remove/install clutch cylinder	6.10-25
Technical data: transmission	6.10-27

Allison WTB500(R) transmission: to check oil level with cold transmission

Introduction

This check enables you to determine whether there is enough oil in the transmission so that it can safely operate until it's warmed up. Check the oil level again with a warm transmission.

Equipment condition

- Vehicle on level ground
- Parking brake applied

Location of dipstick and filler cap

Refer to chapter 1.1, "Access doors and controls at the outside".

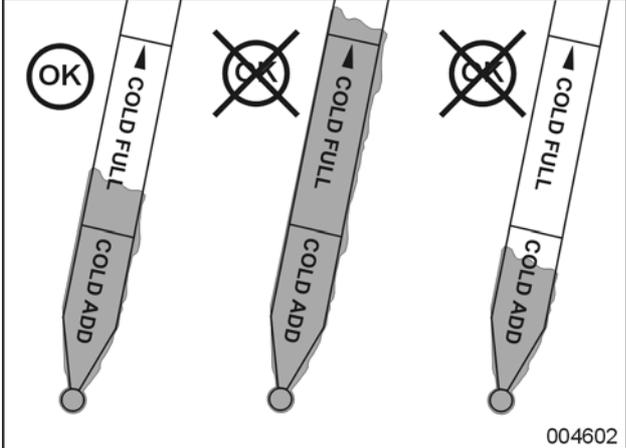
Before starting the check

Step	Action
1	Check the oil level with the dipstick before you start the engine. The level should be close to the "HOT FULL" mark.
2	Top up with oil, if necessary.

Procedure

Step	Action
1	Start engine and let it idle for approximately 1 minute.
2	Engage briefly "D" and then "R" to bleed air from hydraulic circuits.
3	Put the transmission in neutral and let the engine idle.
4	Pull out dipstick.
5	Wipe the dipstick clean with a cloth and reinsert it.

continued on next page

Step	Action
<p>6</p>	<p>Pull out dipstick.</p> <p>The oil level should be between the "COLD ADD" and the "COLD FULL" marks on the dipstick.</p>  <p style="text-align: right;">004602</p>
<p>7</p>	<p>If oil level is too low, top up with oil through filler tube. If the level is too high, drain some oil.</p>

After oil level check with cold transmission

Before taking the vehicle into operation, carry out a check with warm transmission after a check with cold transmission. Refer to "Allison WTB500(R) transmission: to check oil level with warm transmission".

Allison WTB500(R) transmission: to check oil level with warm transmission

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

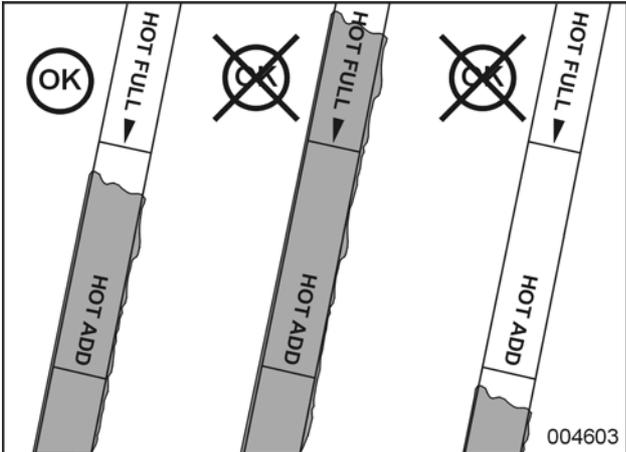
Equipment condition

- Transmission at operating temperature (minimum transmission-oil temperature 160 °F)
- Vehicle on level ground
- Parking brake applied
- Transmission selector in neutral position

Location of dipstick and filler cap

Refer to chapter 1.1, "Access doors and controls at the outside".

Procedure

Step	Action
1	Start engine and let it idle.
2	Pull out dipstick.
3	Wipe the dipstick clean with a cloth and reinsert it.
4	<p>Pull out dipstick.</p> <p>The oil level should be between the "HOT ADD" and the "HOT FULL" marks on the dipstick.</p>  <p style="text-align: right;">004603</p>

Step	Action
5	If oil level is too low, top up with oil through filler tube. If oil level is too high, drain some oil.

Allison WTB500(R) transmission: to call up oil level with transmission selector

Introduction

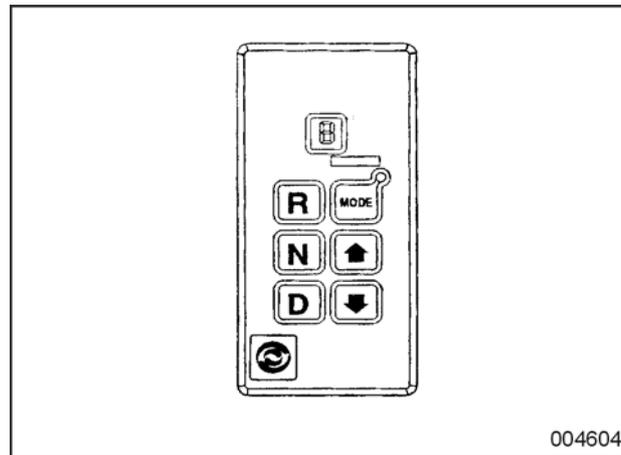
The transmission is equipped with an oil level sensor, allowing the driver to call up the oil level by using the transmission selector in the driver's cab.

NOTE: The display of the transmission selector can only show one character at a time.

Equipment condition

- Vehicle on level ground
- Parking brake applied

Figure: transmission selector



Delayed oil level information

The oil level is shown only when the conditions below have been met:

- transmission at operating temperature (oil temperature between 140°F en 220°F);
- transmission in neutral;
- stationary vehicle (at least 2 minutes);
- engine idling.

The oil level information will be delayed if these conditions are not met. During this delay "o,L" followed by "-" and a digit is shown on the display of the transmission selector.

Display view	Explanation
o,L,-,0,X	Vehicle is not stationary long enough
o,L,-,5,0	Engine speed too low

continued on next page

Display view	Explanation
o,L,-,5,9	Engine speed too high
o,L,-,6,5	Transmission not in neutral
o,L,-,7,0	Oil temperature too low
o,L,-,7,9	Oil temperature too high
o,L,-,8,9	Propeller shaft is turning
o,L,-,9,5	Sensor failure

Procedure

Simultaneously press the "down" and the "up" arrow button of the transmission selector once.

"o,L" followed by a code (refer to table below) is shown on the display of the transmission selector. "o,L" means that you are in "Oil Level Check Mode".

Display view	Explanation
o,L,-,O,K,-,O,K	Oil level is OK
o,L,-,L,O,-,0,1	1 U.S. Qts of oil short
o,L,-,L,O,-,0,2	2 U.S. Qts of oil short
o,L,-,H,I,-,0,1	1 U.S. Qts of oil too much
o,L,-,H,I,-,0,2	2 U.S. Qts of oil too much

To exit Oil Level Check Mode

Press one of the "drive" buttons of the transmission selector.

Allison WTB500(R) transmission: to change oil

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Oil type

Refer to chapter 1.1, "Fluids and lubricants".

Consumables

O-ring for oil pan drain plug	
-------------------------------	--

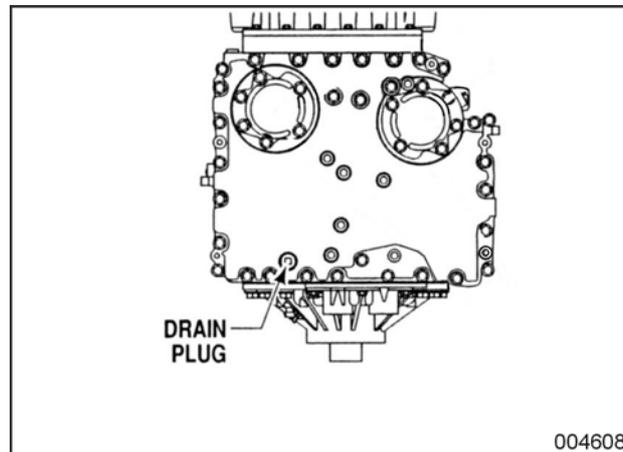
Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Transmission oil temperature at least 160 °F
- Engine stopped

Figure: bottom view of transmission



1 Oil pan drain plug



WARNING!

Hot oil flowing out of the oil pan can cause scalds. Avoid contact with skin.

Procedure

Step	Action
1	Unscrew drain plug (1) from the oil pan and allow oil to drain.
2	Re-install the plug, with a new O-ring, in its place, and tighten it to the prescribed torque.
3	Fill the transmission with oil through filler tube.
4	Check the oil level (refer to "Allison WTB500(R) transmission: to check oil level with cold transmission").
5	Check the transmission for leaks.
6	Check the oil level with warm transmission (refer to "Allison WTB500(R) transmission: to check oil level with warm transmission").

Allison WTB500(R) transmission: to change oil filters

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Consumables

"MAIN" filter set (filter element + O-ring + sealing ring + gasket)	Allison No. 29540495
"MAIN + LUBE" filter set (two filter elements + two O-rings + two sealing rings + two gaskets)	Allison No. 29540493

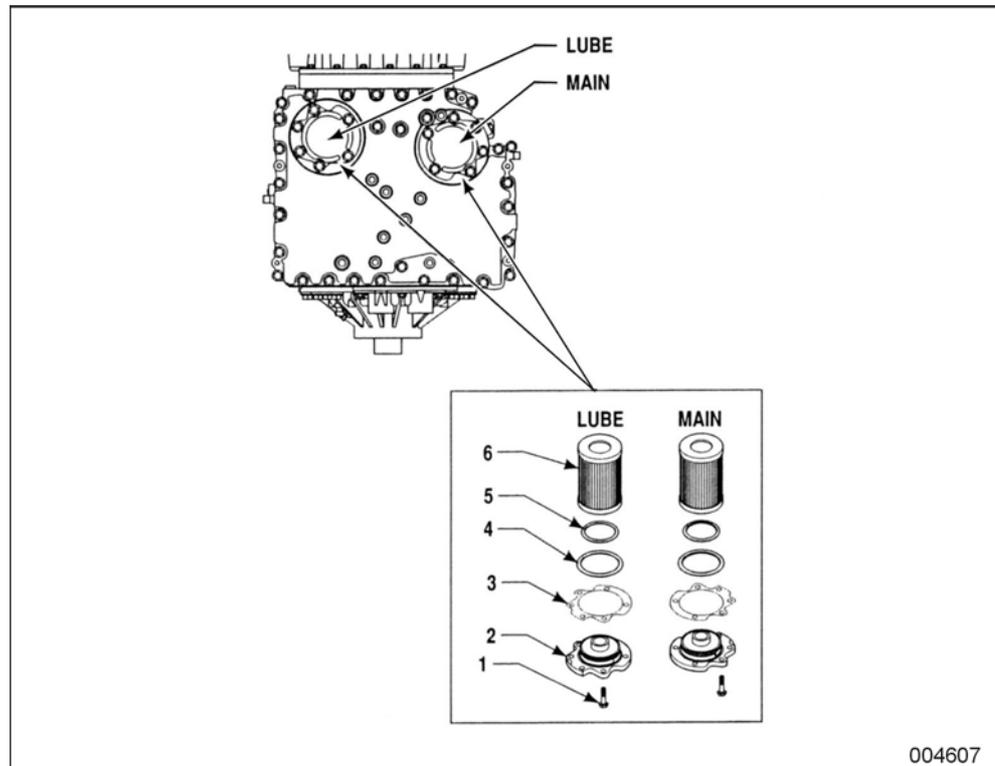
Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

Oil drained, refer to "Allison WTB500(R) transmission: to change oil".

Figure: bottom view of transmission



004607

- 1 Fixing screw
- 2 Filter cover
- 3 Gasket
- 4 Filter cover sealing-ring
- 5 O-ring
- 6 Filter

Procedure

NOTE: Procedures for replacing "MAIN" and "LUBE" filters are identical.

Step	Action
1	Remove the screws securing the filter cover to the transmission.
2	Remove the filter cover together with the filter element from the transmission.
3	Pull the filter element from the filter cover, and dispose of it in accordance with the environmental regulations.
4	Remove gasket (3) and sealing ring (4) from filter cover.
5	Lubricate O-ring (5) with oil, and place it on the filter element.
6	Place sealing ring (4) on the filter cover.
7	Install gasket (3).
8	Push the new filter element on the filter cover.

continued on next page

Step	Action
9	Place the filter cover together with the new filter element into the filter housing and tighten the screws to the prescribed torque.

ZF Astronic transmission: troubleshooting

Introduction

A symbol appears on the multifunctional display if the transmission electronics detect an active fault. At the same time the fault is stored as a code in the electronics memory. The symbol disappears after the malfunction is repaired or has disappeared spontaneously, but the fault code is retained in the memory.

Messages on multifunctional display

Symbol	Message	Action required
 + alarm signal	System error	Read the fault code of the active fault.
 + "SM" on transmission selector display + alarm signal	Serious system error	Read the fault code of the active fault.

To read the fault code of the active fault

Step	Action
1	Switch on vehicle ignition.
2	Hold the "N" button of the transmission selector down while you press the "up" arrow button. The fault code of the active fault appears on the transmission selector display.

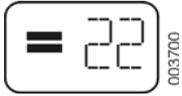
To read the fault memory

Step	Action
1	Switch on vehicle ignition.

continued on next page

Step	Action
2	Press the "N" button of the transmission selector while you hold the brake pedal fully down.
3	While holding the brake pedal down, press and hold the "up" arrow button of the transmission selector. The fault codes in the fault memory appear one by one on the transmission selector display.

**Fault repro-
duction**

	Fault codes 1 to 99 (example: fault code 19)
	Fault codes 100 to 199 (example: fault code 122)
	Fault codes 200 to 299 (example: fault code 227)

Fault code list

Contact ABC.

**To erase fault
memory**

Erasing the fault memory can only be done by "Testman", a special diagnostic device of ZF.

ZF Astronic transmission with ZF retarder: to check oil level

Introduction

The retarder is part of the transmission. The transmission and the retarder are lubricated by the same oil circuit.

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Oil type

Refer to chapter 1.1, "Fluids and lubricants".

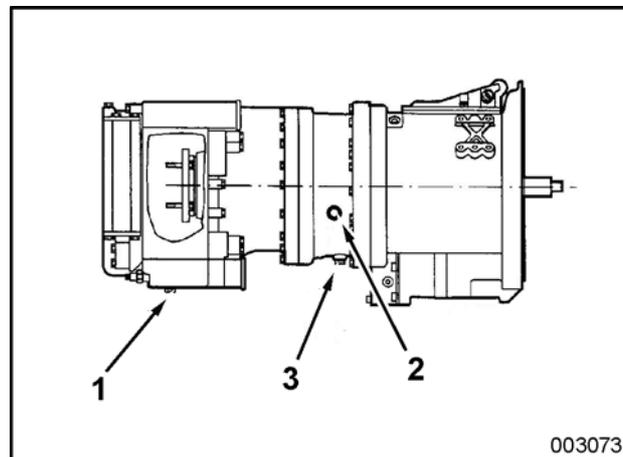
Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Vehicle on level ground
- Oil fully cooled and sunk

Figure: transmission side view



- 1 Drain plug
- 2 Filler/level plug
- 3 Drain plug



CAUTION!

A low oil level will cause transmission damage.

continued on next page

**CAUTION!**

Do not activate the retarder before shutting off the engine, if the oil level has to be checked. Otherwise part of the oil will flow to the retarder, and the oil level check, taking place in the transmission housing, will be inaccurate.

Procedure

Step	Action
1	Clean the surroundings of filler/level plug (2) and unscrew the plug. The oil must reach the edge of the filler/level plug opening.
2	If necessary, top up with oil through the same opening.
3	Install plug (2) and tighten it with the prescribed torque.

ZF Astronic transmission with ZF retarder: to change oil

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Oil content and oil type

Refer to chapter 1.1, "Fluids and lubricants".

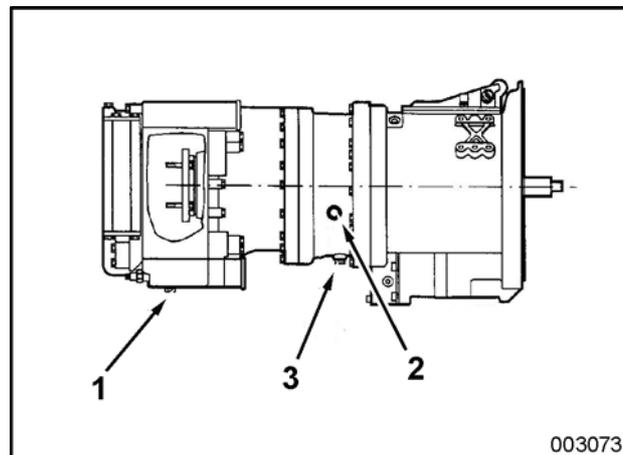
Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Vehicle on level ground.
- Drain immediately after a long trip, when the oil is warm and well mixed.

Figure: transmission side view



- 1 Drain plug
- 2 Filler/level plug
- 3 Drain plug



WARNING!

Hot oil flowing out of the pan can cause scalds. Avoid contact with skin.

**CAUTION!**

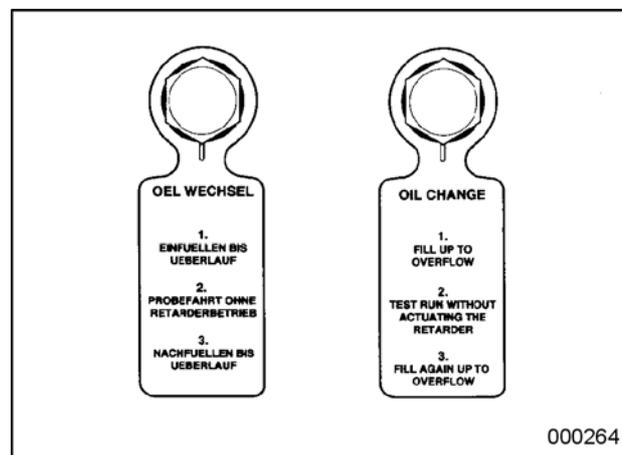
Do not activate the retarder before shutting off the engine, if the oil has to be drained. Otherwise part of the oil will flow to the retarder and not all oil will be drained.

To drain oil

Step	Action
1	Clean the surrounding of drain plugs (1) and (3).
2	Remove drain plugs (1) and (3) and drain the oil.
3	Clean magnetic drain plugs (1) and (3) and provide them with a new sealing ring. When all oil has been drained, reinstall plugs and tighten them to the prescribed torque.
4	Change the oil filter, refer to "ZF Astronic transmission with ZF retarder: to change oil filter".

Oil change instruction tag

The filler/level plug is provided with an instruction tag showing how to change oil. Don't forget to install this tag after the work has been done.

Figure: oil change instruction tag**To fill**

Step	Action
1	Clean the surroundings of filler/level plug (2) and unscrew the plug from the transmission.
2	Fill transmission through filler/level opening (2), until oil begins to overflow.

continued on next page

Step	Action
3	Reinstall filler/level plug (2) with a new sealing ring and tighten it to the prescribed torque.
4	<i>NOTE: Do not activate the retarder during test drive!</i> Go for a test drive of 2 to 3 miles.
5	Position the vehicle above an inspection pit and shut the engine off. Do not activate the retarder.
6	Unscrew filler/level plug (2) from transmission and check the oil level.
7	If necessary, top up until the oil overflows.
8	Install filler/level plug (2) and tighten it with the prescribed torque.
9	Attach oil change instruction tag to filler/level plug (2).

ZF Astronic transmission with ZF retarder: to change oil filter

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Consumables

Oil filter element	ZF No. 0750131003
Filter cover O-ring	ZF No. 0634313067

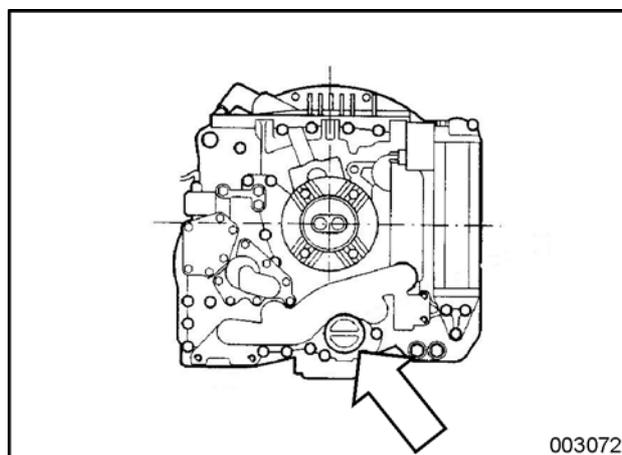
Tightening torques

Refer to "Technical data" at the end of this chapter.

Equipment condition

Oil drained, refer to "ZF Astronic transmission with ZF retarder: to change oil".

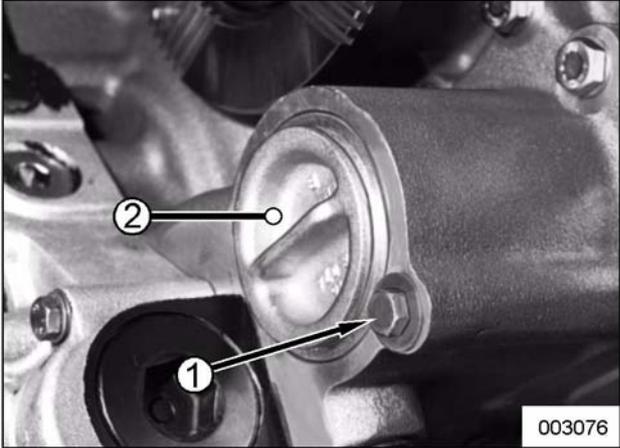
Figure: oil filter location



WARNING!

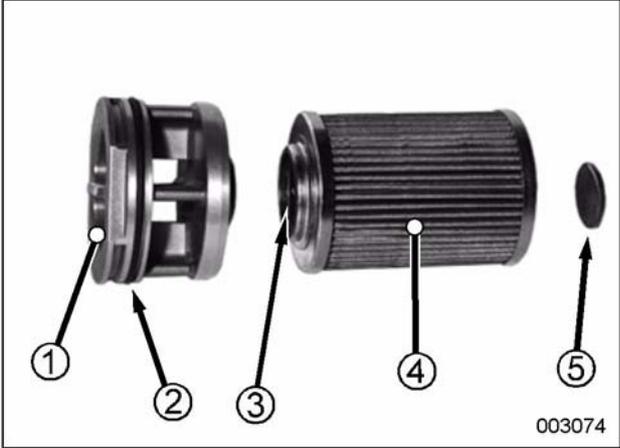
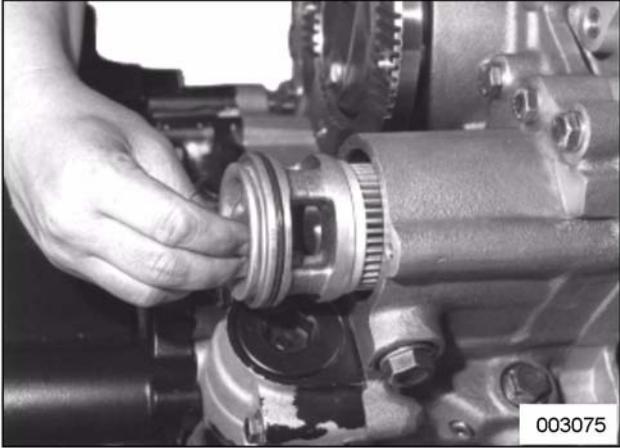
There is still oil in the filter housing! Hot oil can cause scalds. Avoid contact with skin.

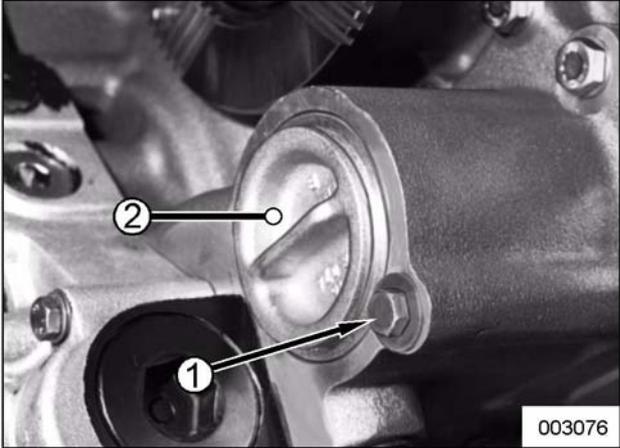
To remove filter

Step	Action
1	Remove fixing screw (1) from filter cover (2). 
2	Remove cover together with the filter element from the filter housing. 

To install filter

Step	Action
1	Pull the filter element from the cover.

Step	Action
2	<p>Check filter cover O-ring (2) for damage and, if necessary, replace it. Grease O-ring (2).</p> 
3	<p>Secure magnet (5) to new element (4). Grease O-ring (3) of filter element (4).</p>
4	<p>Push cover (1) of filter element (4).</p>
5	<p>Push the filter assembly into the filter housing until stop.</p> 

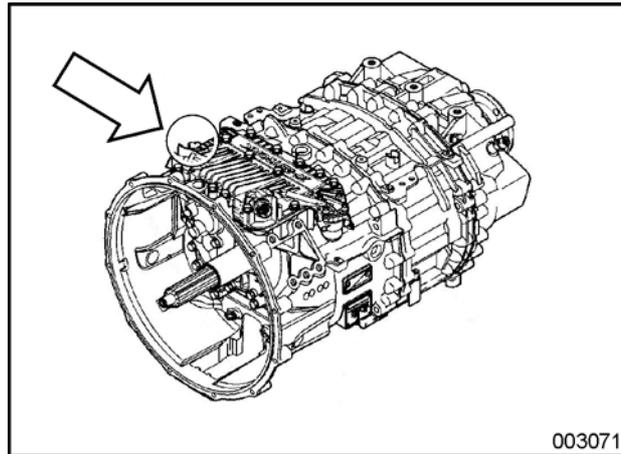
Step	Action
6	<p>Mount fixing screw (1) of filter cover (2) and tighten with the prescribed torque.</p> 
7	<p>Fill the transmission with oil, refer to "ZF Astronic transmission with ZF retarder: to change oil".</p>

ZF Astronic transmission: to check breather

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: transmission breather



Why check breather?

If the breather is clogged, pressure builds up in the transmission due to temperature rise while driving. As a result of which leakage of the oil seal could occur. To prevent this you should check and, if necessary, clean the breather regularly.

ZF Astronic transmission: to remove/install clutch cylinder



WARNING!

Never disconnect a line containing pressure. Never remove a component unless you are certain all system pressure has been depleted.



WARNING!

Always wear safety goggles.

Clutch cylinder

The clutch cylinder is secured to the clutch bell housing and is accessible from underneath the vehicle. The air-operated clutch cylinder is activated by the transmission electronics.

To remove



WARNING!

The transmission electronics activate the clutch cylinder also each time the ignition is switched on (the push rod of the clutch cylinder moves outwards with a force of 4 500 lbf). Follow the procedure below to prevent this from happening when the clutch cylinder has been removed from the clutch bell housing (body injury danger!).

Step	Action
1	Switch off the vehicle ignition.
2	Switch off master switch on dashboard.
3	Release pressure from the air system through drain valves on the compressed-air tanks. For location of compressed-air tanks, refer to chapter 13.17.
4	Remove the clutch cylinder.

continued on next page

To install



WARNING!

Ensure that the compressed-air system is without pressure before installing the clutch cylinder.

Technical data: transmission

Tightening torques

Allison WTB500(R)	Oil drain plug	18 to 24 ft.lbf
	Filter cover fixing screws	38 to 45 ft.lbf
ZF Astronic	Oil filler/level plug	45 ft.lbf
	Transmission oil drain plug	45 ft.lbf
	Retarder oil drain plug	45 ft.lbf
	Filter cover fixing screw	17 ft.lbf

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Part 7 - Steering

Overview

Contents

Chapter	See page
Chapter 6: Front axle steering system	7.6-1

Chapter 6: Front axle steering system

Overview

Introduction This chapter deals with the front axle steering system.

Number of pages 54

Chapter publication date 19 September 2006

Contents

Topic	See page
To check power steering fluid level	7.6-3
To change fluid of power steering system	7.6-5
To connect the "Servotest 570" tester	7.6-8
To check maximum steering pump pressure	7.6-11
To check steering pump flow	7.6-13
To check/set hydraulic steering limitation	7.6-14
To check steering gear pressure	7.6-19
To check steering gear for internal leakage	7.6-21
To check return time of power steering valve	7.6-24
To check steering wheel play	7.6-25
To change filter in steering fluid tank	7.6-28
To check steering fluid lines for leaks	7.6-30
To check security of steering gear, rods and levers	7.6-31
To check steering gear pressure point	7.6-32
To dismantle steering gear	7.6-34
To lubricate intermediate lever of steering system	7.6-35
To check linkage joints	7.6-36
To check clamps of drag-link and tie-rod	7.6-40
To check drag-link and tie-rod tubes	7.6-41
To check straight-ahead position of wheels	7.6-42
To check maximum steering lock angles	7.6-43
To check steering column bearings for excessive play	7.6-44
To check universal joints and flex couplings	7.6-45

continued on next page

Topic	See page
To remove steering assembly	7.6-46
To inspect the steering gear splash-water protective cover	7.6-47
Technical data: front axle steering system	7.6-49
Special tools: front axle steering system	7.6-52

To check power steering fluid level

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Fluid type

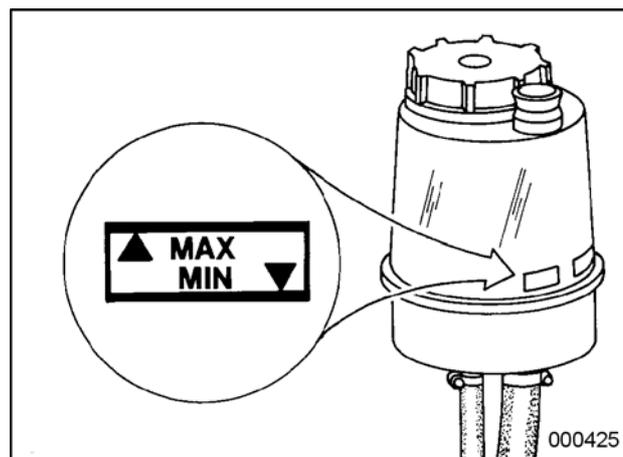
Refer to chapter 1.1, "Fluids and lubricants".

Equipment condition

- Engine idling
 - Steering fluid at operating temperature
-

Location of steering fluid tank

Refer to chapter 1.1, "Access doors and controls at the outside".

Figure: level marks on steering fluid tank**CAUTION!**

If fluid level is too low, malfunctioning and possibly even loss of power steering can be the results.

Correct level

The level is correct, if it reaches the "MAX" mark on the transparent tank.

To add fluid

Step	Action
1	Thoroughly clean tank top.
2	Unscrew filler cap from tank.
3	Add fluid.
4	Screw filler cap back on tank. <i>NOTE: If, after turning off the engine, the level rises more than 0.4 to 0.8 in above the "MAX" mark, this means there is too much air in the fluid system.</i>

To change fluid of power steering system

To be carried out when?

It is recommended to change the complete fluid content of the hydraulic circuit, when the steering gear or the steering pump are overhauled or when fitting a replacement. At the same time change the oil filter and clean out the fluid lines.

Fluid type

Refer to chapter 1.1, "Fluids and lubricants".

Content of fluid circuit

Refer to chapter 1.1, "Fluids and lubricants".

Equipment condition

- Vehicle over inspection pit
- Parking brake applied
- Chocks in front of and behind drive axle wheels
- Vehicle jacked up at the front



CAUTION!

Absolute cleanliness is necessary when servicing hydraulic systems. Solid particles entering the liquid may cause considerable damage within a short space of time. Take care that no dirt enters the tank, when you open it. Before undoing any pipe or hose connections, thoroughly clean the connections and their immediate surroundings.



CAUTION!

Do not re-use fluid which has been drained from the circuit.

To drain fluid

Step	Action
1	Place a container with sufficient capacity underneath steering gear.
2	Disconnect hydraulic pressure and return lines from steering gear.

continued on next page

Step	Action
3	 <p>CAUTION! While executing this step, do not operate engine for more than 10 seconds. Otherwise power steering pump can be damaged.</p> <p>Start engine and allow to idle briefly in order to discharge fluid from tank, lines and pump.</p>
4	<p>Turn steering wheel from stop to stop, until no more fluid comes out.</p> <p><i>NOTE: After this quite some fluid will remain in steering gear. If drained fluid is heavily contaminated (for example due to metal particles generated by a defective pump), steering gear has to be removed. It has to be opened and cleaned in a ZF-approved workshop.</i></p>
5	Reconnect pressure and return lines to steering gear.

**CAUTION!**

The engine must not be allowed to exceed idling speed during the filling procedure.

To fill circuit

Step	Action
1	Unscrew fluid tank cap and fill tank to edge with recommended fluid.
2	<p>Be ready to top up fluid, while assistant starts engine.</p> <p>With engine running, fluid level in tank will drop rapidly. Add new fluid at same rate to avoid tank from getting empty and air being drawn into system.</p>
3	Bleed circuit (see below).

To bleed air from circuit

Start bleeding procedure no sooner than fluid in tank remains at dipstick "MAX" mark, while engine is running.

NOTE: Do not rev up engine. Otherwise the fluid will foam, causing bleeding to take unnecessarily long.

continued on next page

Step	Action
1	Let engine idle for 2 to 3 minutes, while assistant watches fluid level and tops up, if level drops. Thus most of the air is bled from steering gear. <i>NOTE: To speed up bleeding procedure, turn steering wheel from stop to stop a few times (but do not apply effort in full lock positions!).</i>
2	If necessary, add fluid, until level remains at "MAX" mark and no more air bubbles emerge in tank, when steering wheel is turned.
3	Stop engine. If system has been bled properly, fluid should not rise more than 0.4 to 0.8 in above "MAX" mark on dipstick in tank.
4	Lower wheels onto ground.

To connect the "Servotest 570" tester

Introduction

ZF have developed a special tester, which allows for easy checking of the hydraulic power assistance system: the Servotest 570.

The tester comes with a manual, which explains how the tester is to be connected to the steering system and how the controls work.

Figure:
Servotest 570

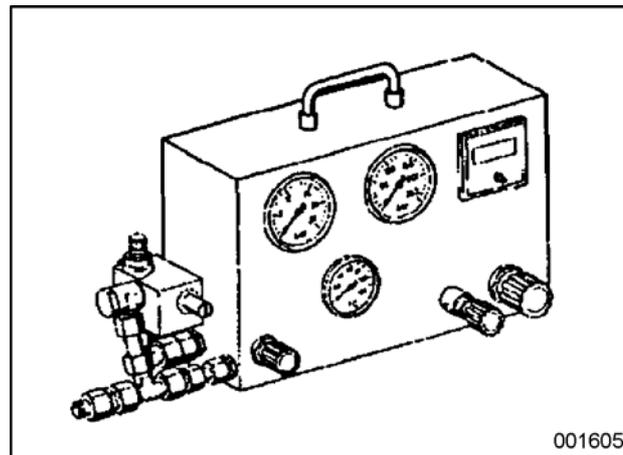
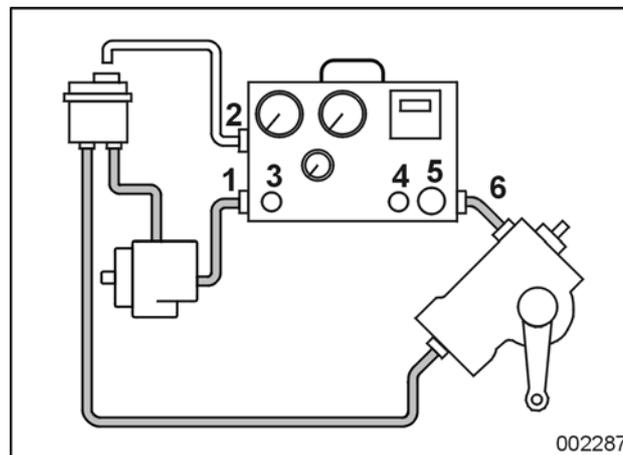


Figure:
connection diagram for Servotest 570

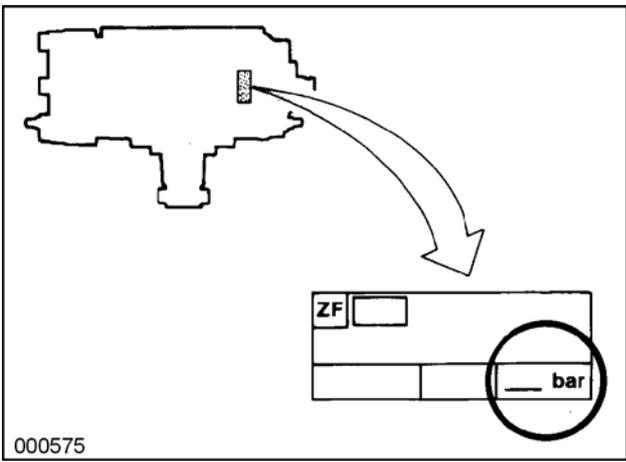


- 1 "EINGANG" (inlet)
- 2 "TANK" (tank)
- 3 "DROSSELVENTIL" (flow control valve)
- 4 "DRUCKBEGRENZUNGSVENTIL" (pressure reducing valve)
- 5 "ABSPERRVENTIL" (shut-off valve)
- 6 "AUSGANG" (outlet)

**CAUTION!**

Absolute cleanliness is necessary when servicing hydraulic systems. Solid particles entering the liquid may cause considerable damage within a short space of time. Before undoing any pipe or hose connections, thoroughly clean the connections and their immediate surroundings.

To connect and set the tester

Step	Action
1	Connect the steering pump pressure line to the "EINGANG" port of the tester.
2	Connect the steering gear pressure line to the "AUSGANG" port of the tester.
3	Connect a hose to the "TANK" port. Hang the other end of the hose loosely in the steering fluid tank of the vehicle.
4	Turn the "DRUCKBEGRENZUNGSVENTIL" knob to maximum operating pressure, as indicated on the steering gear identification plate. 
5	Close the "DROSSELVENTIL" knob.
6	Open the "ABSPERRVENTIL" knob completely.

To bring the steering fluid up to testing temperature

You can use the tester to bring the steering fluid up to testing temperature.

Step	Action
1	Let the engine idle.

continued on next page

Step	Action
2	Set the pressure to 50 bar (725 psi) with the "ABSPERRVENTIL" shut-off valve.
3	Wait until the built-in thermometer indicates the desired temperature, then return the shut-off valve back to the zero position.

To check maximum steering pump pressure

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Special tools

"Servotest 570" tester	ZF No. 7418798574
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Equipment condition

- Parking brake applied
- Chocks in front of and behind drive axle wheels
- "Servotest 570" tester connected and set as described under "To connect Servotest 570 tester" in this chapter
- Hydraulic power steering system filled and bled, refer to "To change fluid of power steering system" in the present chapter
- Steering fluid temperature 50 °C (122 °F)



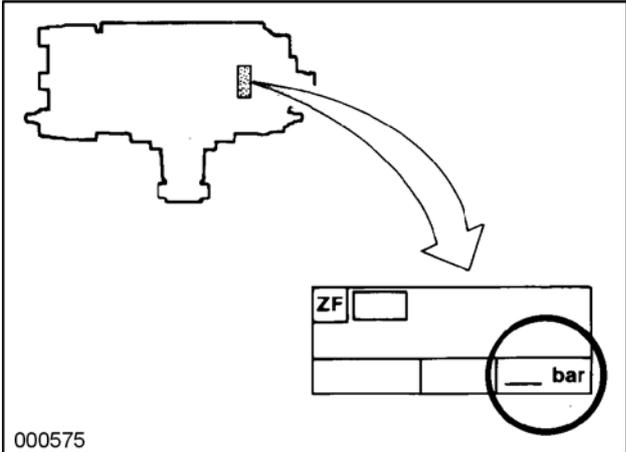
CAUTION!

Under no circumstances should engine speed exceed idling speed during the test. The sharp pressure rise that would be the result could cause lines to burst and damage the steering pump.

To check maximum pump pressure

Step	Action
1	Let the engine idle.

continued on next page

Step	Action
2	<div style="display: inline-block; vertical-align: top;">  </div> <div style="display: inline-block; vertical-align: top; margin-left: 10px;"> <p>CAUTION!</p> </div> <div style="display: inline-block; vertical-align: top; margin-left: 10px;"> <p>Do not keep pressure at maximum value for longer than 5 seconds, otherwise the steering pump will burn out.</p> </div> <div style="display: inline-block; vertical-align: top; margin-left: 10px;"> <p>Slowly close tester shut-off valve, until pressure gauge indicates maximum operating pressure stated on steering gear identification plate. Do not close valve any further, but re-open it completely within 5 seconds.</p> </div> <div style="text-align: center; margin-top: 20px;">  <p>000575</p> </div>

**To evaluate
pump
pressure
measured**

If the maximum operating pressure is not reached, the steering pump (or the flow control valve located in the pump cover) is failing.

To check steering pump flow

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Special tools

"Servotest 570" tester	ZF No. 7418798574
------------------------	-------------------

Checking values

Refer to separate tester manual "Servotest 570"

Equipment condition

- "Servotest 570" tester connected, refer to "To connect Servotest 570 tester" earlier in this chapter
- Steering system filled with sufficient fluid
- Vehicle engine at operating temperature
- Parking brake applied
- Chocks in front of and behind drive axle wheels

Procedure

Step	Action
1	Let the engine idle.
2	With the shut-off valve of the tester, set the checking pressure listed in the tester manual.
3	Read flow.
4	Compare the measured value with the prescribed value in the tester manual.

To check/set hydraulic steering limitation

Introduction

If a front wheel were to be turned against the steering stop with full power-assisted pressure, the steering pump and steering mechanism would be damaged due to overstraining. This is why the steering gear has two valves that automatically reduce pressure, just before a road wheel reaches its maximum steering turning angle. It is possible to set the point in time at which these valves open.

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Special tools

Steering wheel puller	Van Hool No. 619900910
Torque meter socket with serrations	Van Hool No. 10575651
Hose to connect pressure checking gauge	Van Hool No. 639901590

Setting values

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Parking brake applied
- Chocks in front of and behind drive axle wheels.
- Steering angle lock angles set correctly, refer to "To check/set steering lock angles" in chapter 12.6.
- Steering fluid temperature between 40 and 60 °C (104 and 140 °F), refer to "To bring steering fluid up to temperature" below.

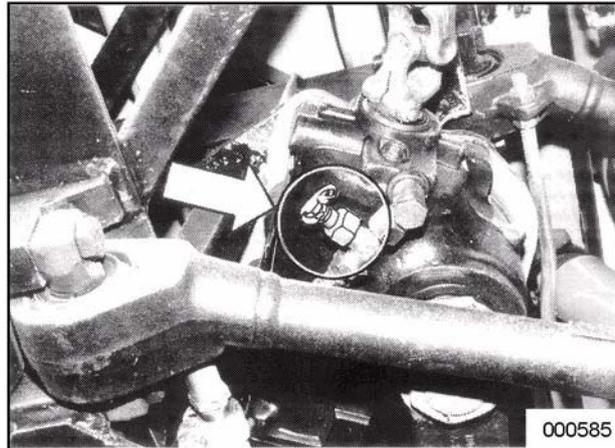
To bring steering fluid up to temperature

You can warm up the steering fluid by running the engine and turning the steering wheel from stop to stop a few times. Measure the temperature in the fluid tank.

NOTE: If you are using the special tester by ZF, you can warm up the fluid quickly by operating the shut-off valve of the tester (refer to "To connect Servotest 570 tester" earlier in this chapter).

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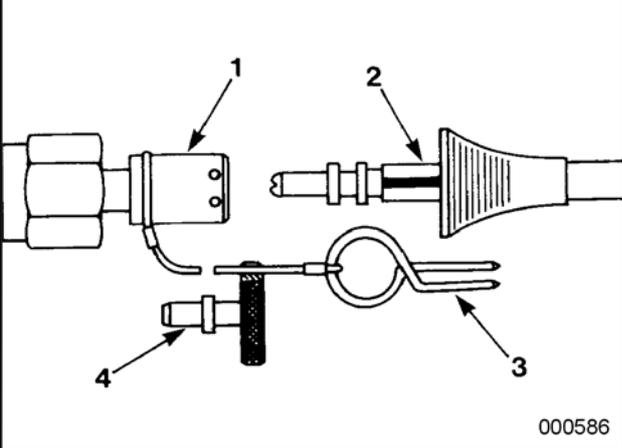
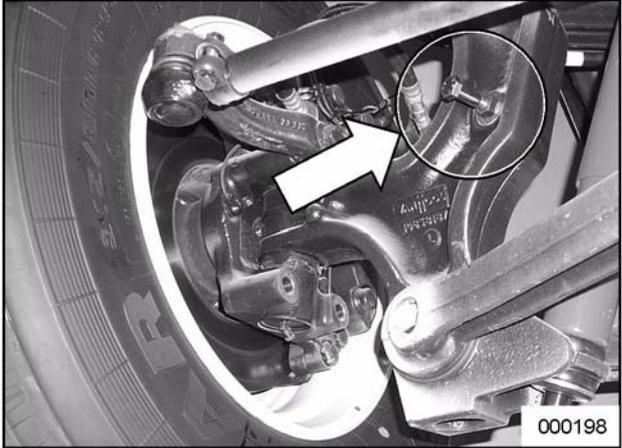
Figure: test fitting near steering gear



To check maximum limitation pressure values

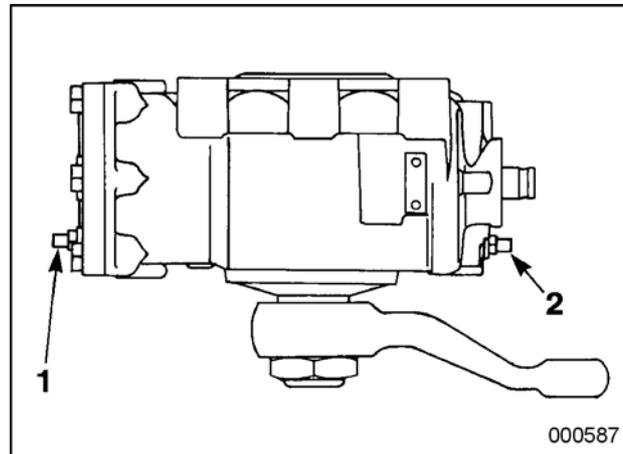
NOTE: If you use the tester to measure limitation pressure values, take care that the tester shut-off valve is open completely.

Step	Action
1	Jack up vehicle at front, until wheels clear ground.
2	Using a screwdriver pry cover from steering wheel hub. Remove the steering-wheel nut and pull the steering wheel off the steering column with a special puller.
3	Place a torque meter with the special socket on the serrated steering column end.

Step	Action
4	<p>There is a T-piece with test fitting underneath the vehicle near the steering gear. Pull spring cotter (3) of plug (4) from test fitting (1). Remove plug (4). Connect a pressure gauge of 250 bar (3 600 psi) to hose (2) (special tool). Connect hose (2) to test fitting.</p> 
5	Start the engine and let it idle during the remaining part of the test.
6	<p>Have an assistant hold a 0.12 in thick hard steel plate against adjusting screw (see figure) of LH steering knuckle carrier.</p> 
7	Use the torque meter to turn the steering column counter-clockwise until the strip is caught between the adjusting screw and the tie-rod arm.

Step	Action
8	 <p>CAUTION! Do not keep steering column end in end-of-travel position for longer than 5 seconds.</p> <p>Using a torque meter, pull steering column briefly against left end stop at 18 to 36 ft.lbf. and read pressure on pressure gauge.</p>
9	Repeat test for right wheel.
10	Compare measured values with values in technical data.

Figure:
adjusting
screws on
steering gear



- 1 Limiting end-pressure on left turns
2 Limiting end-pressure on right turns

**To set end
limitation
pressure
values**

Step	Action
1	Let go of steering column end, so that only no-load pressure is still in system.
2	Using a 14 mm wrench, loosen locknut of relevant adjusting screw on steering gear.
3	Turn adjusting screw with 5 mm socket wrench: <ul style="list-style-type: none"> • counterclockwise to increase pressure; • clockwise to reduce pressure.
4	Check whether pressure has changed as described under "To check maximum limitation pressure values".
5	Repeat steps 1 and 3, until prescribed maximum limitation pressure is reached.

continued on next page

Step	Action
6	Tighten locknut to prescribed torque without adjusting screw turning as well.
7	Lower front wheels onto ground.
8	Fix the steering wheel in straight-ahead position on the steering column.
9	Turn off engine. Remove pressure gauge and reinstall test fitting plug.
10	Check setting, refer to "To check setting".

To check setting

Slowly drive vehicle (with normal load) forward and turn steering wheel clockwise (and a second time counterclockwise as well), until point where power assistance falls out. Some clearance should still remain between the tie-rod arm and the adjusting screw on the steering knuckle carrier.

To check steering gear pressure

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

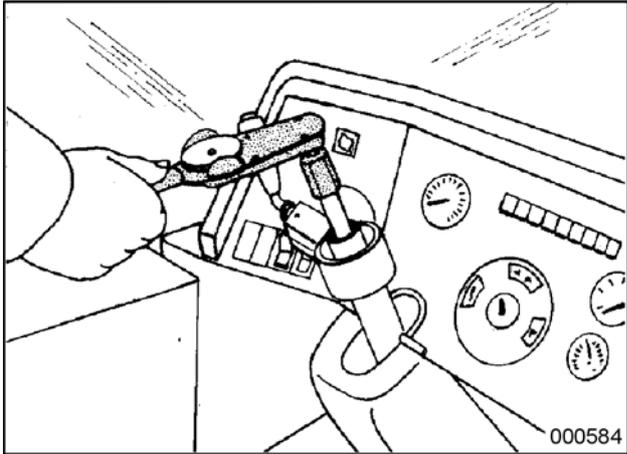
Special tools

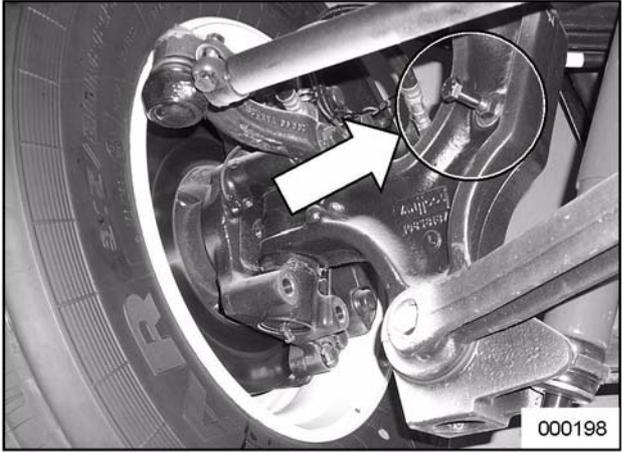
"Servotest 570" tester	ZF No. 7418798574
Steering wheel puller	Van Hool No. 619900910
Torque meter socket with serrations	Van Hool No. 10575651

Equipment condition

- "Servotest 570" tester connected, refer to "To connect Servotest 570 tester" earlier in this chapter
- Shut-off valve of "Servotest 570" tester fully open
- Parking brake applied
- Chocks in front of and behind drive axle wheels

Procedure

Step	Action
1	Using a screwdriver pry cover from steering wheel hub. Remove the steering wheel nut and pull the steering wheel off the column with the special puller.
2	Place a torque meter with the special socket on the serrated steering column end. 
3	Start the engine and let it idle during the remaining part of the test.

Step	Action
4	<p>Have an assistant hold a 0.6 in thick hard steel strip against adjusting screw (see figure) on the left steering knuckle carrier.</p> 
5	<p>Use the torque meter to turn the steering column counter-clockwise until the strip is caught between the adjusting screw and the tie-rod arm.</p>
6	<p> WARNING!</p> <p>There is a danger that the test block will be squeezed out from between the stops; therefore do not look straight at the block. If the block has to be held by hand during the pressure test, first check whether sufficient space is available between the wheel and the chassis parts to do so safely. Danger of crushing your hands, if for example the block is squeezed out and the wheel springs back.</p> <p>Using the torque meter now pull the steering column end with 18 to 36 ft.lbf against the left stop – but no longer than 5 seconds.</p> <p>Make note of highest reading on pressure gauge.</p>
7	<p>Repeat same test for right wheel.</p>

To evaluate steering gear pressure measured

If the measured pressure values (or one of them) are (is) less than the maximum steering pump pressure measured in "To check steering pump pressure":

- either the pressure relief valve in the steering gear is faulty;
- or oil leakage in the steering gear is excessive (as a result of parts wear).

To check steering gear for internal leakage

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Special tools

"Servotest 570" tester	ZF No. 7418798574
Steering wheel puller	Van Hool No. 619900910
Torque meter socket with serrations	Van Hool No. 10575651

Checking values

Refer to "Technical data" at the end of this chapter.

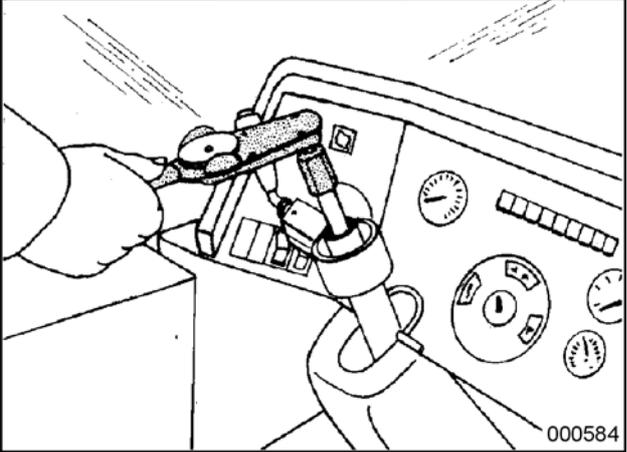
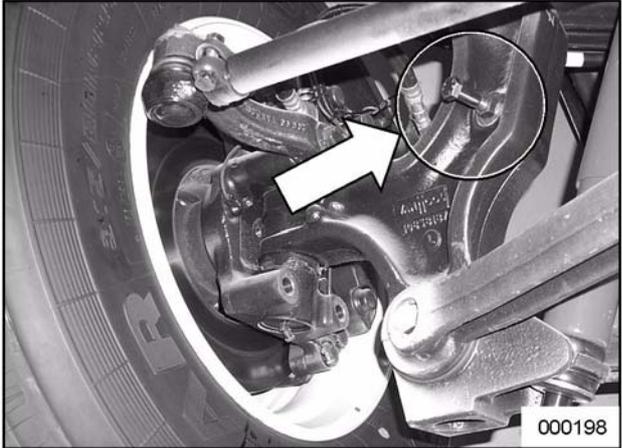
Equipment condition

- Vehicle over inspection pit
- "Servotest 570" tester connected, refer to "To connect Servotest 570 tester" earlier in this chapter
- Parking brake applied
- Chocks in front of and behind drive axle wheels

Procedure

Step	Action
1	Using a screwdriver pry cover from steering wheel hub. Remove the steering wheel nut and pull the steering wheel off the column with the special puller.

continued on next page

Step	Action
2	<p>Place a torque meter with the special socket on the serrated steering column end.</p>  <p style="text-align: right;">000584</p>
3	<p>Start the engine and let it idle during the remaining part of the test.</p>
4	<p>Close shut-off valve on tester completely and close flow-control valve far enough to create a pressure which is 30 bar (435 psi) below the maximum pump pressure measured in "To check maximum steering pump pressure".</p>
5	<p>Re-open shut-off valve.</p>
6	<p>Have an assistant hold a 0.6 in thick hard steel strip against adjusting screw (see figure) on the left steering knuckle carrier.</p>  <p style="text-align: right;">000198</p>
7	<p>Use the torque meter to turn the steering column counter-clockwise until the strip is caught between the adjusting screw and the tie-rod arm.</p>

Step	Action
8	 <p>WARNING!</p> <p>There is a danger that the test block will be squeezed out from between the stops; therefore do not look straight at the block. If the block has to be held by hand during the pressure test, first check whether sufficient space is available between the wheel and the chassis parts to do so safely. Danger of crushing your hands, if for example the block is squeezed out and the wheel springs back.</p> <p>Using the torque meter now pull the steering column end with 18 to 36 ft.lbf against the left stop – but no longer than 5 seconds. Read oil leakage and release torque meter from steering column end.</p>
9	Repeat same test for right wheel.
10	<p>Check whether high-pressure seals in steering gear leak more than is allowed with low pump flow as well. Set Servotest to 3 dm³/min (0.8 gal/min) flow. If necessary, repeat steps 4 through 8.</p> <p>The leak flow measured must not exceed the value found at normal operating flow.</p>
11	Secure the steering wheel in the straight-ahead position on the steering column.

Causes of excessive leak flow

Cause	What to do?
Defective pressure reducing valve in steering gear	Have a specialized professional change the pressure reducing valve.
Pressure reducing valve in steering gear opens up too soon	Set steering limiter valves as described in "To check/adjust hydraulic steering lock" earlier in this chapter.
Seals in steering gear show leaks	Remove the steering gear for repair in an authorized ZF workshop.

To check return time of power steering valve

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule"

Special tools

"Servotest 570" tester	ZF No. 7418798574
------------------------	-------------------

Checking values

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Parking brake applied
- Chocks in front of and behind drive axle wheels
- "Servotest 570" tester connected, refer to "To connect Servotest 570 tester" earlier in this chapter

Procedure

Step	Action
1	Block pitman arm in mid-position.
2	Start the engine and let it idle during the remaining part of the test.
3	Turn steering wheel to close power steering valve in steering gear, i.e. until maximum pump pressure is being reached on pressure gauge.
4	Slowly release steering wheel, until pressure gauge pointer indicates no-load pressure.
5	Use shut-off valve of tester to set pressure that is 10 bar (145 psi) higher than no-load pressure.
6	Release steering wheel. Power steering valve must return to neutral position within 1 second. In other words, pressure must drop within that time to a value not excessive of 0.5 bar (7.25 psi) above no-load pressure.

To check steering wheel play

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

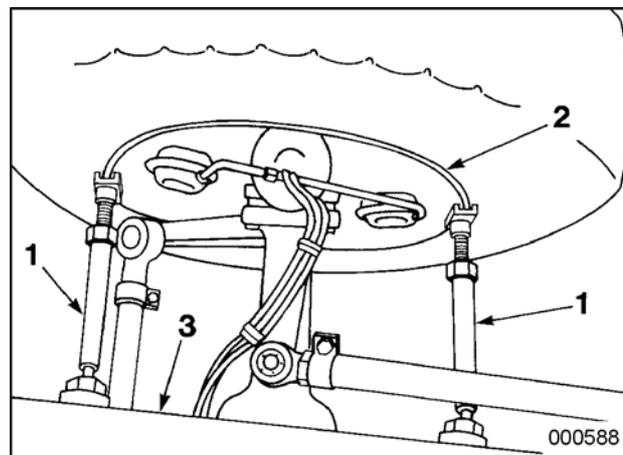
Special tools

"Servotest 570" tester	ZF No. 7418798574
Two adjustable struts	ZF No. 7418798653
Scale and pointer	Van Hool No. 10675798

Equipment condition

- Front wheels in straight-ahead position
- Parking brake applied
- Chocks in front of and behind drive axle wheels
- "Servotest 570" tester connected, refer to "To connect Servotest 570 tester" earlier in this chapter

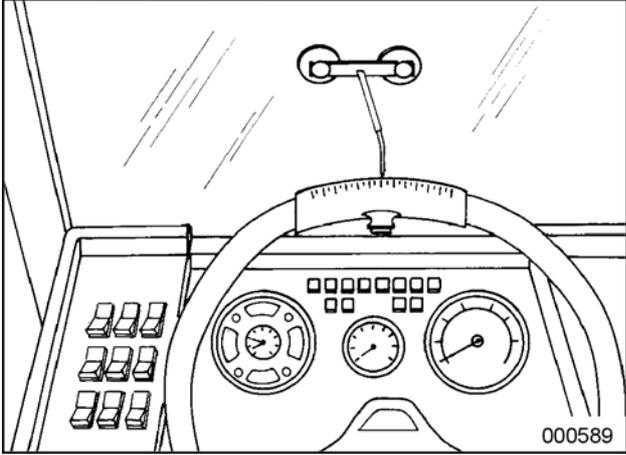
Figure: blocking arrangement



Example of set-up to block wheels in straight-ahead position

- 1 Adjustable strut
- 2 Wheel rim
- 3 Chassis beam

Procedure

Step	Action
1	<p>Block left front wheel (right front wheel on right-hand drive vehicles).</p> <p>This can be achieved, for instance, by installing adjustable struts between wheel rim edge and chassis frame in front of and behind center point of wheel.</p>
2	<p>Attach special scale to steering wheel and associated pointer on vehicle windshield or dashboard.</p> <p>The pointer has to be aligned with the zero in the middle of the scale.</p> 
3	<p>Start engine and warm up steering fluid to about 50 C° (122 °F). Refer to "To connect Servotest 570 tester" earlier in this chapter.</p>
4	<p>Have engine run at about 1 000 rpm. Slowly turn steering wheel counterclockwise, until Servotest pressure gauge indicates a pressure value exceeding no-load pressure by 1 bar (14.5 psi).</p>
5	<p>Mark corresponding steering wheel travel on scale.</p>
6	<p>Perform same measurement turning steering wheel clockwise. Again mark steering wheel travel on scale.</p>
7	<p>The marks on the scale must not be further apart than 45 mm (1.77 in). Otherwise there is too much play in the steering gear.</p>
8	<p>If there is too much play, repeat entire test with pitman arm locked by one means or another (struts removed). Thus you can find out whether play is located before or after pitman arm (e.g. in rod joints).</p>

continued on next page

Step	Action
9	If steering wheel travel still exceeds 45 mm (1.77 in), even when the pitman arm is blocked, then the excess play is in the steering gear. In that case remove steering gear and have it repaired in an authorized workshop.

**Greater play
without power
assistance**

To avoid any misunderstandings it must be mentioned that steering wheel play is always far greater, when the wheel is turned without power assistance than when turned with power assistance. This becomes apparent, when the vehicle is being towed with the engine off.

To change filter in steering fluid tank

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Consumables

Filter element	Van Hool No. Z632141102
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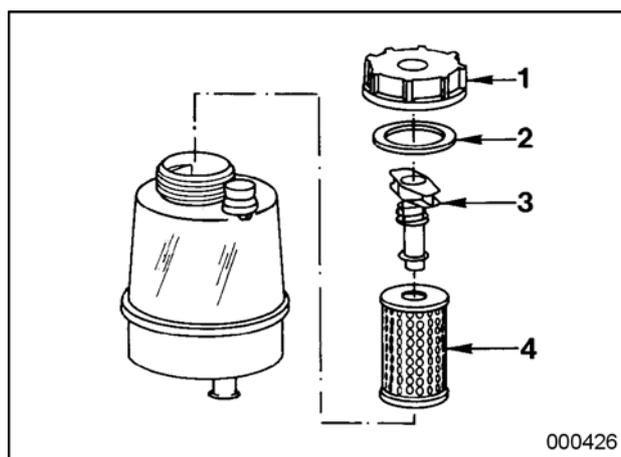
Fluid type

Refer to chapter 1.1, "Fluids and lubricants".

Tightening torques

Refer to "Technical data" at the end of this chapter.

Figure: filter in steering fluid tank



- 1 Filler cap
- 2 Gasket
- 3 T-shaped filter retainer
- 4 Filter element

Procedure

Step	Action
1	Clean the exterior of the tank.
2	Disconnect the two hoses at the bottom of the tank and remove the tank. Blank the hose openings so that no impurities can enter.
3	Unscrew filler cap(1) of the tank.

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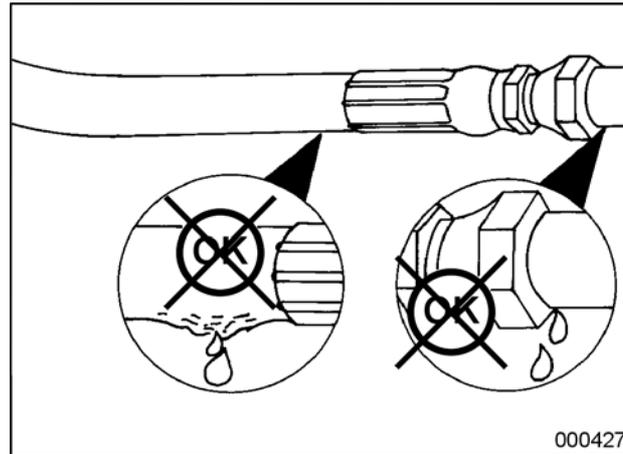
Step	Action
4	Twist T-shaped filter retainer (3) a quarter of a turn to release filter (4).
5	Lift the filter element from the tank and pull on the retainer to detach it from the filter element.
6	Empty the tank and thoroughly clean its interior.
7	Fit the retainer to the new element and engage the filter assembly on the seat in the tank.
8	Check gasket (2) and install the filler cap.
9	Install the tank and attach the hoses. Tighten the hose clamp screws to the prescribed torque.
10	Fill the tank up to the prescribed level with the recommended fluid.

To check steering fluid lines for leaks

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: checking steering fluid lines for leaks



Procedure

- Check the fluid lines for damages and leaks.
- Move hoses that are rubbing against parts of the chassis.
- Tighten leaky connections.
- Replace defective parts.

To check security of steering gear, rods and levers

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Tightening torques

Refer to "Technical data" at the end of this chapter.



WARNING!

Never retighten nuts or screws fitted with locking adhesive or "micro-encapsulated" nuts or screws, since this will destroy their locking properties. Once they have been removed, micro-encapsulated screws must not be reused.

How to check?

Visually check bolts, screws and nuts that are locked by means of a cotter pin, liquid adhesive (Loctite), staking or "micro-encapsulation". The security of all others must be checked mechanically. Retighten, if necessary.

To check steering gear pressure point

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

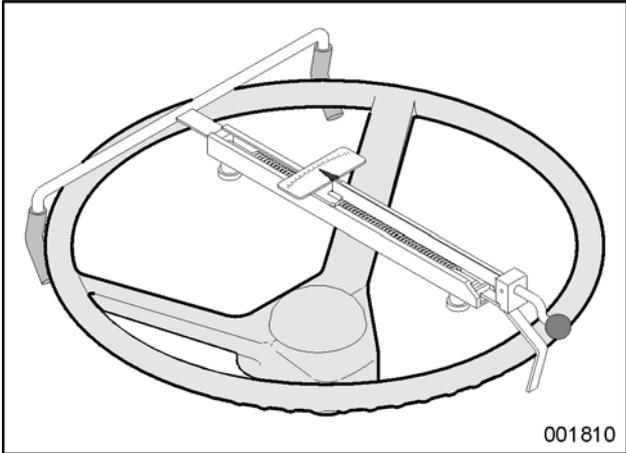
Special tools

Torque meter	ZF No. 7418798703
--------------	-------------------

Equipment condition

- Parking brake applied
- Chocks in front of and behind drive axle wheels

To check pressure point

Step	Action
1	Disconnect drag link at pitman arm.
2	Position torque meter (special tool) onto steering wheel. 
3	By means of torque meter turn steering wheel through its full travel and measure amount of frictional torque at approx. 1/2 turn from end positions. Note down torque reading.
4	With torque meter turn steering wheel to the right and to the left and this time measure frictional torque, when mid-position is being crossed (pressure point). Torque can exceed value found in step 3 by 20 to 160 Ncm (1.77 to 14.16 in.lbf). <i>NOTE: With a worn-in steering system frictional torque increase may also be less than 20 Ncm (1.77 in.lbf).</i>

**To adjust
pressure point**

Steering gear pressure point can be adjusted with steering gear removed only (have steering gear removed in ZF workshop).

To dismantle steering gear

**WARNING!**

The steering gear should be dismantled or repaired at ZF authorized workshops only. They have original spare parts and appropriate tools at their disposal, as well as the necessary know-how.

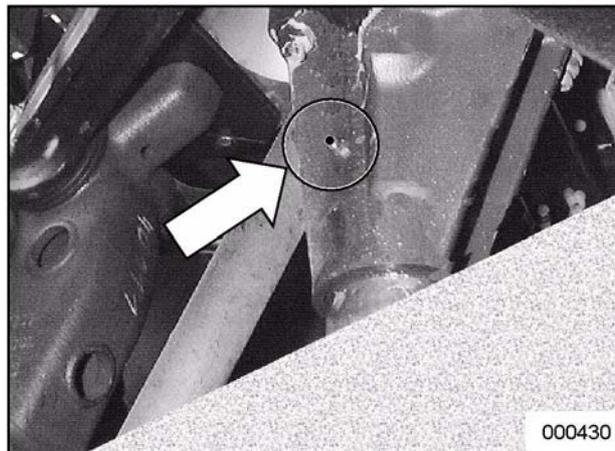
To lubricate intermediate lever of steering system

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Grease type

Refer to chapter 1.1, "Fluids and lubricants".

Figure: grease nipple on intermediate lever

Procedure

Push grease in the grease nipple until new grease escapes from the bottom of the bearing housing.

To check linkage joints

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Exterior of joint that is to be checked must have been cleaned with a dry cloth or cotton waste

To check what?

- joint exterior for corrosion
- dust cover of steering linkage joint
- dust cover retaining rings
- joint for play



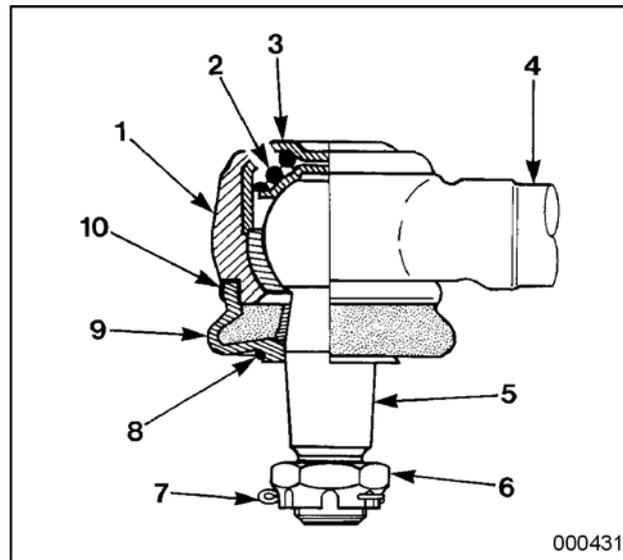
CAUTION!

Do not damage ball-joint dust cover. Do not use any detergents or solvents.



CAUTION!

Water entering the ball-joint through an untight dust cover will damage the joint in no time.

Figure: typical linkage joint

- 000431
- 1 Casing
 - 2 Compression spring
 - 3 Cover
 - 4 Shank
 - 5 Ball-joint pillar
 - 6 Castellated nut
 - 7 Cotter pin
 - 8 Dust cover retaining ring
 - 9 Dust cover
 - 10 Dust cover retaining ring

To check exterior for corrosion

There must not be any corrosion marks with a depth of more than 0.04 in. Especially check whether edge of casing (1) around cover (3) is free of corrosion.

If the joint is corroded to a greater extent than permitted, change it completely by a new one.

Change cotter pin (7), if any pitting marks are found.

To check dust cover

Check dust cover (9) for punctures, cracks or tears. Work the flexible cover between your fingers. No grease should escape through the dust cover walls (only through the opening in the middle).

If the dust cover is faulty, change the complete linkage joint by a new one.

To check dust cover retaining rings

First check whether rings (8) and (10) have been installed in the right way. Also, it has to be possible to rotate cover (9) by hand with respect to

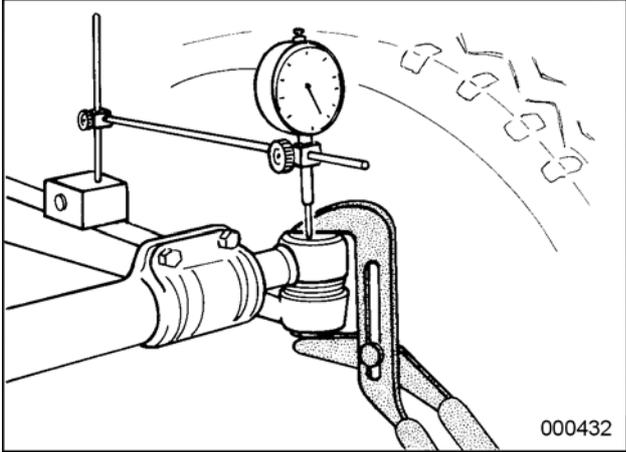
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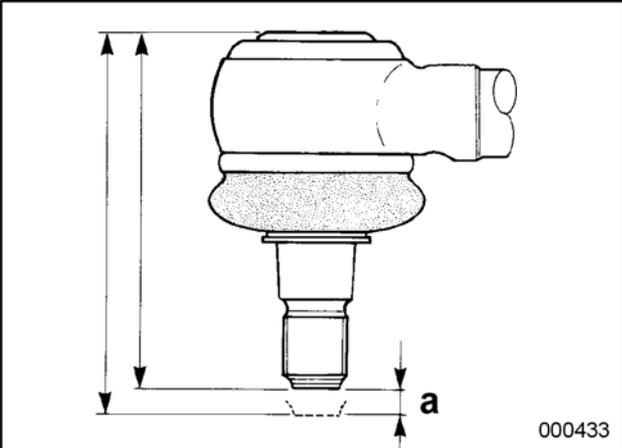
casing (1) (Grab cover with your fingers, near the largest ring, and try to turn it. Do not use any tools!).

If the rings are not up to standard, replace the entire linkage joint by a new one.

To check joint for play

Normal wear will not cause the ball-joint pillar to become any looser in its casing. After all, a spring pushes it against the joint liners. Play due to wear only shows, when you press the ball-joint pillar inwards against the spring pressure.

Step	Action
1	Set vehicle wheels in straight ahead position.
2	Mount a dial indicator with magnetic base on arm the joint is secured to. 
3	Position dial indicator stylus with slight pre-pressure against cover (3) of joint at a right angle.

Step	Action
4	<p>With adjustable-joint pliers compress joint and read travel of ball-joint pillar (5) on indicator.</p> <p>If play measurement result (a) exceeds 5/64 in, change complete joint by a new one.</p> <div><p>The diagram shows a ball joint assembly. A vertical double-headed arrow on the left indicates the total height of the upper part of the joint. A horizontal double-headed arrow at the bottom indicates the width of the lower part. A vertical double-headed arrow labeled 'a' indicates the vertical travel of the ball-joint pillar. The number '000433' is printed in the bottom right corner of the diagram area.</p></div>

To check clamps of drag-link and tie-rod

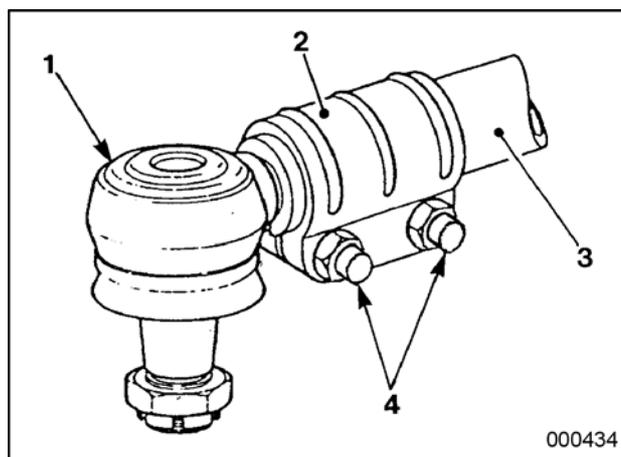
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

Exterior of joint that is to be checked must have been cleaned with a dry cloth or cotton waste

Figure: drag-link or tie-rod end



- 1 Joint
- 2 Clamping collar
- 3 Tube
- 4 Clamping bolts

Guidelines

- Clamping collar, clamping bolts and clamping nuts should be free of corrosion pitting marks with a depth of over 0.02 in. Otherwise: change affected parts.
- Change clamping bolts that are visibly bent.
- If clamping collar has not been tightened securely, there is a chance that inside thread of clamping collar and outside thread of rod tube will be damaged. Inspect thread. If damaged: change clamping collar and tube.
- Check inside thread of rod tube for play. Procedure: with axle loaded by vehicle weight (wheels on the ground) turn steering wheel alternately in both directions over a short distance, while an assistant feels (with his finger against the tube edge), whether there is any play between ball-joint shank and tube. If there is play (thread damage), change complete rod/ball-joint assembly.

To check drag-link and tie-rod tubes

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".



WARNING!

It is not permitted to straighten a bent drag-link or tie rod.

Procedure

Visually check rod tube for deformation and damage.

Change the tube if you can see that it is not in proper condition.

To check straight-ahead position of wheels

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Equipment condition

- Parking brake applied
- Chocks in front of and behind wheels of drive axle
- Vehicle jacked up at the front



WARNING!

If it is found that the straight-ahead position is out of adjustment, examine the complete steering system closely for deformation and cracks (impact damage). Remove the pitman arm with a special puller and check the pitman-arm shaft taper serrations. If they are no longer dead straight, the pitman-arm shaft is distorted. If there is the slightest indication of any defect, immediately change those parts. On no account must bent or twisted parts be straightened for re-use.

Procedure

Step	Action
1	Turn the steering wheel from lock to lock and count the number of revolutions.
2	Turn back half the number of revolutions and align the mark on the steering gear input shaft with the mark on the steering gear housing.
3	Check whether the front wheels are exactly aligned with the wheels of the drive axle (if necessary, approximate, by laying a straight ruler along the wheels at each side of the vehicle). Do take the toe into account. If the front wheels deviate excessively from the straight-ahead position, the drag-link is too long or too short.
4	If necessary, adjust the length of the drag link by loosening the clamps from the rod ends and turning the rod tube the correct direction.
5	Also check the play in the steering gear as described in "To check steering wheel play".

To check maximum steering lock angles

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Procedure

Refer to chapter 12.6, "To check/adjust steering lock angles".

To check steering column bearings for excessive play

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Procedure

Alternate pushing and pulling on the steering wheel.
If you feel too much play, have the steering column bearings replaced.

To check universal joints and flex couplings

To be carried out when?

Refer to "Steering system: to perform major inspection" in chapter 1.1, "Maintenance schedule".

Procedure

Turn the steering wheel with short motions back and forth while an assistant watches how the joints behave.

Replace joints that "clack" (play) or bind.

To remove steering assembly

Equipment condition

- Vehicle over inspection pit
- Parking brake applied
- Steering fluid drained, refer to "To change fluid of power steering system"

To remove steering gear



WARNING!

The steering gear weighs approximately 90 lbs. Support it in a safe manner, before undoing its fixing screws.

To disconnect pitman arm



WARNING!

Do not under any circumstances hammer pitman arm to break it loose from its shaft, nor drive a wedge between pitman arm and steering gear. To do so can cause serious internal damage to the steering gear. Equally, do not attempt to free the pitman arm by heating it with a blowtorch. The heat affects the metal structure of the pitman arm, thus creating a risk of potential catastrophic failure.

The pitman arm has to be removed with a special puller.

To remove steering wheel center trim

To remove steering wheel center trim, simply pry it out with a screwdriver.

To inspect the steering gear splash-water protective cover

Grease type

Refer to chapter 1.1, "Fluids and lubricants".

Equipment condition

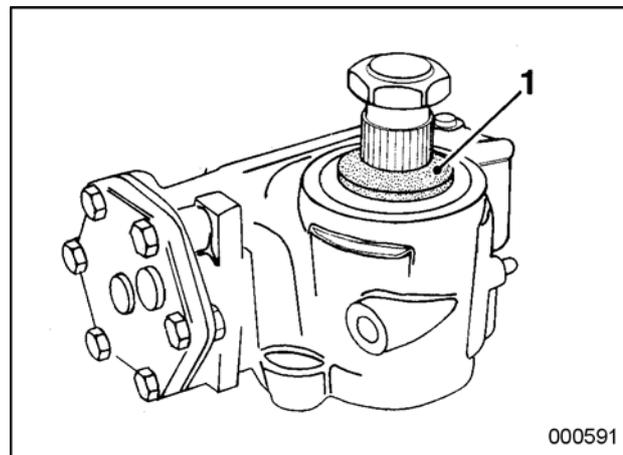
- Parking brake applied
- Chocks in front of and behind drive axle wheels

Location of protective cover

On the pitman shaft, between the pitman arm and the steering gear

Purpose of the protective cover

The plastic cover filled with grease is used for preventing pitman-shaft rusting. Rust at the pitman-shaft seal would damage the seal and cause the steering gear to leak.

**Figure:
steering gear
ZF 8089**

1 Splash-water protective cover

Procedure

**WARNING!**

Do not under any circumstances hammer pitman arm to break it loose from its shaft, nor drive a wedge between pitman arm and steering gear. To do so can cause serious internal damage to the steering gear. Equally, do not attempt to free the pitman arm by heating it with a blowtorch. The heat affects the metal structure of the pitman arm, thus creating a risk of potential catastrophic failure.

Step	Action
1	Remove the pitman arm with a special puller.
2	Inspect the cover and replace it when damaged or worn. <i>NOTE: Fill the space inside the new cover completely with the specified grease.</i>

Technical data: front axle steering system

Hydraulic circuit

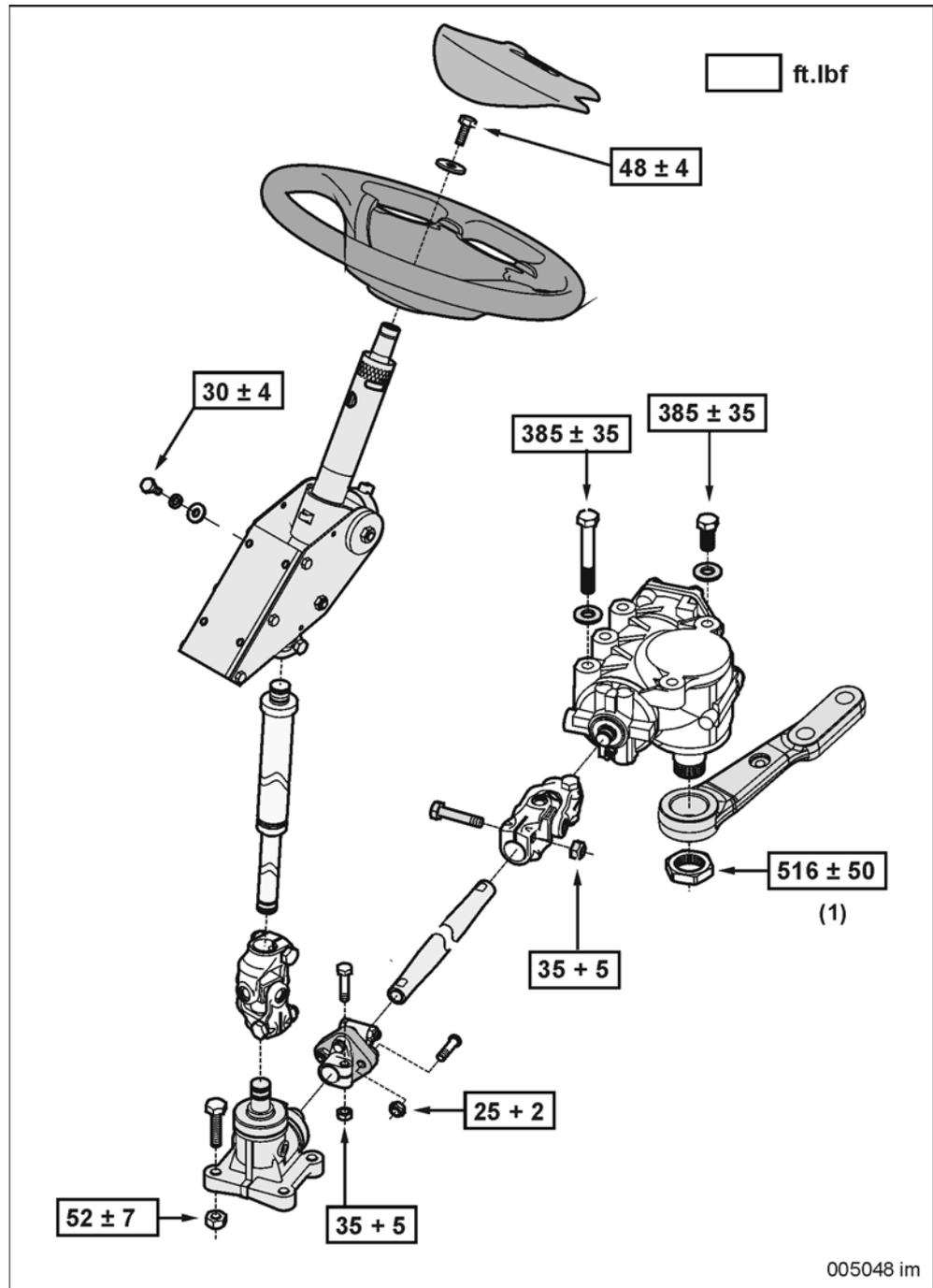
Maximum pressure	170 + 10 bar (2 466 + 145 psi)
No-load pressure	4 bar (58 psi)
Steering limiter valve relief pressure	50 to 60 bar (725 to 870 psi) at a fluid temperature of 50 ± 10 °C (122 ± 18 °F)
Steering gear internal leakage rate	Maximum 2.5 dm ³ /min (0.66 gal/min)

Tightening torques

Standard hose clamps, clamping range up to 0.9 in dia.	2.2 ± 0.4 ft.lbf
Standard hose clamps, clamping range up to 1.06 in dia.	3.3 + 0.4 ft.lbf
Constant torque hose clamps (manufacturer "Breeze"), with four conical spring washers	5.2 ± 0.4 ft.lbf
Constant torque hose clamps (manufacturer "Breeze"), with five conical spring washers	6.6 + 0.7 ft.lbf
Limiter valve adjuster locknuts	15 + 7 ft.lbf

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Figure:
tightening
torques

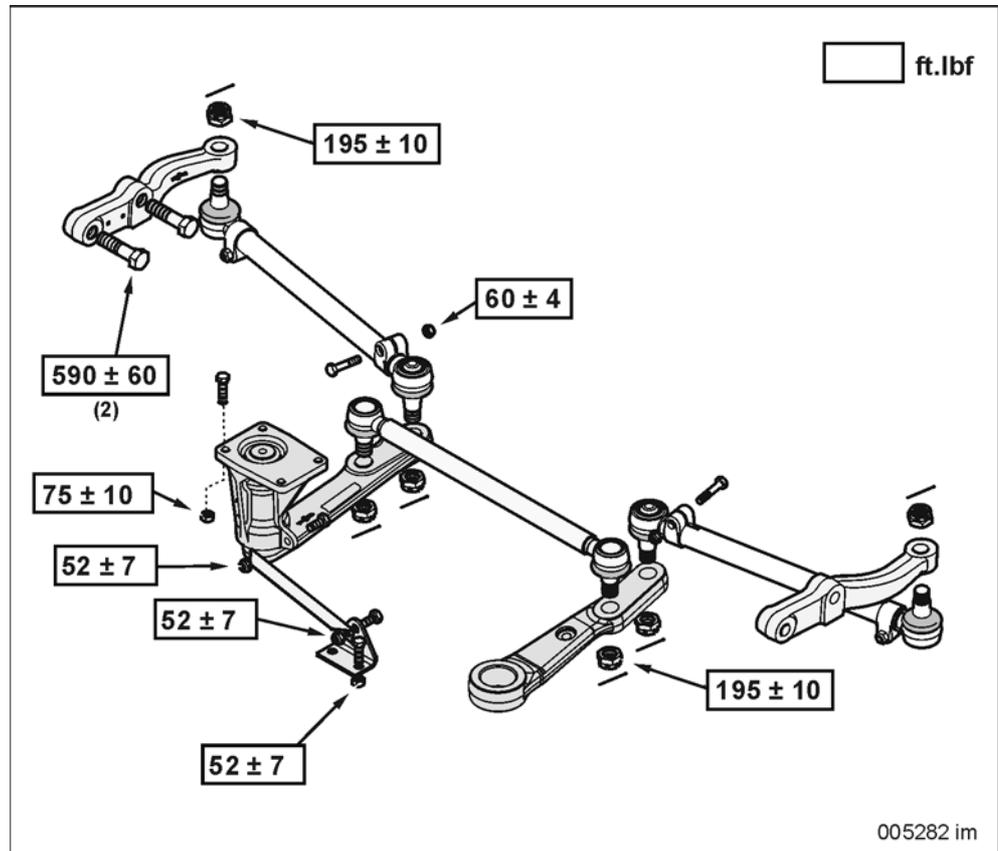


Security of steering column and steering gear

(1) Locked by staking

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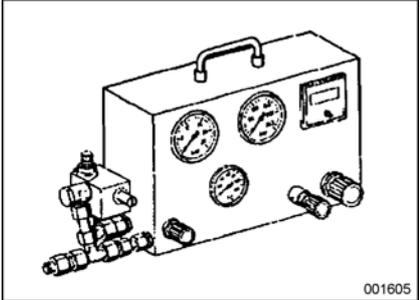
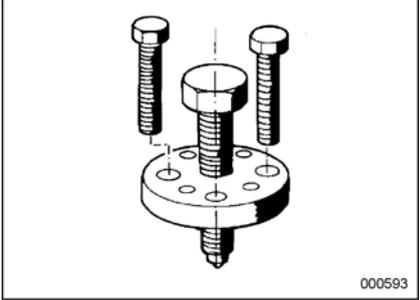
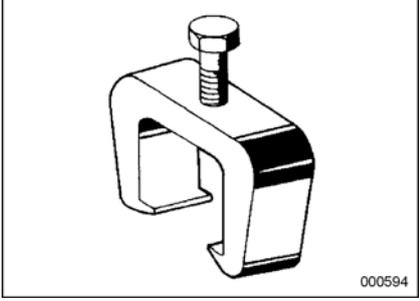
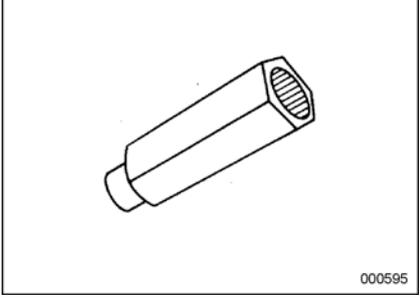
Figure:
tightening
torques

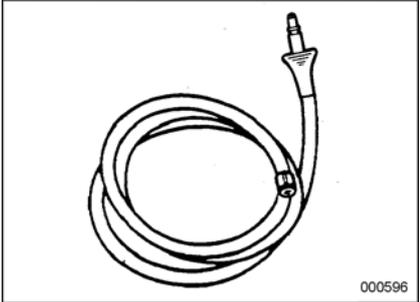
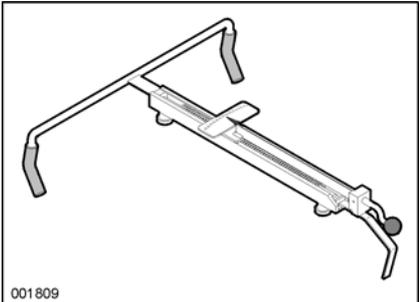
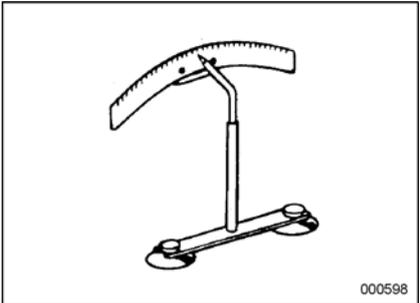
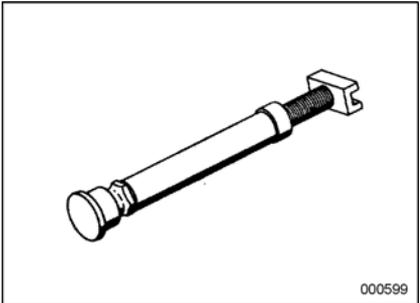


Security of linkage

(2) "Micro-encapsulated" screws, or screws locked with Loctite 243

Special tools: front axle steering system

Ordering number	Description	Figure
ZF 7418798574	"Servotest 570" tester with a 2 dm ³ /min flow control valve	 <p>001605</p>
Van Hool 619900910	Steering wheel puller	 <p>000593</p>
Van Hool 619900920	Pitman arm puller	 <p>000594</p>
Van Hool 10575651	Torque meter socket with serrations, fitting the steering column end	 <p>000595</p>

Ordering number	Description	Figure
Van Hool 639901590	Hose for pressure checking gauge with a M16 union nut	 <p>000596</p>
ZF 7418798703	Torque meter	 <p>001809</p>
Van Hool 10675798	Scale and pointer for measuring play at steering wheel	 <p>000598</p>
ZF 7418798653	Two struts to lock front wheels in straight-ahead position	 <p>000599</p>

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Part 8 - Climate control

Overview

Contents

Chapter	See page
Chapter 2: Control systems	8.2-1
Chapter 6: Airside systems	8.6-1
Chapter 10: Water circuit	8.10-1
Chapter 14: Refrigerant circuit	8.14-1

Chapter 2: Control systems

Overview

Introduction This chapter deals with the control system.

Number of pages 38

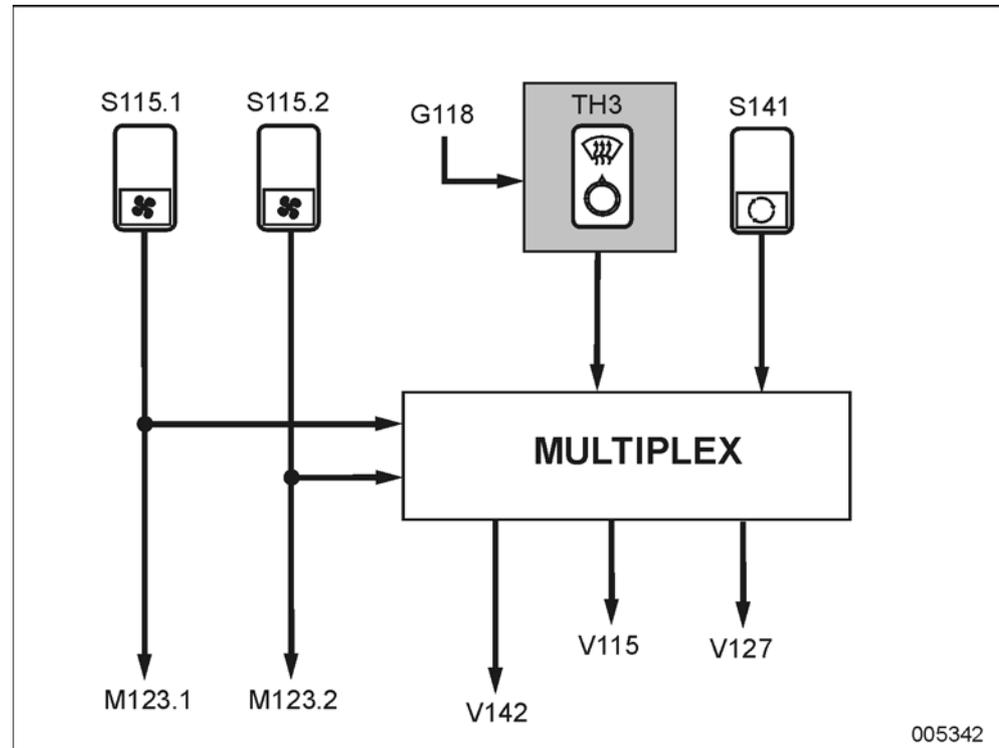
Chapter publication date 19 September 2006

Contents

Topic	See page
Driver's cab control system: layout	8.2-2
Driver's cab control system: visual identification of components	8.2-3
Driver's cab control system: operation	8.2-5
Driver's cab control system: component location	8.2-7
Passenger compartment control system: layout	8.2-9
Passenger compartment control system: visual identification of components	8.2-11
Passenger compartment control system: operation	8.2-14
Passenger compartment control system: component location	8.2-22
Passenger compartment control system: to troubleshoot using the multifunctional display	8.2-25
Passenger compartment control system: to activate the "engine running" simulation	8.2-28
Passenger compartment control system: to call up temperatures	8.2-30
Passenger compartment control system: to set temperature	8.2-32
Passenger compartment control system: to check temperature sensors	8.2-35
Technical data: control system	8.2-37

Driver's cab control system: layout

Figure: block diagram of driver's cab control system



References in figure

Reference in figure	Explanation
G118	Temperature sensor, outlet air
M123.1	First fan motor
M123.2	Second fan motor
S115.1	Switch first fan
S115.2	Switch second fan
S141	Inside/outside air flap switch
TH3	Temperature control unit
V115	Pilot valve of hot-water supply metering valve
V127	Pilot valve of inside/outside air flap
V142	Shut-off valve in refrigerant line to evaporator in driver's cab climate-control unit

Driver's cab control system: visual identification of components

Components

Element	Figure
Temperature control unit (TH3)	<p>A black rectangular electronic control unit with a rotary knob on the front panel and a small label on the top right corner.</p> <p>000175</p>
Outlet-air temperature sensor (G118)	<p>A black cable with a multi-pin connector at one end and a sensor probe at the other.</p> <p>001646</p>
Switch for fan speed setting (S115.1 and S115.2)	<p>A rectangular switch with a fan icon symbol.</p> <p>000660</p>
Inside/outside air flap switch (S141)	<p>A rectangular switch with a circular arrow symbol.</p> <p>000687</p>

Element	Figure
Pilot valve of hot-water supply metering valve(V115)	 <p>001661</p>
Pilot valve of inside/outside air flap (V127)	 <p>001662</p>

Driver's cab control system: operation

Outlet-air temperature sensor G118

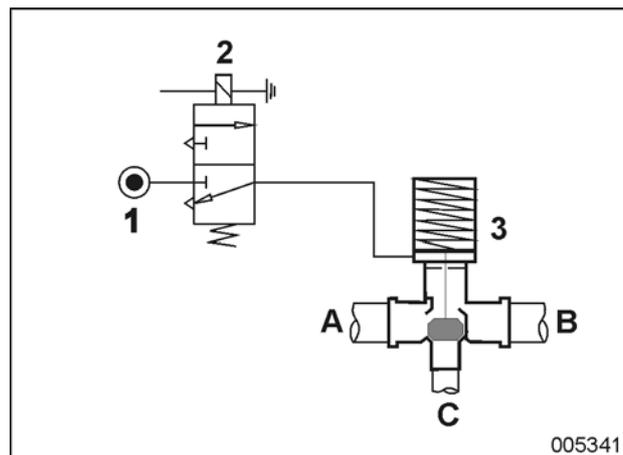
Sensor G118 measures the outlet-air temperature of the driver's cab climate-control unit. The measured value is sent to control unit TH3.

Control unit TH3

Control unit TH3 compares the value of sensor G118 with the value set by means of the rotary knob on the dashboard. When air temperature starts to differ from the set value, the control unit intervenes by opening or closing pilot valve V115 as long as necessary.

Pilot valve V115 of hot-water supply metering valve

The "normally closed" pilot valve V115 is controlled by control unit TH3. If V115 is energized, the "normally open" metering valve in the hot-water supply closes (passage from A to C open, passage from A to B closed).



- 1 Compressed-air supply
- 2 Pilot valve V115
- 3 Metering valve in hot-water supply
- A Supply
- B To climate-control unit
- C Back to engine cooling

Pilot valve V127 of inside/outside air flap

The choice of inside/outside air is made by means of a switch on the dashboard. If you press the lower part of the dashboard switch, pilot valve V127 is energized and the inside/outside air flap is put in the inside air position.

Fan motor M123

The driver's cab climate-control unit has two fans, each one controlled by a three-position switch (S115).

- Position 0: off

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- Position 1: low speed
- Position 2: high speed

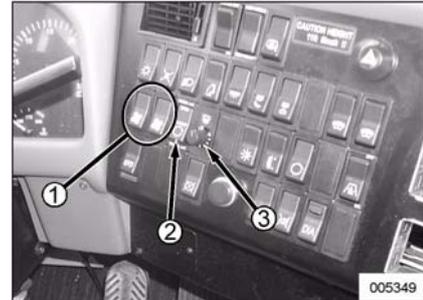
**Shut-off valve
V142 in refrigerant circuit**

The "normally closed" solenoid shut-off valve V142 is controlled by the passenger compartment control system (refer to "Passenger compartment control system: operation"). The climate control program prevents the shut-off valve from opening with fan motor stopped.

Driver's cab control system: component location

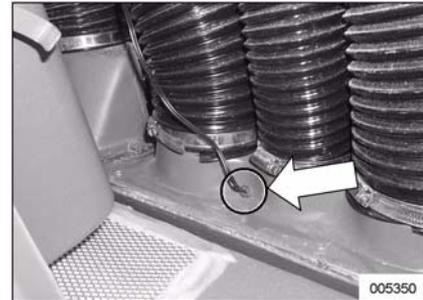
Dashboard controls

- 1 Switches for fan speed setting (S115.1 and S115.2)
- 2 Temperature control unit (TH3)
- 3 Inside/outside air flap switch (S141)



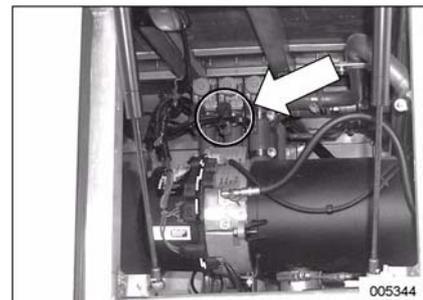
Temperature sensor (G118)

In the outlet manifold of the climate-control unit

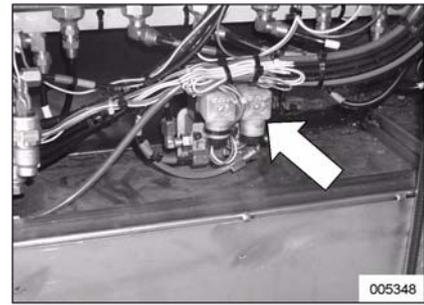


Pilot valves

On the interior-heating valve block: pilot valve of metering valve in hot-water supply to driver's cab climate-control unit (V115)



In the rear wall of the luggage compartment: pilot valve of inside/outside air flap (V127)

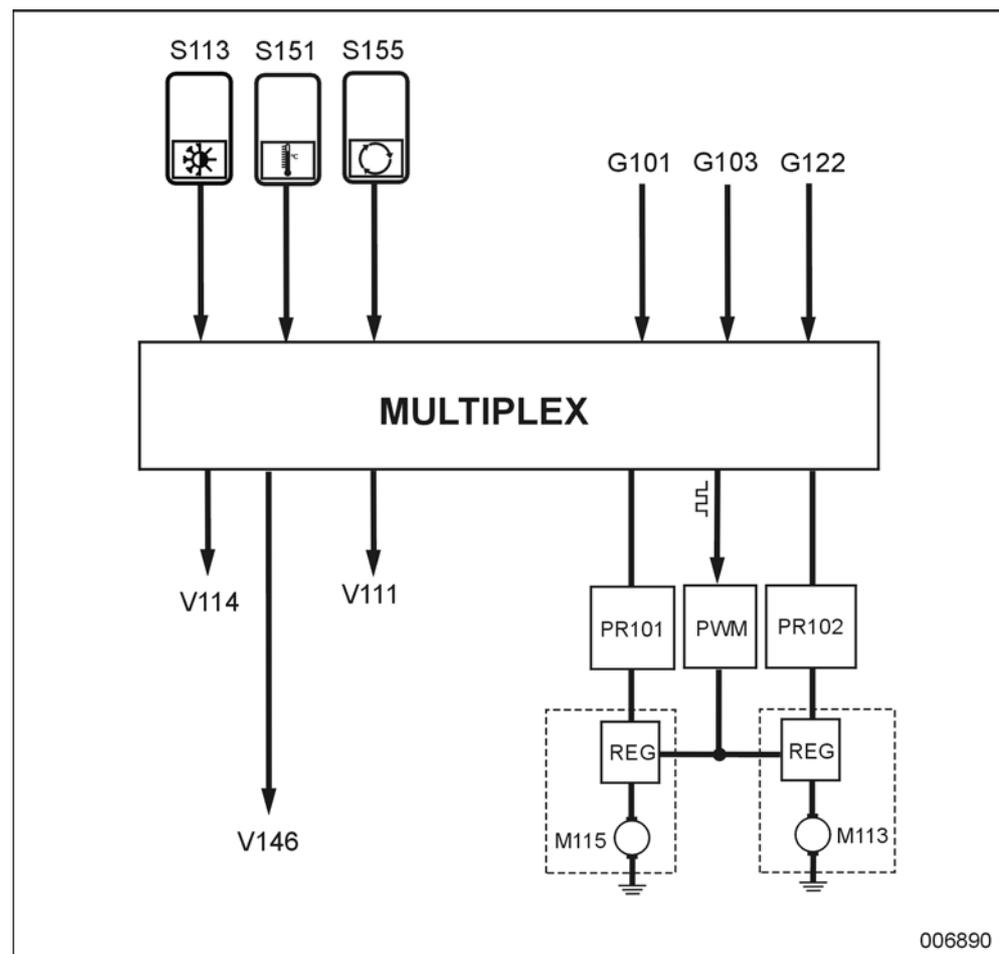


Passenger compartment control system: layout

Introduction

The climate-control system program has been stored in the computer module of the multiplex system. The computer module assesses the input signals (from temperature sensors, switches,...), and controls the output components (pilot valves, motors,...).

Figure: block diagram of passenger compartment control system



References in figure

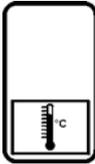
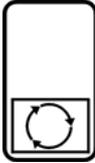
Reference in figure	Explanation
G101	Interior-air temperature sensor
G103	Outside-air temperature sensor
G122	Duct-air temperature sensor
M113	RH evaporator fans motors
M115	LH evaporator fans motors

continued on next page

Reference in figure	Explanation
PR101	Printed circuit with relay and fuses of RH evaporator fans
PR102	Printed circuit with relay and fuses of LH evaporator fans
PWM	"Digital/analog" inverter
REG	Electronic speed controller (chopper)
S113	Switch to cut off the system
S151	Temperature setting switch
S155	Switch for 100% inside air
V111	Pilot valve of outside-air flaps
V114	Pilot valve of metering valve in hot-water supply to roof heating
V146	Pilot valve of metering valve in hot-water supply to floor heating

Passenger compartment control system: visual identification of components

Dashboard controls

Element	Figure
Switch to cut off the system (S113)	 001351
Temperature setting switch (S151)	 003368
Switch for 100% inside air (S155)	 000087

Temperature sensors

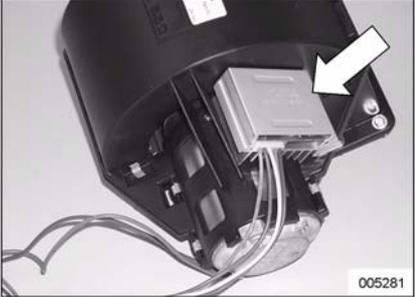
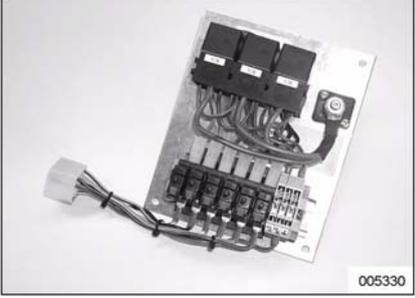
Element	Figure
Interior-air temperature sensor (G101)	 001647

Element	Figure
Duct-air temperature sensor (G122)	 <p style="text-align: right;">001646</p>
Outside-air temperature sensor (G103)	 <p style="text-align: right;">001645</p>

Pilot valves

Element	Figure
<ul style="list-style-type: none"> • Pilot valve (V114) of metering valve in hot-water supply to roof heating • Pilot valve (V146) of metering valve in hot-water supply to floor heating 	 <p style="text-align: right;">001661</p>
Pilot valve of outside-air flaps (V111)	 <p style="text-align: right;">001662</p>

Other components

Element	Figure
"Digital/analog" inverter (PWM)	 <p>005279</p>
Electronic speed controller (REG)	 <p>005281</p>
Printed circuit with relay and fuses of evaporator fans (PR101 and PR102)	 <p>005330</p>

Passenger compartment control system: operation

Controller

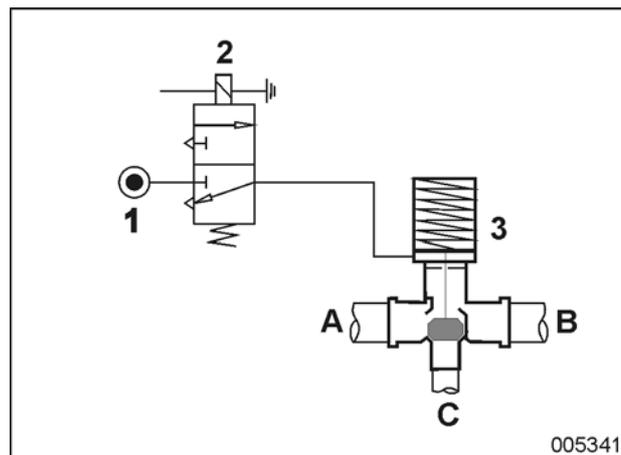
The controller, programmed in the computer module of the multiplex system, compares the current interior temperature to the set temperature and uses that information to calculate the duct temperature. Then, it compares this duct temperature to the current duct temperature and calculates the control signal for the pilot valve V114.

PWM

PWM is short for "Pulse width modulation".

Pilot valve V114 of roof-heating metering valve

The "normally closed" pilot valve V114 is controlled by a PWM signal with a period of approximately 20 seconds. The pulse width depends on the required amount of heating. If V114 is energized, the "normally open" metering valve in the hot-water supply closes (passage from A to C open, passage from A to B closed).



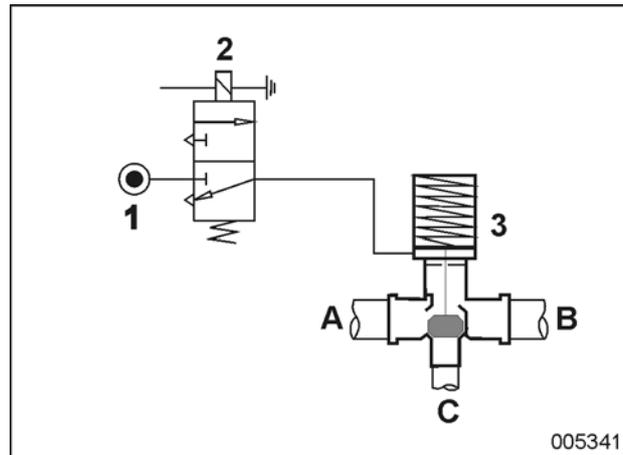
- 1 Compressed-air supply
- 2 Pilot valve V114
- 3 Metering valve in hot-water supply
- A Supply
- B To climate-control unit
- C Back to engine cooling

Pilot valve V146 of floor-heating metering valve

The "normally closed" pilot valve V146 is controlled by a PWM signal with a period of approximately 20 seconds. The signal runs synchronous with the PWM signal of pilot valve V114 until the duct temperature drops below the set temperature value.

NOTE: The floor heating is switched off if the exterior temperature exceeds 55°F.

continued on next page



- 1 Compressed-air supply
- 2 Pilot valve V146
- 3 Metering valve in hot-water supply
- A Supply
- B To climate-control unit
- C Back to engine cooling

Pilot valve V111 of outside-air flaps

Under normal circumstances, the installation operates with 80% inside air and 20% outside air. If necessary, you can have the installation operate continuously with 100% inside air. If you press dash switch S155 momentarily, pilot valve V111 is energized. The outside-air flaps close and the installation operates with 100% inside air. A symbol appears on the multifunctional display to indicate that the installation operates with 100% inside air.

NOTE: To switch to the normal condition again, press S155 a second time.

Evaporator fans

NOTE: The computer module knows the bus engine coolant temperature through the CAN bus of the drive line.

The speed of the evaporator fans (M113/M115) is controlled by an electronic speed controller (chopper) mounted on the fan housing. The amplitude of the pilot signal (constant direct voltage) at the speed controller determines the fan speed (44 to 100%). 44% corresponds to a pilot signal of 16V, 100% to 0V. Consequently, fan speed is inversely proportional to the amplitude of the pilot signal.

The evaporator fans turn at what speed?

Mode	Fan speed	
Heating	Bus-engine coolant temperature below 113°F	44%
	Bus-engine coolant temperature above 113°F and...	

continued on next page

Mode	Fan speed	
	<ul style="list-style-type: none"> interior temperature more than 7°F lower than the set temperature interior temperature less than 7°F lower than the set temperature 	<p>66%</p> <p>44%</p>
"REHEAT", refrigeration	<p>Stepless between 44 and 100%</p> <div> <p style="text-align: right; font-size: small;">005272 im</p> </div> <p><i>V: Fan speed, Ti: interior temperature, Tset: set temperature</i></p>	

"Digital/analog" inverter (PWM)

The "Digital/analog" inverter translates the pilot signal for the electronic speed controller from a PWM signal into a constant direct voltage. The generated PWM signals have a frequency of 50 kHz. This corresponds with a period of 0.2 ms. The amplitude of the direct voltage at the "Digital/analog" inverter output depends on the pulse width of the signal (the wider the pulses, the higher the output voltage)

Climate-control compressor clutch

Refer to "Climate-control compressor: electromagnetic clutch" in chapter 8.14.

Shut-off valves in refrigerant circuit

Refer to "Solenoid shut-off valves" in chapter 8.14.

Refrigerant circuit pressure switches

Refer to "Pressure switches" in chapter 8.14.

continued on next page

Condenser fans M21M/M26M

Refer to "Condenser" in chapter 8.14.

Coolant heater (Proheat)

To switch on the coolant heater by means of the dashboard switch or the programmable control, refer to operating manual.

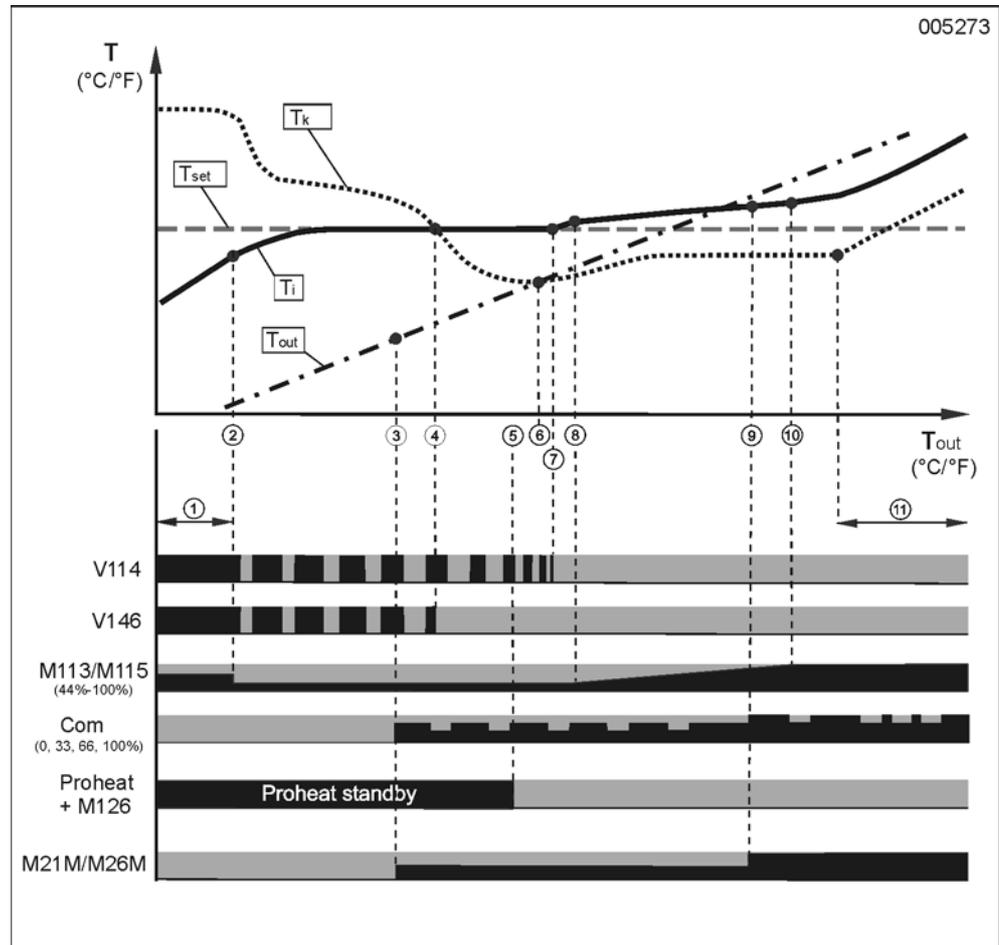
The coolant heater is automatically set in the standby mode when the roof heating metering valve is open for more than 65% of the time. The coolant heater is automatically switched off 5 minutes after the metering valve is open for less than 15% of the time.

Circulating pump M126

The heating-circuit circulating pump runs when the coolant heater is in standby mode.

continued on next page

Switching points with warm engine



- T_i* Interior temperature
- T_{out}* Exterior temperature
- T_{set}* Set temperature
- T_k* Calculated duct temperature
- Com* Climate-control compressor

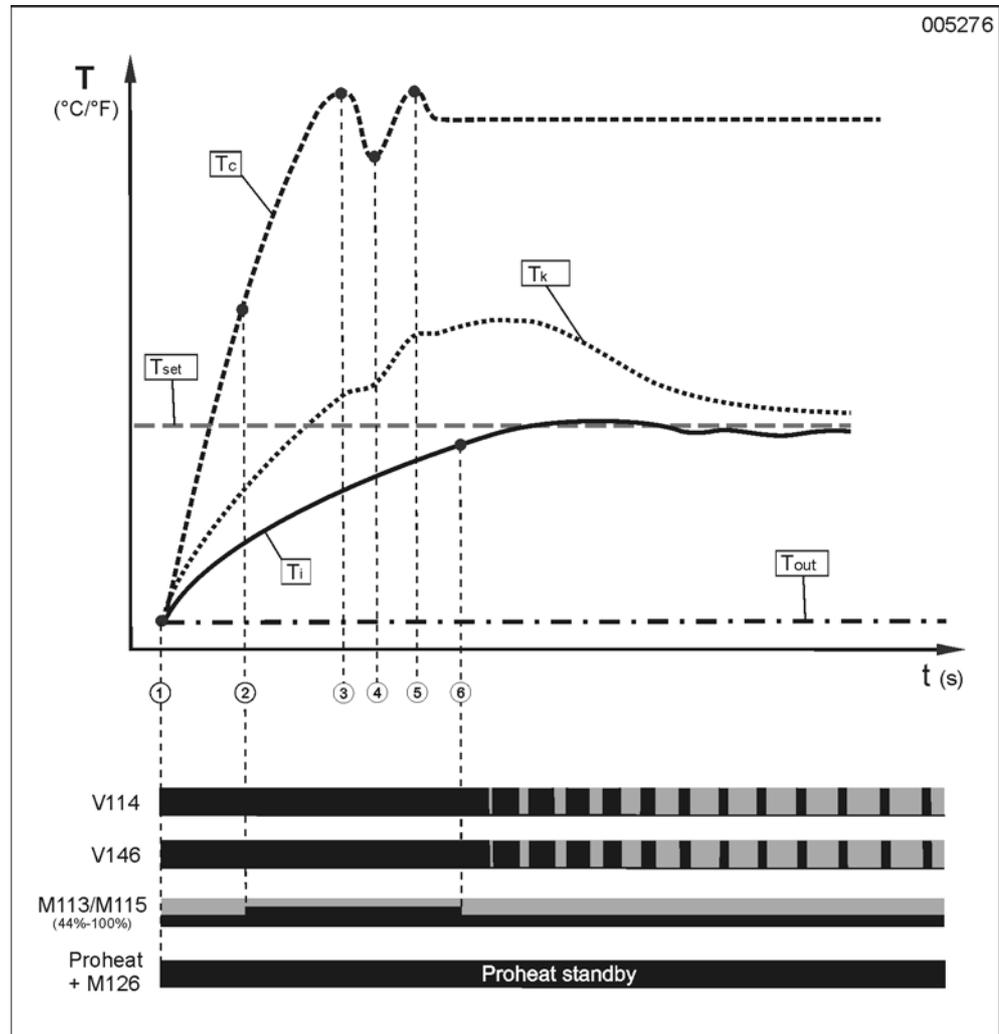
Explanation of switching points with warm engine

Switching point	Explanation
1	Interior temperature below control range (maximum heating capacity)
2	Interior temperature 7°F below set temperature
3	Exterior temperature 25°F
4	Calculated duct temperature equal to set temperature
5	Roof-heating metering valve open for more than 40% of the time

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Switching point	Explanation
6	Calculated duct temperature equal to exterior temperature
7	Heating balanced on set point (heating off, climate-control compressor on)
8	Interior temperature 1°F above set temperature
9	Interior temperature 4°F above set temperature
10	Interior temperature 5°F above set temperature
11	Interior temperature above control range (maximum refrigeration capacity)

Switching points on cold start



Cold start at low exterior temperature

- T_i Interior temperature
- T_{out} Exterior temperature
- T_{set} Set temperature
- T_k Calculated duct temperature
- T_c Bus-engine coolant temperature

Explanation of switching points on cold start

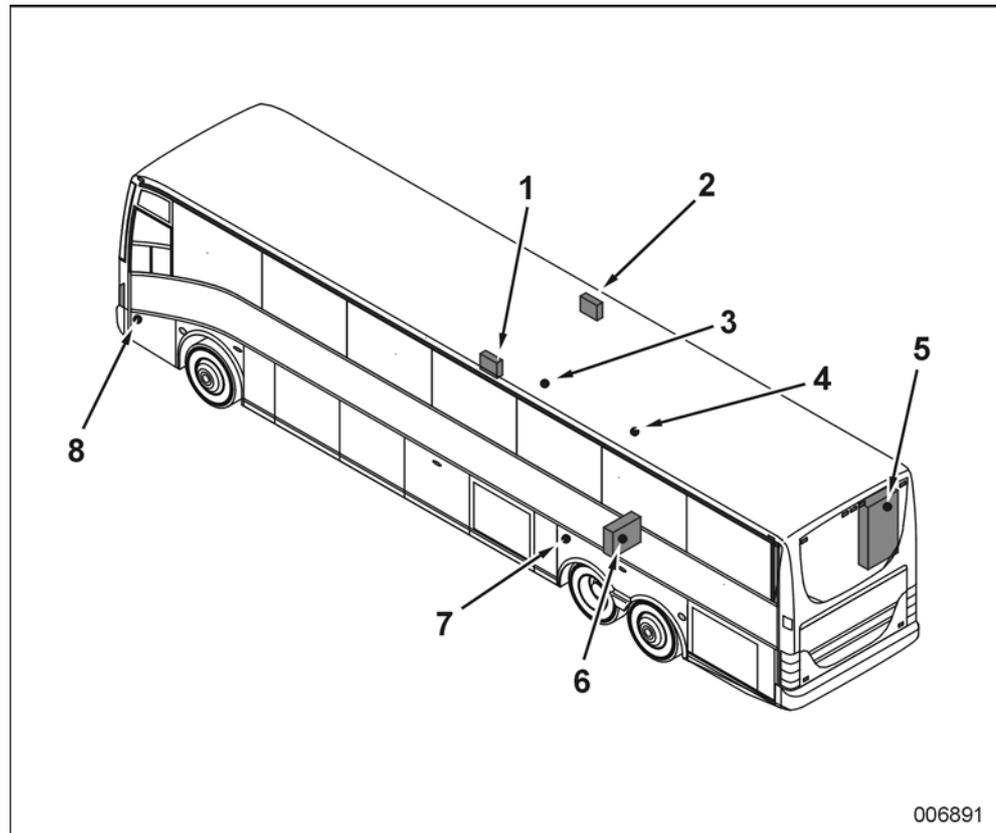
Switching point	Explanation
1	Bus-engine started
2	Coolant temperature 113°F
3	Coolant heater cut-off temperature (185°F)
4	Coolant heater cut-in temperature (160°F)

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Switching point	Explanation
5	Interior temperature 7°F lower than set temperature

Passenger compartment control system: component location

Figure:
location in
vehicle



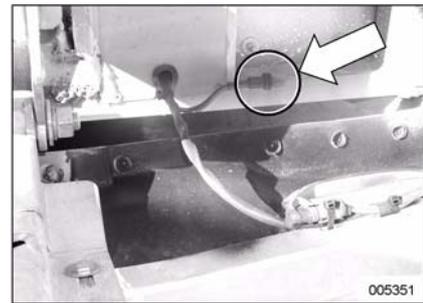
- 1 Printed circuit with relay and fuses of LH evaporator fans (PR102)
- 2 Printed circuit with relay and fuses of RH evaporator fans (PR101)
- 3 Duct-air temperature sensor (G122)
- 4 Interior-air temperature sensor (G101)
- 5 "Digital/analog" inverter (PWM)
- 6 Pilot valve (V111) of outside-air flaps
- 7 Pilot valve (V114) of metering valve in hot-water supply to roof heating, pilot valve (V146) of metering valve in hot-water supply to floor heating
- 8 Outside-air temperature sensor (G103)

Temperature sensors

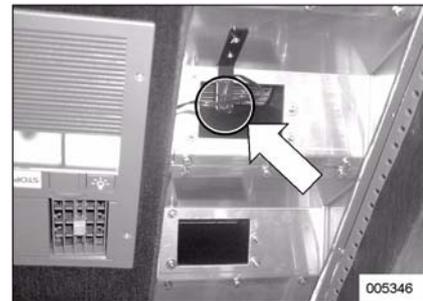
On a post of the left-hand luggage rack: interior-air temperature sensor G101



At the left, behind front bumper: outside-air temperature sensor G103

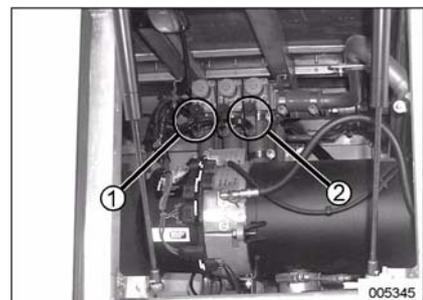


In the outlet of a LH evaporator fan: duct-air temperature sensor G122

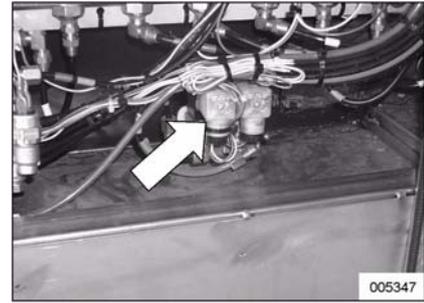
**Pilot valves**

On the interior-heating valve block:

- 1 Pilot valve V146 of metering valve in hot-water supply to floor heating
- 2 Pilot valve V114 of metering valve in hot-water supply to roof heating

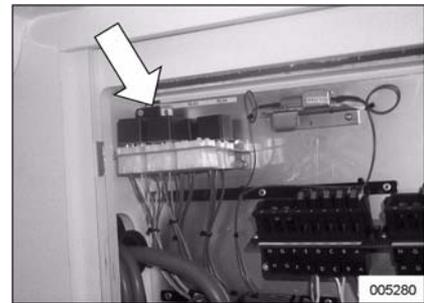


In the rear wall of the luggage compartment: pilot valve V111 of outside-air flaps



**"Digital/
analog"
inverter (PWM)**

In toilet compartment junction box



Passenger compartment control system: to troubleshoot using the multifunctional display

Introduction The dashboard node contains a test program to make troubleshooting easier.

Equipment condition Battery isolating switch on

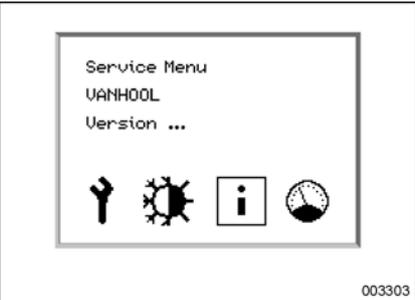
To operate the multifunctional display For more information on how to scroll through menus and to select functions in the service menu of the multifunctional display, see chapter 11.1: "To operate the multifunctional display".

"engine running" simulation Some components of the climate control system can only operate if the engine is running. A "engine running" simulation program allows you to activate these components without the engine actually running. To activate this program, see "Passenger compartment control system: to activate the "engine running" simulation".

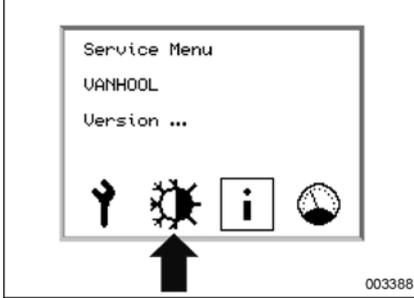
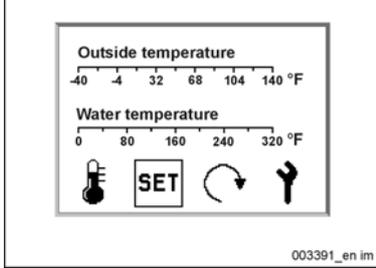
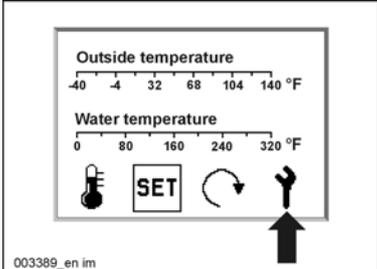
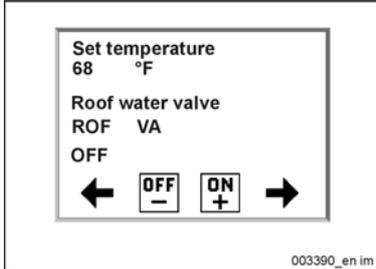
NOTE: It is not recommended to use the climate control system fans during the "engine running" simulation, unless there good reasons for doing so. This will avoid putting a load on the batteries and draining them.

To check equipment operation You can use the test program to activate equipment yourself to determine how it responds to control signals.

NOTE: If you use the "engine running" simulation to activate the electromagnetic clutch of the climate-control compressor, do so only for a short time while an assistant checks that the clutch responds. If it remains activated for too long, the electromagnet will overheat.

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display. 

continued on next page

Step	Action	Result
<p>2</p>	<p>Press the button under the climate control symbol.</p> 	<p>The climate control menu appears on the display.</p> 
<p>3</p>	<p>Press the button under the wrench symbol.</p> 	<p>The following will appear on the display:</p> <ul style="list-style-type: none"> • set temperature; • equipment description; • equipment code; • equipment condition. 
<p>4</p>	<p>Change the equipment status by pressing the button under "OFF" or "ON".</p>	<p>Check if the activated equipment responds to the status change.</p> <p><i>NOTE: The component will remain in the new status until you change it again or exit the service menu.</i></p>
<p>5</p>	<p>Press the button under the left or right arrow to navigate to the next or previous item of equipment.</p>	<p>See step 3.</p>
<p>6</p>	<p>Repeat steps 4 and 5 until all equipment has been checked.</p> <p><i>NOTE: See further on for the equipment sequence.</i></p>	

continued on next page

**Equipment
sequence on
the display**

Abbreviation	Component
ROF VA	Valve controlling hot water metering valve of roof heaters
CNV VA	Valve controlling hot water metering valve of floor heaters/convectors (if fitted)
CIRC	Water circulating pump
GAS CH	CLU, COND, EVAP1 and EVAP2 (only on vehicles with interior cooling)
CLU	Climate control compressor clutch (only on vehicles with interior cooling)
COND	Condenser fans (only on vehicles with interior cooling)
EVAP1	Roof heater fans ("low" speed)
EVAP2	Roof heater fans ("medium" speed)
EVAP3	Roof heater fans ("high" speed)
RF FSH	Inside/outside air selection flap
CNV 1	Floor heater fans ("low" speed)
CNV 2	Floor heater fans ("high" speed)
CAP VA	Climate-control compressor capacity control (only on vehicles with interior cooling)

**To exit test
program**

Momentarily press the far left button under the multifunctional display as many times as necessary to return to the service menu.

Passenger compartment control system: to activate the "engine running" simulation

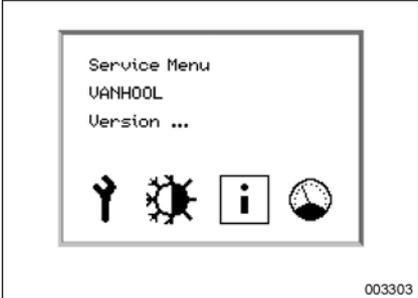
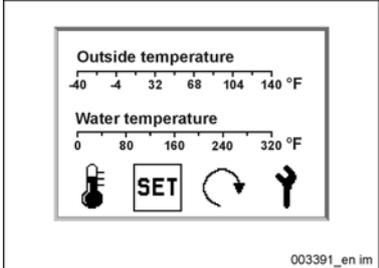
Equipment condition

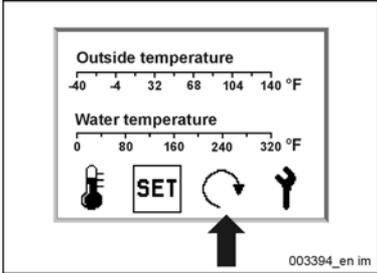
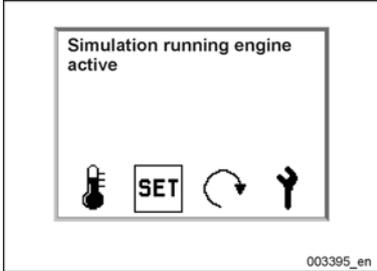
- Engine off
- Battery isolating switch on

To operate the multifunctional display

For more information on how to scroll through menus and to select functions in the service menu of the multifunctional display, see chapter 11.1: "To operate the multifunctional display".

Procedure

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the climate control symbol.  003388	The climate control menu appears on the display.  003391_en im

Step	Action	Result
3	<p>Press the button under the symbol for "engine running" simulation.</p>  <p>003394_en im</p>	<p>The message that the simulation has been activated is shown for 5 seconds on the display. An indicator light next to the dashboard revolution counter pointer comes on.</p>  <p>003395_en</p>

To end the simulation

Repeat steps 2 and 3 of the simulation activating procedure.

NOTE: The simulation also ends as soon as you exit the service menu.

To exit the climate control menu

Momentarily press the far left button under the multifunctional display as many times as necessary to return to the service menu.

Passenger compartment control system: to call up temperatures

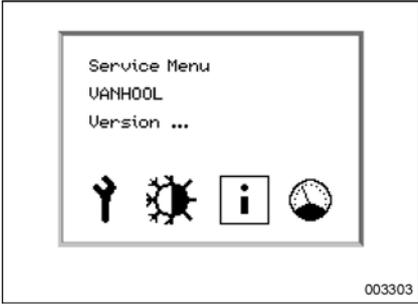
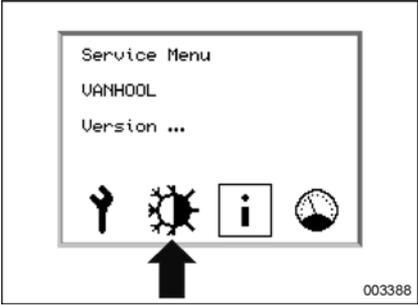
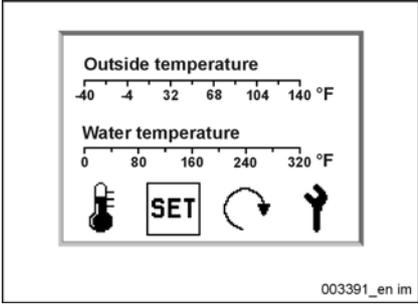
Equipment condition

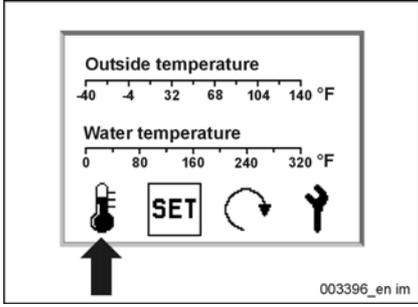
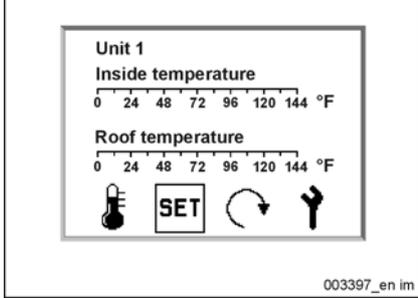
Battery isolating switch on

To operate the multifunctional display

For more information on how to scroll through menus and to select functions in the service menu of the multifunctional display, see chapter 11.1: "To operate the multifunctional display".

Procedure

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display. 
2	Press the button under the climate control symbol. 	The climate control menu appears on the display: outside and coolant temperatures are displayed. 

Step	Action	Result
3	<p>Press the button under the symbol for calling up inside and duct temperatures.</p> 	<p>The inside and duct temperatures are shown on the display.</p> 
4	<p>Press the button under the same symbol once again, to call up the inside and duct temperatures of the next control unit of the climate-control system (dependent on the vehicle type).</p>	<p>See step 3.</p>

To close the temperature adjustment menu

Briefly press the far left button under the multifunctional display as many times as necessary to return to the service menu.

Passenger compartment control system: to set temperature

To be carried out when?

- If you think the interior temperature is too high, too low or ...
- after installing a new Kibes computer module.

Equipment condition

Battery isolating switch on

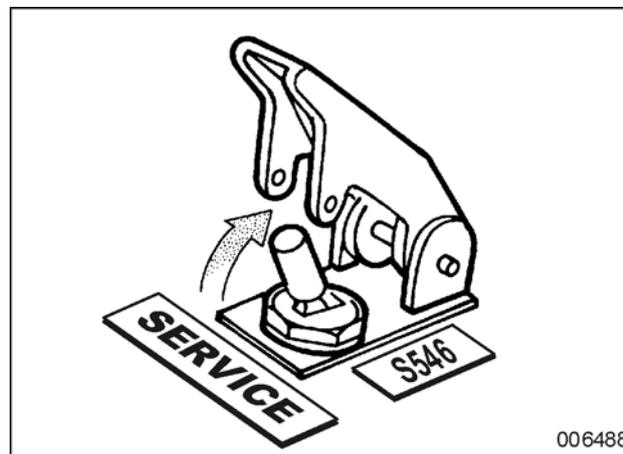
To operate the multifunctional display

For more information on how to scroll through menus and to select functions in the service menu of the multifunctional display, see chapter 11.1, under "To operate the multifunctional display".

"Service" switch (only for regular service buses)

In the junction box in the cab ceiling, there is a service switch (with identification plate S546). You need this to unlock the temperature control for operation.

Figure: "Service" switch

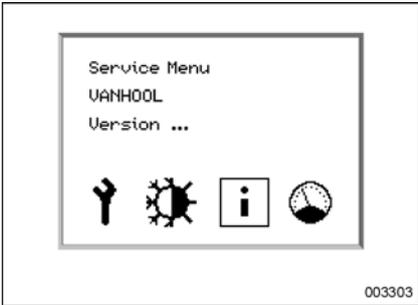
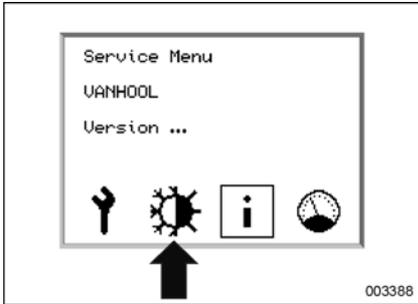
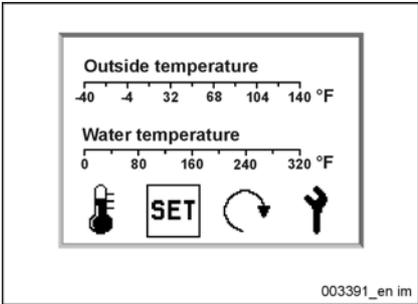
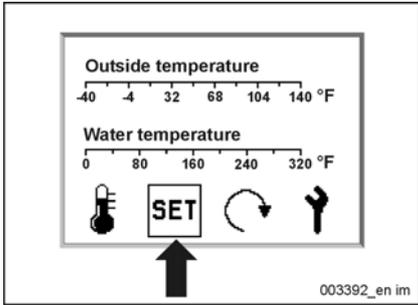
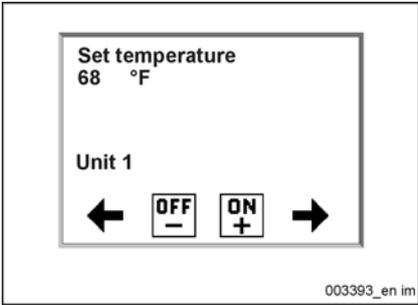


WARNING!

Danger of accidents. When operating the service switch (S546), some safety functions of the vehicle are switched off.

continued on next page

Procedure

Step	Action	Result
1	Only for regular service buses: tip the handle of the "Service" switch momentarily as far as it will go against spring pressure.	The temperature control is now unlocked. <i>NOTE: Some vehicle safety functions have now been switched off.</i>
2	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display. 
3	Press the button under the climate control symbol. 	The climate control menu appears on the display. 
4	Press the button under the "SET" symbol. 	The temperature adjustment menu appears on the display. 

continued on next page

Step	Action	Result
5	Press the button under: <ul style="list-style-type: none"> • “-” to decrease the set temperature; • “+” to increase the set temperature; 	Temperature rendering on the display changes.
6	Push the button under the left-hand or right-hand arrow to go to the next or previous control unit of the climate control system (dependent on the type of vehicle).	

To exit the temperature adjustment menu

Momentarily press the far left button under the multifunctional display as many times as necessary to return to the service menu.

After setting the temperature of the passenger compartment on a transit bus

After having set the temperature of the passenger compartment, see to it that the safety functions that you have switched off by means of the "Service" switch (S546) are switched back on.

Step	Action
1	Press and hold the far left button under the multifunctional display for longer than 5 seconds. The service menu closes.
2	Switch off the electrical battery switch and wait until the on-board voltage is cut off. The battery relay is now switched off. If the battery switch is consequently switched on, the multiplex system will again cut in the safety functions that you had switched off by means of the "Service" switch.

Passenger compartment control system: to check temperature sensors

Introduction

The control system contains three temperature sensors: one for interior temperature, one for duct temperature and one for outside temperature.

Sensor type

The temperature sensors are of the NTC type (negative temperature coefficient) with a resistance of 4 700 ohms at 77°F. NTC means that resistance decreases, as temperature increases.

To check sensor

When in doubt whether sensor is okay, you can check it with the resistances given in the table.

Temperature (°F)	Resistance (ohms)
-40	191541
-31	134029
-22	95172
-13	68520
-4	49975
5	36898
14	27559
23	20809
32	15874
41	12228
50	9507
59	7456
68	5896
77	4700
86	3774
95	3052
104	2485
113	2037
122	1679
131	1393
140	1162
149	974
158	821

continued on next page

Temperature (°F)	Resistance (ohms)
167	696

Technical data: control system

Driver's cab climate- control system

Outlet-air temperature sensor G118	NTC resistance with a value of 4700 ohm at 77°F.
------------------------------------	--

Passenger- compartment climate- control system

Outside-air temperature sensor G103	NTC resistance with a value of 4700 ohm at 77°F.
Interior-air temperature sensor G101	NTC resistance with a value of 4700 ohm at 77°F.
Duct-air temperature sensor G122	NTC resistance with a value of 4700 ohm at 77°F.

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Chapter 6: Airside systems

Overview

Introduction This chapter deals with the airside systems.

Number of pages 6

Chapter publication date 19 September 2006

Contents

Topic	See page
To check/clean filter cloth of climate-control units	8.6-2
To remove filter cloth of driver's compartment climate-control unit	8.6-4
To remove filter cloth of passenger compartment climate-control units	8.6-5

To check/clean filter cloth of climate-control units

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

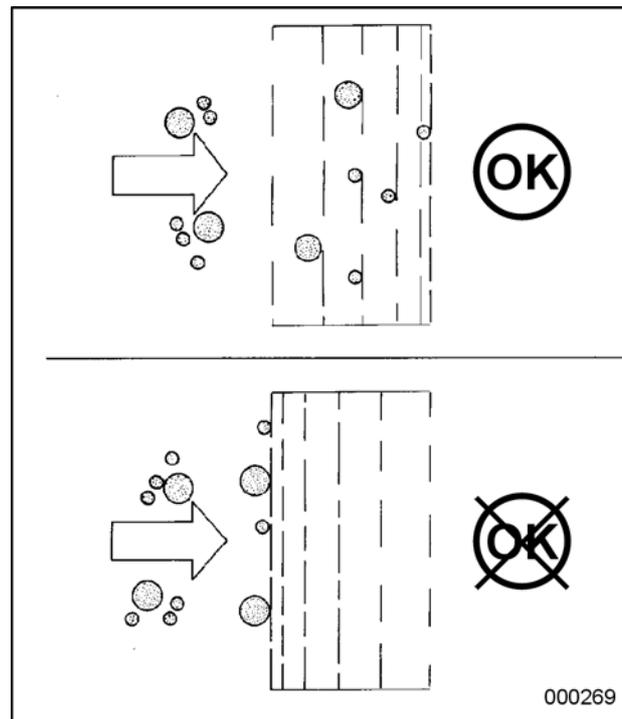
General

- The filter cloth has to be in front of the air-inlet opening of the heat exchangers at all times, otherwise dirt will collect between the strips of the heat exchanger and on the fans.
- If the cloth gets too dirty, system problems due to inadequate air flow will arise.

Installation direction of filter cloth

Some filter cloths have a coarsely woven side and a tightly woven side. With this kind of filter cloths the coarsely woven side has to face the air-inlet side at all times. If reversed, the filter will not work in terms of depth: in that case dirt will remain on the tightly woven surface and soon block the air passage (see figure).

Figure: schematic cross-section of filter material



Proper and improper direction of air flow

To clean filter cloth

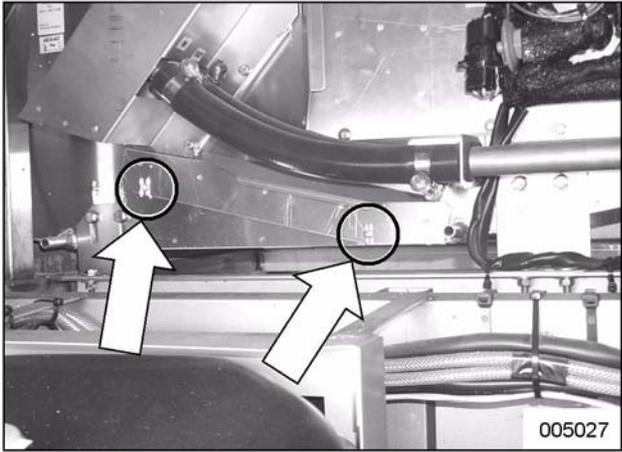
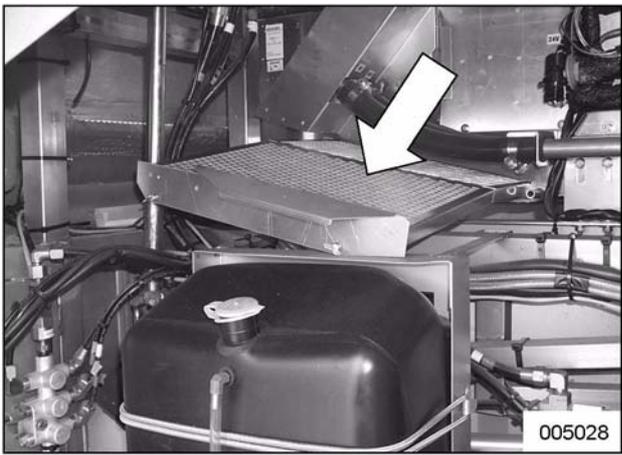
Step	Action
1	Remove filter cloth from climate-control unit.
2	Shake out cloth.
3	Wash cloth in lukewarm water. If heavily soiled, add mild detergent to water.
4	Rinse cloth thoroughly.
5	Allow cloth to dry completely before using. Do not wring it out; do not blow dry with compressed air.

To install filter cloth

Re-install cloth (procedure for removing filter cloth in reverse order).
Take care that new or cleaned filter cloth covers entire air flow opening.
Never install a cloth that is too small or damaged.

To remove filter cloth of driver's compartment climate-control unit

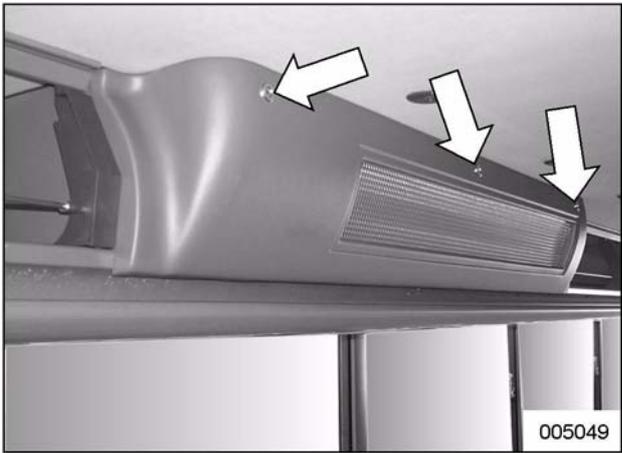
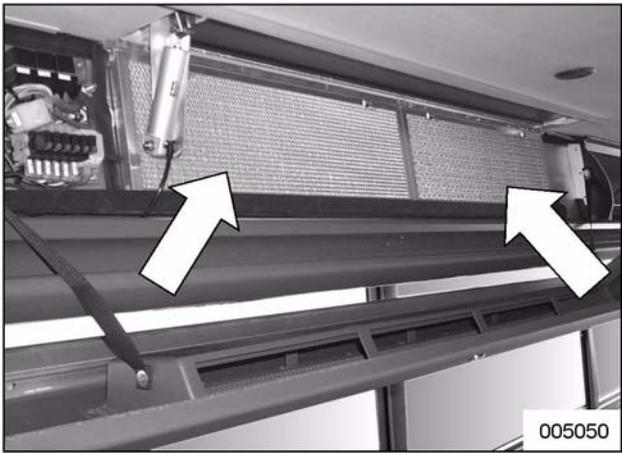
Procedure

Step	Action
1	Open exterior door on left-hand side at the very front.
2	Turn the two quick-release screws of the filter frame a quarter of a turn counterclockwise. 
3	Pull filter frame out of climate-control unit. 
4	Remove filter cloth from frame.

To remove filter cloth of passenger compartment climate-control units

Procedure

Carry out the work for the climate-control units in the left- and right-hand roof duct (two filters per climate-control unit)

Step	Action
1	Turn the three square locks of access plate to filters counter-clockwise by a quarter of a turn.  005049
2	Remove access plate and lower it slowly, until supported by safety straps.
3	Remove filters.  005050

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Chapter 10: Water circuit

Overview

Introduction This chapter deals with the water circuit.

Number of pages 10

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety instructions with respect to the water circuit	8.10-2
Protection against frost, deposits and corrosion	8.10-4
To operate interior heating circuit isolating valves	8.10-5
To check water circulating pump for leaks	8.10-6
To check condition of water hoses	8.10-7
Hose clamp types	8.10-8
To check hose clamps tightening torque	8.10-9

Safety instructions with respect to the water circuit

**WARNING!**

Antifreeze and coolant with antifreeze contain the toxic chemical ethylene glycol. Hazardous for ingestion or inhalation of fumes. Causes irritation upon contact with the eyes. In the event of ingestion, have a first-aider cause the victim to vomit (if conscious); in the event of inhalation, move the victim into the open air. Seek medical assistance in both cases. In the event of contact with the eyes, rinse the eyes with ample water. If eye irritation develops, consult an eye doctor.

**WARNING!**

Fleetguard DCA4 contains alkaline. Take care that it does not get into your eyes. In the event of contact with the eyes, rinse the eyes with ample water for at least 15 minutes. Seek medical assistance. Avoid prolonged or repeated contact with the skin. In the event of contact, wash the skin with soap and water immediately. Keep out of children's reach.

**WARNING!**

Never open the coolant expansion tank filler cap or pressure relief cap if the coolant temperature gauge indicates more than 122 °F. The pressure could cause hot water to squirt outward and cause scalds.

**WARNING!**

If the expansion tank filler cap or pressure relief cap has to be opened, first turn it carefully counterclockwise to the first stop and let the pressure escape. Then turn to the second stop and remove the cap.

**CAUTION!**

Never add cold coolant, when the engine is hot. The sudden cooling could cause parts of the engine block to crack.

Protection against frost, deposits and corrosion

**Cross-
reference**

Refer to chapter 2.34, "Cooling system".

To operate interior heating circuit isolating valves

Purpose of isolating valves

Two manual shut-off valves in water pipes allow engine cooling system to be completely isolated from heating system if required.

Location of isolating valves

For location of isolating valves, refer to "Access doors and controls at the outside".



CAUTION!

There is no objection against the vehicle being driven with isolating valves closed, but on no account must heating system be switched on in this condition.

To close isolating valves

Step	Action
1	Turn handle of isolating valve in supply line of interior heating system clockwise until handle is square to pipe.
2	Turn handle of isolating valve in return line of interior heating system clockwise until handle is square to pipe.

To open isolating valves

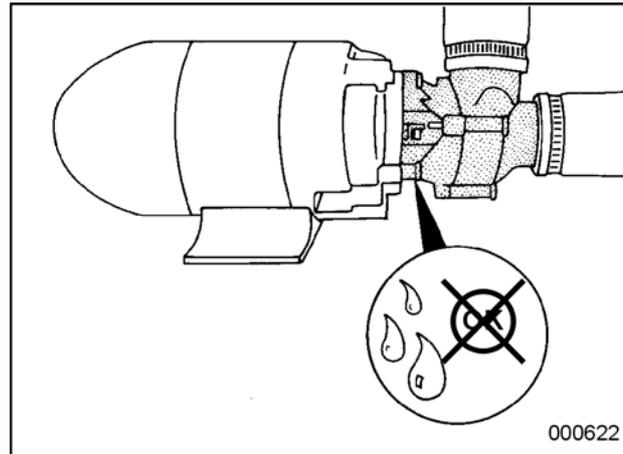
Step	Action
1	Turn handle of isolating valve in supply line of interior heating system counterclockwise until handle is in line with pipe.
2	Turn handle of isolating valve in return line of interior heating system counterclockwise until handle is in line with pipe.

To check water circulating pump for leaks

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure: to check water circulating pump for leaks



Pump gland ok?

If...	then ...
the gland of the pump leaks more than one drop of water per second	you need to replace the gland.

To check condition of water hoses

**Cross-
reference**

Refer to chapter 2.34, "Cooling system".

Hose clamp types

**Cross-
reference**

Refer to chapter 2.34, "Cooling system".

To check hose clamps tightening torque

**Cross-
reference**

Refer to chapter 2.34, "Cooling system".

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Chapter 14: Refrigerant circuit

Overview

Introduction This chapter deals with the refrigerant circuit.

Number of pages 38

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety instructions when working on refrigerant circuit	8.14-3
Operation	8.14-4
To connect pressure gauge set	8.14-6
To disconnect pressure gauge set	8.14-9
To check refrigerant charge	8.14-12
To add refrigerant	8.14-15
To flush refrigerant circuit	8.14-16
Climate-control compressor: general	8.14-17
Climate-control compressor: capacity control	8.14-18
Climate-control compressor: oil level check	8.14-19
Climate-control compressor: to add oil	8.14-20
To replace the climate-control compressor	8.14-21
Climate-control compressor: electromagnetic clutch	8.14-22
Climate-control compressor: to activate clutch during cold season.	8.14-23
Evaporators	8.14-25
Condenser	8.14-26
To change filter/dryer	8.14-27
Thermostatic expansion valve: general	8.14-29
Service valves: general	8.14-32
Solenoid shut-off valves	8.14-34
Pressure switches	8.14-35
Technical data of refrigerant circuit	8.14-37

continued on next page

Safety instructions when working on refrigerant circuit

**WARNING!**

Maintenance and repair works should only be carried out by a refrigeration technician.

**WARNING!**

The refrigerant circuit is pressurised.

**WARNING!**

Never work with refrigerant in a confined space or near an open fire.

**WARNING!**

Make sure that your eyes and skin do not come in contact with the refrigerant. In the event of contact with the eyes, rinse the eyes with ample water. In the event of contact with skin, apply pure vaseline to the affected spot. Always consult a physician.

Operation

General

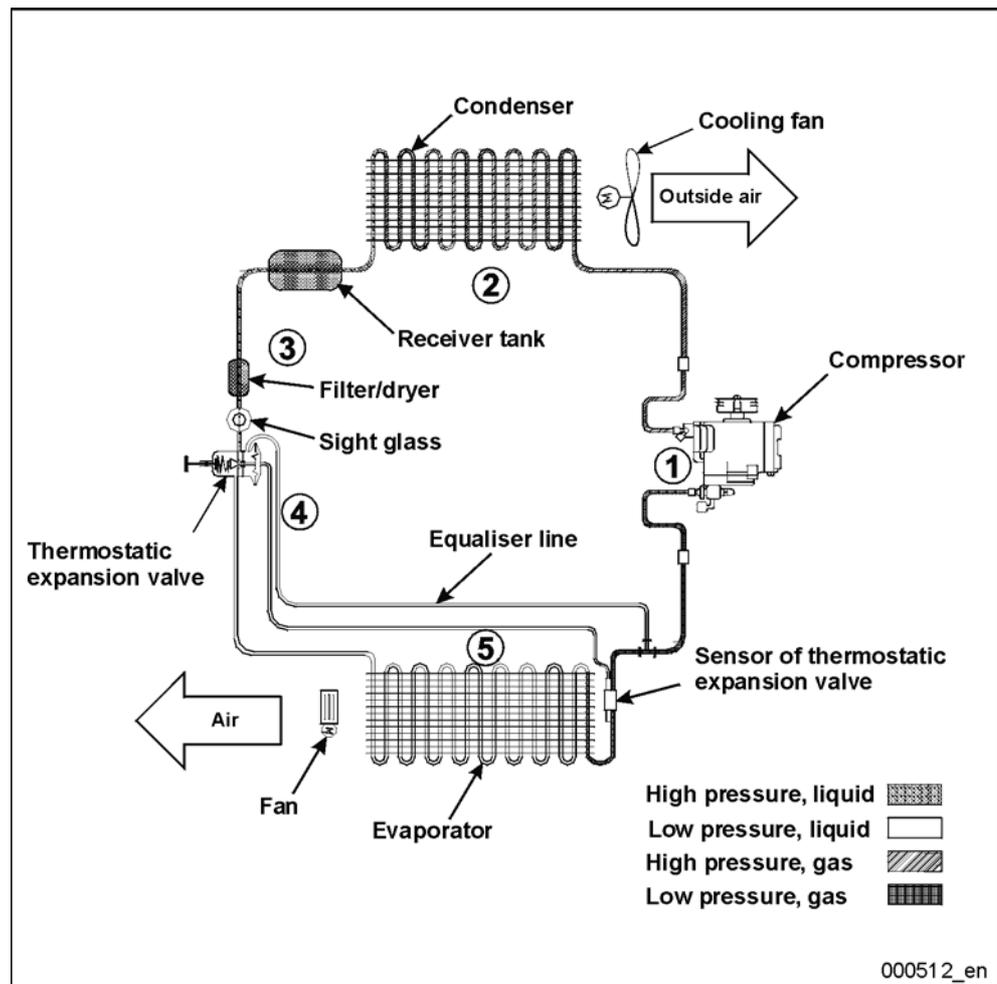
In the event of outside temperatures higher than 68 °F, the desired inside temperature can only be achieved by refrigerating the air. The climate control system must therefore contain a refrigerant system, which reduces the temperature of the air supply.

Refrigerants

The refrigerant acts as a means of conveyance that takes away heat on one place in the system by evaporating it and gives off this heat by condensing it on another place. No chemical changes occur during this process.

The refrigerant used in your vehicle is R-134a (tetrafluoroethane, which does not damage the ozone layer).

Figure:
cooling cycle



Cooling cycle

Phase	Name	Description
1	Compression	The gaseous refrigerant is compressed into the compressor. This causes both the pressure and the temperature of the gas to rise.
2	Cooling	In the condenser, the gas gives off heat to the surrounding air and condenses into a liquid. <i>NOTE: Cooling can be speeded with fans</i>
3	Storage	The liquid refrigerant is stored in the receiver tank. It remains in this tank, until the evaporator requires refrigerant.
4	Filtration/drying	Humidity and dirt are caught in the filter/dryer.
5	Flow control	The thermostatic expansion valve permits just enough liquid refrigerant to flow to the evaporator. Here the temperature and pressure of the liquid refrigerant decline, and a part of the refrigerant takes on a gaseous form.
6	Evaporation	The partially liquid and partially gaseous refrigerant, which has a lower pressure and temperature, flows to the evaporator. The refrigerant continues to evaporate by extracting heat from the air flow, which passes through the evaporator coil. All the liquid refrigerant is converted into a gaseous form in the evaporator, and only the warmed gaseous refrigerant flows to the compressor.

To connect pressure gauge set

Introduction

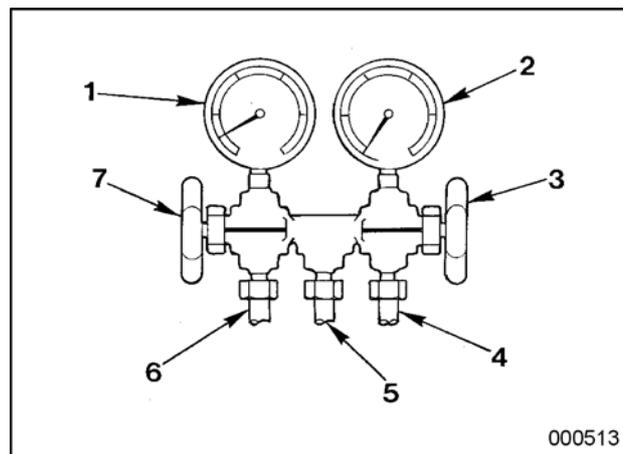
The pressure gauge set is used for measuring the suction and discharge pressure of the refrigerant system. In combination with other tools, maintenance tasks can also be carried out with it.



CAUTION!

The hoses of the pressure gauge set must be vacuumed, after they have been connected to the installation. Otherwise the installation will be contaminated by the air and the humidity in the hoses.

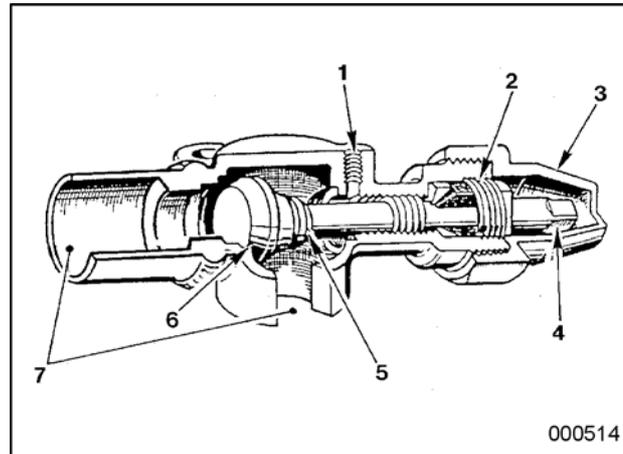
Figure:
pressure
gauge set



- 1 Low-pressure gauge
- 2 High-pressure gauge
- 3 High-pressure cock
- 4 High-pressure hose
- 5 Center hose
- 6 Low-pressure hose
- 7 Low-pressure cock

000513

Figure: service valve



- 1 Service connection
- 2 Gland
- 3 Protective cap
- 4 Stem
- 5 Rear valve seat
- 6 Front valve seat
- 7 Inlet or outlet (depending on application)

Location of climate-control compressor service valves

Refer to "Climate-control compressor: general"

Preliminary operations

Step	Action
1	Clean the area surrounding the two service valves on the climate-control compressor.
2	Close the cocks of the pressure gauge set (clockwise, as far as it will go).
3	Remove protective cap (3) from the service valve and turn stem (4) counterclockwise until the stop is reached. Connection (1) is now isolated from the refrigerant circuit.
4	Repeat step 3 with the other service valve.
5	Remove the protective cap from service connection (1) on both service valves.

continued on next page

What happens with the center hose?

If...	then ...
you only have to check the suction and the discharge pressure of the refrigerant system.	you leave the cocks of the pressure gauge set closed and do not connect the center hose to the set.
you carry out other tasks	you connect the center hose to the equipment, which is required for carrying out your tasks.

To connect pressure gauge set

Step	Action	Result
1	Connect the high-pressure hose of the pressure gauge set to service connection (1) at the "discharge side" service valve.	
2	Connect the low-pressure hose of the pressure gauge set to service connection (1) at the "suction side" service valve.	
3	Turn the stem of both service valves half a turn in a clockwise direction, so that the service connections are connected to the refrigerant circuit.	The gauges of the set should now indicate pressure.
4	Connect a receiving cylinder to the center hose of the pressure gauge set.	
5	Open the high-pressure cock of the pressure gauge set.	The air in the high-pressure hose flows to the receiving cylinder, together with a small quantity of refrigerant.
6	Close the high-pressure cock of the pressure gauge set.	The high-pressure hose is now deaerated.
7	Open the low-pressure cock of the pressure gauge set.	The air in the low-pressure hose flows to the receiving cylinder, together with a small quantity of refrigerant.
8	Close the low-pressure cock of the pressure gauge set.	The low-pressure hose is now deaerated.

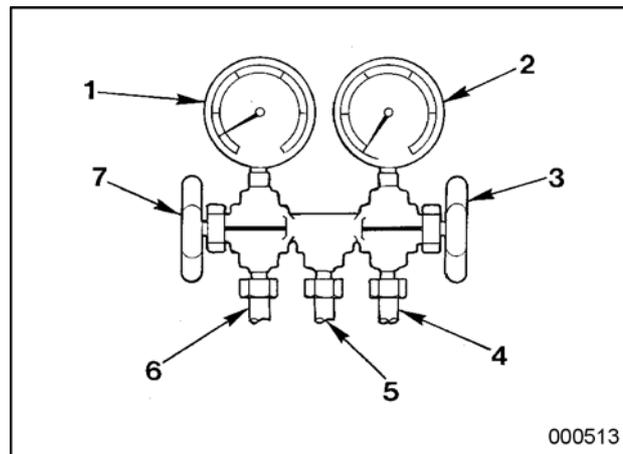
To disconnect pressure gauge set



CAUTION!

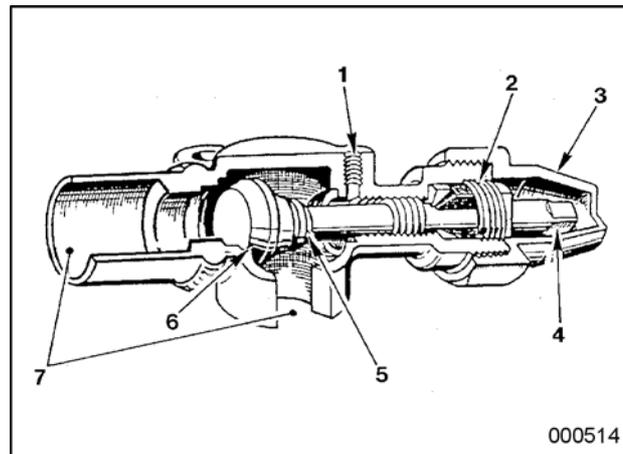
The hoses of the pressure gauge set must be emptied before they are disconnected, to prevent that refrigerant escapes.

Figure:
pressure
gauge set



- 1 Low-pressure gauge
- 2 High-pressure gauge
- 3 High-pressure cock
- 4 High-pressure hose
- 5 Center hose
- 6 Low-pressure hose
- 7 Low-pressure cock

Figure: service valve



- 1 Service connection
- 2 Gland
- 3 Protective cap
- 4 Stem
- 5 Rear valve seat
- 6 Front valve seat
- 7 Inlet or outlet (depending on application)

To disconnect pressure gauge set

Phase	Action	Result
1	Turn stem (4) of the service valve counterclockwise as far as it will go. Do this for both the service valves.	Service connection (1) is now isolated from the refrigerant circuit.
2	Close the cocks of the pressure gauge set by turning them clockwise as far as they will go.	
3	Connect a vacuum pump with a receiving cylinder to the center hose of the pressure gauge set.	
4	Open the high-pressure cock of the pressure gauge set.	The vacuum pump sucks the refrigerant out of the high-pressure hose into the receiving cylinder.
5	Close the high-pressure cock of the pressure gauge set.	The high-pressure hose is now empty.

continued on next page

Phase	Action	Result
6	Open the low-pressure cock of the pressure gauge set.	The vacuum pump sucks the refrigerant out of the low-pressure hose into the receiving cylinder.
7	Close the low-pressure cock of the pressure gauge set.	The low-pressure hose is now empty.
8	Disconnect the low- and high-pressure hoses of the pressure gauge set from the climate-control compressor service valves.	
9	Disconnect the center hose of the pressure gauge set from the vacuum pump.	
10	Mount the protective caps on the service valves.	

To check refrigerant charge

To be carried out when?

Refer to chapter 1.1, "Climate-control system maintenance schedule".

Equipment condition

- Pressure gauge set connected, refer to "To connect pressure gauge set".
- Outside temperature higher than 25°F.

Preparation of check

Step	Action
1	Disconnect the connectors of the capacity control valves. This prevents the capacity control from coming in operation during one of the following steps. For the location of the control valves of the capacity control, refer to "Climate-control compressor: capacity control".
2	Check the contamination of the filter cloths. If necessary, clean or replace filter cloths. Reinstall the access plates to the filters.
3	Start engine and let it run at approximately 1 200 to 1 300 rpm.
4	Set a temperature of 78°F with the dashswitch; refer to "To operate the passenger compartment climate control".
5	Set the air outlet temperature from the driver's cab climate unit to minimum.
6	Set the fan speed of the driver's cab climate unit to maximum.
7	Put the passenger compartment climate control system in the "EVAP3" state. Follow the instructions included in "Passenger compartment control system: to troubleshoot using the multifunctional display".
8	Have the climate control (that of the driver's cab as well as that of the passenger compartment) operate with 100% inside air.
9	Wait until the temperature in the vehicle is 74 to 78°F.
10	Read the high-pressure gauge on the pressure gauge set. The gauge should indicate a pressure of 174 to 203 psi.

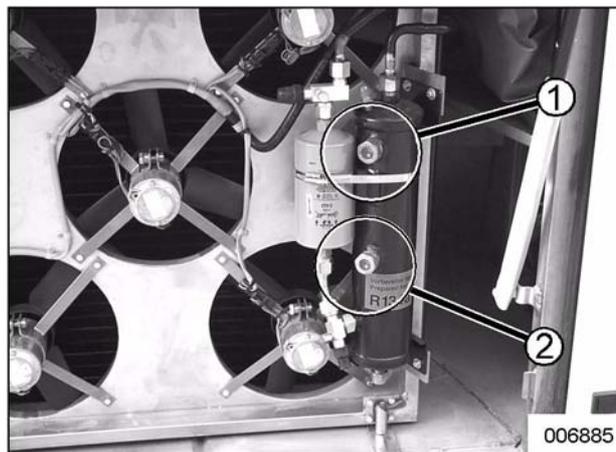
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Step	Action
11	<p>If necessary, increase the pressure by disconnecting one or more on the condenser fans (disconnect connector).</p> <p>If various fans have to be switched off, do this in a way that the condenser is cooled evenly from top to bottom. To ensure that the liquid subcooler at the top of the condenser is sufficiently cooled, leave at least one of the two upper condenser fans connected.</p> <p><i>NOTE: An excessive discharge pressure can be caused by too much refrigerant, or by air in the installation.</i></p>

Waiting time

Make sure that the test conditions in steps 3, 9 and 10, which are described under "Preparation of check", are maintained for 20 minutes.

Figure: sight-glasses



In climate-control condenser compartment

Check

Carry out the check 20 minutes after "Preparation of check".

Step	Action
1	<p>Inspect the sight-glasses of the refrigerant circuit.</p> <ul style="list-style-type: none"> • Too little refrigerant: the ball of the lower sight-glass is not at the top. • Sufficient refrigerant: the ball of the lower sight-glass is at the top and the ball of the upper sight-glass is not floating. • Too much refrigerant: the ball of the lower sight-glass is at the top and the ball of the upper sight-glass is floating.
2	<p>If necessary, add refrigerant (refer to "To add refrigerant").</p>

continued on next page

Step	Action
3	Reconnect the disconnected condensor fans and the pilot valves of the capacity control.
4	Disconnect the pressure gauge set; refer to "To disconnect the pressure gauge set".

To add refrigerant

**Equipment
condition**

Steps mentioned under "To check refrigerant charge" carried out.

Procedure

Step	Action
1	Connect the center hose of the pressure gauge set to a charging cylinder.
2	Open the cock of the charging cylinder.
3	Loosen the union nut of the center hose just below the gauge set to purge the hose. Tighten the union nut after purging.
4	Open the low-pressure cock of the pressure gauge set a little. Refrigerant flows from the charging cylinder to the system.
5	Close the low pressure cock of the pressure gauge set if the circuit is properly charged; refer to "To check refrigerant charge".

To flush refrigerant circuit

Introduction

"Flushing" means the removal of air and other contaminations from the installation. This is performed by blowing nitrogen through the system.

Climate-control compressor: general

Drive

The vehicle engine drives the refrigerant compressor by means of two belts and a disconnectable clutch.

Refer to chapter 2.46 "Accessory drive system" for more information about the belt drive.

Compressor oil

The compressor circulates an amount of compressor oil together with the refrigerant.

It has hardly any disadvantageous influence on the system if the amount of oil which is brought in the refrigerant circuit by the compressor is very small. It is even good because the compressor valves will be lubricated.

On the other hand, the following problems can occur if a too large amount of oil circulates in the system:

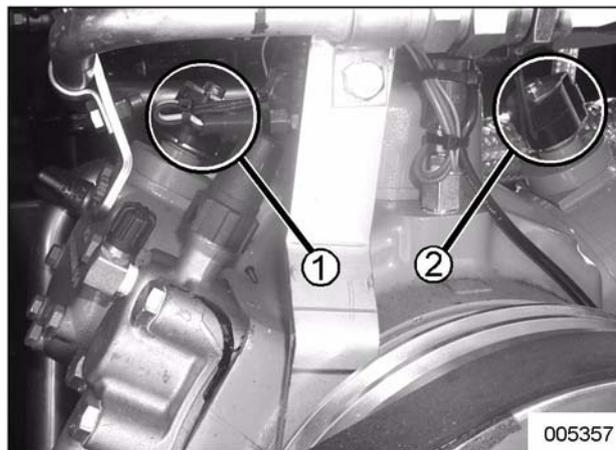
- Because oil is withdrawn from the compressor sump, lubrication of the compressor can be insufficient. The compressor can seize.
 - The amount of oil which circulates with the refrigerant is not constant. The oil can accumulate in the evaporator, which can cause a sudden release of a large amount of oil to the compressor. Oil that is accumulated in the evaporator reduces the heat transfer whereby the cooling capacity reduces.
-

Climate-control compressor: capacity control

Introduction

As its operation requires a lot of energy and it is not always necessary to have it operating at full capacity, the climate-control compressor has been equipped with a capacity control. The main components of this control are two pressure switches (DK102.1 and DK103) and two electromagnetic pilot valves (V139 and V140) on the climate-control compressor.

Figure: pilot valves of capacity control



- 1 Pilot valve V139 of capacity control
2 Pilot valve V140 of capacity control

Pilot valve V139 of capacity control

V139 is switched on by pressure switch DK102.1 or DK103.

When pilot valve V139 is energized, two of the six cylinders of the climate-control compressor are switched off.

Pilot valve V140 of capacity control

V140 is switched on if the interior temperature is lower than the set temperature + 4°F ($T_i < T_{set} + 4^\circ\text{F}$).

When pilot valve V140 is energized, two of the six cylinders of the climate-control compressor are switched off.

Pressure switches

Refer to "Pressure switches" in chapter 8.14.

Climate-control compressor: oil level check

To be carried out when?

Refer to chapter 1.1, "Climate-control system maintenance schedule".

Correct oil level

The oil level must be between the "MIN" and "MAX" mark.

Figure: oil level sight-glass



There is a sight-glass at the left-hand and right-hand side.

Procedure

Step	Action
1	Start the engine.
2	Put the climate-control system in the "GAS CH" state. Follow the instructions included in "Passenger compartment control system: to troubleshoot using the multifunctional display".
3	Turn off the engine after 20 minutes.
4	Check the oil level within 30 seconds.

Climate-control compressor: to add oil

Oil type Refer to chapter 1.1, "Fluids and lubricants".

General The compressor does not consume oil. Nevertheless, if it is necessary to add oil, this usually means that there is a leak in the refrigerant circuit. Check the refrigerant circuit for leaks first.

To add oil

Step	Action
1	Turn the stem of the "suction side" service valve counterclockwise as far as it will go. The "suction side" service valve is closed.
2	Turn the cocks of the pressure gauge set fully clockwise. The cocks are closed.
3	Fill the low-pressure hose and the center hose of the pressure gauge set with oil.
4	Connect the low-pressure hose of the pressure gauge set to the service connection of the "suction side" service valve.
5	Immerse the loose end of the center hose in a can with 1 gallon of compressor oil.
6	Turn the stem of the "suction side" service valve clockwise as far as it will go. The service connection is now connected to the refrigerant circuit.
7	Start the engine.
8	Let the compressor run until the low-pressure switch cuts out the compressor clutch.
9	Shut off the engine.
10	Open the low-pressure cock of the pressure gauge set a little. The oil is sucked into the compressor.
11	Close the low-pressure cock when the correct oil level is reached.
12	Turn the stem of the "suction side" service valve counterclockwise as far as it will go. The service connection is now isolated from the refrigerant circuit.

To replace the climate-control compressor



WARNING!

The refrigerant circuit is pressurised. First relieve the pressure, before you carry out any works on the compressor. Also see to it that no one can start the engine.

Dirt and humidity

The main enemies of a refrigerant system are dirt and humidity. During the installation of a new compressor, the protective gas must remain in the compressor as long as possible. Then take the necessary measures for protecting the compressor against dirt and humidity.

How much oil in the new compressor?

When changing the compressor, the new compressor must be taken into operation with the same quantity of oil as the quantity present in the removed compressor. New compressors are usually supplied with a standard quantity of oil; you will therefore probably have to remove a certain quantity of oil from the compressor.

Climate-control compressor: electromagnetic clutch

Compressor clutch V141

An electromagnetic clutch is applied for switching the connection between the engine and the compressor on and off.

The stator, the rotor with a belt pulley and the pressure plate are the primary components. The stator is fixed to the compressor housing and the pressure plate is mounted on the compressor shaft.

The belt pulley always rotates when the engine is running because it is connected to the engine crankshaft by means of drive belts. But the compressor only begins to operate, when the electromagnetic clutch is energised. Whenever cooling is required, the control unit sends an electrical current to the magnetic coil. The electromagnet pulls the pressure plate against the friction plates of the belt pulley. Due to the friction between the plates, the clutch components will rotate as a whole and drive the compressor.

When does the clutch cut in?

NOTE: The clutch only cuts in when the on-board voltage is higher than 21.6 V and the compressed-air system is pressurised.

The clutch cuts in if:

- outside temperature exceeds 25°F and...
- the roof-heating metering valve is closed for more than 40 % of the time.

NOTE: Pressure switches DK101 or DK102.2 switch the clutch off if the pressure in the refrigerant circuit becomes too low or too high.

Climate-control compressor: to activate clutch during cold season.

Introduction

Because the climate-control compressor does not run, or runs only very little during the cold season, you must activate the electric clutch of the climate-control compressor regularly to prevent drying out of the crankshaft seal.

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment condition

- Outside temperature higher than 32 °F
- Warm engine

Procedure



CAUTION!

To prevent damage to the climate-control compressor, do not carry out these works at an outside temperature lower than 32 °F. If necessary, place the vehicle in a heated workshop.

Step	Action
1	Start the engine.
2	Open the metering valve (ROF VA) in the hot water supply line to the roof heaters. Follow the instructions included in "Passenger compartment control system: to troubleshoot using the multifunctional display" in chapter 8.2.
3	Open the metering valve (CNV VA) in the hot water supply line to the convectors/interior heaters (if installed). Follow the instructions included in "Passenger compartment control system: to troubleshoot using the multifunctional display" in chapter 8.2.
4	Make sure that the water circulation pump (CIRC) of the heating circuit has been activated. Follow the instructions included in "Passenger compartment control system: to troubleshoot using the multifunctional display" in chapter 8.2.
5	Set the temperature of the air outlet from the climate unit in the cab to maximum.
6	Set the speed of the fan in the climate unit in the cab to maximum.
7	Wait until the temperature in the vehicle is above 72 °F. <i>NOTE: This temperature can be reached more quickly, if you additionally switch on the coolant heater (if installed).</i>

continued on next page

Step	Action
8	<p>Put the climate control in the "GAS CH" state. Follow the instructions included in "Passenger compartment control system: to troubleshoot using the multifunctional display".</p> <p>The clutch of the climate-control compressor is activated.</p>
9	<p> WARNING!</p> <p>The engine turns! Keep your distance from turning parts.</p> <p>Check that the core of the electric clutch turns along with the belt pulley. This confirms that the electric clutch is switched on.</p>
10	<p>Turn off the engine after 15 minutes.</p>
11	<p>Switch off the battery isolating switch.</p> <p>The electronics of the climate-control system return to automatic mode.</p>

Evaporators

Introduction

The refrigerant evaporates in the evaporator unit by absorbing heat from the surroundings.

The passenger compartment is cooled by two evaporators in the roof ducts. The cab is cooled by an evaporator in the climate-control unit of the cab.

Condenser

Introduction

The hot refrigerant gas, which has been compressed by the compressor, is cooled in the condenser until it becomes a fluid.

Fans speed up the heat exchange in the condensor.

To clean the condensor externally



WARNING!

Wear a dust mask, when cleaning with compressed air.

Check the condensor regularly for contamination (leaves, dust, ...). . If necessary, blow the condensor through with compressed air (approx. 116 psi pressure).

Condensor suspension maintenance

The suspension system makes it possible to fold out the condensor for maintenance.

To prevent some of the suspension elements from seizing after a while, perform the following maintenance works regularly.

Step	Action
1	Apply a drop of oil to the latches that keep the condensor in its place.
2	Only for hinges with a grease nipple: press grease into the grease nipple of the two condensor suspension hinges.

Condensor fans speed control

The condenser fans will switch to low speed when the climate-control compressor clutch is switched on. They switch to high speed if the interior temperature exceeds the set temperature 4°F ($T_i > T_{set} + 4^\circ\text{F}$).

Speed is controlled by connecting the fans in series/parallel.

NOTE: The condensor fans will keep on running when the climate-control compressor clutch is switched off by high-pressure switch DK102.2.

To change filter/dryer

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

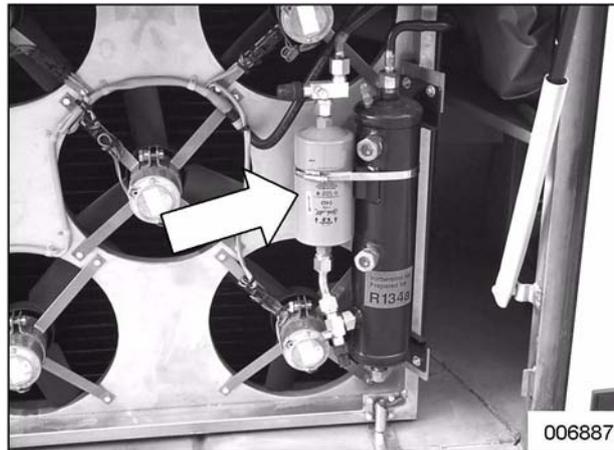
Function of the filter/dryer

The filter/dryer catches humidity and dirt in the refrigerant circuit.

Location of the filter/dryer

The filter/dryer is mounted in the climate-control condenser compartment.

Figure: filter/dryer



To remove the filter/dryer

Step	Action
1	Turn the stem of the two service valves, which are located above and under the filter/dryer, clockwise up to the stop.
2	Connect a recovery station to the service connection of one of the service valves, and remove the refrigerant from the filter/dryer.
3	Loosen the line connectors at the filter/dryer ends. Remove the filter/dryer.

To install filter/dryer

Step	Action
1	Install a new filter/dryer.
2	Connect the lines to the filter/dryer ends.

continued on next page

Step	Action
3	Vacuum down the filter/dryer.
4	Turn the stem of the two service valves, which are located above and under the filter/dryer, counterclockwise up to the stop.
5	Check for leaks

Thermostatic expansion valve: general

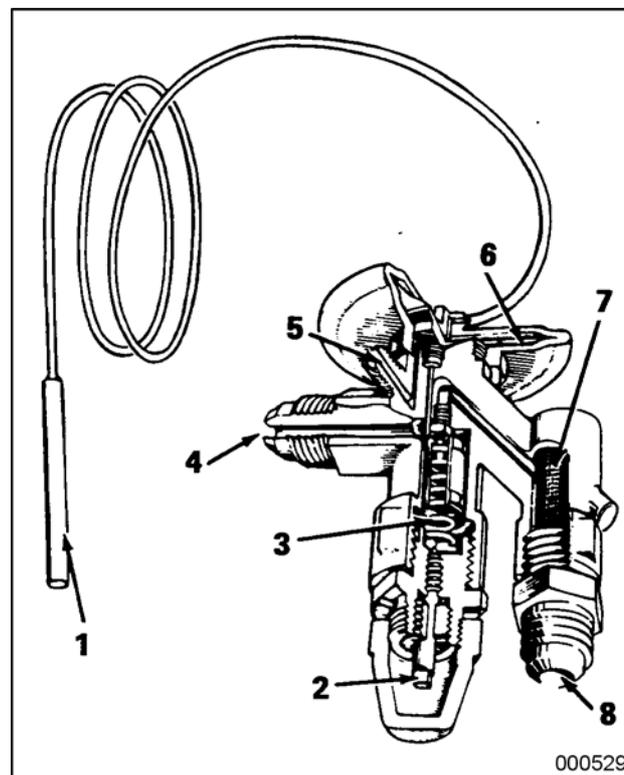
Introduction

The system has three thermostatic expansion valves: one for each evaporator in the climate-control unit on the roof, and one for the evaporator in the climate-control unit of the cab.

Function

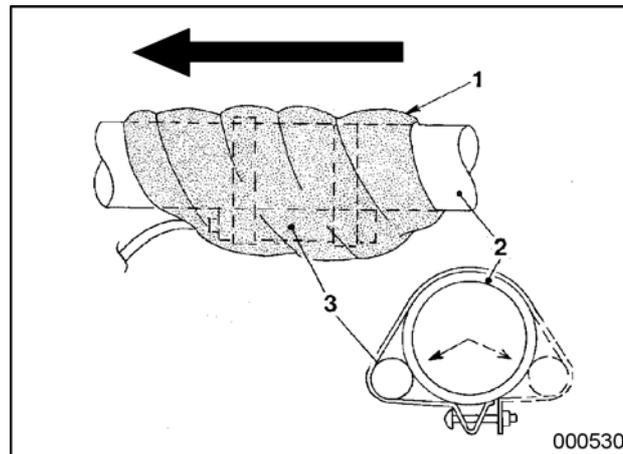
The thermostatic expansion valve admits only so much refrigerant to the evaporator as can be evaporated. The sensors of the thermostatic expansion valves are mounted on the line leaving the evaporator; they detect and react to any overheating.

Figure: thermostatic expansion valve



- 1 Sensor (heat-sensitive tube)
- 2 Adjusting screw
- 3 Needle and seat
- 4 Outlet
- 5 External equalizer
- 6 Membrane
- 7 Screen
- 8 Inlet

Figure: sensor installation



The arrow indicates the refrigerant flow direction.

- 1 Insulating tape
- 2 Copper tube
- 3 Sensor

Contact between the sensor and the refrigerant pipe

The system will only function properly if the sensor has a good contact with the copper pipe.

To position the sensor

With respect to the longitudinal axis of the copper pipe, the sensor should be in the 4 or 8 o'clock position (see figure).

Capillary line

This is the thin line between the thermostatic expansion valve and the sensor.



CAUTION!

Be careful not to bend the capillary line. Otherwise the thermostatic expansion valve does not operate.

To install the sensor

Step	Action
1	Clean the copper pipe and the sensor with fine abrasive paper. Do not use acids or copper polish!

continued on next page

Step	Action
2	To prevent oxidation, coat sensor and copper pipe with a thin layer of a heat conducting paste.
3	Secure the new sensor to a horizontal part of the pipe, with the help of a few hose clamps. Refer to "To position the sensor".
4	Wrap insulating tape around the sensor and the pipe.

Service valves: general

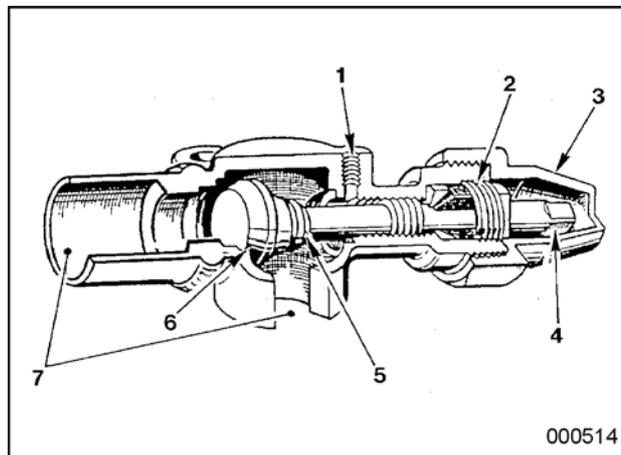
Introduction

The refrigerant circuit is fitted with four service valves: two on the compressor and two near the filter/dryer.

Function

- By closing the two service valves of a circuit component, you isolate that component from the rest of the circuit.
- Maintenance works can be carried out via the service connection on the valves, such as: evacuate, flush (with nitrogen), high-pressure test, charging with refrigerant.

Figure: service valve



- 1 Service connection
- 2 Gland
- 3 Protection cap
- 4 Stem
- 5 Rear valve seating
- 6 Front valve seating
- 7 Inlet or outlet (depending on application)

Service valve positions

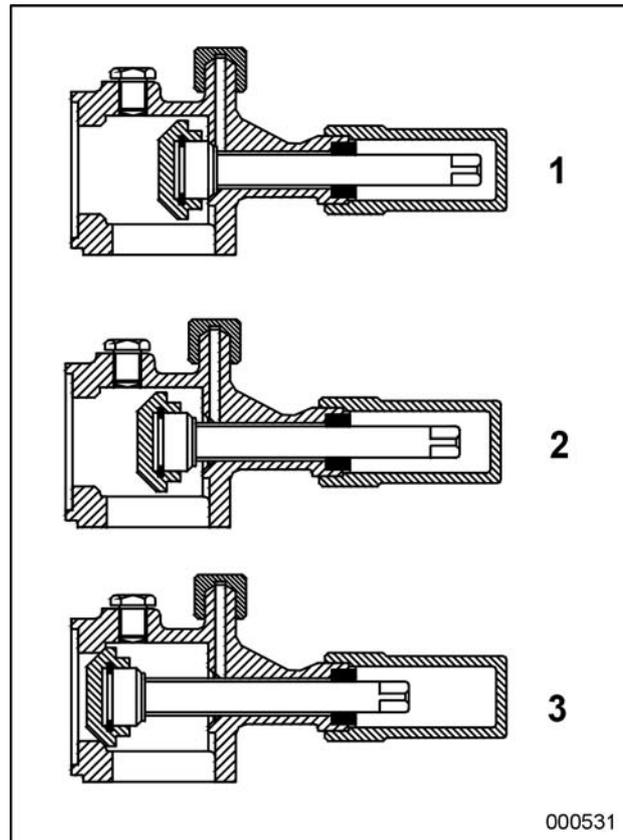
Each service valve has three positions (see figure).

Number in figure	Position	Result
1	Valve stem rotated counter-clockwise as far as it will go. This is the normal running position.	The valve is open, but the service connection is isolated from the refrigerant circuit.

continued on next page

Number in figure	Position	Result
2	Valve stem in the mid-position. This is the test position.	The valve is open, and the service connection to the refrigerant circuit is open.
3	Valve stem rotated clockwise as far as it will go.	The valve is closed.

Figure: service valve positions



Solenoid shut-off valves

Introduction

The refrigerant circuit has been equipped with three solenoid shut-off valves.

- Shut-off valve V142 in the line to the driver's cab climate-control unit evaporator.
- Shut-off valve V144.1 in the line to the evaporator in the LH roof duct of the passenger compartment.
- Shut-off valve V144.2 in the line to the evaporator in the RH roof duct of the passenger compartment.

When do the shut-off valves open?

The "normally closed" solenoid shut-off valves V142, V144.1 and V144.2 will open when the climate-control compressor clutch is switched on.

NOTE: The shut-off valves remain energized when the climate-control compressor clutch is switched off by pressure switch DK101.

NOTE: The program prevents shut-off valve V142 from being opened when the fan motor in the driver's cab climate-control unit is not running.

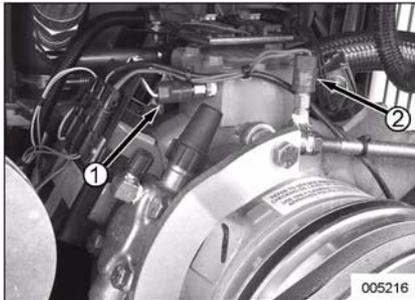
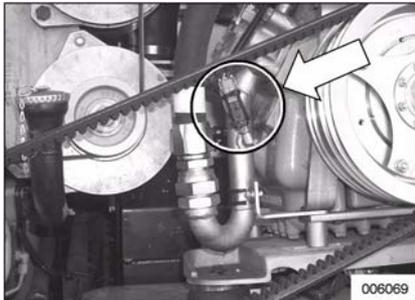
Pressure switches

Introduction

In order to monitor and to limit the pressure in the refrigerant circuit, four switches have been installed:

- DK101 and DK102.2 protect the installation against abnormal operating pressures,
- DK102.1 and DK103 switch on the capacity control.

Location of pressure switches

Element	Figure
<p>On the climate-control compressor:</p> <p>1 High-pressure switch DK102.2 of protection system</p> <p>2 Low-pressure switch DK101 of protection system</p>	
<p>On the climate-control compressor: high-pressure switch DK102.1 of capacity control</p>	
<p>On the climate-control compressor: low-pressure switch DK103 of capacity control</p>	

Low-pressure switch DK101

Pressure switch DK101 protects the installation against low operating pressure.

continued on next page

The contacts of the low-pressure switch open if the suction-side pressure drops to the value mentioned in the technical data. The electrical circuit of the compressor clutch is then interrupted, whereby the compressor is switched off. The pressure will continue to rise, because the compressor has been switched off. The contacts of the low-pressure switch close if the pressure has again reached the value mentioned in the technical data. The compressor is then switched in again.

**High-pressure switch
DK102.2**

Pressure switch DK102.2 protects the installation against high operating pressure.

The contacts of the high-pressure switch open if the discharge-side pressure reaches the value mentioned in the technical data. The electrical circuit of the compressor clutch is then interrupted, whereby the compressor is switched off. Because the condenser fans continue to run, the pressure will decrease slowly. The contacts of the high-pressure switch close if the pressure has once again dropped to the value mentioned in the technical data. The compressor is then switched in again.

**High-pressure switch
DK102.1**

Pressure switch DK102.1 activates the capacity control.

The contacts of the pressure switch close if the discharge-side pressure reaches the value mentioned in the technical data. The electrical circuit of pilot valve V139 on the climate-control compressor is then closed and two of the six cylinders of the climate-control compressor are disconnected.

Low-pressure switch DK103

Pressure switch DK103 activates the capacity control.

The contacts of the pressure switch close if the suction-side pressure drops under the value mentioned in the technical data. The electrical circuit of pilot valve V139 on the climate-control compressor is then closed and two of the six cylinders of the climate-control compressor are disconnected.

Technical data of refrigerant circuit

Pressure switches

Low-pressure switch DK101	<ul style="list-style-type: none">• Contact closes at 26 to 35 psi• Contact opens at 3 to 7 psi.
High-pressure switch DK102.1	<ul style="list-style-type: none">• Contact closes at 295 to 315 psi• Contact opens at 230 to 250 psi.
High-pressure switch DK102.2	<ul style="list-style-type: none">• Contact closes at 230 to 255 psi• Contact opens at 330 to 360 psi.
Low-pressure switch DK103	<ul style="list-style-type: none">• Contact closes at 18 to 21 psi• Contact opens at 25 to 28 psi.

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Part 9 - Occupant protection systems

Overview

Contents

Chapter	See page
Chapter 6: Safety belts	9.6-1

Chapter 6: Safety belts

Overview

Introduction This chapter deals with the safety belts.

Number of pages 4

Chapter publication date 19 September 2006

Contents

Topic	See page
To check/clean safety belts	9.6-2
Technical data: safety belts	9.6-3

To check/clean safety belts

**WARNING!**

**Never strain the belt, while it is wet. This may impair fabric strength.
Never bleach or dye belt fabric for the same reason.**

**Replace belts
when?**

Replace belt, if mechanism no longer works properly or if fabric is torn or frayed.

To wash belts

If necessary, hand-wash belts in warm water with neutral soap. Keep buckles dry! Rinse thoroughly and allow to dry (not in the sun, however).

Technical data: safety belts

Tightening torques

Safety belt fixing screw	45 ft.lbf
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Part 10 - Body and body accessories

Overview

Contents

Chapter	See page
Chapter 1: General	10.1-1
Chapter 2: External lighting and signalling devices	10.2-1
Chapter 6: Interior lighting equipment	10.6-1
Chapter 62: Entrance and exit doors	10.62-1

Chapter 1: General

Overview

Introduction This chapter deals with general information about body and body accessories.

Number of pages 16

Chapter publication date 19 September 2006

Contents

Topic	See page
Vehicle exterior: anti-corrosive measures	10.1-2
To repair fiberglass damage	10.1-3
Vehicle exterior: lacquer care	10.1-5
Vehicle exterior: underbody care	10.1-7
Vehicle exterior: to clean chrome or anodized aluminum	10.1-8
Vehicle interior: to clean floor	10.1-9
Vehicle interior: to clean moquette seat upholstery	10.1-10
Vehicle interior: to wash crepe head-rest covers	10.1-11
Vehicle interior: to remove stains from fabric upholstery	10.1-12
Vehicle interior: to clean leatherette	10.1-13
Vehicle interior: to clean ABS plastic parts	10.1-14
Vehicle interior: to clean Plexiglas panels	10.1-15

Vehicle exterior: anti-corrosive measures

What to do?

-
- Always make sure the vehicle is stored in the best conditions.
 - Follow the instructions for maintenance of the vehicle underbody closely, refer to "Vehicle exterior: underbody care".
 - After each washing, check the lacquer for scratches and damage from small stones. Cover areas where layer of lacquer is lacking as quickly as possible with paint, so rust cannot work its way underneath the lacquer.
 - Accident damage must be repaired as quickly as possible to prevent rust.
 - When corrosion starts, take timely measures to prevent it from worsening. Repairs must never be delayed for longer than 3 months, otherwise the damaged area cannot be saved.
 - Every 2 years, the hollow sections that are located completely or partially under the floor level must be sprayed with a good rust preventive liquid for hollow spaces, such as Teroson Terotex HV 300 (Van Hool order number 660843407). The body posts are open at the bottom; there are holes drilled into the horizontal sections to be treated.
-

To repair fiberglass damage

Introduction

No matter how strong, impact-resistant and flexible fiberglass is, it can be damaged in a collision. In most cases, you can easily repair minor damage yourself.

Consumables

- Liquid, pre-accelerated polyester resin
- Hardener (catalyst)
- Glass fiber mats



WARNING!

Avoid getting hardener into your eyes. Should this happen anyway, rinse your eyes with abundant water and get medical assistance. Never use ointment!

Preparatory work

Step	Action
1	Trim back the damaged area to a round hole with a neat edge, free from cracks.
2	Grind the edges of the hole to a chamfer.
3	Clean the surface around the hole.
4	If possible, cover the hole on the inside with a piece of sheet material or cardboard in order to facilitate laying up the glass fiber mats.
5	Cut some pieces of glass fiber mat to a diameter allowing at least 2 in overlap all around the hole.
6	While stirring, mix 1 to 3% hardener with no more polyester resin than you think you can apply in 20 minutes.

To fill the hole

Step	Action
1	Lay the glass fiber mats on a scrap piece of cardboard and, using a paint brush, impregnate them with the activated polyester resin.
2	Place mat by mat over the opening until the hole is sufficiently filled up.

continued on next page

Step	Action
3	Dab the mats down with the brush. This should remove the air inclusions from the material.

To clean the tools

Clean the tools immediately after use, using acetone or cellulose thinners.

To finish off

Step	Action
1	Leave the polyester resin to set for about an hour.
2	Sand the hardened fiberglass level using a power grinder or coarse sandpaper.
3	Apply putty to the sanded fiberglass.
4	Paint the repair work.

Vehicle exterior: lacquer care



CAUTION!

When using commercial cleaning agents, preservative products and paint, always strictly follow the manufacturer's instructions.

General washing instructions

- Wash the body with ample, preferably softened, water.
 - Use non-aggressive, non-abrasive cleaning agents only, always in liquid form and in the amount indicated by the manufacturer.
 - Always wash the vehicle with clean water first. During this preliminary washing sand is soaked off and removed so that it cannot scratch the lacquer during the actual washing process. Use a soft brush to which no pressure is being applied.
 - For hand-washing use a sponge or a car wash brush with soft bristles set in a holder made of rubber or soft synthetic material.
 - Before removing dried-on insects, first soak them off with a special retail product.
 - After washing, rinse the body thoroughly with soft water. Soap residues can damage the lacquer.
 - After rinsing, you can dry the body with a soft chamois cloth.
-

To wash with brush machines

- When washing vehicles with exterior mirrors that have been attached by means of dovetail connectors, remove the mirrors before washing.
 - Many automatic car wash systems use sensors to open doors automatically or to activate machines. The parts of these sensors that touch the body have to be made of soft rubber or soft synthetic material.
 - Take care that the vehicle goes through the car wash system positioned right in the center.
 - The washing brushes must be adjusted correctly, so that they can reach everywhere without causing any wear. They must not touch the vehicle underside.
 - The brushes should never work on one location of the body for too long; the vehicle has to move along the brushes without stopping, or vice versa.
 - The sprinklers of the car wash system have to spray with their normal flow rate. Therefore, not too many sprinkler holes should be clogged.
-

To wash with high-pressure cleaners

- High-pressure cleaners do remove dirt, but not the greasy film on the body. A brush or sponge is still needed to remove this film.
- Do not set the machine too hot; 160 °F is the maximum.
- Pressure on the jet pipe must not exceed 580 psi.
- Keep the jet pipe head at least 12 in away from the lacquer and not on the same spot for too long. Otherwise, if the water is hot, you run the risk that the dirt is driven into the lacquer.

To remove road tar

- Remove tar spots with a special product or with denaturated alcohol. Apply the cleaning agent with a soft cloth and carefully rub the cloth over the spot. Do not press too hard. Otherwise the sand grains that are stuck in the tar will scratch the lacquer.
- After the tar has been removed, wash and rinse the treated area.

Minor repairs to finish

- Repairs can be made with any type of good quality lacquer, without risking harm to the existing lacquer.
- First thoroughly clean the area that is to be treated (remove dirt and grease).
- Carefully sand the area that is to be repaired, so that the new lacquer can adhere well to the existing layer.
- Use a rust-preventive primer.
- Closely follow the paint manufacturer's instructions.

**CAUTION!**

Metallic paint may not be treated with an ordinary cleaner, because this may render the lacquer mat.

To wax finish

- After winter, it is a good idea to wax the vehicle with a liquid, non-abrasive polish. The body has to be absolutely clean and dry, before doing so.
 - To give weathered or spotted lacquer its original shine a slightly grinding polish can be used. To prevent the lacquer from getting too thin, rub evenly and not on the same spot for too long. After cleaner treatment, apply a preservative layer of wax immediately.
-

Vehicle exterior: underbody care

To be carried out when?

Once a year, after winter, the vehicle underbody has to be cleaned and inspected.

Procedure

Step	Action
1	 <p>CAUTION!</p> <p>Do not spray the following spots with a high-pressure cleaner: greasing points, bearings, shaft seals, universal joints, protective covers of steering system. Penetrating water may cause damage due to corrosion.</p> <p>Spray vehicle underbody with cold water to remove all mud and salt.</p> <p><i>NOTE: The water must not contain any detergents or petroleum derivatives, because they can damage the rust-preventive layer. Pressure on jet pipe must not exceed 725 psi.</i></p>
2	<p>Check rust-preventive layer for discontinuities.</p> <ul style="list-style-type: none"> • No discontinuities: underbody is all right. • Discontinuities: go to step 3.
3	<p>Allow underbody to fully dry.</p>
4	 <p>CAUTION!</p> <p>If you have to spray rust-preventing liquid near compressed-air devices, first cover openings or mufflers of these devices.</p> <p>Spray the areas that show discontinuities with proper anti-rust product for vehicle underbodies, such as Diffutherm UBC WAX 70 Metallic (Van Hool order number 660827810).</p>

Vehicle exterior: to clean chrome or anodized aluminum

Chrome

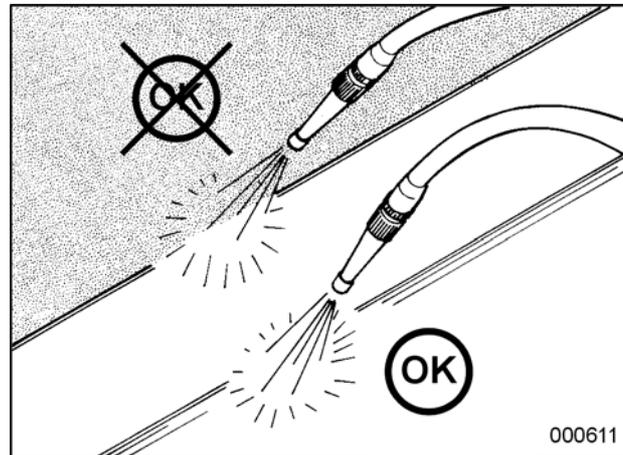
- Wash the chrome with soapy water, followed by a thorough rinsing.
- You can polish slightly neglected chrome with chrome polish.
- Protect chrome parts in the winter months by waxing them with special protective wax available from retail sale.

Anodized aluminum

- Clean anodized aluminum parts with neutral, non-abrasive synthetic products (definitely not chrome polish or agents containing soda, ammonium, chlorine or phosphoric acid).
 - Stubborn spots should not be treated with steel wool, or else the extremely thin protective layer will be worn away and the aluminum will start oxidizing. If necessary, use a dish washing scrub pad made of polyamide wool, such as Scotch Brite (from 3M).
 - Thoroughly rinse aluminum afterwards to remove any residue of the cleaning product.
-

Vehicle interior: to clean floor

Figure:
cleaning floor



CAUTION!

When cleaning the floor, do not point any pressurized water jet at, or upwards of, the seam between the wall covering and the upright extension of the floor covering.

Vehicle interior: to clean moquette seat upholstery

To vacuum Clean upholstery weekly with a vacuum cleaner.

To wash Moquette upholstery can be washed without any risk using a solution of neutral soap in cold water.

Step	Action
1	Apply soapy water in small amounts using a sponge or soft brush. Rub in the same direction as the fibers of the fabric go.
2	Remove soap with a soft, clean cloth or sponge.
3	Repeatedly rub the treated area with a dry cloth.
4	Rub moquette that is still damp with a fairly hard brush.
5	Once the seat upholstery is dry, brush it once again, brushing in the same direction as the fibers.

To rejuvenate The moquette can be "rejuvenated" by steaming it. Lay a wet cloth over the seat upholstery and run a hot iron over it. The steam goes into the fibers and perks them up.

Vehicle interior: to wash crepe head-rest covers

Guidelines

-
- The cloths have to be washed without softener. Otherwise the crepe becomes unattractive.
 - Use detergent "for fine washables", in water of about 86 °F. Rinse well in clean water and air-dry (do not wring out). Do not use any bleach.
-

Vehicle interior: to remove stains from fabric upholstery

Guidelines

- Clean stains as quickly as possible, before they dry or oxidate; afterwards, it is much more difficult to remove them.
 - Use a retail stain remover suited to the nature of the stain and that is harmless to the fabric to be cleaned (read the packaging). Simple household cleaners can also do a good job. Consult a stain-removal guide to see which cleaner is the best suited to which kind of stain.
 - If the nature of the stain is unknown, first treat it with a solution of water and detergent. If the stain does not go away, use a dry-cleaning chemical once you have allowed the fabric to dry completely.
 - Only use white cloths or kitchen paper to apply stain-removal agents.
 - Fresh coffee or chocolate stains are not difficult to remove with detergent in lukewarm water. But once they have dried, there is not much you can do about these stains.
 - Felt tip marker can only be removed with alcohol, felt pen marks with trichlorethylene, and nail polish with acetone.
 - The best way to remove chewing gum is to first freeze it with a spray product and then smash it and scrape it off.
 - Always try chemical stain removers out on an area that is not or hardly visible first, to make sure it does not cause any discoloration or damage.
 - When using chemical stain removers, ventilate the vehicle interior as well as possible.
-

Vehicle interior: to clean leatherette

Guidelines

-
- Occasionally wipe the leatherette with lukewarm, soapy water and rinse with water to which has been added a little vinegar.
 - Problematic stains can be removed with denaturated alcohol. Still, before treating large spots, it is advisable to do a test on a piece that is not so visible, so as to make sure no discoloration occurs.
 - Keep the leatherette supple by treating it occasionally with a mixture of 0.8 gallons of water, 0.08 gallons of milk and a handful of kitchen salt. Use a sponge to apply the mixture. Do not rinse, dry with a chamois cloth only. Rinse and wring out the chamois cloth as you go.
-

Vehicle interior: to clean ABS plastic parts

**WARNING!**

Do not use polish on steering wheel and ABS seats, or they will become too slippery.

**CAUTION!**

Solvents such as white spirit, paint thinner, trichlorethylene or cleaning spirit damage ABS plastic.

Guidelines

- Sponge the ABS plastic clean with warm, soapy water. A soft brush may be used with light pressure to remove stubborn spots.
 - To renew the original shine of ABS parts, use a special retail product.
-

Vehicle interior: to clean Plexiglas panels



CAUTION!

Solvents such as white spirit, thinner, trichlorethylene or cleaning spirit damage Plexiglas.

Guidelines

- Never shine Plexiglas, when it is dry.
 - Wash the panel thoroughly and dry it with an absolutely clean chamois cloth. After washing, apply anti-static polish.
 - You can polish out small scratches with a fine polish sold retail for the purpose.
-

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Chapter 2: External lighting and signalling devices

Overview

Introduction This chapter deals with the exterior lighting and signalling devices.

Number of pages 10

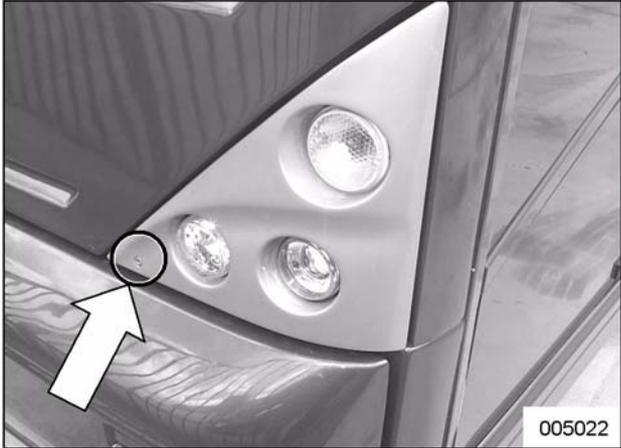
Chapter publication date 19 September 2006

Contents

Topic	See page
To adjust headlamps	10.2-2
Exterior lighting lamp list	10.2-3
To replace headlamp bulb	10.2-5
To replace bulb of rear lamp cluster	10.2-9

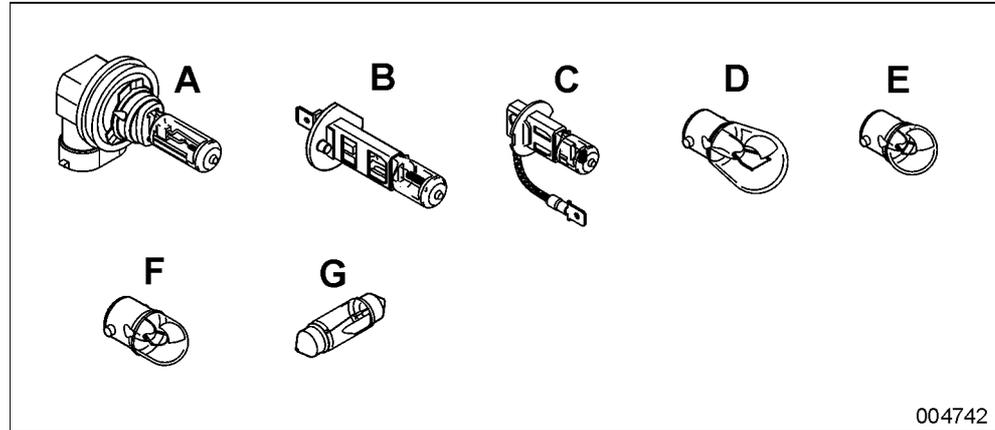
To adjust headlamps

Access to headlamps adjusting screws

Step	Action
1	Remove Allen screw of headlamp holder. 
2	Swing open headlamp holder. Adjusting screws of headlamps are now accessible.

Exterior lighting lamp list

Figure: lamp overview



004742

Lamp type/
socket type
overview

Letter in figure	Lamp type/socket type
A	H9/PGJ19-5
B	H1/P14.5e
C	H3/PK22s
D	R15W/BA15s
	P21W/BA15s
	PY21W/BAU15s
E	R10W/BA15s
F	R5W/BA15s
G	C5W/SV8.5
	K10W/SV8.5

Exterior
lighting

Application	Lamp type/ socket type	Power/ voltage	Van Hool No.
Headlights (low beam and high beam)	H9/PGJ19-5	65W/12V	10890283
Front fog lights	H3/PK22s	55W/12V	660718001
<ul style="list-style-type: none"> • Turn signals, rear • Reversing lights • Rear fog lights 	P21W/BA15s	21W/24V	660720501

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Application	Lamp type/ socket type	Power/ voltage	Van Hool No.
Turn signals, front	PY21W/ BAU15s	21W/24V	10737576 ^a
<ul style="list-style-type: none"> • Stop lights • Rear position lights 	Sealed unit with LEDs		10985545
Turn signals, left and right	Sealed unit with LEDs		10898474
“Cornering lamps”	R15W/BA15s	15W/24V	660720400
License plate lighting	C5W/SV8.5	5W/24V	660725000
Stop light above engine compartment	Sealed unit with LEDs		10996977
<ul style="list-style-type: none"> • “Identification lamps” • “Clearance lamps” • “Side marker lamps” 	Sealed unit with LEDs		10757391 (red) 10757389 (orange)

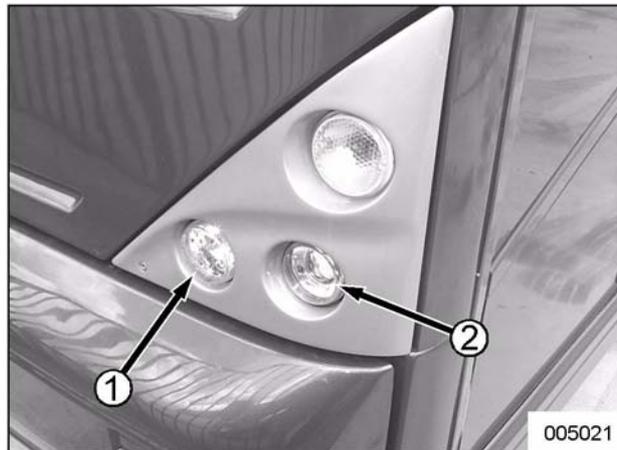
a. Orange bulb

To replace headlamp bulb

Consumables

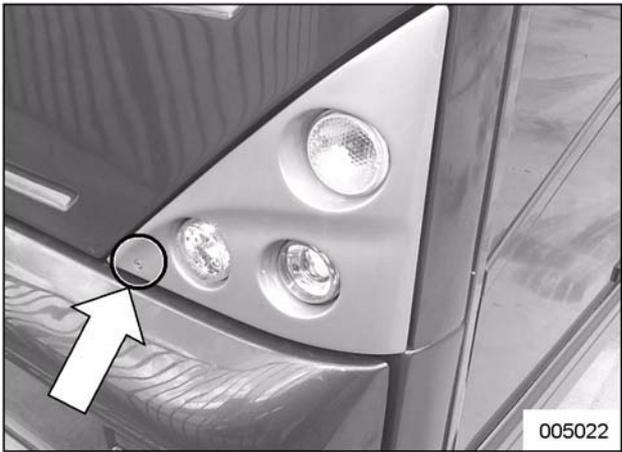
Halogen bulb for low beam	Van Hool No. 10890283
Halogen bulb for high beam	Van Hool No. 10890283

Figure: left-hand headlamp holder



- 1 High beam headlamp
- 2 Low beam headlamp

Preliminary operations

Step	Action
1	Remove Allen screw of headlamp holder. 

Step	Action
2	Swing open headlamp holder. Back of headlamps is now accessible.

To remove bulb



WARNING!

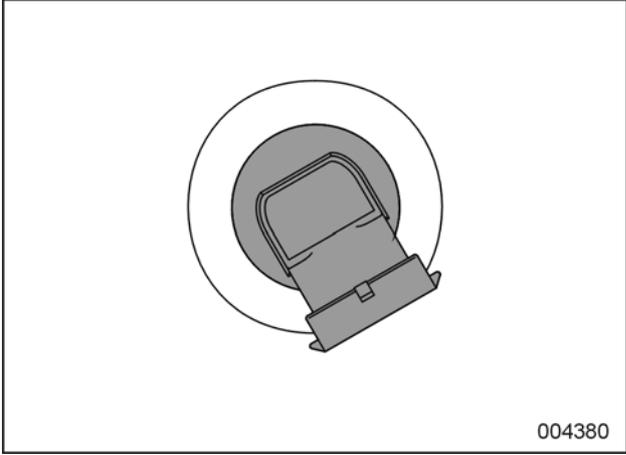
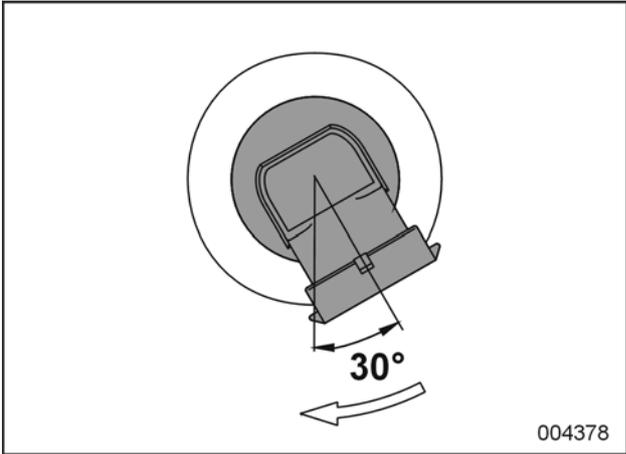
Before removing a headlamp bulb that has just been burning, wait a few minutes for it to cool off sufficiently. You could seriously burn yourself on the hot bulb glass.

Step	Action
1	Disconnect connector from lamp socket.
2	Turn lamp socket 30° counterclockwise and remove bulb. <div> </div>

To install bulb

**CAUTION!**

Seize new bulb by its base only. The slightest finger print or grease trace on the glass bulb will cause the bulb to burn out in a very short time. When in doubt over the cleanliness of the glass, clean it with alcohol.

Step	Action
1	Position new bulb into reflector opening.  004380
2	Turn lamp socket 30° clockwise.  004378
3	Connect connector to lamp socket.

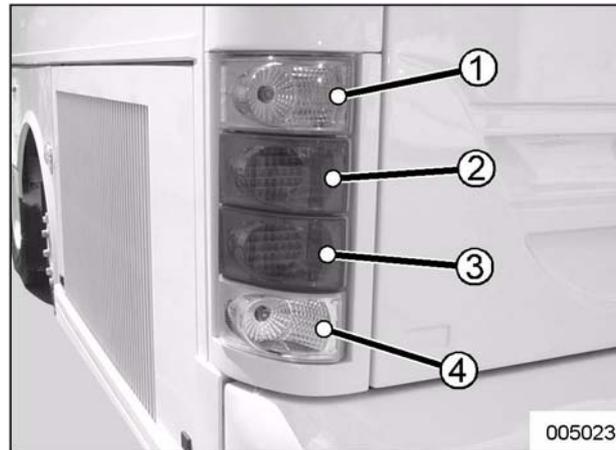
After changing a bulb

After changing a bulb, you have to check headlamp setting and, if necessary, correct it.

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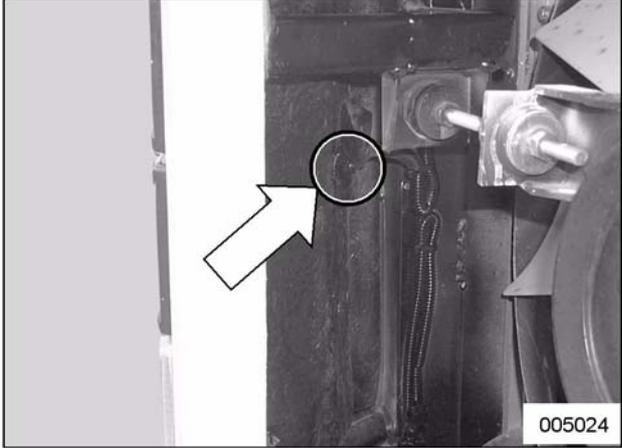
To replace bulb of rear lamp cluster

Figure: left-hand rear lamp cluster



- 1 Turn signal
- 2 Stop lamp
- 3 Rear position lamp
- 4 Reversing lamp

Preliminary operations

Step	Action
1	Open engine compartment door.
2	Open starting interlock switch in engine compartment to prevent anyone from starting engine.
3	Put warning on steering wheel saying "DO NOT START: MAINTENANCE".
4	Remove wing nut from rear lamp cluster. 

Step	Action
5	Open door that holds rear lamp cluster.
6	Change bulb, refer to "To change bulb" further on.
7	Close rear lamp cluster door and fasten wing nut.
8	Close starting interlock switch in engine compartment.

To change bulb

NOTE: The procedure below is valid for the turn signal and the reversing lamp. The stop and rear position lamps are sealed units with LEDs and are replaced as whole units.

Step	Action
1	Pull rubber protective cap backwards.
2	Turn plastic lamp holder counterclockwise, until you can pull it back.
3	Replace defective bulb and reinstall plastic lamp holder.
4	Reinstall rubber protective cover.

Chapter 6: Interior lighting equipment

Overview

Introduction This chapter deals with the interior lighting equipment.

Number of pages 4

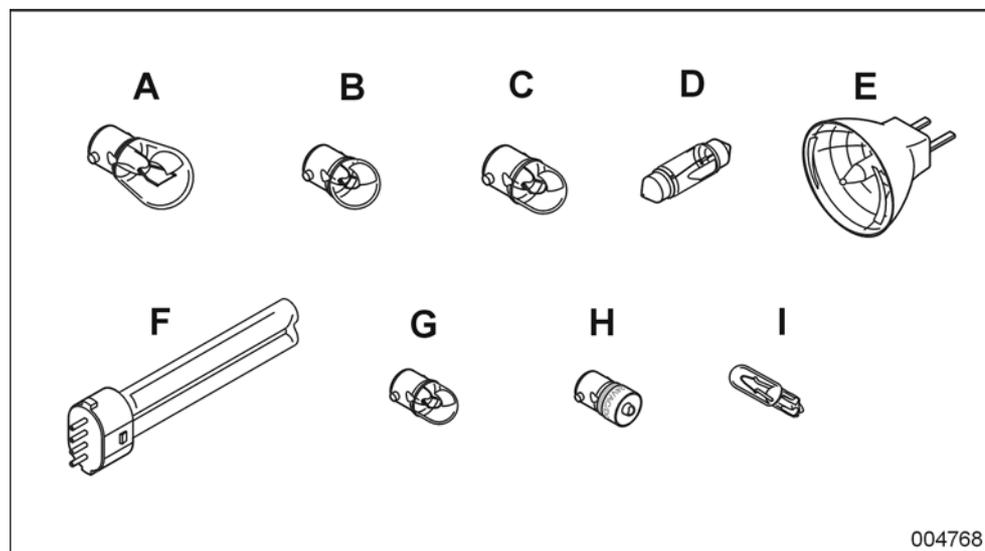
Chapter publication date 19 September 2006

Contents

Topic	See page
Interior lighting lamp list	10.6-2
"LIGHT" plug in main junction box	10.6-4

Interior lighting lamp list

Figure: lamp overview



Lamp type/
socket type
overview

Letter in figure	Lamp type/socket type
A	P21W/BA15s
	R15W/BA15s
B	R10W/BA15s
C	R5W/BA15s
D	C5W/SV8.5
	K10W/SV8.5
E	GU5.3
F	PL/2G7
G	H/BA9s
H	LED/BA9s
I	1.2W/W2x4.6d

Interior
lighting

Application	Lamp type/ socket type	Power/ voltage	Van Hool No.
Driver's cab/step well lighting	GU5.3	20W/24V	10555447
Luggage compartment lighting	K10W/SV8.5	10W/24V	660725001

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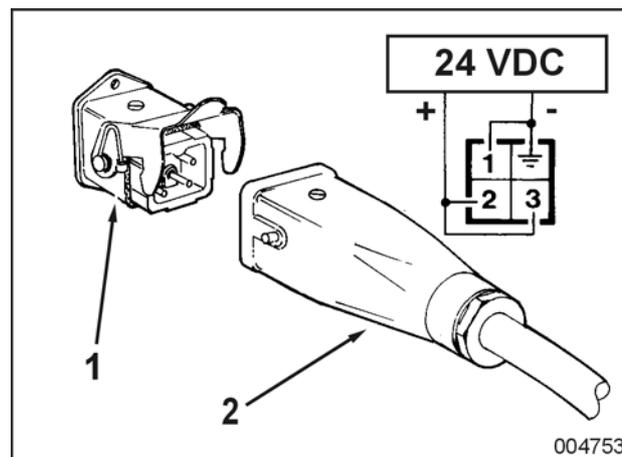
Application	Lamp type/ socket type	Power/ voltage	Van Hool No.
Aisle lighting	Sealed unit with LEDs		10896327
<ul style="list-style-type: none"> • Passengers reading lights • "WATCH YOUR STEP" 	R10W/BA15s	10W/24V	10958033
"Toilet occupied"	Sealed unit with LEDs		10554243
Night lighting above passengers	C5W/SV8.5	5W/24V	660725002
Toilet compartment lighting	Sealed unit with LEDs		10922302
<ul style="list-style-type: none"> • Engine compartment lighting • Wheelchair lift compartment lighting 	R15W/BA15s	15W/24V	660720400
Luggage compartment lighting	PL/2G7	11W/24V	10594378
Dash switches lighting	LED		10727019
Hazard warning signal dashboard push-button lighting	1.2W/W2x4.6d	1.2W/24V	660720002
Passenger door dashboard push-button lighting	H/BA9s	2W/24V	660720000

"LIGHT" plug in main junction box

Introduction

You can connect a 24 volt DC source to power the aisle lighting. Use the plug if you wish to leave the aisle lighting on for a longer time with the engine off, for example in order to clean the vehicle. This will avoid excessive draining of vehicle batteries. The socket 10643046 fits on the plug. The aisle lighting will come on automatically as soon as you connect the voltage source.

Figure:
"LIGHT" plug



- 1 "LIGHT" plug (accessible through the luggage door behind the right front wheel)
- 2 Socket (Van Hool No. 10643046)

To connect special socket

Step	Action
1	Connect the "+" wire of the voltage source to contacts "2" and "3" of the socket.
2	Connect the "-" wire of the voltage source to contacts "1" and "ground" of the socket.

To remove connecting cable



CAUTION!

Remove the connecting cable before driving off.

Chapter 62: Entrance and exit doors

Overview

Introduction This chapter deals with the entrance and exit doors.

Number of pages 16

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety precautions for passenger doors	10.62-2
Passenger door: schematic diagram	10.62-3
Passenger door: to check door safety systems and emergency valves	10.62-5
Passenger door: to lubricate locking wedges and cams	10.62-7
Passenger door: to lubricate door spindle	10.62-8
Passenger door: to check opening/closing time	10.62-9
Passenger door: to adjust opening/closing time	10.62-10
Passenger door: to set reversing-system switches	10.62-12
To preserve rubber door seals	10.62-15

Safety precautions for passenger doors

**WARNING!**

After working on a passenger door, check the closing power of that door before putting the vehicle back into service.

Equipment condition

Air system charged to maximum operating pressure

Procedure

Step	Action
1	Close the door from the dashboard.
2	From the interior, push firmly in the middle of the door. The door should not open.

Passenger door: schematic diagram

Figure:
passenger
door
schematic
diagram

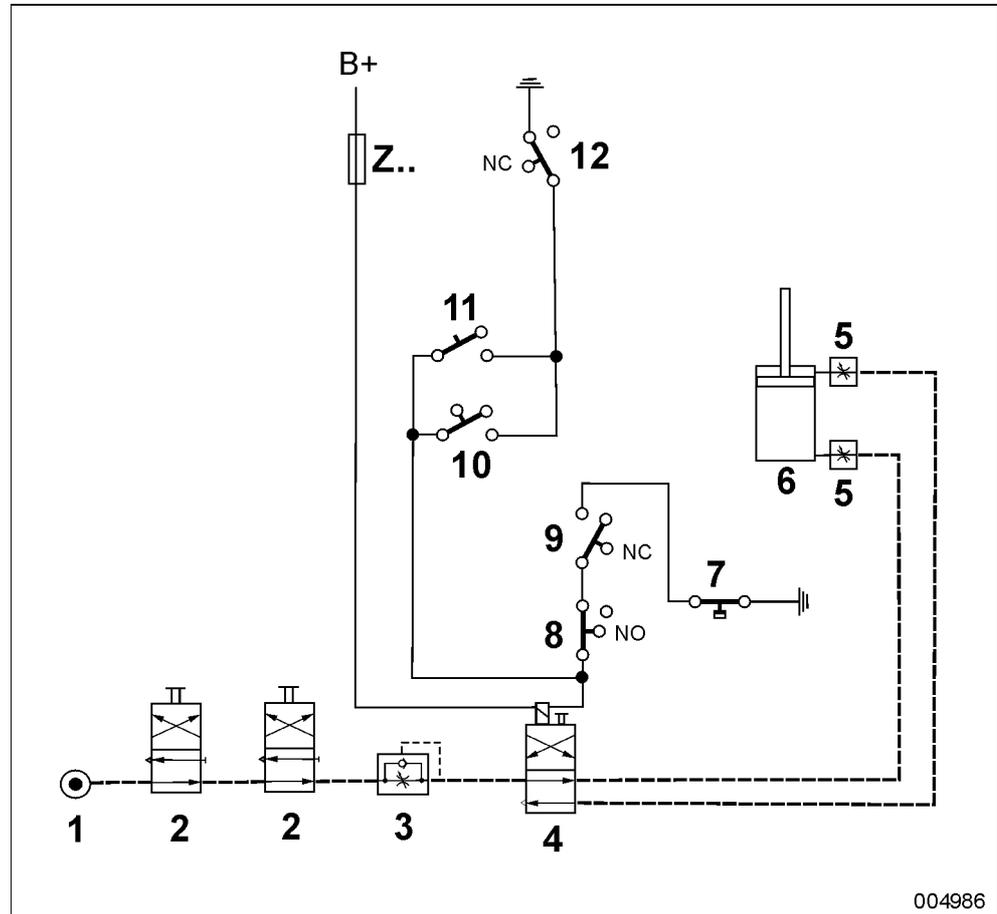


Figure shows a closed, unlocked passenger door

- 1 Compressed-air supply
 - 2 4/2-way valve, manually operated
 - 3 Flow control valve
 - 4 4/2-way valve, electrically operated (V011)
 - 5 Flow control valve
 - 6 Door actuating cylinder
 - 7 Pressure switch (DK055)
 - 8 Reversing switch (MS028)
 - 9 Limit switch (MS033.2)
 - 10 Switch (MS059) to open/close the door from the exterior
 - 11 Dashswitch (S091) to open/close the door from the interior
 - 12 Locking switch (MS057)
- B+ Voltage after batteries
Z Circuit breaker or fuse

continued on next page

Function and location of switches

Switch	Function	Location
MS028	Reverse door movement if the door panel runs into something or somebody	on door cylinder
MS033.2	Cuts off the reversing system just before the door is fully closed.	on door cylinder
MS057	Ensures that the door can only be opened/closed if it is not locked.	door control panel on the outside
MS059	To open/close from outside	door control panel on the outside
S091	To open/close from inside	on dashboard
DK055	Ensures that the reversing system only works while closing the door.	screwed into port "21" of 4/2-way valve (4)

Passenger door: to check door safety systems and emergency valves

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Re-opening system

The reversing system is a safety device that protects against entrapment.

Figure: to check re-opening system

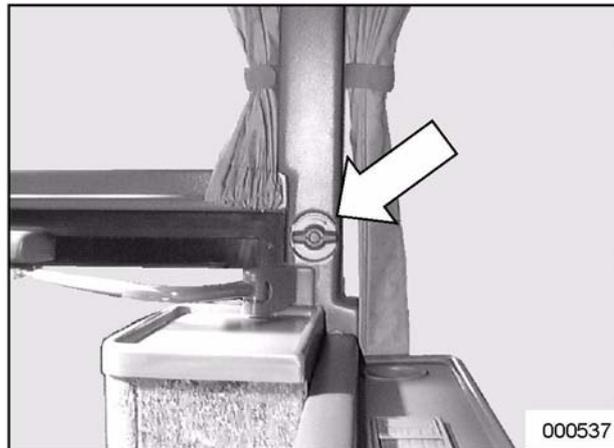


To check re-opening system

Step	Action
1	Try to stop closing door leaf by hand, when it is approximately half closed (this requires some force).
2	Does passenger door re-open automatically within 2 seconds? <ul style="list-style-type: none"> • Yes: re-opening system is ok. • No: go to step 3.
3	Have safety switches of door drive gear checked.

continued on next page

**Figure:
emergency
handle**



**To check the
emergency
release valves**

The emergency handle actuates an air valve, which depressurizes the door cylinders.

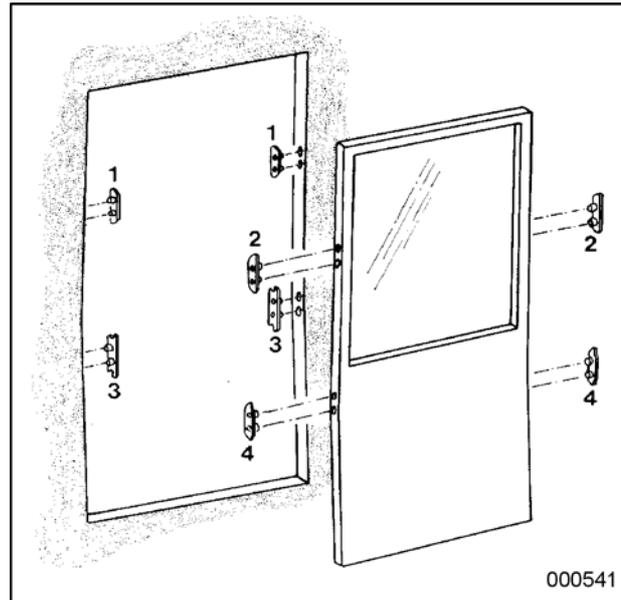
Turn the door emergency handle counterclockwise by a quarter of a turn. The door leaf should lower immediately, causing it to come loose of the locking wedges, so that it can be pulled open by hand. Repeat this check for each of the emergency handles (inside and outside).

Passenger door: to lubricate locking wedges and cams

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

**Figure:
locking
wedges and
cams**



- 1 Upper locking wedges on door posts
- 2 Upper locking cams on door leaf
- 3 Lower locking wedges on door posts
- 4 Lower locking cams on door leaf

Procedure

Apply small amount of vaseline on sliding surfaces of locking wedges and cams.

Passenger door: to lubricate door spindle

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

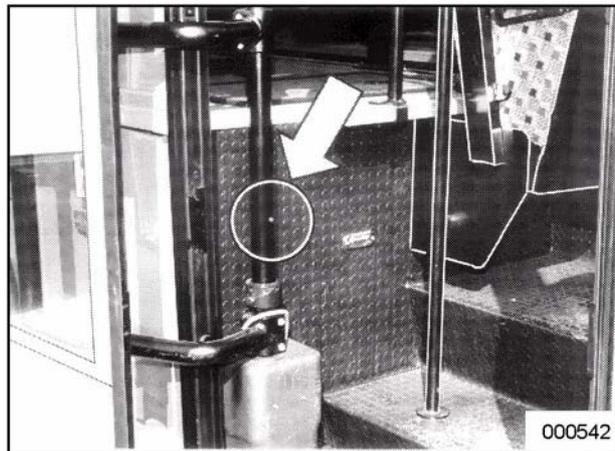
Grease type

Refer to chapter 1.1, "Fluids and lubricants".

Special tools

Tube to be used with grease pump	Van Hool No. 639901610
----------------------------------	------------------------

Figure: grease nipple on door spindle



CAUTION!

Use only the specified grease.

Procedure

Step	Action
1	Screw the adaptor tube fitting the flat grease nipple on the door spindle onto a hand-force grease pump.
2	Pump 3 to 5 strokes of grease into the nipple.

Passenger door: to check opening/closing time

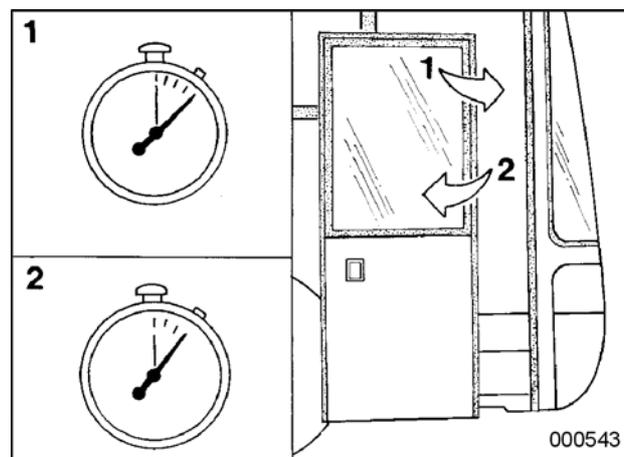
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Equipment conditions

A pressure of 115 to 130 psi in the air tanks

Figure: opening/closing time



Procedure

With a stop watch, check the duration of the door wing movement.
Door opening/closing time should be 4 to 5 seconds.

Passenger door: to adjust opening/closing time

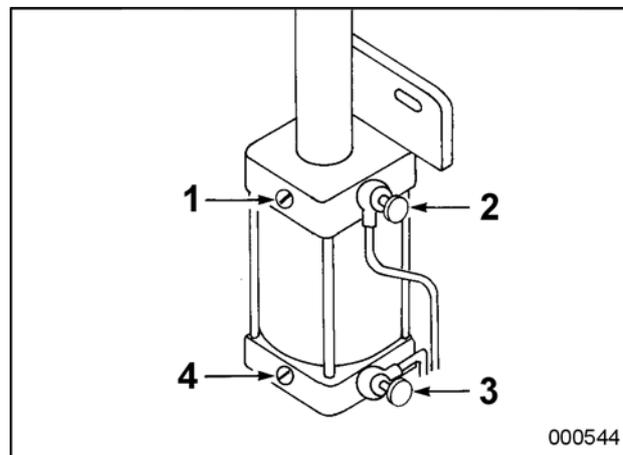
Introduction

The air cylinder, which opens and closes the passenger door leaf, has been fitted with four adjusting screws: one pair for adjusting door movement speed, the other pair for adjusting end damping (slowing down the door leaf towards the end of the movement to avoid door slamming).

Equipment conditions

- A pressure of 115 to 130 psi in the air tanks
- Air cylinder plastic protection cap removed

Figure: adjusting screws on air cylinder



Cylinder protective cap has been removed

- 1 Damping at closing
- 2 Closing speed
- 3 Opening speed
- 4 Damping at opening

To adjust movement speed

First, rotate counterclockwise both end-damping adjustment screws by an eighth to a quarter turn at the most and adjust door movement speed.

If door leaf...	rotate speed screw...
moves too slowly,	counterclockwise by a quarter turn at a time, until speed is correct.
moves too fast,	clockwise by a quarter turn at a time, until speed is correct.

**To adjust
damping**

To...	turn adjusting screw...
increase damping	clockwise.
decrease damping	counterclockwise.

Passenger door: to set reversing-system switches

Equipment conditions

Door cylinder depressurized

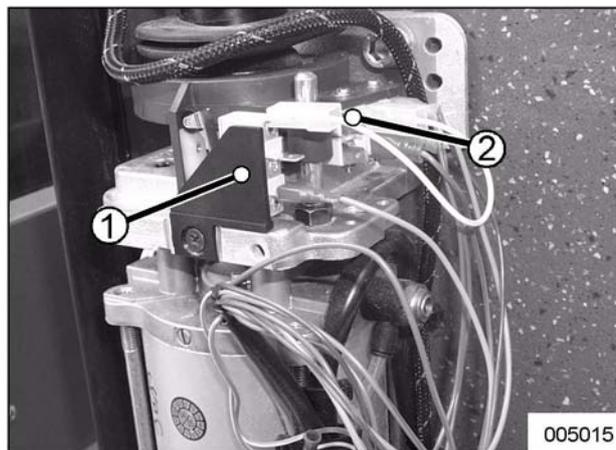
Reversing system

The reversing system is a safety device that protects against entrapment. If a door leaf runs into something or somebody while closing, the door movement will reverse immediately.

Location of switches

In the entrance, behind the protective cap of the door cylinder.

Figure: reversing- system switches

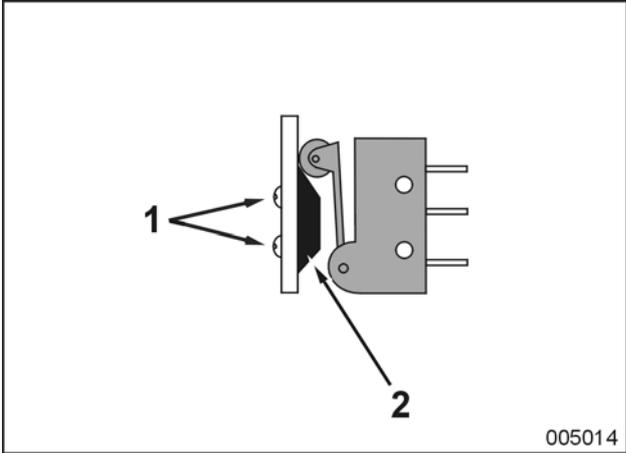


1 Reversing switch (MS028)

2 Limit switch (MS033.2)

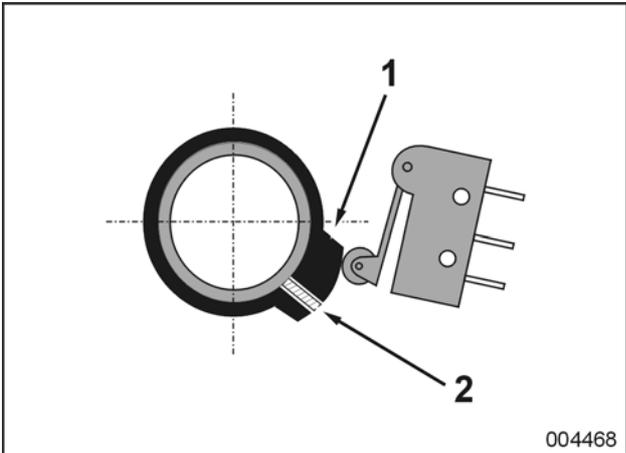
To set reversing switch

The reversing switch activates the door control valve so that door-leaf movement is reversed.

Step	Action
1	Untighten fastening screws (1) of actuating cam (2).  005014
2	Slide the actuating cam upward, until the switch contacts close.
3	Slide the actuating cam approximately 0.2 in (maximum 0.25 in) downward.
4	Secure the actuating cam in this position.

To adjust limit switch

The limit switch cuts off the reversing system just before the door is fully closed.

Step	Action
1	Untighten fastening screw (2) of actuating cam (1).  004468

continued on next page

Step	Action
2	Close the door by pushing it by hand.
3	Turn the actuating cam, until the switch contacts open.
4	Secure the actuating cam in this position.

To preserve rubber door seals

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Procedure

Rubber edge trims on door(s) harden less quickly if you treat them with silicone grease. Make sure you do not forget the inside of the rubber seals on the door leaf: the inside has to be able to slide smoothly along the posts, when the door leaf rises.



CAUTION!

Do not use vaseline as it freezes in winter, and will tear the rubbers.

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Part 11 - Control systems

Overview

Contents

Chapter	See page
Chapter 1: Multiplex system	11.1-1
Chapter 2: ATC	11.2-1

Chapter 1: Multiplex system

Overview

Introduction This chapter deals with the multiplex system.

Number of pages 78

Chapter publication date 19 September 2006

Contents

Topic	See page
Multiplex safety instructions	11.1-3
Introduction	11.1-5
Visual identification of components	11.1-7
Layout	11.1-8
Kibes computer module	11.1-10
Nodes	11.1-11
Dashboard node	11.1-13
CAN bus	11.1-14
Technology of node inputs and outputs	11.1-19
Component location	11.1-24
To operate the multifunctional display	11.1-25
Service menu layout	11.1-27
On-board diagnostics system: functional check	11.1-28
On-board diagnostics system: self-diagnosis	11.1-31
Aids for testing: "running engine" simulation	11.1-35
Aids for testing: "moving vehicle" simulation	11.1-37
Identification of the programs	11.1-39
To change the language of the multifunctional display	11.1-41
Aids for testing: garage feature	11.1-43
PC-aided diagnosis	11.1-46
To troubleshoot using "Diagnosis with a PC".	11.1-54
To load program in Kibes computer module	11.1-56
To connect a PC to the diagnostic socket	11.1-63

continued on next page

Topic	See page
To install Kibes RT software on PC	11.1-64
Function diagram (FUP)	11.1-73
Logic circuits	11.1-74
Overview of inputs and outputs, software version 3	11.1-77
Special tools: multiplex system	11.1-78

Multiplex safety instructions

**WARNING!**

Before operating the multifunctional display to perform simulations or functional tests via the multiplex system, warn people working on the vehicle or about to do so that climate-control system fans and other devices may suddenly engage without the engine running.

**WARNING!**

Never operate the multifunctional display while driving.

**CAUTION!**

Before carrying out electrical welding on the vehicle, first turn off the battery isolating switch and subsequently remove the connectors from all electronic control units.

**CAUTION!**

Only use a multimeter as a test device, not a test lamp.

**CAUTION!**

Do not lengthen or shorten the CAN bus. Do not remove termination resistors.

**CAUTION!**

The electronics are very sensitive. Incorrect connection leads to damage. Avoid reversing polarity connections.

**CAUTION!**

Repairs to the wiring must always be carried out in accordance with the principles of good workmanship. Take appropriate care when soldering and crimping.

Introduction

What is multiplex?

Multiplex is a collective term for the technology used to transmit multiple signals (data/commands) through two conductors between two or more components in an electrical network.

Why multiplex?

The advantages of a multiplex system in relation to classic electrical equipment:

- a considerable reduction of the number of wires;
- thinner main cable looms in the vehicle.

The fact that all kinds of switching conditions can be built into a circuit easily means that the entire arrangement of electrical circuits is simplified. This leads to:

- a reduction of the number of relays;
- simplification of the junction boxes;
- a reduction of the vehicle mass (= reduced fuel consumption).

The fact that one or more diagnosis possibilities are available in the program makes it easier to test the vehicle or trace faults. Testing can be done through on-board diagnosis or by connecting an external PC. On-board diagnosis means the possibilities provided without the use of special equipment.

The multiplex system also reduces the number of separate electronic circuits (for example: turn signal box, windshield wiper interval, time switches,...).

The multiplex system can also read messages that are available on the CAN bus of the driveline (SAE J 1939). This also leads to a reduction of the number of wires and components in the periphery of the drive line.

What system is used by Van Hool?

Van Hool use the KIBES multiplex system. KIBES is the abbreviation of "Kienzle Bord Elektronik System".

Figure:
schematic of
classic wiring

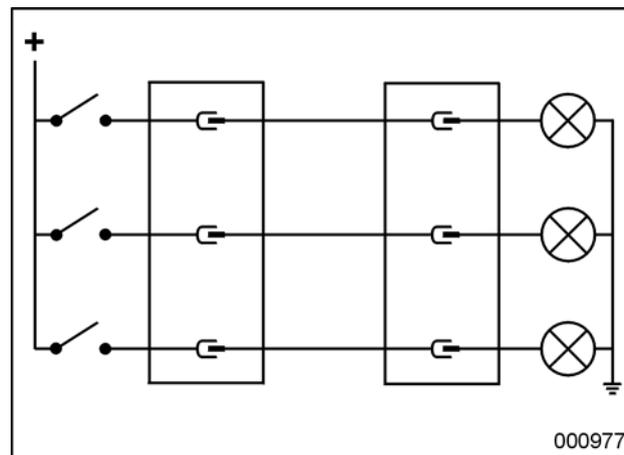
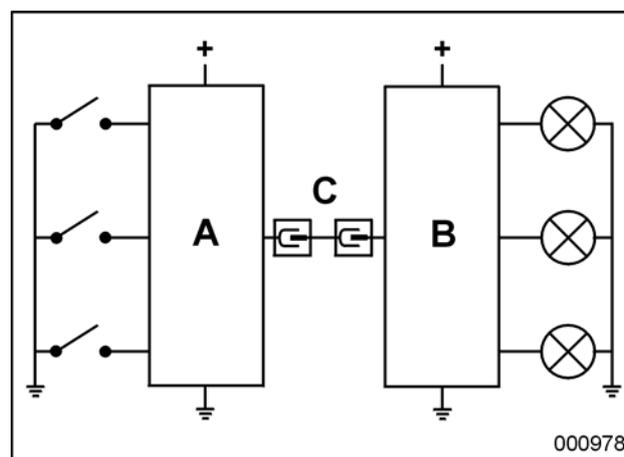


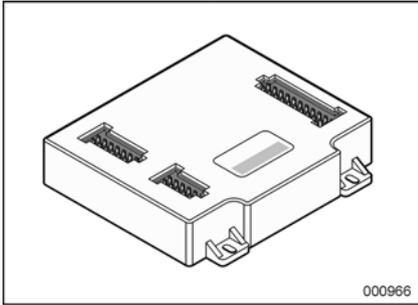
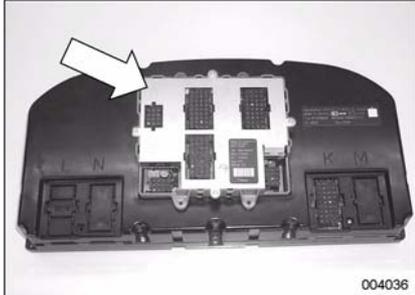
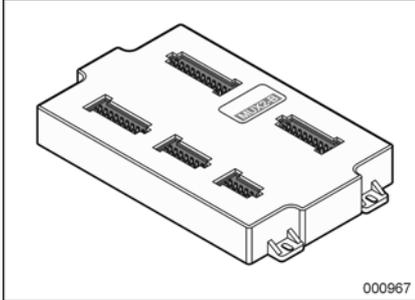
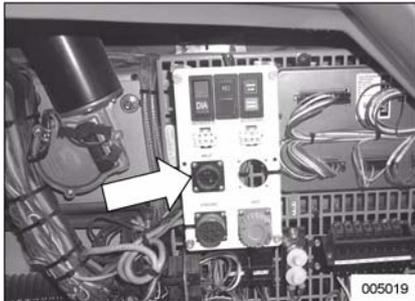
Figure:
schematic of
multiplex
wiring



- A Electronics box
- B Electronics box
- C Signal line

Visual identification of components

Hardware components

Element	Figure
Computer module (ZR2-BD)	 <p style="text-align: right;">000966</p>
Dashboard node (DMUX)	 <p style="text-align: right;">004036</p>
Node (NODE)	 <p style="text-align: right;">000967</p>
Diagnostics socket (on the diagnostics panel in the front junction box)	 <p style="text-align: right;">005019</p>

Layout

Introduction

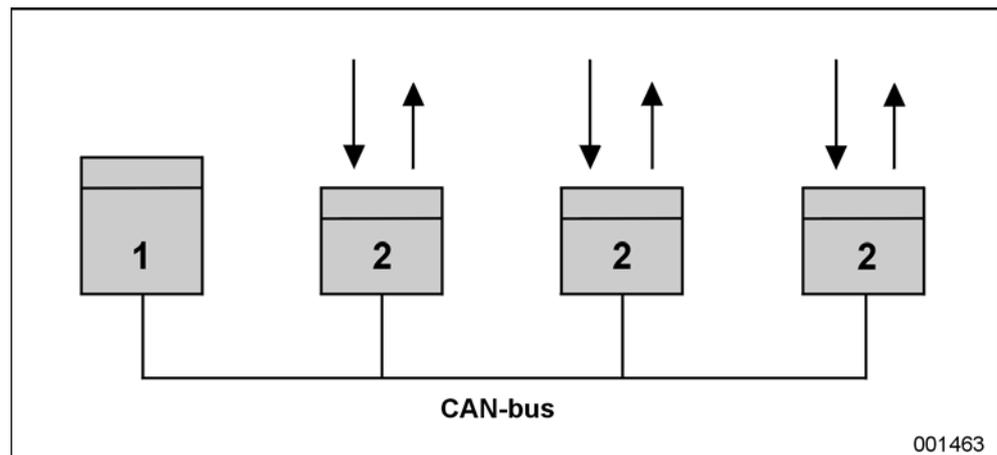
The system is constructed with "hardware" components (= all equipment in the system). This "hardware" is controlled by the "software" (= program which enables the "hardware" to function as required).

Hardware components

The Kibes system consists of the following "hardware" components:

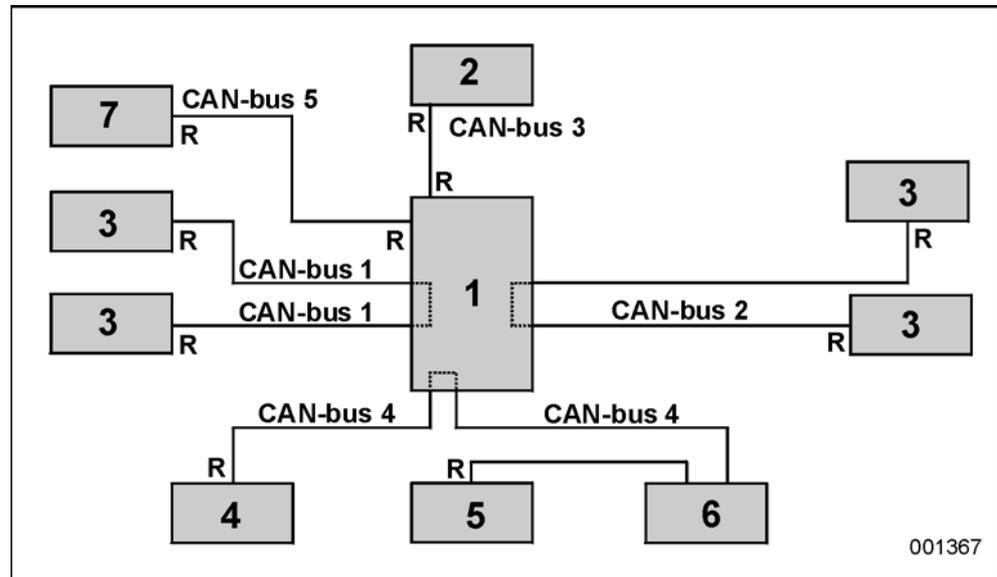
- a computer module (master) that contains the driver, in other words the programmable intelligence;
- a dashboard node (slave) that contains programmable information;
- a number of nodes (slaves) without programmable intelligence, just inputs and outputs;
- CAN-bus (interconnection between the elements of the multiplex system).

Figure: layout



1 Master
2 Slave

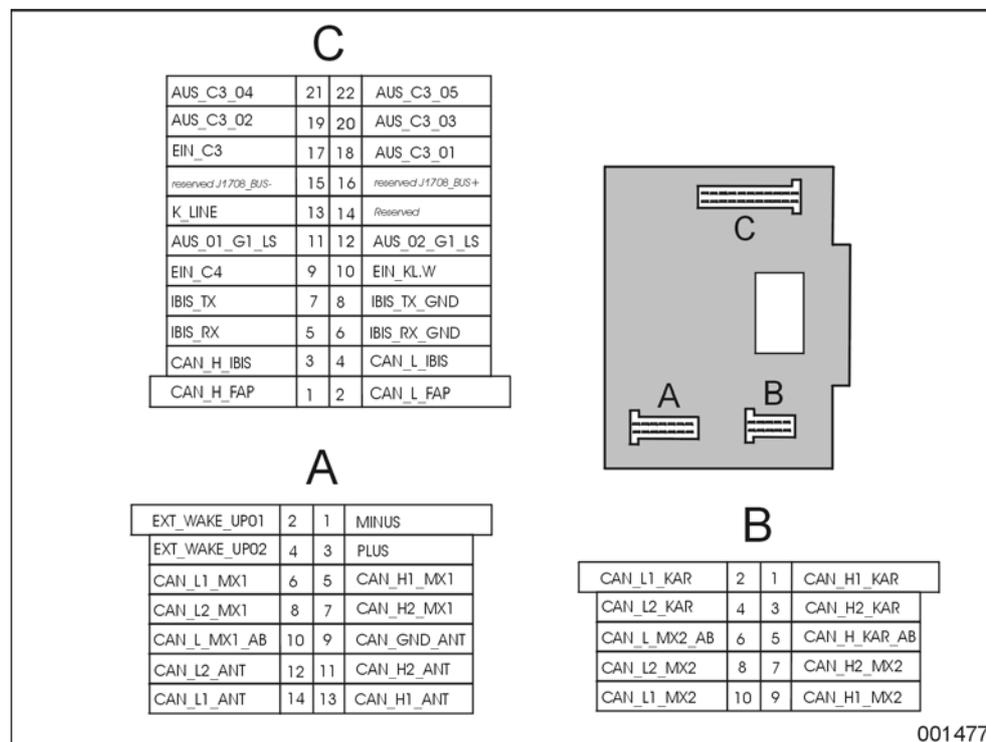
Figure: a
KIBES
multiplex
network in
practice



- 1 Computer module
- 2 Dashboard node
- 3 Node
- 4 Vehicle engine control unit
- 5 Transmission control unit
- 6 ABS/ASR control unit
- 7 Door controls
- R Termination resistor

Kibes computer module

Figure: pin numbering of connectors at computer module



Connectors as seen from wire input side.

What does the computer module contain?

The computer module contains the executive program (the "software") that controls the system.

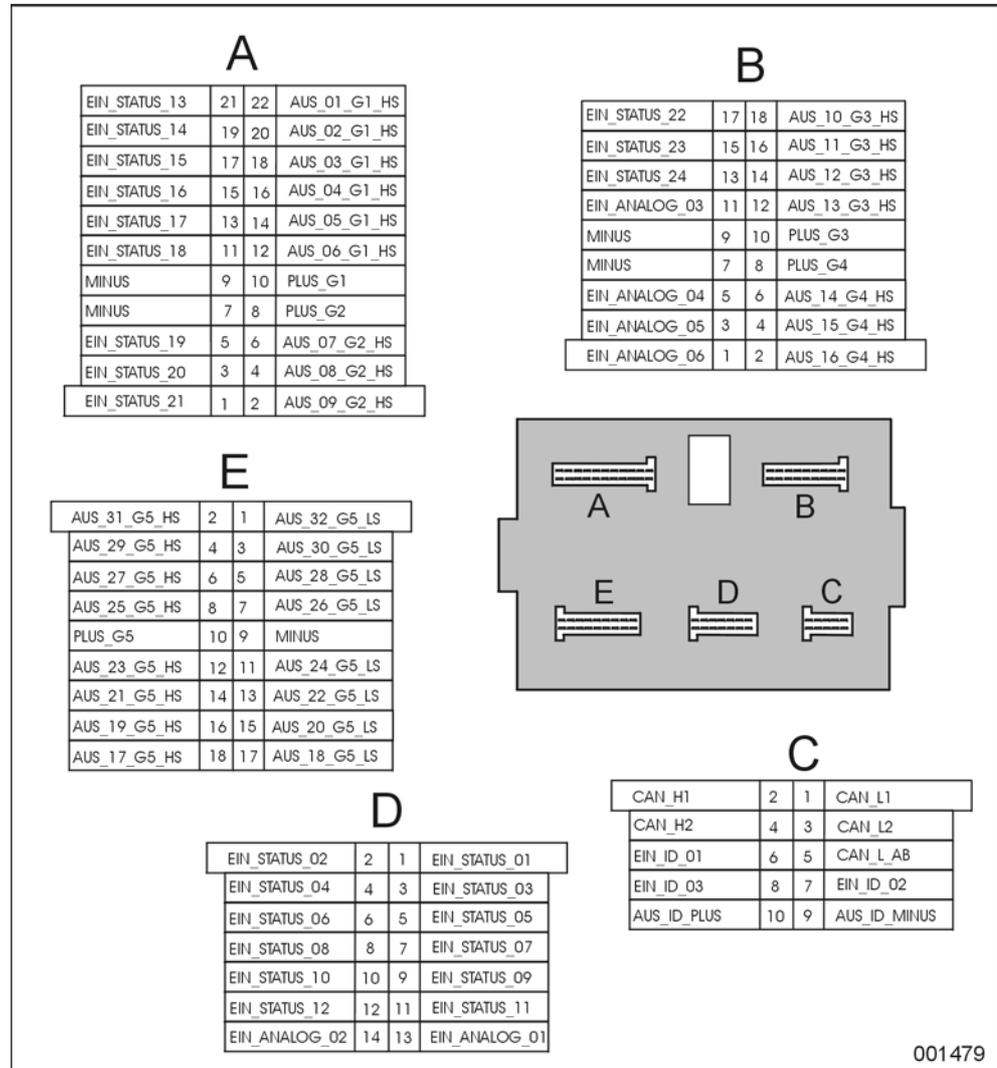
Refer to "Function diagram (FUP)" for the logic of this program.

What in case of defective computer module?

The computer module does not contain repairable parts. If there is a defect, it is to be replaced as a whole by a unit with identical Van Hool order number. This number also contains the code of the program in the computer module.

Nodes

Figure: pin numbering of connectors at node



Connectors as seen from wire input side.

What is a node?

A node is an electronic "switchbox" with inputs and outputs controlled by the computer module to operate (via the outputs) or monitor (via the inputs) the electrical functions of the vehicle.

Inputs

There are two types of input: static and analog.

A(n) ... input	is indicated by ...
static	Ein_Status_

continued on next page

A(n) ... input	is indicated by ...
analog	Ein_Analog_

Outputs

The outputs are protected against overloads and short-circuits. An output is indicated with "Aus_".

The outputs are NOT protected against external application of a voltage to the output.

Power supply

Each node is powered via five separate circuits, each fitted with a 15 A fuse. Each fuse protects a "group" of node outputs.

The internal electronics are fed via the fuse of "group 1" and/or "group 2".

Node locations

The nodes are located throughout the vehicle, close to the components to which they relate, thereby greatly reducing the amount of main cabling.

Are nodes interchangeable?

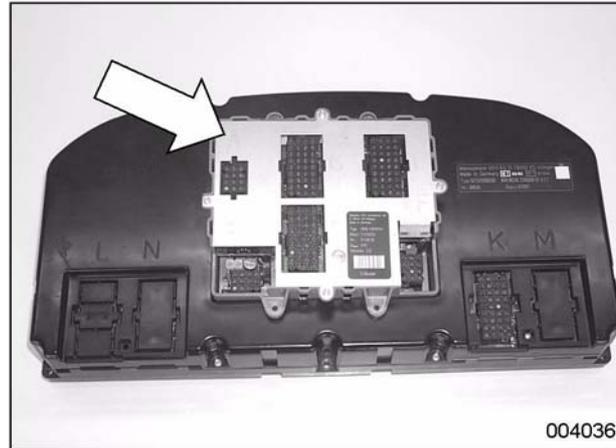
All nodes are interchangeable, with the exception of the dashboard node. This is because the nodes do not contain any software on the one hand and the "addressing" takes place by means of an external wire combination in a connector on the other hand. Addressing ensures that the node recognizes the messages that are intended for it.

What in case of a defective node?

The nodes do not contain any user-repairable parts. A faulty unit must be replaced as a whole.

Dashboard node

Figure:
dashboard
node



What does the dashboard node do?

- The dashboard node receives information relating to the position of the switches on the dashboard and sends this information to the computer module.
- The computer module controls the multifunctional display and the warning and indicator lights on the dashboard via the dashboard node.

Differences from other nodes

- Lower output current rating
- Integrated into the instrument panel
- Contains a program

What in case of a defective dashboard node?

The dashboard node does not contain any components that can be repaired by the user. If there is a fault, you have to replace it together with the instrument panel by a unit of the same Van Hool ordering number as the original. This ordering number relates not only to the dashboard "hardware", but also to the dashboard node program.

CAN bus

What is a communications bus?

A communications bus is an electrical conductor that transfers digital signals in both directions between the components in a multiplex system. This conductor runs throughout the entire vehicle.

What is a CAN bus?

There are different types of bus designs. A CAN bus is a type that has been defined in both ISO and SAE standards. "CAN" is the abbreviation for "Controller Area Network".

A twisted pair of wires (30 twists per meter) or a twin-core shielded cable are used as signal carriers in a CAN bus system.

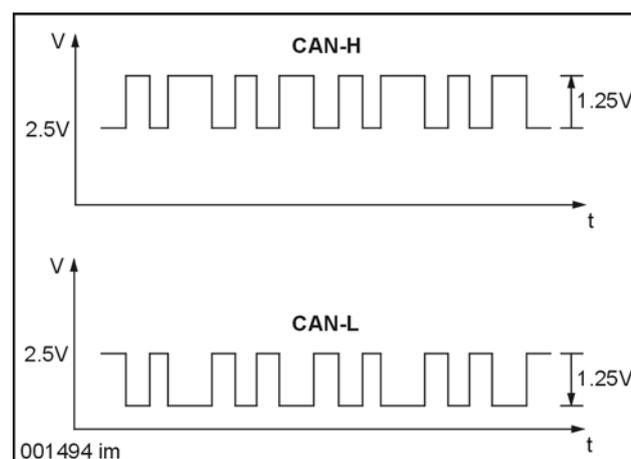
	Twisted wire pair	Twin-core shielded cable
CAN H(igh)	blue	brown
CAN L(ow)	brown	white

Voltages on CAN bus

- CAN H(igh): basic voltage of 2.5V with a positive signal voltage of 1.25V.
- CAN L(ow): basic voltage of 2.5V with a negative signal voltage of 1.25V.

The signal on CAN-L is called the "mirror" signal of CAN-H. This double signal allows for fault detection on data exchange and provides a high degree of protection against interference.

Figure: voltages on CAN bus



Communication speed

The communication speed of a CAN bus depends on the protocol used. The computer module can communicate using different speeds and protocols via separate CAN bus lines:

continued on next page

- For the driveline (SAE J1939): speed of 250 kbit/s (example: communication between control units of the engine, transmission, brakes, ABS,...)
- For bodywork applications (ISO): different speeds possible (example: communication between Kibes computer module and the nodes is effected at a speed of 125 kbit/s).

Termination resistors

Each CAN bus is terminated at both ends with a 120 Ohm resistor. The resistors are necessary to guarantee integrity of data transfer and network stability.

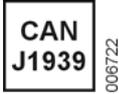
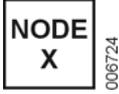
The nodes in the Kibes system are fitted with an internal termination resistor. If necessary, you can switch in the termination resistor simply by placing a wire bridge between pin "3" and "5" of the "C" connector.

Devices with permanent built-in resistor must be fitted at the start or end of the CAN bus.

CAN bus failures

When a CAN bus failure occurs, the MUX symbol appears on the multifunctional display. As from June 2006, a second symbol indicating the location of the failure will appear next to the MUX symbol.

The symbols below may appear together with the MUX symbol:

Symbol	Location
	CAN bus line between computer module and vehicle engine control unit
	CAN bus line between computer module and transmission control unit
	CAN bus line between computer module and ABS/ASR system control unit
	CAN bus line between computer module and retarder control unit
	SAE J1939 connection of computer module
	CAN bus line between computer module and node

continued on next page

Symbol	Location
	CAN bus line between computer module and dash-board node

To test the CAN bus

The CAN bus can be tested with a multimeter:

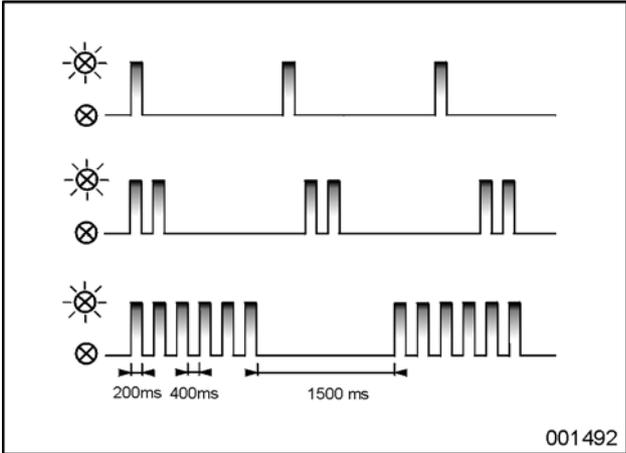
- Vehicle ignition on: There should be a voltage of more than 2.6 V on CAN H and less than 2.4 V on CAN L. An interrupted, inverted or shorted CAN bus can be traced by measuring the voltage.
- Vehicle ignition off: there should be a resistance of 60 Ohms between the two wires on the CAN bus.

You can also test the CAN bus at the node.

NOTE: However, this does not apply to the drive line CAN bus.

The CAN bus may also exceptionally be tested with a test lamp (this differs from the "Safety instructions for the multiplex system" at the beginning of this chapter):

Step	Action
1	<p>Connect a test lamp of maximum 1.4 W between pin C10 of node and ground.</p>

Step	Action
2	<p>Switch the vehicle ignition on.</p> <p>The test lamp starts to flash in a particular pattern.</p> <ul style="list-style-type: none">• Top pattern: CAN bus OK• Middle pattern: CAN bus interrupted• Bottom pattern: only appears when initializing the CAN bus <div style="border: 1px solid black; padding: 10px;"></div> <p>If the lamp goes out or stays off, then:</p> <ul style="list-style-type: none">• the CAN bus has been interrupted or inverted or ...• there is no power to the node, or ...• the node is defective. <p>If the lamp remains on continuously, the node is defective.</p>

Working on the CAN bus



CAUTION!

Do not disconnect CAN bus with the ignition on. Fault messages will be displayed.

**After working
on the CAN
bus****CAUTION!**

The multiplex system must be reset after work has been carried out on the CAN bus.

Follow the procedure below to reset the multiplex system:

Step	Action
1	Switch off the vehicle ignition.
2	Wait for 30 seconds.
3	Turn the central emergency switch off and on. The multiplex system is reset.

**Failure of the
CAN bus**

If the CAN bus fails, the affected node switches to an emergency program that activates specific outputs.

In practice, this means that the outputs of the exterior lighting (front and rear position lamps) connected to this node are activated. This guarantees vehicle safety (visibility).

Technology of node inputs and outputs

Node inputs

There are two types of input: static and analog.

A(n) ... input	changes the voltage level to ...
static	"0" or "1" (e.g. switch off or on). This digital data is then sent via the CAN bus to the computer module for processing. <i>NOTE: The current flow required to operate a static input is only 7mA.</i>
analog	a digital value that corresponds to the magnitude of the input signal (e.g. fuel gauge float).

Static inputs

The static inputs can be powered in different ways: positive (S3), ground (S2) or by a combination of both (S1).

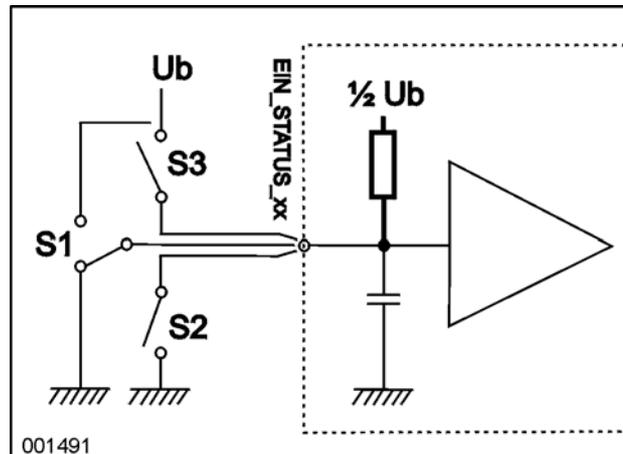
NOTE: You measure a voltage of about half the on-board voltage at the input if the switch is open.

	Switch setting	Voltage at node input	Digital signal
S1 ^a	ground switched	lower than 5V	0
	positive switched	higher than 19 V	1
S2	closed (to ground)	lower than 5 V	1
	open	higher than 7 V	0
S3	open	lower than 16 V	0
	closed (to positive)	higher than 19 V	1

a. This way of switching allows you to determine with a voltmeter whether the switch itself is faulty or whether there is an interruption in the wiring to the node. This switching method is sometimes used with the dashboard node.

continued on next page

Figure:
switching possibilities at static node input



Ub: on-board voltage

S1 Change-over switch

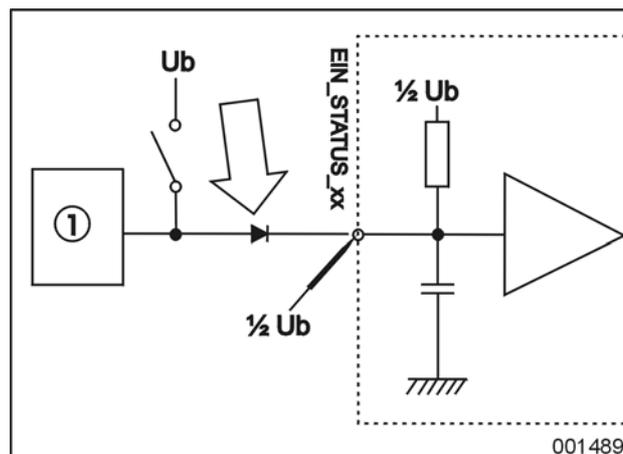
S2 Ground switched

S3 Positive switched

Electronic circuit at static node input

As mentioned above under "Static inputs", there is a voltage equal to approximately half the on-board voltage at the node input, if the switch is open. If you connect an electronic circuit to the node input, in parallel with the switch, then the node input voltage can affect the input of that electronic circuit. To avoid this, a diode (see figure for the correct direction) is placed in the wiring to the electronic circuit.

Figure:
electronic circuit at static node input



Ub: on-board voltage

1 Electronic circuit

continued on next page

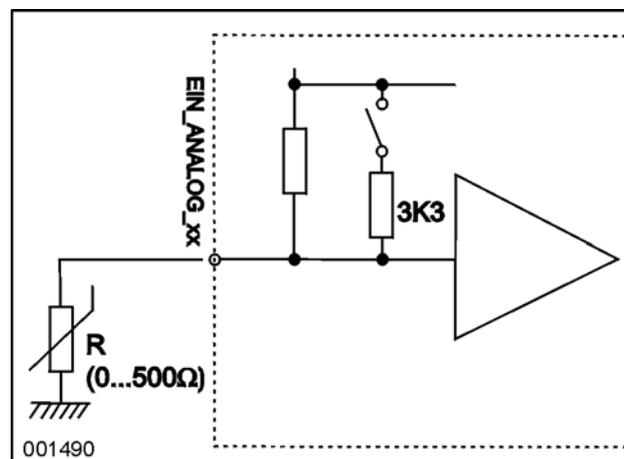
Analog inputs

A number of inputs on each node are specific analog inputs. You can connect a variable resistance of between 0 and 500 ohms to these inputs for further analog processing.

The analog inputs can also be used as static inputs (see table).

Voltage at node input	Digital signal
lower than 5 V	0
higher than 19 V	1

**Figure:
variable
resistance at
analog input**



**Outputs on
nodes**

The outputs are divided into the following types:

High or low switching	Each node has outputs that are positive (high switching) and outputs that are ground (low switching) switched. The "positive" outputs are indicated with "HS", the "ground" outputs with "LS".
Maximum current	All node outputs are protected against short-circuits and overloads. Nevertheless, each output has a maximum output current rating. There are outputs of 1A, 3A, 5A and 10A.
Group	The outputs are divided into five groups. The total load on all outputs in a group must not exceed 15A. The groups are indicated with the letter "G", followed by a group number. For example "G3"

continued on next page

Voltage at node HS output

Output status		Voltage at output
Not active	Not loaded or load circuit interrupted	Few volts
	Loaded	About 0V
Active	Not shorted	On-board voltage
	Shorted	0V

Voltage at node LS output

Output status		Voltage at output
Not active	Not loaded or load circuit interrupted	About 0V
	Loaded	On-board voltage
Active	Not shorted	0V
	Shorted	0V

How do the electronics detect a short circuit at the output?

A short-circuit at a node output is detected via internal feedback.

How do the electronics detect an overload at the output?

An overload at a node output is detected by the thermal cut-outs of the final stages.

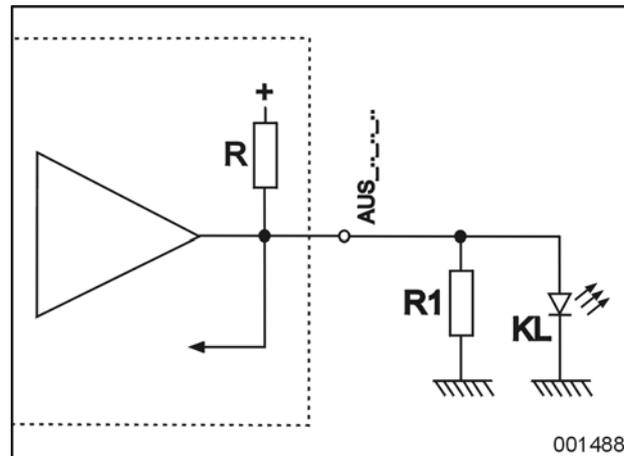
Load with extremely high impedance at node output

An output connected to a load with very high impedance (example: LED) behaves like a non-loaded or interrupted output. Thus, the voltage at the node output can amount to several volts.

On the one hand, this means that very high impedance loads cannot be checked for interruption. On the other hand, the residual voltage can cause side-effects that can only be avoided by installing a resistor (R1) in parallel with the load. This resistor introduces an extra load, making the voltage at the output drop.

continued on next page

Figure: very high impedance load at node output



R: Internal resistance

R1: "Pull-down" resistor

KL: Very high impedance load (for example: LED)

Numbering of inputs and outputs

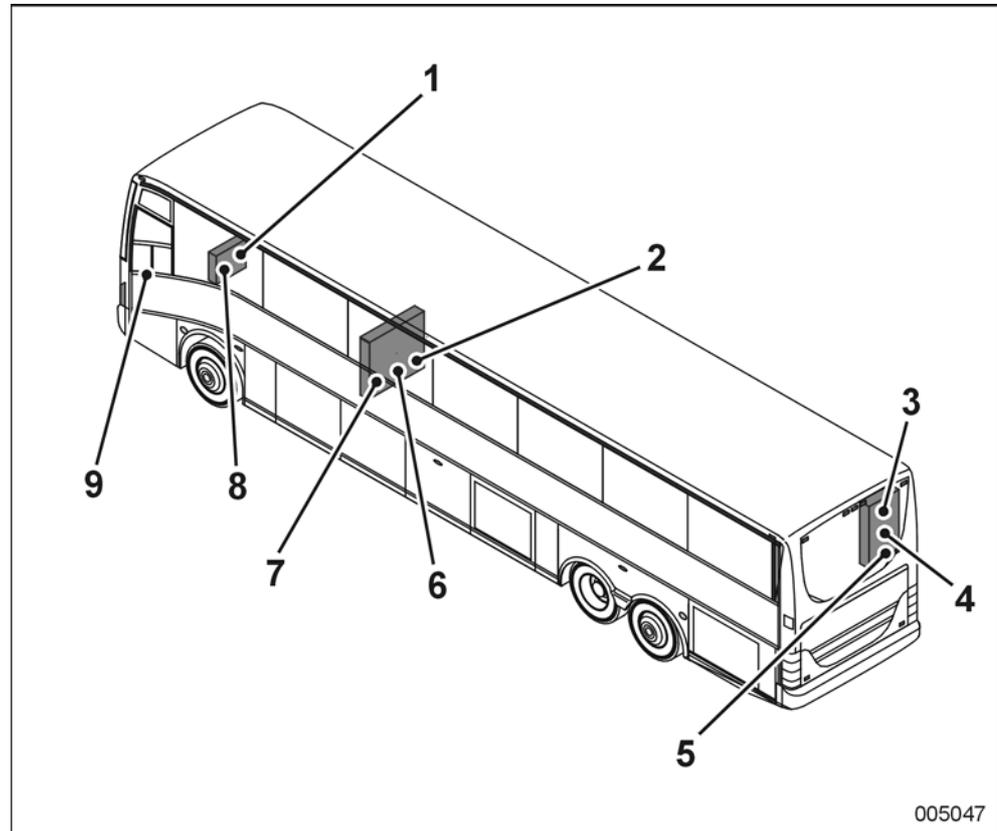
The numbering of inputs and outputs is coded. You will also find this numbering on the schematic circuit diagrams and in the fault code during diagnosis.

Example: N5E12

- N: Node
- 5: Node number
- E: Connector name
- 12: Pin number on connector.

Component location

Figure:
component
location



005047

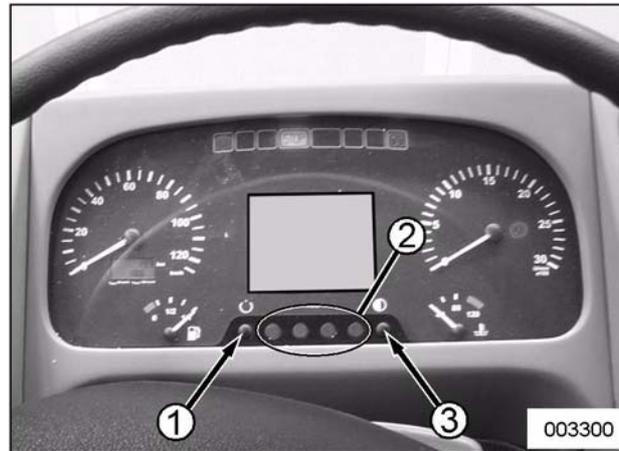
- 1 Node 1
- 2 Computer module
- 3 Node 4
- 4 Node 5
- 5 Node 6
- 6 Node 3
- 7 Node 2
- 8 Diagnostic socket
- 9 Dashboard node

To operate the multifunctional display

Introduction

The aids for testing and the diagnostic systems are activated with the buttons located under the multifunctional display.

Figure: activation buttons of central multi- functional display



- 1 Menu button
- 2 Selection buttons
- 3 Adjusting button for the brightness of the dashboard instruments

Function of control buttons

Button	Function
Menu button	<ul style="list-style-type: none"> • To open/close service menu • To return to previous menu.
Selection buttons	Select the symbols in the lower part of the display to: <ul style="list-style-type: none"> • open the submenu; • select functions in the submenu.



WARNING!

Before operating the multifunctional display to perform simulations or functional tests via the multiplex system, warn people working on the vehicle or about to do so that climate-control system fans and other devices may suddenly engage without the engine running.

continued on next page

**WARNING!**

Never operate the multifunctional display while driving.

**How to open/
close the
service menu?**

To ... the service menu	press ...
open	and hold the menu button for longer than 5 seconds.
close	and hold the menu button again for longer than 5 seconds

**How to open
the submenu?**

Briefly press the selection button below the symbol of the submenu you wish to open.

**How to select a
function from
the submenu?**

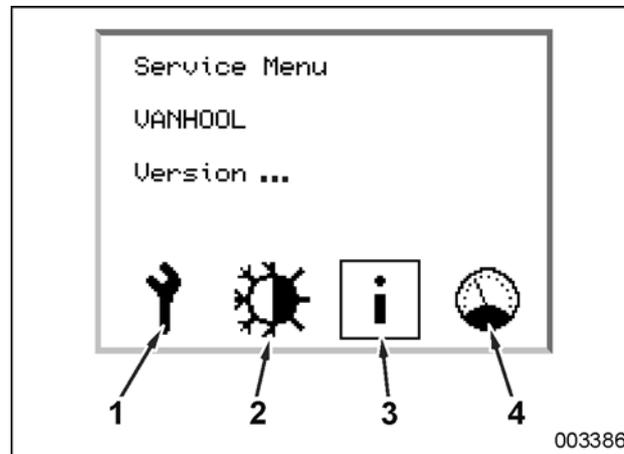
Briefly press the selection button below the symbol of the function you wish to activate.

**How to close
the submenu?**

Briefly press the menu button.

Service menu layout

Figure: the service menu



- 1 *Diagnostics menu*
- 2 *Climate-control menu*
- 3 *Miscellaneous menu*
- 4 *Garage feature menu*

Service menu layout

For more about ...	see ...
diagnostics menu (1)	<ul style="list-style-type: none"> • "On-board diagnostics system: functional check" • "On-board diagnostics system: self-diagnosis".
climate-control menu (2)	Chapter 8.02: "Climate control: control system"
miscellaneous menu (3)	<ul style="list-style-type: none"> • "Aids for testing: "running engine" simulation" • "Aids for testing: "driving vehicle" simulation" • "Identification of the programs" • "To change the language of the multifunctional display"
garage feature menu (4)	"Aids for testing: garage feature"

On-board diagnostics system: functional check

Introduction

The program in the computer module also contains a "functional check". The purpose of it is to check the outputs to which the interior and exterior lights are connected.

Which outputs are checked?

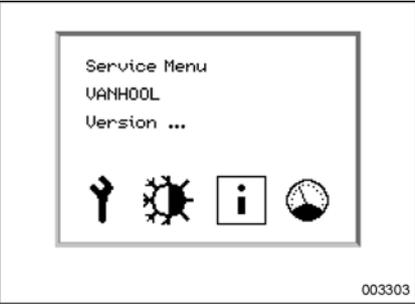
Only the outputs crossed in column "F" (see under "Overview of the inputs and outputs") are checked.

The output marked with a ...	is checked at functional check ...
1	exterior lights.
2	interior lights.

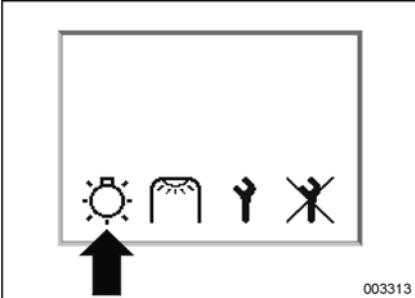
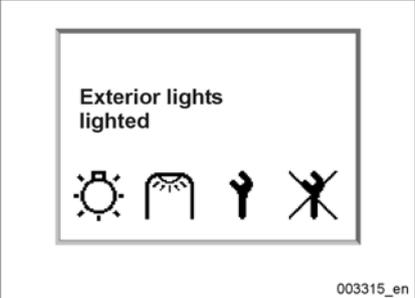
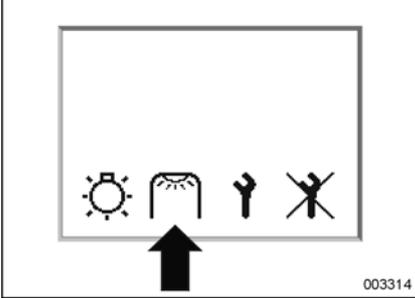
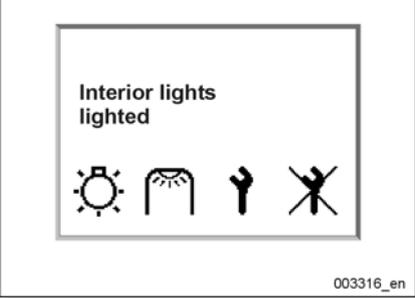
Equipment condition

- Engine off
- Battery isolating switch on

To carry out functional check

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	<p>The service menu appears on the display.</p> 

continued on next page

Step	Action	Result
2	Press the button under the wrench symbol.	<p>The on-board diagnosis menu appears on the display.</p>  <p>003305</p>
3	<p>Press the button under the exterior lights symbol.</p>  <p>003313</p>	<p>The exterior lights will come on.</p>  <p>003315_en</p>
4	Press the button under the exterior lights symbol once more to switch off the function.	
5	<p>Press the button under the interior lights symbol.</p>  <p>003314</p>	<p>The interior lights will come on.</p>  <p>003316_en</p>
6	Press the button under the interior lights symbol once more to switch off the function.	

continued on next page

**To exit
functional
check**

Briefly press the far left button of the multifunctional display as many times as needed to return to the service menu.

On-board diagnostics system: self-diagnosis

Introduction

As soon as the vehicle ignition (+15) is switched on, the computer module checks a number of node inputs and outputs for interruptions and short-circuits.

Equipment condition

- Engine off
- Battery isolating switch on
- Vehicle ignition on

Which inputs and outputs are checked?

Only the inputs and outputs crossed in column "D" (see under "Overview of the inputs and outputs") are checked.

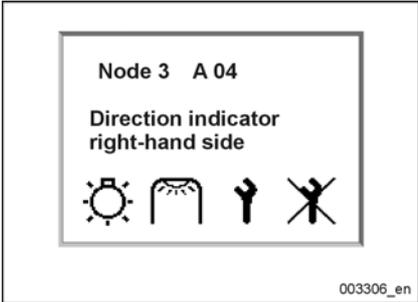
The inputs and outputs indicated by ... in column D	are checked for...
the letter A	interruption and short-circuit.
the letter K	short-circuit.
a digit	interruption and short-circuit.

How are you notified?

If the electronics detect a fault, the wrench symbol appears on the multifunctional display. At the same time the fault is stored as a code in the computer module memory.

To call up a fault code

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	<p>The service menu appears on the display.</p> 

Step	Action	Result
2	Press the button under the wrench symbol.	The on-board diagnosis menu appears on the display. 
3	Press the button under the wrench symbol again.	The node number, connector pin and a description of the fault appear on the display. 
4	Repeat step 3 until you have gone through all of the faults.	

Trouble-shooting

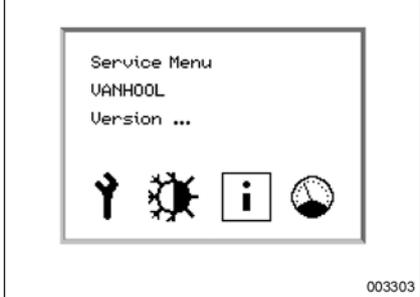
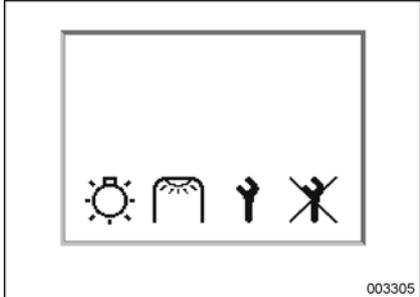
A multimeter and the electric diagram of the vehicle are required to find the exact location of the fault on your vehicle.

To exit self-diagnosis

Briefly press the far left button of the multifunctional display as many times as needed to return to the service menu.

continued on next page

To erase fault memory

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the wrench symbol.	The on-board diagnosis menu appears on the display.  003305
3	Press the button under the crossed out wrench symbol.	The fault memory is erased.  003312_en

When will the wrench symbol disappear?

Even after the fault has been repaired or disappeared spontaneously, the wrench symbol will remain on the display and the fault code(s) will remain in the memory, until you erase the memory manually.

continued on next page

If at the moment you give the erase command ...	then ...
there are no more faults active	the wrench symbol disappears from the display.
there are still faults active	the wrench symbol will remain on the display. Only the non-active faults have been erased. In that case repeat the procedure "To call up fault code". Repair error and repeat "To erase error memory" procedure, until error code disappears.

Aids for testing: "running engine" simulation

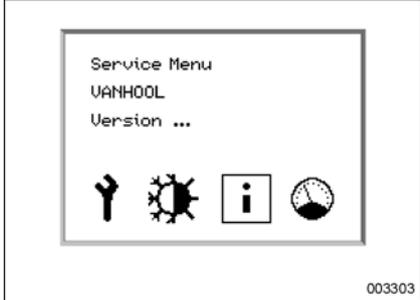
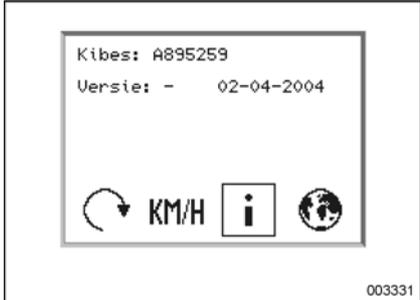
Introduction

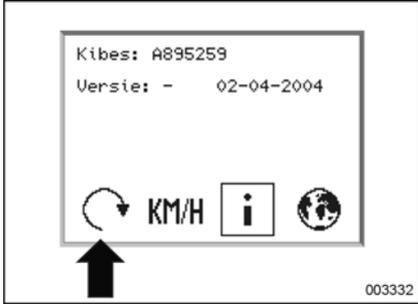
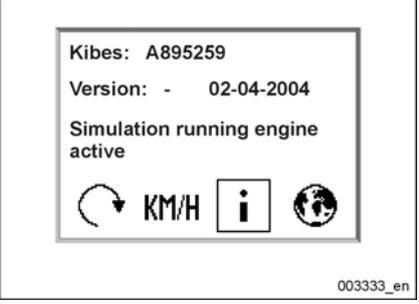
A number of electrical circuits are only powered when the vehicle engine is running. It may occasionally be necessary to simulate the electrical signal of the 'turning engine' (D+) in order to test these electrical circuits without the engine actually being in operation.

Equipment condition

- Engine off
- Battery isolating switch on

To start simulation

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the "i" symbol.	The miscellaneous menu appears on the display.  003331

Step	Action	Result
3	<p>Press the button under the symbol to simulate the "running engine" situation.</p> 	<p>The simulation is now activated and an indicator light comes on next to the pointer in the dashboard revolution counter.</p> 

To end the simulation

Press the button under the symbol for the "running engine" simulation.

The simulation is deactivated and the indicator light does not illuminate any more.

To exit miscellaneous menu

Briefly press the far left button under the multifunctional display as many times as necessary to return to the service menu.

Aids for testing: "moving vehicle" simulation

Introduction

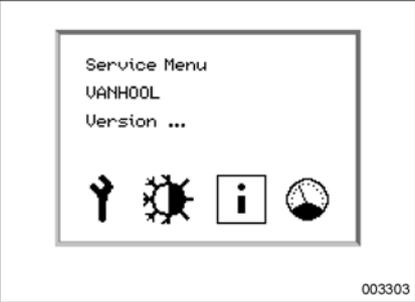
A number of electrical circuits are only powered when the vehicle is in motion. It may occasionally be necessary to simulate the electrical signal of a "moving vehicle" to enable these circuits to be tested without the vehicle actually moving.

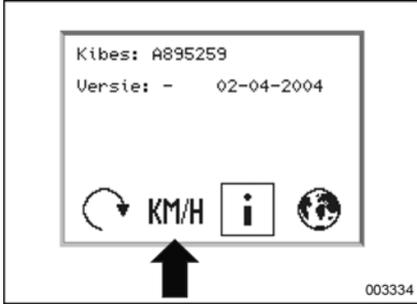
NOTE: When you start this function, the "running engine" simulation will also start. This is in order to approximate a realistic situation as closely as possible.

Equipment condition

- Engine off
- Battery isolating switch on

To start simulation

Step	Action	Result
1	Press and hold the far left button of the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the "i" symbol.	The miscellaneous menu appears on the display.  003331

Step	Action	Result
3	<p>Press the button under the symbol for "moving vehicle" simulation.</p> 	<p>The simulation is activated.</p> 

To end the simulation

Press the button under the symbol for the "moving vehicle" simulation again. The simulation is deactivated.

To exit miscellaneous menu

Briefly press the far left button under the multifunctional display as many times as necessary to return to the service menu.

Identification of the programs

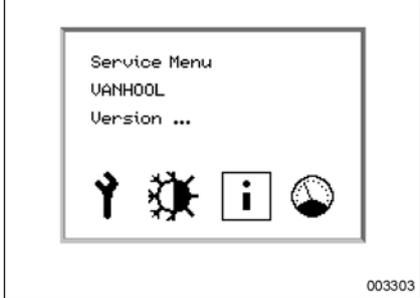
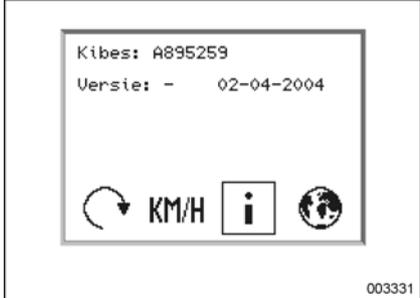
Introduction

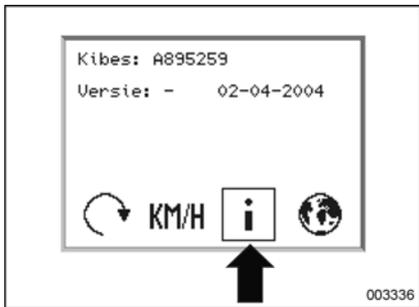
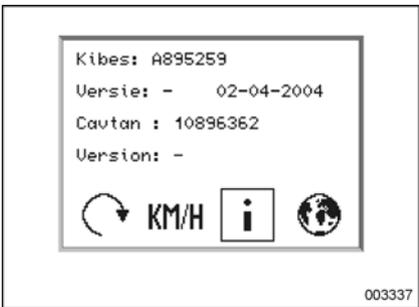
The program for the computer module and that for the dashboard node have unique identification numbers. Both numbers can be called up via the display.

Equipment condition

- Engine off
- Battery isolating switch on

Procedure

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the "i" symbol.	The miscellaneous menu appears on the display.  003331

Step	Action	Result
3	<p>Press the button under the symbol for calling up identification data.</p> 	<p>The identification data of the programs appear on the display.</p> 
4	<p>Press the button under the symbol for calling up identification data again.</p>	<p>The miscellaneous menu appears on the display again.</p>

Recognizing the identification data

After ...	the display shows ...
"Kibes:"	the program identification number in the computer module.
"Version:" (under "Kibes:")	the change code (letter) of the computer module program.
"Cavtan:"	the program identification number in the dashboard node.
"Version:" (under "Cavtan:")	the change code (letter) of the program in the dashboard node.

To exit miscellaneous menu

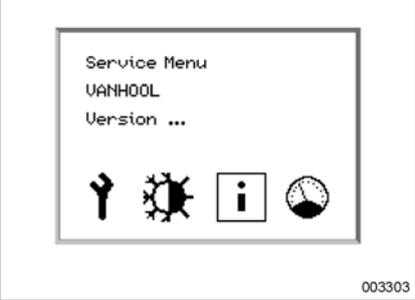
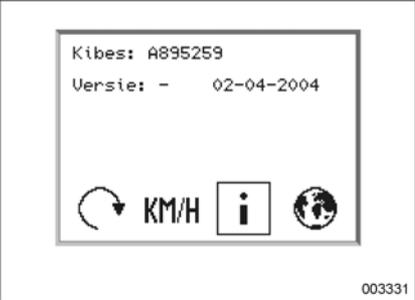
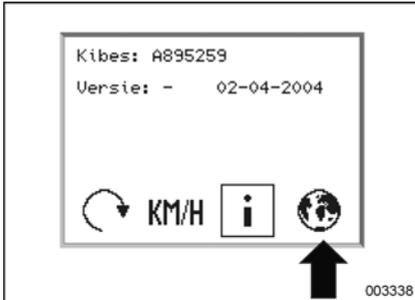
Briefly press the far left button under the multifunctional display as many times as necessary to return to the service menu.

To change the language of the multifunctional display

Equipment condition

- Engine off
- Battery isolating switch on

Procedure

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the "i" symbol.	The miscellaneous menu appears on the display.  003331
3	Press the button under the symbol for language choice.  003338	A different language is given on the display.  003339

continued on next page

Step	Action	Result
4	Repeat step 3 until the desired language appears on the display.	See step 3.
5	Wait for 5 seconds.	The chosen language is loaded into the memory.

To exit miscellaneous menu

Briefly press the far left button under the multifunctional display as many times as necessary to return to the service menu.

Aids for testing: garage feature

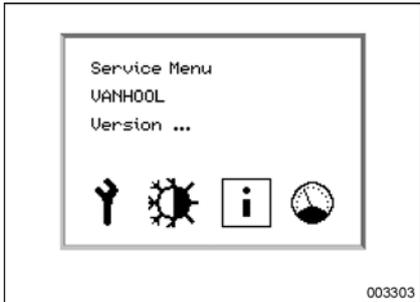
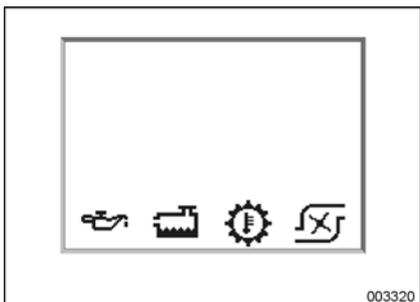
Introduction

It may sometimes be necessary while working on the vehicle to have an information screen permanently visible on the multifunctional display. This can be done with the "garage feature".

Equipment condition

Vehicle ignition on

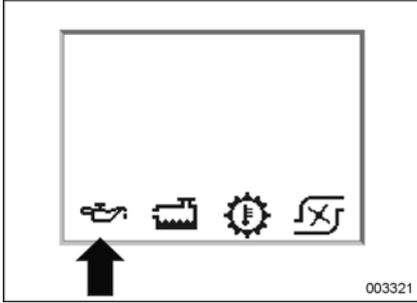
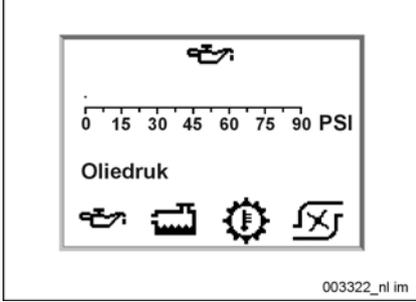
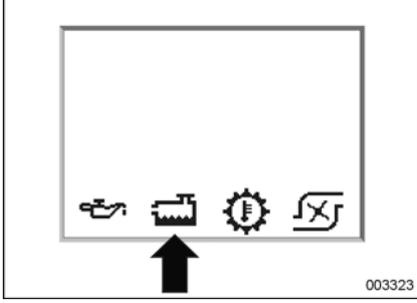
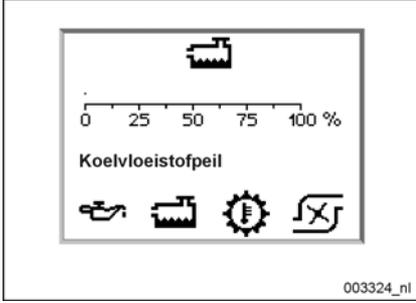
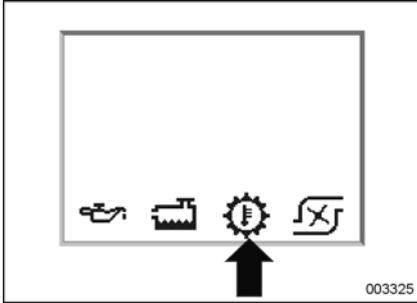
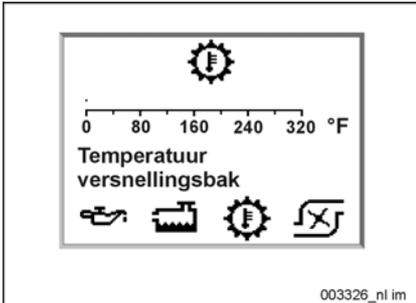
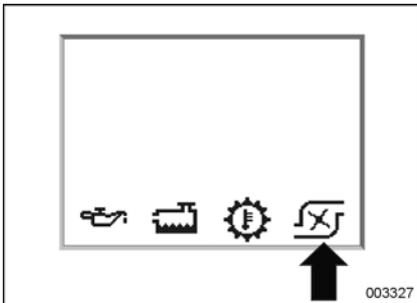
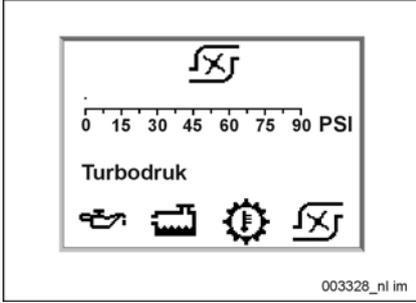
To start garage feature

Step	Action	Result
1	Press and hold the far left button under the display for longer than 5 seconds.	The service menu appears on the display.  003303
2	Press the button under the dial symbol.	The garage feature menu appears on the display.  003320

Possible information screens

NOTE: If a priority fault occurs, the corresponding message will appear on the display, deleting the called-up information screen.

continued on next page

Press the button under ...	to call up ...
 <p style="text-align: right;">003321</p>	<p>oil pressure</p>  <p style="text-align: right;">003322_ni im</p>
 <p style="text-align: right;">003323</p>	<p>coolant level^a</p>  <p style="text-align: right;">003324_ni</p>
 <p style="text-align: right;">003325</p>	<p>transmission temperature^b</p>  <p style="text-align: right;">003326_ni im</p>
 <p style="text-align: right;">003327</p>	<p>turbocharger pressure</p>  <p style="text-align: right;">003328_ni im</p>

- a. Not available for T2100.
- b. Only available in case of a WT transmission.

To exit garage feature

Briefly press the far left button under the multifunctional display as many times as necessary to return to the service menu.

PC-aided diagnosis

Introduction

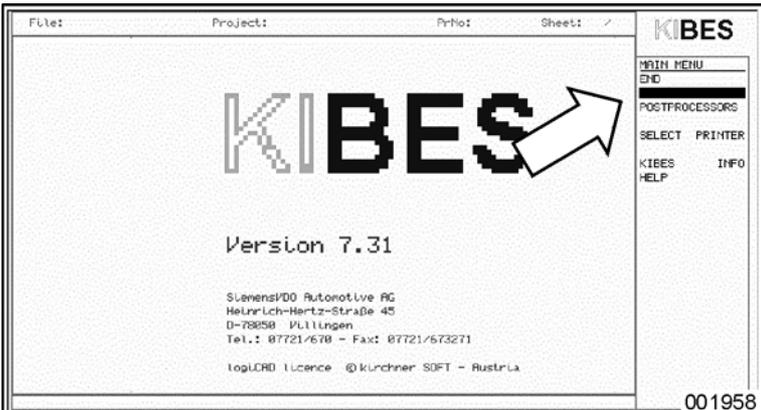
If on-board diagnostics do not yield a solution, you can carry out a complete test of the program present in the Kibes computer module using a PC (or laptop).

Equipment condition

- Kibes RT software installed on PC (refer to "To install Kibes RT software on a PC")
- PC connected to diagnostic socket (refer to "To connect PC to diagnostic socket")
- Battery isolating switch on

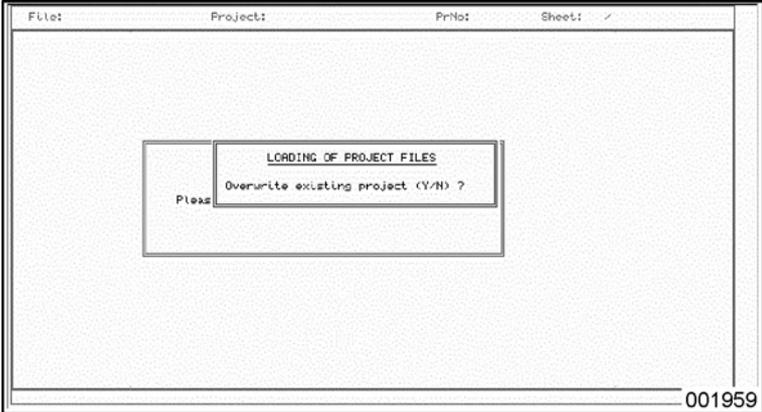
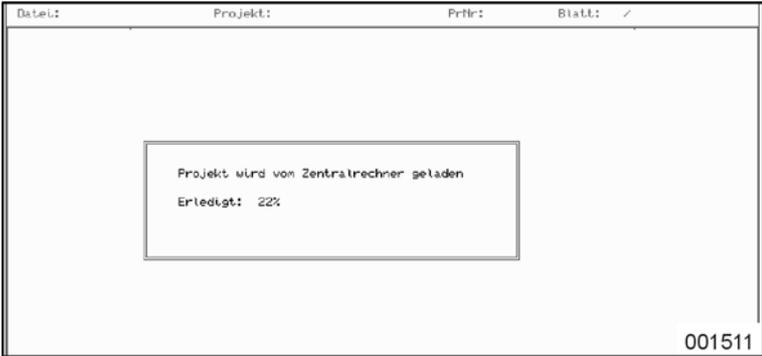
To start diagnosis with O.S. Windows NT/9x/2000/XP

Step	Action
1	<p>Double-click on the KIBES icon.</p> <p>The following is displayed:</p> 

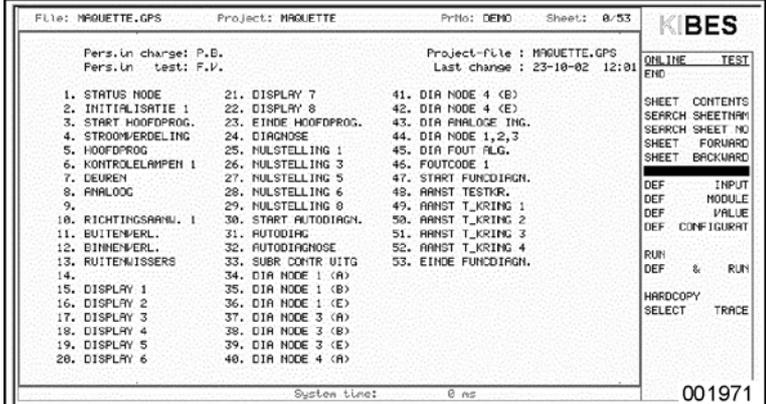
Step	Action
<p>2</p>	<p>Press any key. The following is displayed:</p> 
<p>3</p>	<p>Select "POSTPROCESSORS" from the menu and press ENTER.</p> 

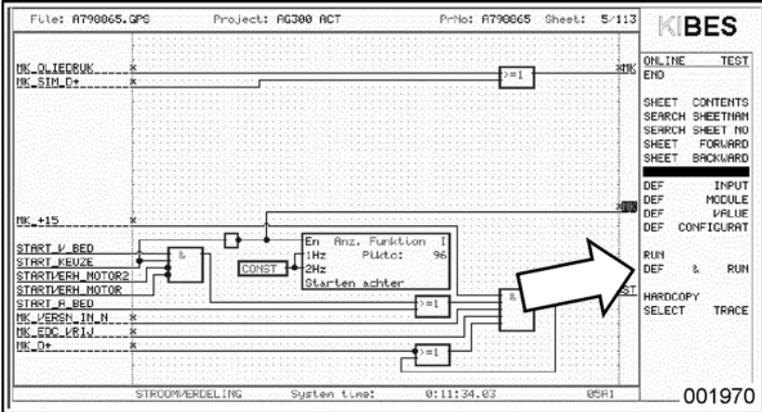
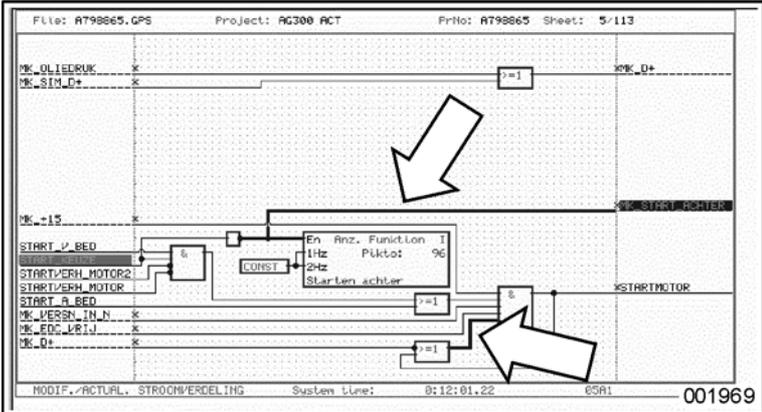
Step	Action
4	<p>Select "ONLINE TEST" from the menu and press ENTER key.</p> <div> </div> <p>The program is loaded into the PC from the computer module. The progress is displayed in percentage.</p> <div> </div> <p><i>NOTE: This screen only appears when you carry out this diagnosis with a PC for the first time.</i></p> <p>If the program version on the PC is older than the one in the computer module, the text below is displayed on the screen. If this is not the case, skip steps 5 and 6 and continue with step 7.</p> <div> </div>

continued on next page

Step	Action
<p>5</p>	<p>Press ENTER.</p> <p>The following is displayed:</p>  <p>The screenshot shows a terminal window with a title bar containing 'Files:', 'Project:', 'Print:', and 'Sheet: /'. In the center, a dialog box titled 'LOADING OF PROJECT FILES' is displayed, asking 'Overwrite existing project (Y/N) ?' with the word 'Please' to the left. The terminal window has the number '001959' in the bottom right corner.</p>
<p>6</p>	<p>Press the "Y" key.</p> <p>The following is displayed:</p>  <p>The screenshot shows a terminal window with a title bar containing 'Datei:', 'Projekt:', 'Print:', and 'Blatt: /'. In the center, a dialog box displays the text 'Projekt wird von Zentralrechner geladen' and 'Erledigt: 22%'. The terminal window has the number '001511' in the bottom right corner.</p> <p>Continue with step 8.</p>
<p>7</p>	<p>The following information is displayed:</p> <p>“ONLINE TEST</p> <p>You now start with the KIBES-online test and confirm to accept the accompanying license agreement with the restrictions stated in paragraph 1.5. The online test can influence the vehicle's behavior on the road. The license holder is responsible for all the consequences of carrying out the test with a moving vehicle.</p> <p>Continue <Y/N>?”</p> <p><i>NOTE: If the program has been read from the computer module before, the overview page will be displayed immediately (see later in the procedure).</i></p>

continued on next page

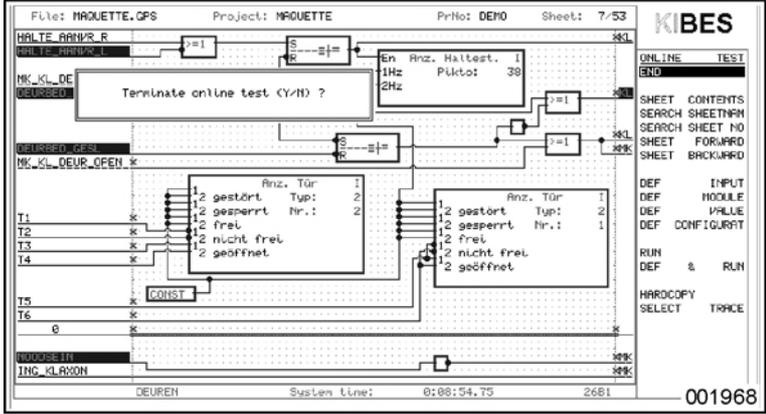
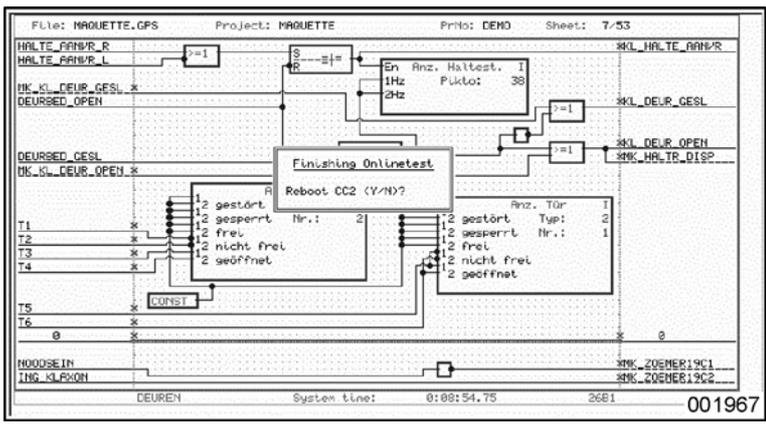
Step	Action
8	<p>Press "Y" followed by the ENTER key.</p> <p>The program overview page appears on the screen:</p> 
9	<p>Select the page that contains the logic of the function to be tested.</p> <p>You can now make your choice:</p> <ul style="list-style-type: none"> • via the table of contents. Choose "SHEET CONTENTS" and press ENTER. The table of contents is displayed. Select the desired page with the arrow keys. • via the page name or number. Select the "SEARCH SHEETNAM" or "SEARCH SHEET NO" and press ENTER. Enter the page name or number. The desired page will be displayed immediately. • Function keys F9 and F10. Use F10 to browse forwards, F9 to browse backwards. This function will remain available, even when the computer is "on line".

Step	Action
<p>10</p>	<p>Select "DEF & RUN" from the menu and press ENTER. The "ON LINE" function is now active.</p>  <p>The status of the inputs and outputs can now be followed on screen. A thick blue line means "active", a thin line means "not active".</p> 

To end diagnosis

Step	Action
<p>1</p>	<p>Press "ESC" key.</p>

continued on next page

Step	Action
2	<p>Select "END" from the menu and press ENTER key to stop diagnosis.</p> <p>The following is displayed:</p> 
3	<div style="display: flex; align-items: center;">  <p>WARNING!</p> </div> <p>If the "ON-LINE" test is carried out during driving, you are not permitted to select "Y". "Y" means that all electrical circuits connected to the multiplex system are temporarily deactivated. This can be dangerous with a moving vehicle.</p> <ul style="list-style-type: none"> • Moving vehicle: Press "N" key. • Stationary vehicle: Press "N" or "Y" key. 

To start diagnosis with O.S. Windows 3.11

Step	Action
1	Double-click on DOS icon or restart in DOS.

continued on next page

Step	Action
2	Type "KS" and press ENTER key.
3	Continue with steps 2 to 10 under "To start diagnosis with O.S. Windows NT/9x/2000/XP".

**To start
diagnosis with
O.S. DOS**

Step	Action
1	Type "KS" and press ENTER key.
2	Continue with steps 2 to 10 under "To start diagnosis with O.S. Windows NT/9x/2000/XP".

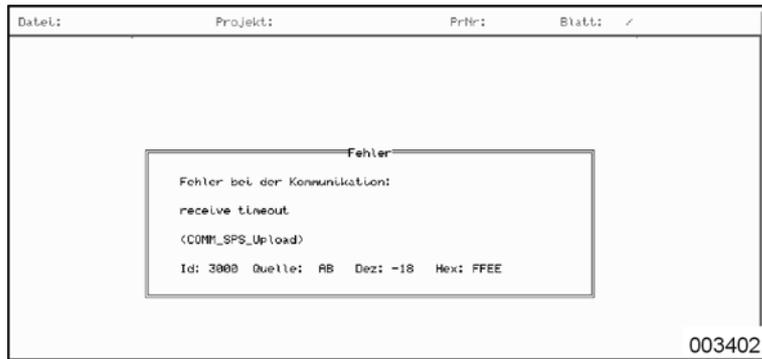
**What if there is
a communi-
cation error?**

See "Troubleshooting" under "Diagnosis with a PC".

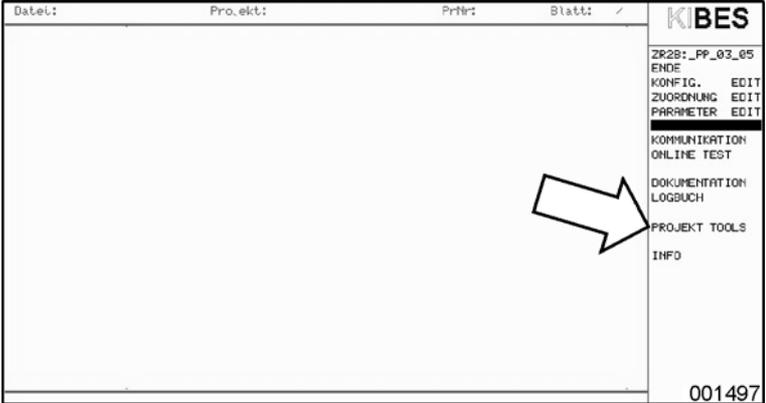
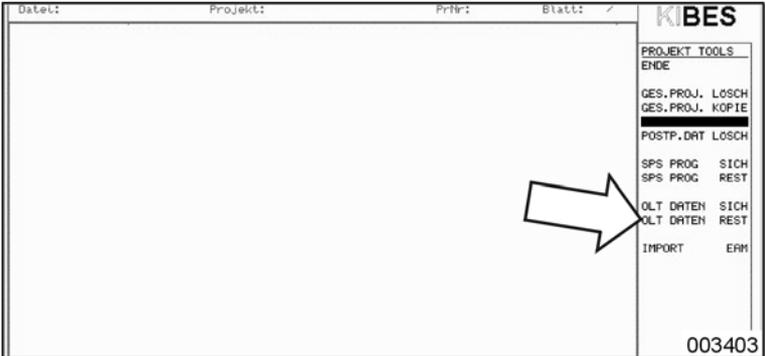
To troubleshoot using "Diagnosis with a PC".

Communication problem

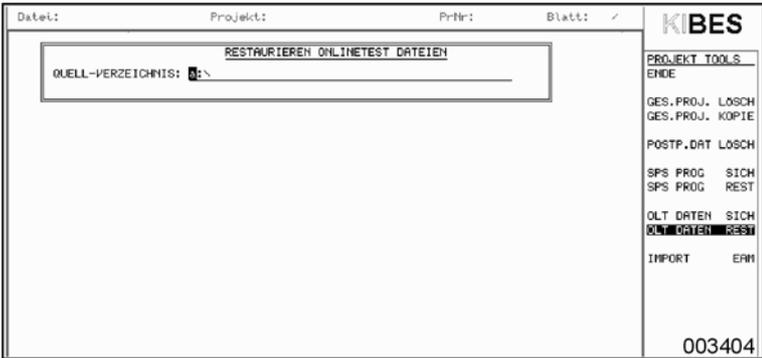
The following error message may appear when starting the diagnosis using a PC:



To solve the problem

Step	Action
1	<p>Select "PROJEKT TOOLS" and press ENTER.</p> 
2	<p>Select "OLT DATEN REST" and press ENTER.</p> 

continued on next page

Step	Action
3	<p>Enter the location of the "ZIP" file:</p> <ul style="list-style-type: none"> • "a:\", if loading directly from diskette; • "c:\" followed by the name of the folder you have copied the files to, when loading is done from the hard disc. 
4	<p>Press ENTER. A form screen appears.</p>
5	<p>Press ENTER. A list of programs at the previously specified location displays.</p>
6	<p>Select the appropriate program number. You will find this number on the diskette label, in the e-mail or on the Kibes computer module.</p>
7	<p>Wait for approximately 4 seconds. Select "ENDE" from the menu and press ENTER. You can now start the diagnosis as described in "Diagnosis with a PC".</p>

To load program in Kibes computer module

Introduction

Sometimes it is necessary to update the program in the Kibes computer module. The update is supplied to you by Van Hool on a diskette or by e-mail. It always consist of two files (one with "prg" extension and one with "zip" extension).

Equipment condition

- PC connected to diagnostic socket (refer to "To connect PC to diagnostic socket")
- Kibes RT software installed on PC (refer to "To install Kibes RT software on PC")
- Vehicle at standstill
- Battery isolating switch on

To call up program number and change code

See "Identification of the programs"



WARNING!

Do not load the program while the vehicle is being driven. All the electrical circuits connected to the multiplex system are temporarily deactivated during the loading of the program. This will cause you to lose control of the vehicle.

Procedure

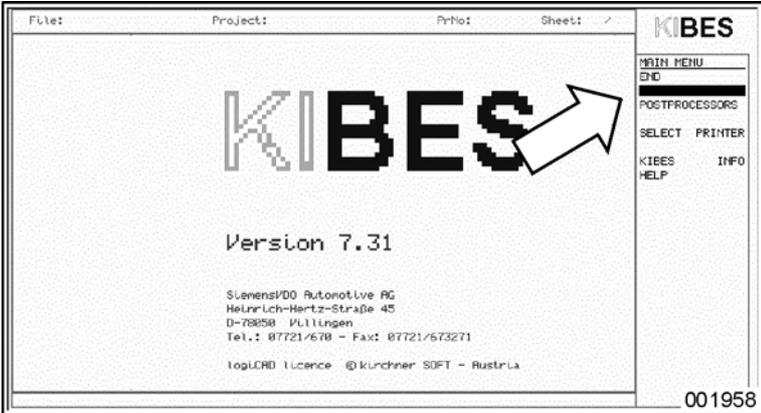


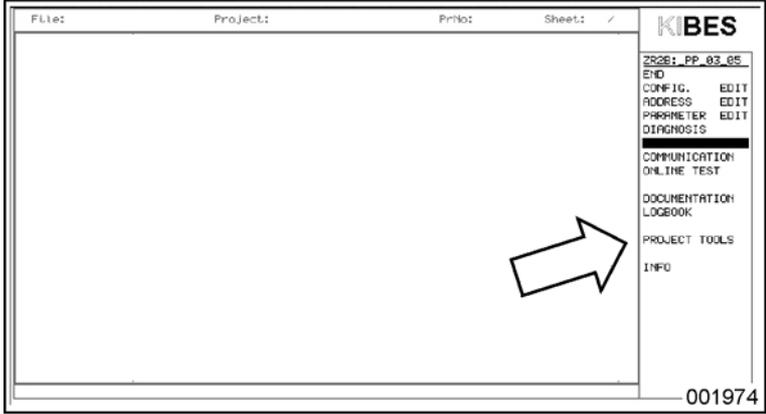
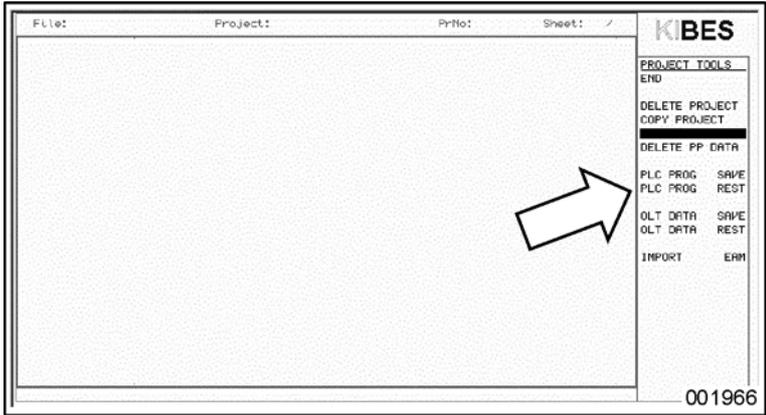
CAUTION!

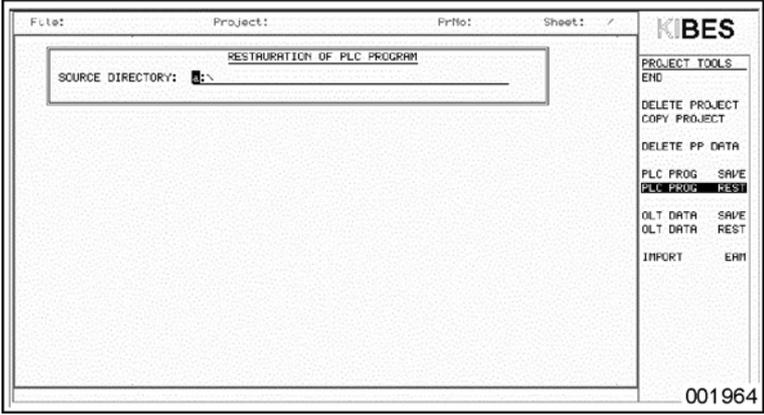
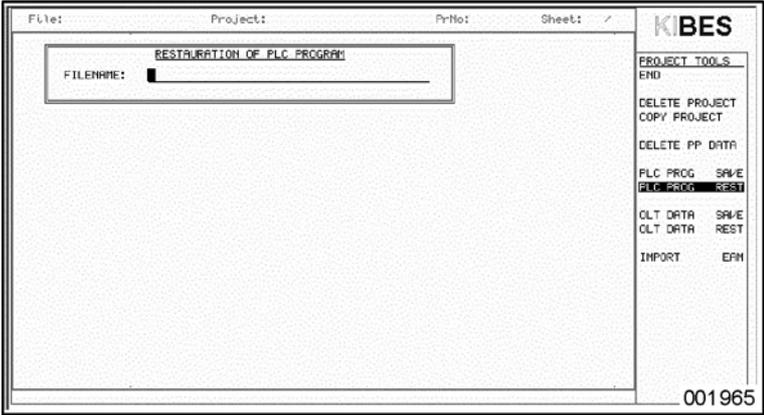
The "zip" file can be opened with the Kibes RT software only, not with "WinZip". Otherwise the file will be damaged.

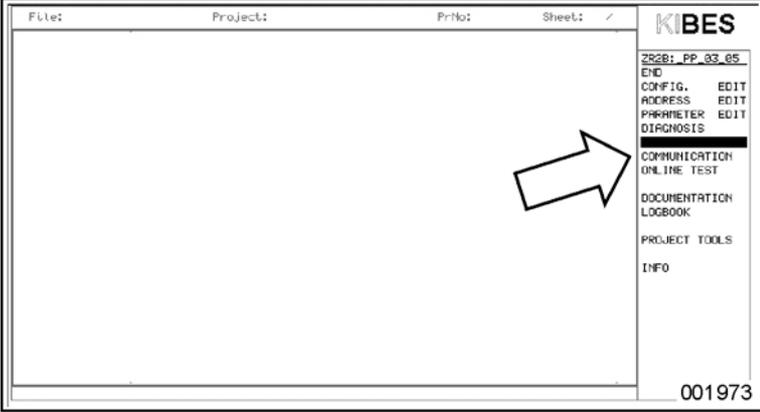
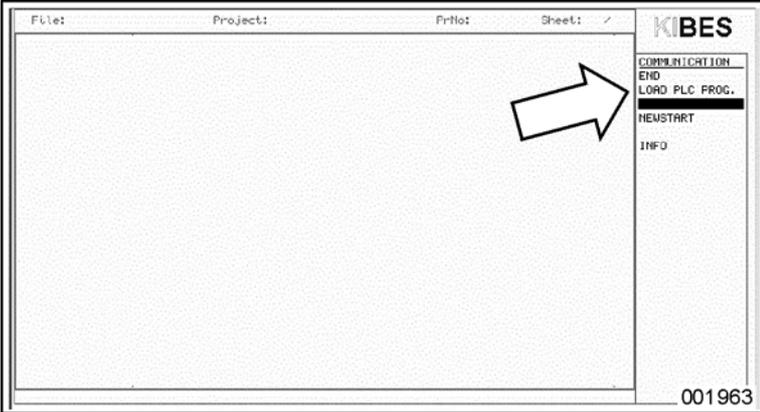
The new program can be installed as follows:

- either directly from diskette, or
- first copy it to the hard disc and then load it from there. Look for the location of the files, as you will be required to enter it further on.

Step	Action
<p>1</p>	<p>Double-click on the KIBES icon.</p> <p>The following is displayed:</p> 
<p>2</p>	<p>Press any key.</p> <p>The following is displayed:</p> 
<p>3</p>	<p>Select "POSTPROCESSORS" from the menu and press ENTER.</p> 

Step	Action
<p>4</p>	<p><i>NOTE: Steps 4 through 9 only have to be carried out, when the program is loaded for the first time.</i></p> <p>Select "PROJECT TOOLS" from the menu and press ENTER key.</p>  <p>The screenshot shows the KIBES software interface. The menu on the right lists several options: ZSBE: PP_02_05, END, CONFIG. EDIT, ADDRESS EDIT, PARAMETER EDIT, DIAGNOSIS, COMMUNICATION, ONLINE TEST, DOCUMENTATION, LOGBOOK, PROJECT TOOLS (highlighted with a thick bar and an arrow), and INFO. The bottom right corner of the window displays the number 001974.</p>
<p>5</p>	<p>Select "PLC PROG REST" from the menu and press ENTER key.</p>  <p>The screenshot shows the KIBES software interface with the 'PROJECT TOOLS' menu open. The menu options are: PROJECT TOOLS, END, DELETE PROJECT, COPY PROJECT, DELETE PP DATA, PLC PROG SAVE, PLC PROG REST (highlighted with a thick bar and an arrow), OLT DATA SAVE, OLT DATA REST, and IMPORT ERM. The bottom right corner of the window displays the number 001966.</p>

Step	Action
6	<p>Enter the location of the "prg" file:</p> <ul style="list-style-type: none"> • "a:\", if loading directly from diskette; • "c:\" followed by the name of the folder you have copied the files to, when loading is done from the hard disc. 
7	Press ENTER.
8	<p> WARNING!</p> <p>Before continuing, check whether the program number on the diskette label or on the e-mail matches that on the Kibes computer module. Installing the wrong program can lead to hazardous situations.</p> <p>Enter program number.</p> 
9	Wait for approximately 4 seconds. Choose "END" from the menu and press ENTER key.

Step	Action
<p>10</p>	<p>Choose "COMMUNICATION" from the menu and press ENTER key.</p>  <p>The screenshot shows a terminal window with a menu on the right side. The menu items are: 2528: PP_03_05, END, CONFIG. EDIT, ADDRESS EDIT, PARAMETER EDIT, DIAGNOSIS, COMMUNICATION (highlighted with a thick bar and an arrow), ONLINE TEST, DOCUMENTATION, LOGBOOK, PROJECT TOOLS, and INFO. The number 001973 is at the bottom right.</p>
<p>11</p>	<p>Select "LOAD PLC PROG" from the menu and press ENTER key.</p>  <p>The screenshot shows the same terminal window as in step 10, but the menu is now open to the 'COMMUNICATION' submenu. The items are: COMMUNICATION, END, LOAD PLC PROG. (highlighted with a thick bar and an arrow), NEWSTART, and INFO. The number 001963 is at the bottom right.</p>

Step	Action
<p>12</p>	<div> </div> <p>WARNING!</p> <p>Before continuing, check whether the program number on the diskette label or on the e-mail matches that on the Kibes computer module. Installing the wrong program can lead to hazardous situations.</p> <p>Enter program number.</p> <div> </div>

Step	Action
15	<p>On the Kibes computer module sticker, mark the change code you find on the diskette label or in the e-mail. The change code consists of one letter.</p> <div style="border: 1px solid black; padding: 10px;"><p>Software Kibes</p><p style="text-align: right;">VANHOOL</p><p>Type: _____</p><p>VHnr: _____</p><p>A <input type="checkbox"/> B <input type="checkbox"/> C <input type="checkbox"/> D <input type="checkbox"/> E <input type="checkbox"/> F <input type="checkbox"/> G <input type="checkbox"/></p><p>H <input type="checkbox"/> I <input type="checkbox"/> J <input type="checkbox"/> K <input type="checkbox"/> L <input type="checkbox"/> M <input type="checkbox"/> N <input type="checkbox"/></p><p style="text-align: right;">003423</p></div>

To connect a PC to the diagnostic socket

Introduction

You have to use a special adapter module to connect the PC to the vehicle diagnostic socket.

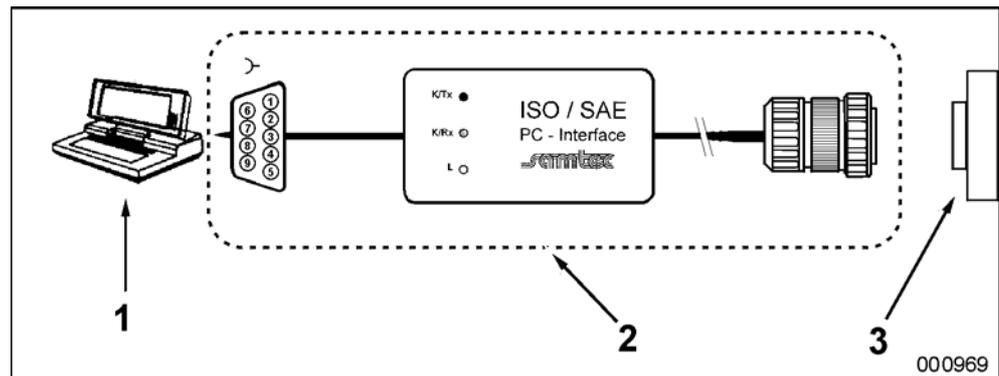
Special tools

Adapter module K-Line V24	Van Hool No. 10797942
---------------------------	-----------------------

PC system requirements

Processor	at least Intel 386 or equivalent
Internal memory	at least 8 MB RAM
Conventional memory	at least 580 kB
Graphic card	EGA (640 x 350) or VGA (640 x 480)
Diskette drive	3.5"
Free space on hard disc	at least 10 MB
Ports	<ul style="list-style-type: none"> • serial port for mouse • serial port (RS232) for connection to computer module ZR2-BD (Kibes)
Driver	<ul style="list-style-type: none"> • DOS 5.0 or higher, or... • Windows 95, 98, NT, 2000 or XP

Figure:
connection
diagram



- 1 PC
- 2 Adapter module K-Line V24
- 3 Vehicle diagnostic socket

To install Kibes RT software on PC

How is the software supplied?

The Kibes RT software is supplied by Van Hool:

- on a cd-rom, or...
- by e-mail.

Windows 2000/XP

Apart from the Kibes RT software, the cd-rom (or e-mail) also contains some supplementary files. These only have to be installed if your computer works under Windows 2000 or Windows XP.

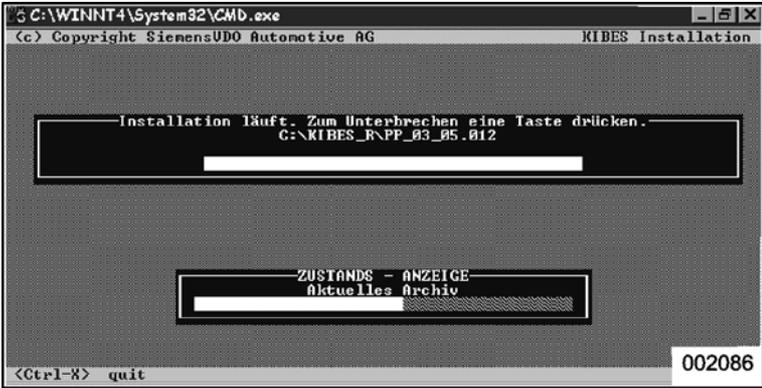
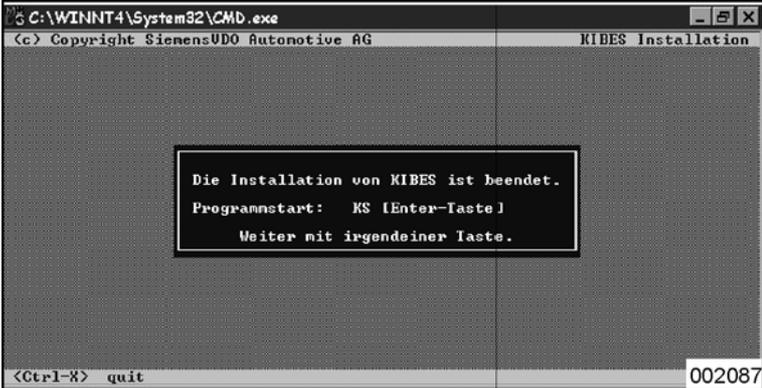
Where do I find these files?

Information carrier	Location
cd-rom	In the "Dos Enabler", "Kithara Tool" or "Tool for Win 2000 and Win XP" directory
e-mail	In the compressed file ("zip" file)

To install software with cd-rom

Step	Action
1	Put the cd-rom in the cd-rom player.
2	Use the explorer to go to the cd-rom player.
3	Double click on the "Rt_03_05_versie." directory.
4	Double click on the "Install.bat" file. The following is displayed: <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <pre>C: lokale-Festplatte (569212928 Bytes frei) F: Netz-Laufwerk (190000128 Bytes frei) J: Netz-Laufwerk (190000128 Bytes frei) M: Netz-Laufwerk (190000128 Bytes frei) N: Netz-Laufwerk (190000128 Bytes frei) O: Netz-Laufwerk (190000128 Bytes frei) X: Netz-Laufwerk (190000128 Bytes frei)</pre> </div>
5	Select "c: lokale-Festplatte (..... Bytes frei)" and press ENTER. The following is displayed: <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <pre>BITTE WÄHLEN SIE DAS INSTALLATIONS-VERZEICHNIS (Benutzen Sie ein Plattenlaufwerk) [C:\KIBES_R_</pre> </div>

continued on next page

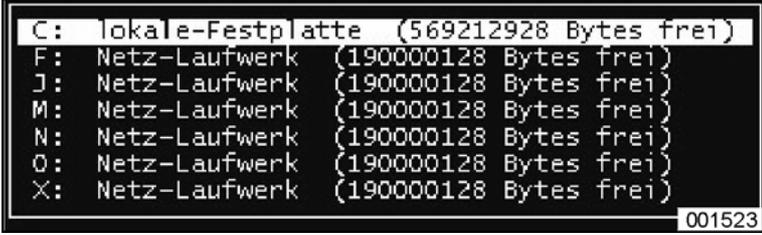
Step	Action
<p>6</p>	<p>Press ENTER. The following is displayed:</p> 
<p>7</p>	<p>Select "COM1" and press ENTER. The Kibes RT software is now loaded onto the PC. A bar shows loading progress.</p>  <p>The message below will appear when the entire Kibes RT software has been loaded.</p> 

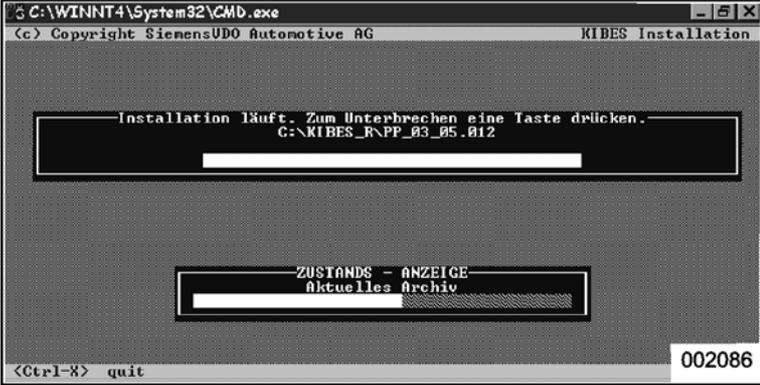
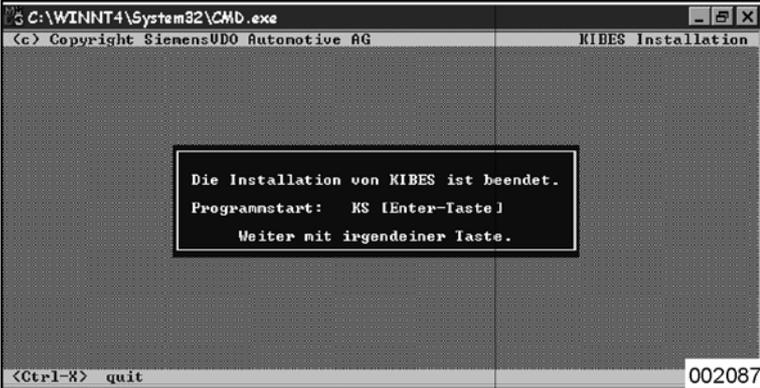
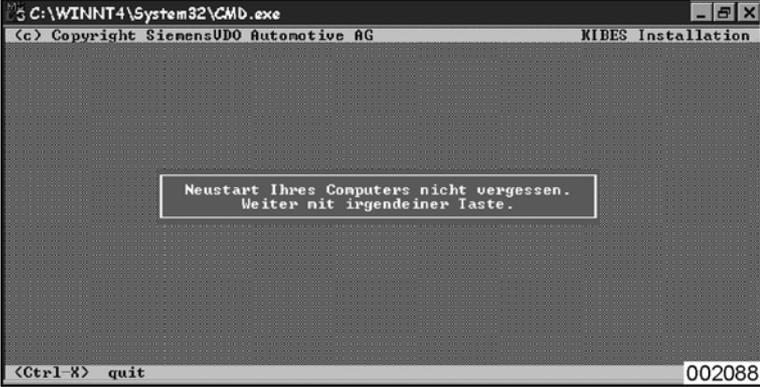
Step	Action
8	<p>Press any key of the keyboard.</p> <p>The message below appears, reminding you that the PC has to be restarted.</p> 
9	Press any key of the keyboard.
10	<p>Create a hyperlink to c:\KIBES_R\KS.BAT on your desktop.</p> <p>The Kibes RT software has been installed.</p>
11	<ul style="list-style-type: none"> • If you use Windows 95/98, follow the instructions mentioned under "Only for Windows 95/98" as described below. • If you use Windows 2000/XP, install the supplementary software for Windows 2000/XP as described below.
12	<p><i>NOTE: Only execute this step if you use Windows XP.</i></p> <p>Follow the instructions mentioned under "Only for Windows XP".</p>

To install software by e-mail

Step	Action
1	Open the e-mail.
2	Copy the compressed file "rt-03-05.zip" to the hard disk (C:\) of the PC.
3	<p>Open the explorer to go to the compressed file "rt-03-05.zip" on the hard disk of the PC and double click on the file.</p> <p>The compressed file is unpacked. The PC creates a directory on the hard disk with the same name but without the "zip" extension.</p>
4	<p>Open directory "rt-03-05".</p> <p>Here you will find files related to the Kibes RT software as well as to the supplementary software for Windows 2000/XP.</p>
5	Create a new directory under the "rt-03-05" directory.

continued on next page

Step	Action
6	Put the Kibes RT files (disk.id, english.exe, german.exe, install.bat, kibes.001, kibes.002, runtime.inf) in the new directory under "rt-03-05".
7	<p>Double click on the "Install.bat" file.</p> <p>The following is displayed:</p>  <p>The screenshot shows a command prompt window with the following text: C: lokale-Festplatte (569212928 Bytes frei), F: Netz-Laufwerk (190000128 Bytes frei), J: Netz-Laufwerk (190000128 Bytes frei), M: Netz-Laufwerk (190000128 Bytes frei), N: Netz-Laufwerk (190000128 Bytes frei), O: Netz-Laufwerk (190000128 Bytes frei), X: Netz-Laufwerk (190000128 Bytes frei). A cursor is at the end of the first line. A small box with '001523' is in the bottom right corner of the screenshot.</p>
8	<p>Select "c: lokale-Festplatte (..... Bytes frei)" and press ENTER.</p> <p>The following is displayed:</p>  <p>The screenshot shows a text-based menu with the text: BITTE WÄHLEN SIE DAS INSTALLATIONS-VERZEICHNIS (Benutzen Sie ein Plattenlaufwerk). Below it, [C:\KIBES_R_] is highlighted with a cursor. A small box with '001524' is in the bottom right corner of the screenshot.</p>
9	<p>Press ENTER.</p> <p>The following is displayed:</p>  <p>The screenshot shows a screen titled 'Kommunikations-Schnittstelle' with two options: 'COM1' and 'COM2'. 'COM1' is highlighted with a cursor. A small box with '001525' is in the bottom right corner of the screenshot.</p>
10	<p>Select "COM1" and press ENTER.</p>  <p>This screenshot is identical to the one in step 9, showing 'COM1' selected. A small box with '001525' is in the bottom right corner of the screenshot.</p>

Step	Action
11	<p>Press ENTER.</p> <p>The Kibes RT software is now loaded onto the PC. A bar shows loading progress.</p>  <p>The message below will appear when the entire Kibes RT software has been loaded.</p> 
12	<p>Press any key of the keyboard.</p> <p>The message below appears, reminding you that the PC has to be restarted.</p> 

Step	Action
13	Press any key of the keyboard.
14	Create a hyperlink to c:\KIBES_R\KS.BAT on your desktop. The Kibes RT software has been installed.
15	<ul style="list-style-type: none"> If you use Windows 95/98, follow the instructions mentioned under "Only for Windows 95/98" as described below. If you use Windows 2000/XP, install the supplementary software for Windows 2000/XP as described below.
16	<i>NOTE: Only execute this step if you use Windows XP.</i> Follow the instructions mentioned under "Only for Windows XP".

Only for Windows 95/ 98

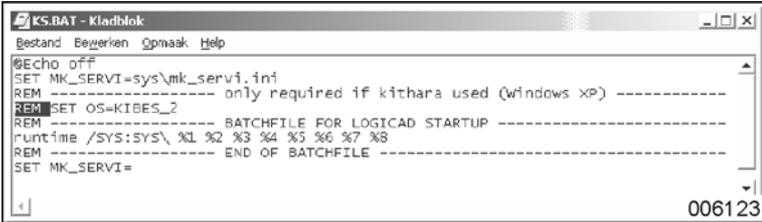
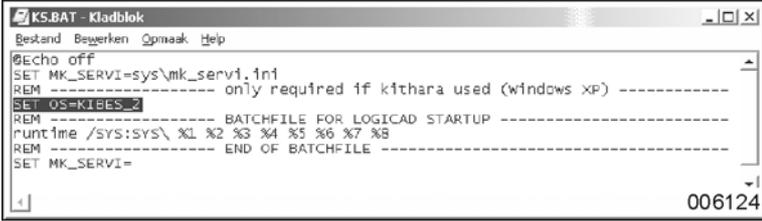
Windows 95/98 offers the possibility to start a program in MS-DOS. Starting the Kibes RT software in MS-DOS gives better results regarding communication between PC and computer module. Follow instructions below if you want that the Kibes RT software automatically starts in MS-DOS.

Step	Action
1	Open the explorer, go to c:\KIBES_R and click on the "KS.bat" file.
2	Press the right mouse button and choose "Properties".
3	Click on "Compatibility".
4	Select MS-DOS as starting program.
5	Click on OK
6	Open the explorer, go to c:\KIBES_R and click on file "Autoexec.bat".
7	Press the right mouse button and select "Edit".
8	Add a line and type the text "MODE COM1:9600,n,8,1".
9	Close the window.

To install extra software for Windows 2000 /XP

Step	Action
1	<ul style="list-style-type: none"> Cd-rom: open the "Dos Enabler", "Kithara Tool" or "Tool for WIN2000 and Windows XP" directory on the cd-rom and double click on the "ksetup.exe" file. The software is automatically installed. E-mail: open the "rt-03-05" directory on the hard disk of the PC and double click on the "ksetup.exe" file. The software is automatically installed.

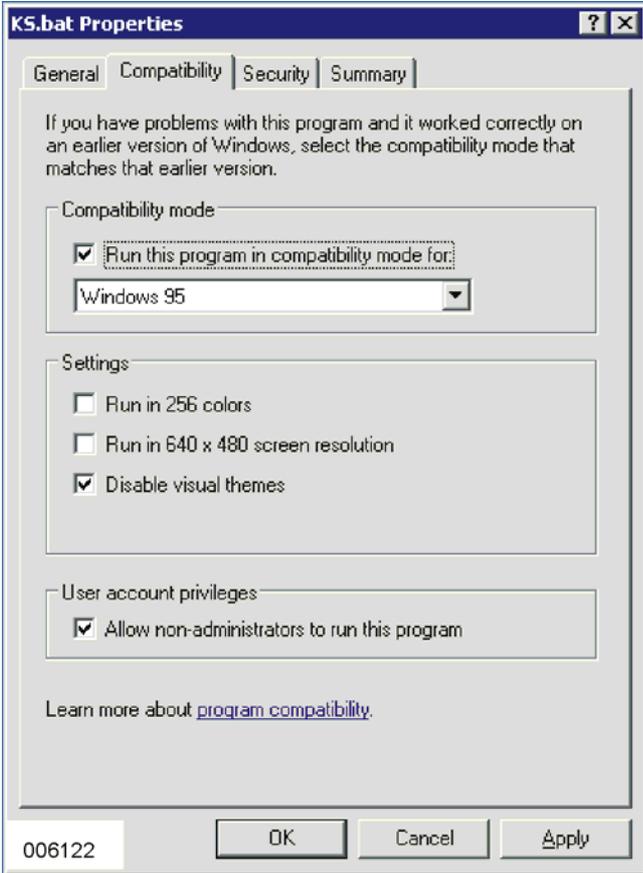
continued on next page

Step	Action
2	<ul style="list-style-type: none"> Cd-rom: copy the "Ks-rt.bat" file from the "Dos Enabler", "Kithara Tool" or "Tool for WIN2000 and Windows XP" directory on the cd-rom to c:\kibes_r\. E-mail: copy the "Ks_rt.bat" file from the "rt-03-05" directory on the hard disk of the PC to c:\kibes_r\.
3	Open the explorer, go to c:\KIBES_R and click on the "KS.bat" file.
4	Press the right mouse button and select "Edit".
5	<p>Remove the text "REM_" as indicated in the figure.</p>  <p>After the change, it looks like this:</p> 
6	Change the shortcut (to c:\Kibes_r\ks.bat) on your desktop with the shortcut to c:\Kibes_r\Ks_rt.bat.
7	Restart the PC to initialise the software.

Only for Windows XP

Step	Action
1	Open the explorer and go to c:\KIBES_R.
2	Click on the "KS.bat" file.
3	Press the right mouse button and choose "Properties".
4	Click on the "Compatibility" button.

continued on next page

Step	Action
5	<p>Adapt the screen as indicated in the figure.</p> 
6	Press OK.
7	Repeat steps 3 to 6 for the "Runtime.exe" file.

Fault messages during installation

Fault code	Cause	Solution
2104	The installation of the Kibes RT software was aborted last time.	Remove from hard disk on PC: <ul style="list-style-type: none"> • "ISFYZQVO" file and... • "KIBES_R" directory (if present). Restart the installation procedure
275	No installation rights on this PC.	Contact the IT administrator.

continued on next page

To change language

You can choose between German, English or French as language on the screens.

Step	Action
1	Open the explorer and go to c:\KIBES_R.
2	Double click on the "Runtime.sys" file.
3	Open the file in the scratch-pad program. Below, behind "Language", you will find the abbreviations "ENG", "GER" or "FRE". "ENG" stands for English, "GER" for German, "FRE" for French.
4	Select the text behind "Language" and type "ENG", "GER" or "FRE".
5	Close the scratch-pad program.

Logic circuits

Introduction

The links between all the inputs and outputs are brought together in a program.

The functional diagram (FUP) shows the sequence of logic circuits in the program. You need to be familiar with the logic functions to understand the functional diagram.

Convention

Digital control systems use elements that can only accept two clearly different states ("0" and "1"). State "1", or active, means 0 V at a low-switching input, or +24 V at a high-switching input.

Simple logic functions

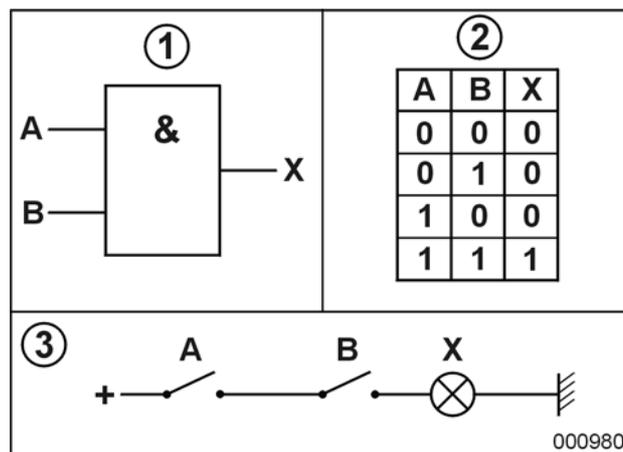
Simple logic functions are:

- "AND" function;
- "OR" function;
- "NOT" function.

"AND" function;

If output signal "X" is only present if all the input signals ("A" and "B" in this example) are present, this circuit fulfills an "AND" function.

Figure: "AND" gate



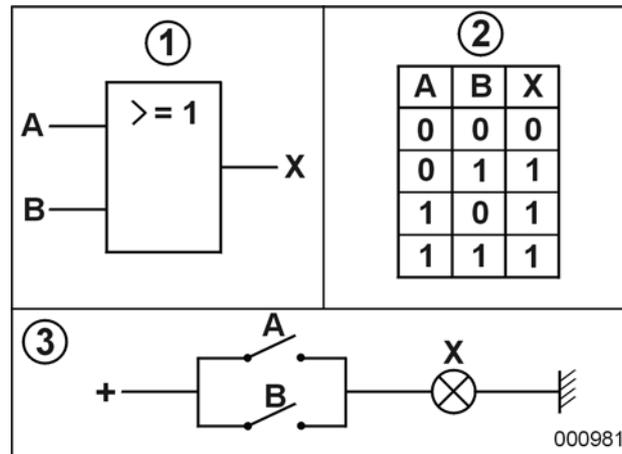
- 1 Symbolic representation
- 2 Truth table (shows all circuit statuses)
- 3 "AND" function with switches

"OR" function

If output signal "X" is present when one of the input signals ("A" or "B" in this example) is present, this circuit fulfills an "OR" function.

continued on next page

Figure: "OR" gate



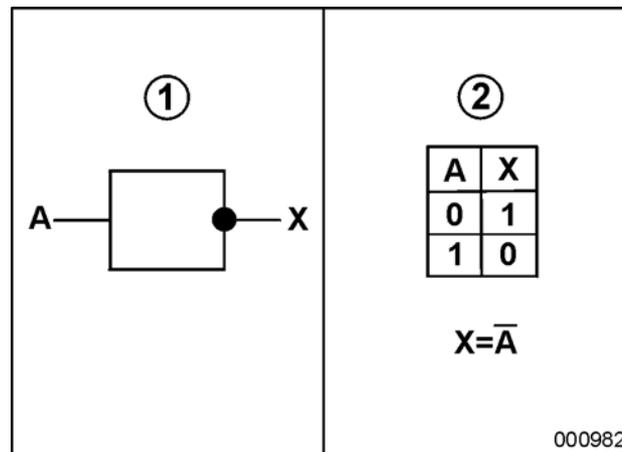
- 1 Symbolic representation
- 2 Truth table (shows all circuit statuses)
- 3 "OR" function with switches

"NOT" function.

A switch fulfills a NOT function (= inverter) when the output signal is present when input signal "A" is not present and vice versa.

NOTE: In the illustration, "X" is the inverted signal of "A". This is indicated in switching algebra by placing a bar above the "A".

Figure: "NOT" gate



- 1 Symbolic representation
- 2 Truth table (shows all circuit statuses)

Combined logic functions

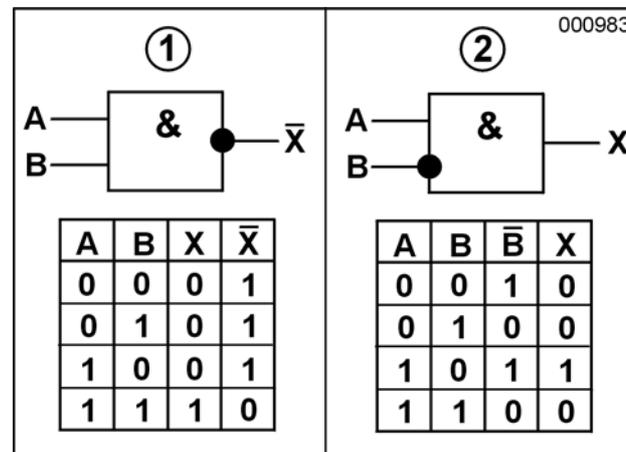
The previous simple logic functions can be combined in one and the same circuit. The following functions will be discussed briefly:

- "NOT-AND" function;

continued on next page

- "AND" function with an inverted input.

Figure:
combined
gates



1 "NOT-AND" gate

2 "AND" gate with inverted input

Overview of inputs and outputs, software version 3

Introduction

The overview is contained in a publication with the title "Overview of inputs and outputs" supplied separately with your vehicle.

Explanation of abbreviations used in overview

Abbreviation	Message
PIN	<ul style="list-style-type: none"> • Letter: name of the plug • Number: plug contact
FUP	Name of the input or output mentioned on the function diagram
F	Functional check <ul style="list-style-type: none"> • "1": exterior lighting • "2": interior lighting
N	Emergency program
D	Diagnosis: <ul style="list-style-type: none"> • "A": input or output is checked for interruption and short circuit • "K": input or output is checked for short circuit • "Digit": input or output is checked for interruption and short circuit
HS	High switching
LS	Low switching
PSNR ^a	Subdiagram number of electrical schematic where you will find the input or the output

a. Not mentioned on all overviews

Special tools: multiplex system

Ordering number	Description	Figure
Van Hool 10797942	Adapter module K-Line V24	 <p>The image shows an adapter module K-Line V24, which is a small rectangular electronic component. It is connected to a black coiled cable with a connector at the end. A separate black cable with a different connector is also shown. The part number 002424 is visible in the bottom right corner of the image.</p>

Chapter 2: ATC

Overview

Introduction This chapter deals with the ATC system.

Number of pages 6

Chapter publication date 19 September 2006

Contents

Topic	See page
Troubleshooting	11.2-2
Precaution in case of performance tests on roller brake tester	11.2-3
To measure resistance of ATC valve	11.2-4
Technical data: ATC system	11.2-6

Troubleshooting

Cross- reference

Refer to chapter 5.2, "Control systems".

Precaution in case of performance tests on roller brake tester

Introduction

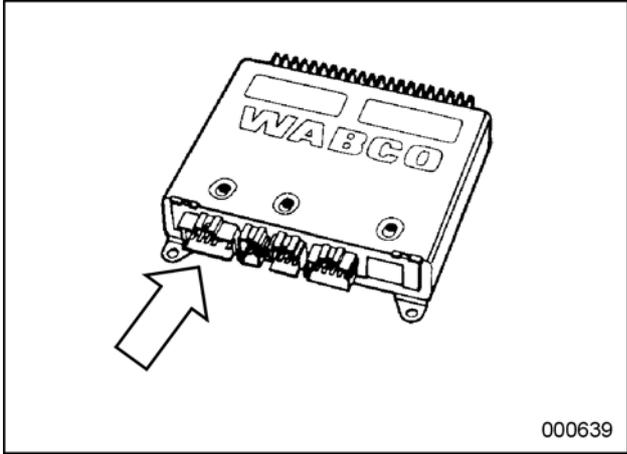
Switch off the ATC-system before carrying out the performance test.



WARNING!

If the ATC-system is not switched off during performance tests, dangerous situations could arise and you risk damaging the vehicle.

Procedure

Step	Action
1	Switch off master switch on dashboard.
2	Disconnect 18-pin connector from electronic control unit.  000639 The power supply to the ABS/ATC system is now switched off.

To measure resistance of ATC valve

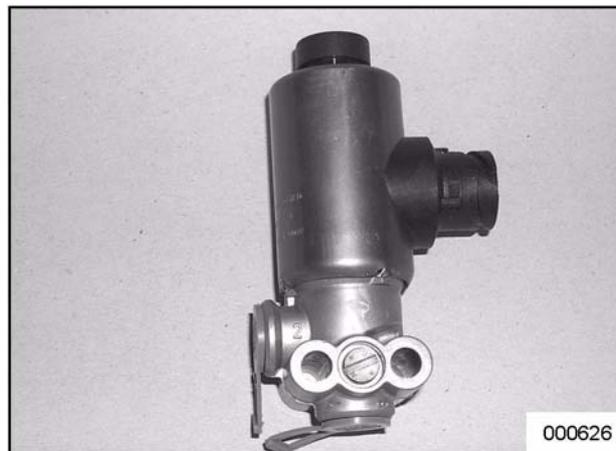
Checking values

Refer to "Technical data" at the end of this chapter.

Location of ASR valve

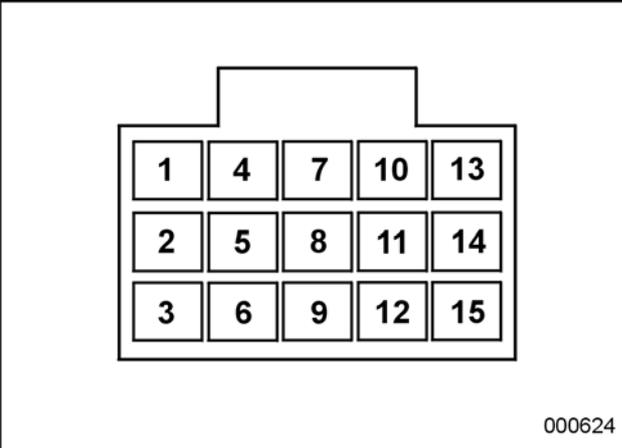
Refer to chapter 5.2, under "ABS: location of components".

Figure: ATC valve



Procedure

Step	Action
1	Switch off master switch on dashboard.
2	Disconnect 15-pin connector from electronic control unit. <div> </div>

Step	Action
3	<p>Measure resistance between pins 4 and 7 of 15-pin connector. The numbers in the figure are to be considered from wire input side.</p> <p>Compare measured value with value in technical data.</p> <div style="text-align: center;">  </div> <p style="text-align: right;">000624</p>

Evaluation of measurement result

If...	then ...
resistance is too great	clean electrical pins of ATC valve.
you measure an interruption (= infinite resistance),	<p>disconnect connector from ATC valve and measure straight at valve pins.</p> <ul style="list-style-type: none"> • Change ATC valve, if ohmmeter still indicates an interruption. • Otherwise there is an interruption in wiring between electronic control unit and ATC valve.

Technical data: ATC system

ATC valve

Electrical resistance	26.3 to 49.0 ohms
-----------------------	-------------------

Part 12 - Axles

Overview

Contents

Chapter	See page
Chapter 6: Front axle	12.6-1
Chapter 10: Drive axle	12.10-1
Chapter 14: Trailing axle	12.14-1

Chapter 6: Front axle

Overview

Introduction This chapter deals with the front axle.

Number of pages 38

Chapter publication date 19 September 2006

Contents

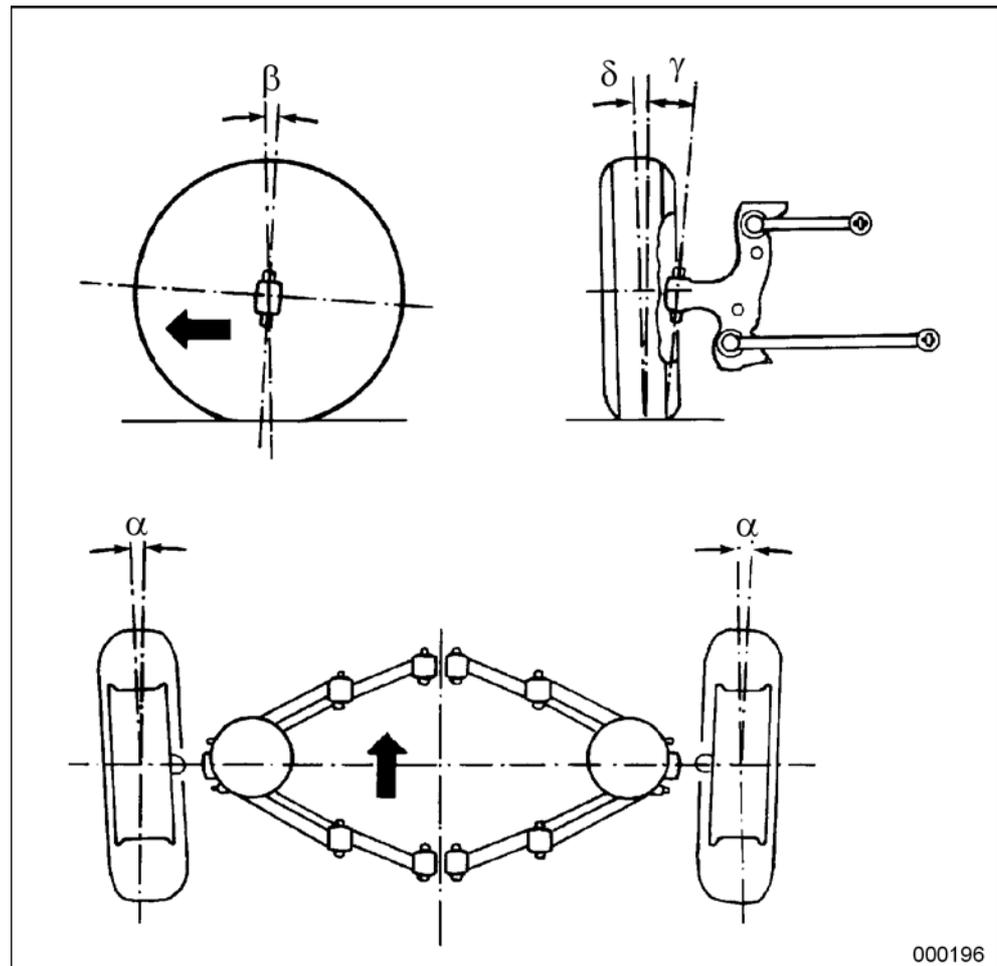
Topic	See page
Geometry	12.6-2
To check/adjust toe	12.6-3
To check/adjust steering lock angles	12.6-5
To remove axle half	12.6-6
To install axle half	12.6-8
To check security of control arms	12.6-10
To replace control arm	12.6-11
To remove rubber bushings of control arm	12.6-12
To install rubber bushings of control arm	12.6-14
To replace flexible ball joint of control arm	12.6-17
To adjust length of control arms tie-rod	12.6-19
To check wheel bearing end-play	12.6-21
To remove wheel hub	12.6-22
To install wheel hub	12.6-26
To grease king-pin bearings	12.6-30
To check play between steering knuckle and axle center	12.6-31
Technical data: front axle	12.6-33
Special tools: front axle	12.6-35
Front axle, exploded view	12.6-36

Geometry

Setting values

Refer to "Technical data" at the end of this chapter.

Figure: geometry



- α Toe
- β Caster
- δ Camber
- γ King-pin inclination

To check/adjust toe

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking/setting values

Refer to "Technical data" at the end of this chapter.

Tightening torques

Refer to "Technical data" at the end of this chapter.

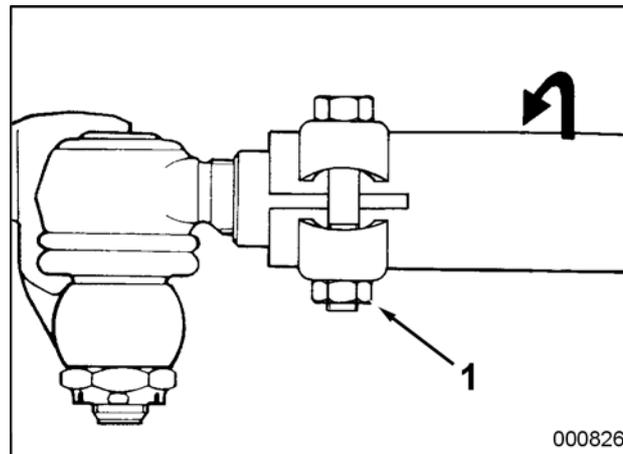
Equipment condition

- Unladen vehicle;
- Wheels on the ground;
- Correct tire pressure;
- Correct air spring height;
- No excessive out-of-balance on the road wheels;
- No excessive play on the steering knuckle;
- No play in the steering linkage ball-joints;
- Steering gear in the mid-position.

To check toe

Check toe for each wheel separately with optical equipment. Follow the instructions by the manufacturer of the equipment.

NOTE: Toe setting may have changed in service due to impact deformation of the tie rod, the tie-rod arms or a control arm. This has to be checked.

Figure: tie-rod end*1 Clamping bolt***To adjust toe**

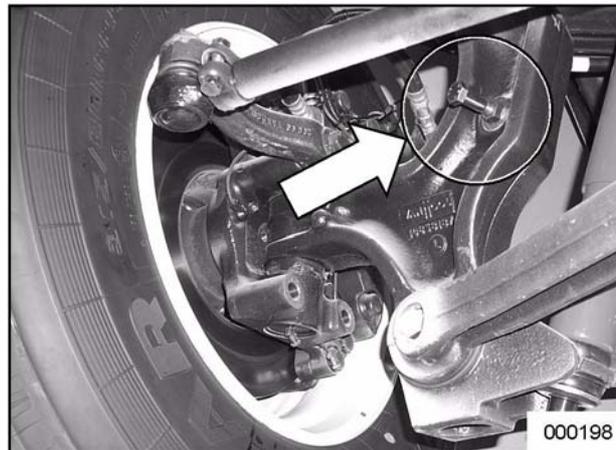
You can adjust the toe by altering the effective length of the tie rod of the wheel.

Step	Action
1	Loosen the clamping bolts of the rod ends.
2	Rotate tie-rod tube in appropriate direction.
3	Install new self-locking nuts on the clamping bolts. Tighten the nuts to the prescribed torque.
4	Recheck toe.

To check/adjust steering lock angles

Setting values Refer to "Technical data" at the end of this chapter.

Figure:
steering lock
stop-screw



Check

Step	Action
1	Place front wheels on graduated turntables.
2	With wheels in straight-ahead position, turn LH wheel, until tie-rod arm contacts adjusting screw on steering knuckle carrier. Read angular movement and compare with "Maximum steering lock angle of inner wheel" value mentioned in technical data. If necessary, adjust steering lock angle.
3	Repeat step 2 for RH wheel.

To adjust

Step	Action
1	Loosen locknut of stop screw.
2	Turn stop screw in appropriate direction.
3	Retighten locknut of stop screw.
4	Check steering lock angle again.

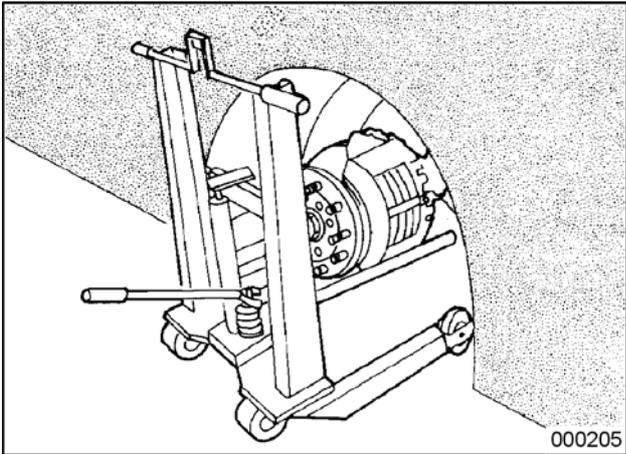
To remove axle half



WARNING!

Ensure that the axle half is well supported before you loosen the fixing bolts.

Procedure

Step	Action
1	Apply the parking brake and place chocks in front of and behind the wheels of the drive axle.
2	Fully deplete the air suspension by means of the drain valve on the auxiliaries tank.
3	Slacken the wheel nuts on the side of the axle half that is to be removed, by half a turn.
4	Put two jacks under the chassis. Raise the vehicle until the front wheels clear the ground. Support the chassis with axle stands or wooden blocks.
5	Mark the position of the wheel in relation to the hub (these parts are balanced together). Remove wheel.
6	Loosen the vertical rod of the leveling valve on the bottom at the right axle half side. Pull the vertical rod downward to release the air from the air bags.
7	Roll a lifting device under the axle half.
	
8	Depressurize the brake system. Disconnect the compressed-air hose from the brake chamber.
9	Disconnect shock absorber from the steering knuckle carrier.

Step	Action
10	Remove the screws that secure the air bag piston to the steering knuckle carrier.
11	Disconnect the tie rod from the tie-rod arm.
12	<i>NOTE: Make note of the number and the position of the camber adjustment shims, for re-use during assembly.</i> Remove the nuts of the four bolts securing the upper control arms to the chassis, then remove the four nuts of the lower control arms. To keep the opposite axle half in place, reinstall the fixing bolts and nuts of the lower control arms.
13	Withdraw the axle half from the vehicle.

To install axle half

Tightening torques

Refer to "Technical data" at the end of this chapter.



CAUTION!

If it is difficult to insert the fixing bolts of the control arm through the holes in the chassis, you need to extend or shorten the tie-rods of the arms until the bolt holes in the control arms exactly line up with the holes in the chassis. This way you prevent that the flexible ball-joints will be preloaded when the bolts are tightened.

Procedure

Step	Action
1	Use a mobile lifting device to place the complete axle half under the vehicle.
2	<p>Secure the control arms - upper ones first, then lower ones - to the chassis, but only hand-tighten the bolts.</p> <p>Ensure that you install the wheel alignment shims, which you found while removing the axle half, at the original place. The shims must be mounted with the opening horizontal and to the outside, see figure.</p> <div> </div>
3	<p>Finally tighten the fixing nuts of the control arms.</p> <p><i>NOTE: Tighten the assembly bolt of the rubber bushings at the steering knuckle side while the control arms are horizontal (refer to "To install rubber bushings of control arms").</i></p>

continued on next page

Step	Action
4	Reinstall the tie rod. Refer to "To check security of steering gear, rods and levers" in chapter 7.6 for tightening torques.
5	Secure air spring piston to the steering knuckle carrier. Tighten the screws to the prescribed torque.
6	Secure shock absorber to the steering knuckle carrier. Tighten self-locking nut to prescribed torque.
7	Secure compressed-air hose to the brake chamber.
8	Connect the vertical rod from the leveling valve to its connection support.
9	Mount the wheel and lower the vehicle.
10	Pressurize the air system and adjust the height of the air springs as described in "To adjust air spring height" in chapter 3.6.
11	Adjust toe, refer to "To check/adjust toe".
12	Road-test the vehicle and recheck the toe.

To check security of control arms

Tightening torques

Refer to "Technical data" at the end of this chapter.

Procedure

Visually check those bolts, screws and nuts that are locked by means of a cotter pin, a locking plate or locking adhesive (Loctite). The security of all others must be checked mechanically. Retighten, if necessary.



WARNING!

Never retighten bolts, screws or nuts that are fitted with locking adhesive, as this would destroy locking properties.

To replace control arm

**CAUTION!**

Control arms are not interchangeable.

Location of the control arms

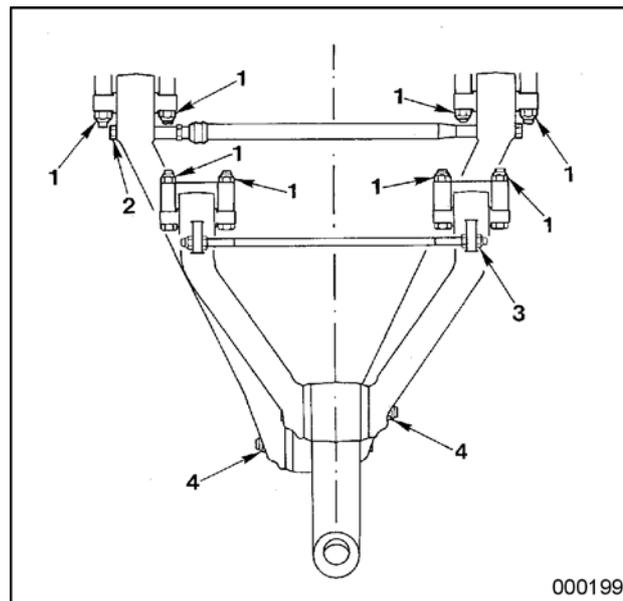
A(n)... is located correctly	If...
upper control arm	the snap ring of the flexible ball-joint is located at the front, and the cast rib with the hole to connect the tie rod is on top.
lower control arm	the snap ring of the flexible ball-joint is at the rear.

To remove rubber bushings of control arm

Special tools

Tool kit to remove rubber bushings of control arm	Van Hool No. 10695670
---	-----------------------

Figure: left axle half, view from above



1 Nuts of control arm fixing bolts

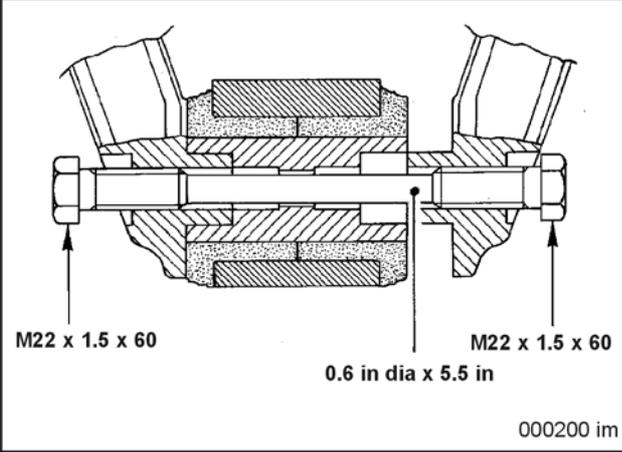
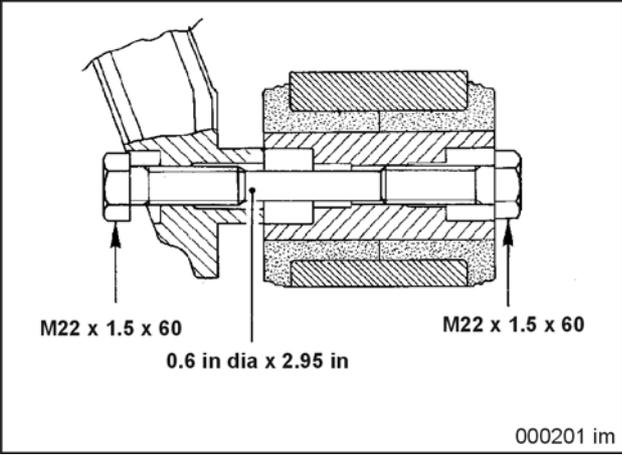
2 Bolt of lower tie rod

3 Nut for upper tie rod

4 Articulation assembly bolt

Procedure

Step	Action
1	Slacken the nuts (1) of bolts securing the two control arms to the chassis by a few turns.
2	Depending on the joint that has to be removed, remove bolt (2) or nut (3) from the tie rod from the corresponding suspension triangle.
3	Remove articulation assembly bolt (4).

Step	Action
4	<p>Use the two M22 bolts and the long 0.6 in dia pin to separate the first control arm.</p> <div></div>
5	<p>Use two M22 bolts and the short 0.6 in dia pin to separate the second control arm.</p> <div></div>
6	<p>Push the articulation shaft out of the steering knuckle carrier, and remove the two rubber bushings.</p>

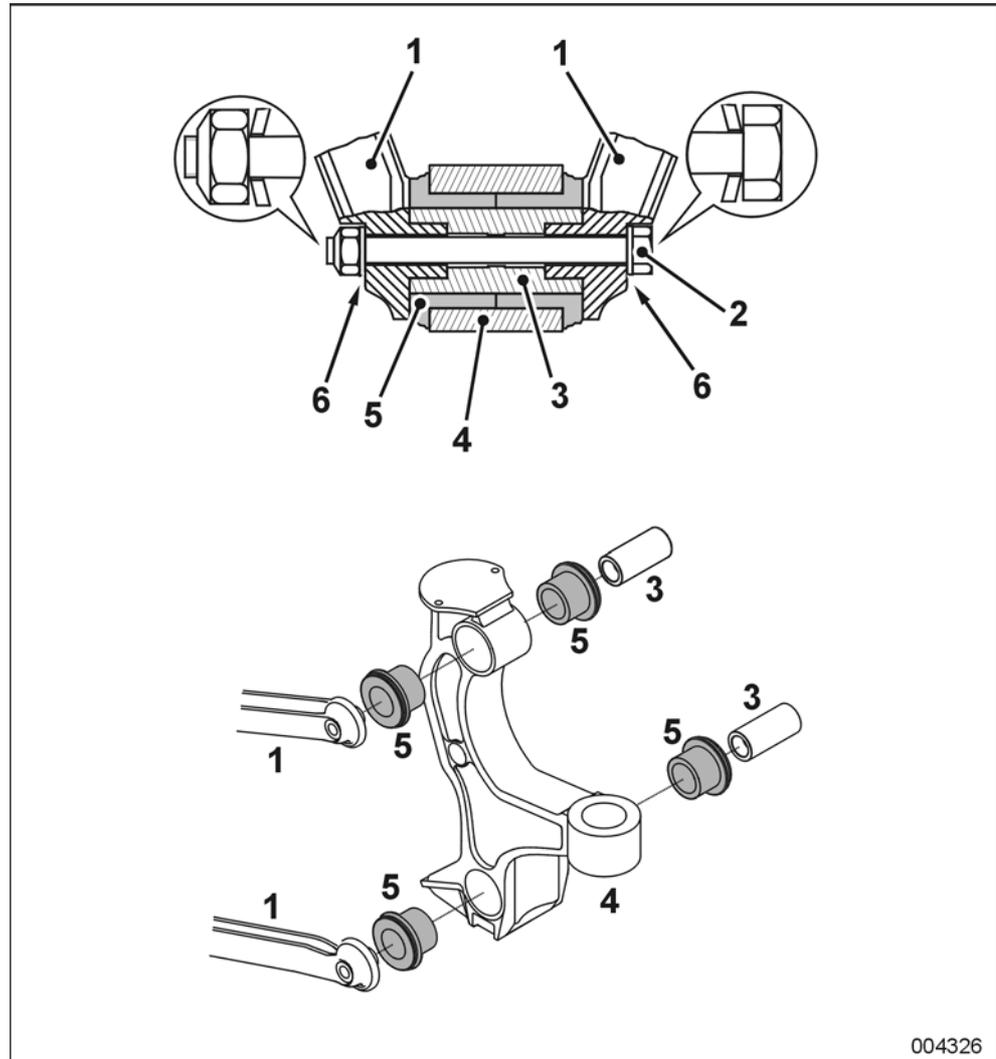
To install rubber bushings of control arm

Consumables

Rubber bushing	Van Hool No. 624317270
Nut of assembly bolt	Van Hool No. 660207287

Tightening torques

Refer to "Technical data" at the end of this chapter.

Figure: control arm joint

004326

- 1 Control arm
- 2 Assembly bolt (with self-locking nut)
- 3 Articulation assembly shaft
- 4 Steering knuckle carrier
- 5 Rubber bushing
- 6 Special spring washer

Procedure

Step	Action
1	Degrease the steering knuckle carrier bore. Wipe with clean cloth.
2	Apply clean water (no soapy water) to the rubber bushings and the bore in the steering knuckle to help assembly.

continued on next page

Step	Action
3	Push both rubber bushings and the articulation assembly shaft into the bore of the steering knuckle carrier.
4	Ensure the nuts of the bolts securing the control arms to the chassis are loose. Push the control arms in the articulation assembly shaft. If necessary, use a soft hammer.
5	Install the assembly bolt with the special spring washer and a new nut. The "hollow" side of the spring washer must be directed towards the control arm. Hand-tighten the nut of the assembly bolt.
6	Connect the tie rod of the control arms. Refer to "To adjust length of control arm tie-rod" if the bolt holes do not line up with the holes in the chassis.
7	Tighten the fixing bolts of the control arms.
8	Jack up the steering knuckle carrier until the control arms are horizontal. <i>NOTE: Both rubber bushings must be twisted equally strong when the wheel deflects and rebounds. For this reason, the articulation assembly bolt may only be fastened while the control arms are horizontal.</i>
9	Tighten the articulation assembly bolt with the prescribed torque.

To replace flexible ball joint of control arm

Introduction

The ball joint in the eye of the control arm can be replaced in the usual way with a drift (bush of appropriate diameter and wall thickness).

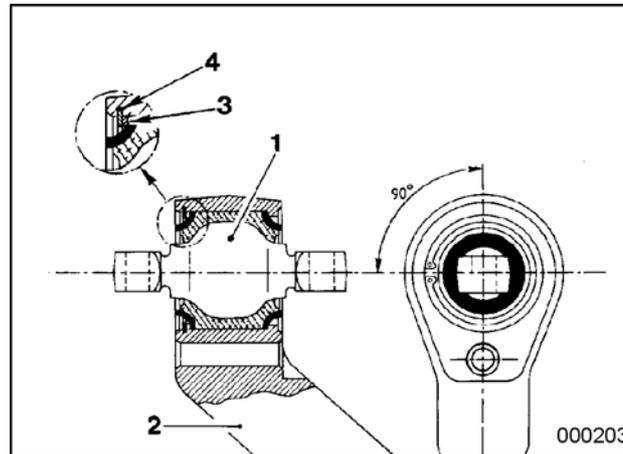
Consumables

Flexible ball joint	Van Hool No. 634301140
---------------------	------------------------

Equipment condition

Control arm removed

Figure: control arm end, chassis side



- 1 Flexible ball joint
- 2 Control arm
- 3 Spacer
- 4 Snap ring

To remove

Step	Action
1	Remove snap ring (4) and spacer (3). <i>NOTE: This is only possible if joint (1) is slightly pressed at the snap ring side.</i>
2	Press ball joint (1) out.

To install

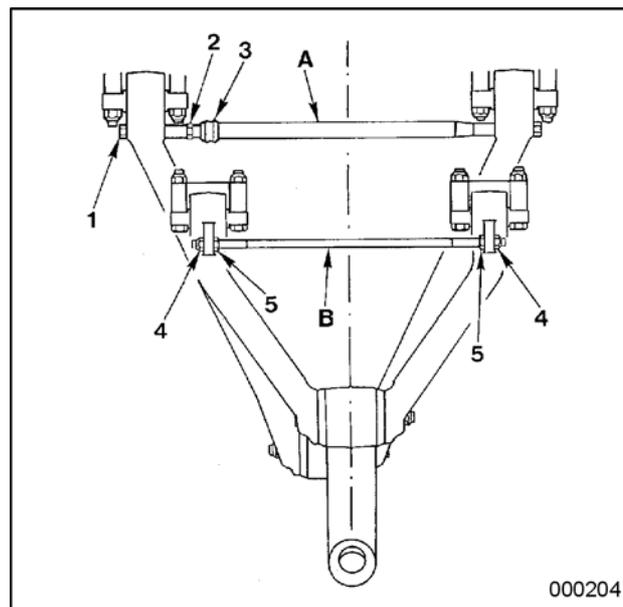
Step	Action
1	<i>NOTE: The joint has to be pressed in dry.</i> Place the ball joint on the hole in the control arm so that the bolt holes in the ball-joint shaft are orientated as shown in the figure.
2	Press the joint into the eye of the control arm.
3	Install spacer (3) and snap ring (4) while the joint is under pressure. <i>NOTE: The opening of spacer (3) must be directed in such way that it comes on top when the control arm is secured to the chassis. The opening in the snap ring circumference must be directly opposite to the opening of the spacer (i.e. on the bottom when the control arm is secured to the chassis).</i>

To adjust length of control arms tie-rod

Introduction

Before the control arms are finally tightened to the chassis, the length of the tie rods has to be adjusted in such way that the bolt holes of the control arms line up exactly with those in the chassis. The tightening of the fixing nuts should not preload the flexible ball joints of the control arms.

Figure: left axle half, view from above



- 1 Fixing bolt
- 2 Hexagon to adjust the tie rod
- 3 Clamp
- 4 Self-locking nut
- 5 Nut to adjust the tie rod
- A Lower connection rod
- B Upper connection rod

Procedure for lower control arms

Step	Action
1	Untighten bolt (1) and the nut of clamping bolt (3).
2	Rotate hexagon (2) to change the length of the tie rod.
3	Tighten bolt (1) and the nut of clamping bolt (3).

continued on next page

**Procedure for
upper control
arms**

Step	Action
1	Loosen nuts (4).
2	Rotate nuts (5) to change the length of the tie rod.
3	Tighten nuts (4).

To check wheel bearing end-play

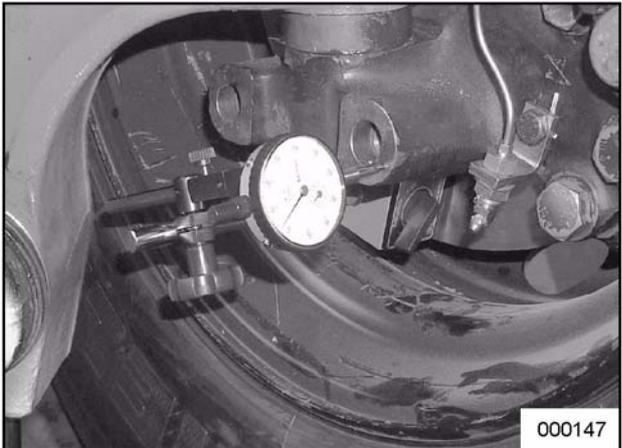
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking values

Refer to "Technical data" at the end of this chapter.

Procedure

Step	Action
1	Jack up steering knuckle carrier, until wheels clear ground.
2	Attach a dial indicator with magnetic base at inside of brake disc near the bottom of the steering knuckle. Position dial indicator stylus squarely on the machined surface of the steering knuckle, right next to the front tapped hole. Set the dial indicator to zero. 
3	Grab wheel and move it as far as possible inwards and outwards (pull and push). At the same time an assistant notes the total variation shown by the dial indicator.
4	Compare measured end-play with maximum permissible value.

End-play out-of-limit?

Wheel bearing end-play is not adjustable. If the measured value is out-of-limit, the entire hub unit must be changed.

To remove wheel hub

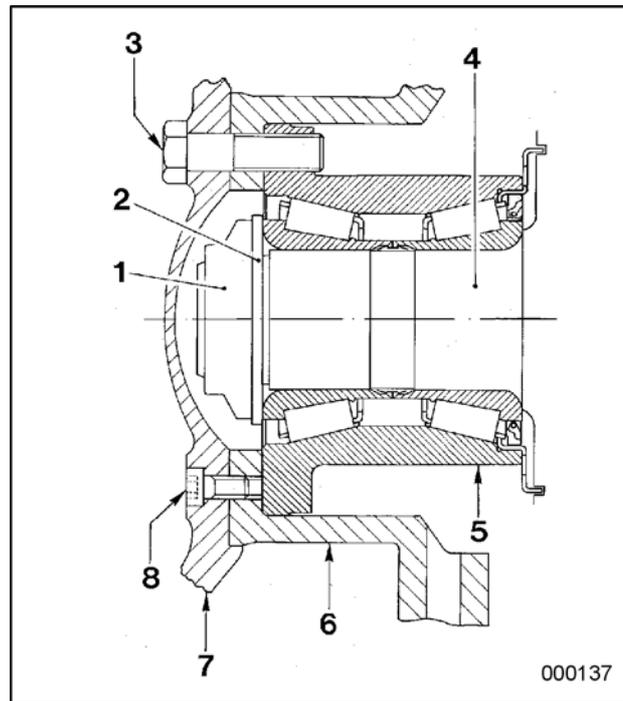
Special tools

Hub nut wrench	Van Hool No. A996030253
Tool set to remove hub unit from steering knuckle spindle <ul style="list-style-type: none"> • Spindle • Flange • Threaded bush • Cover 	<ul style="list-style-type: none"> • Van Hool No. A996060240 • Van Hool No. A996060464 • Van Hool No. A996060251 • Van Hool No. A996060238

Equipment condition

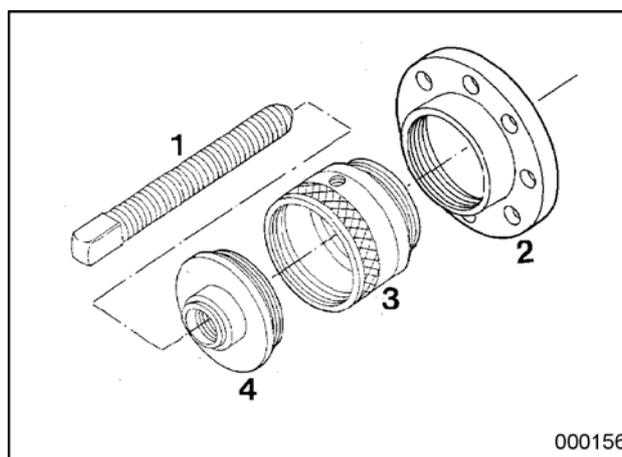
- Parking brake applied
- Wheels remaining on the ground chocked
- Vehicle jacked up at the front
- Road wheel removed
- Brake caliper/brake carrier removed, refer to "To remove brake caliper/brake carrier" in chapter 5.10.

Figure:
section
through wheel
hub



- 1 Hub nut
- 2 Washer
- 3 Screw retaining brake disc and wheel flange to hub unit
- 4 Steering knuckle
- 5 Hub unit
- 6 Brake disc
- 7 Wheel flange
- 8 Hexagonal socket screw

Figure: tool set



Tool set to remove hub unit from steering knuckle spindle

- 1 Spindle
- 2 Flange
- 3 Threaded bush
- 4 Cover

Hub unit

The hub unit combines two bearings, a grease seal and an ABS pulse ring. If one of these components is damaged, the entire unit must be replaced by a new one.

**WARNING!**

The wheel flange and the brake disc are heavy. Be sure they are well supported, before undoing the fixing screws.

Procedure

Step	Action
1	Remove hexagonal socket screw (8).
2	Remove the twelve screws (3) retaining wheel flange and brake disc to hub unit.
3	Remove wheel flange (7)
4	Thread puller screws into the three M12 x 1.5 tapped holes in brake disc. Free brake disc from hub unit using puller screws. Remove brake disc.
5	Remove hub nut (1) using hub nut wrench.
6	Remove washer (2).

continued on next page

Step	Action
7	Secure flange (2) of tool set to hub unit with three screws.
8	Screw threaded bush (3) of tool set into flange (2).
9	Screw cover (4) of tool set into threaded bush (3).
10	Screw spindle (1) of tool set into cover (4).
11	Remove hub unit by turning spindle (1) of tool set clockwise.

To install wheel hub

Consumables

Hub unit	Van Hool No. 10599854
Hub nut	Van Hool No. 10554144

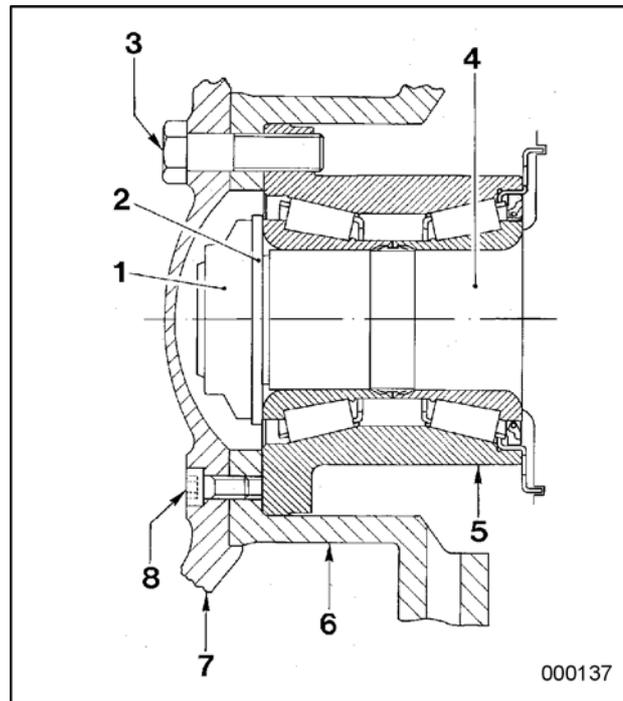
Special tools

Tool set to install the hub unit on the steering knuckle spindle	Van Hool No. 10678700
--	-----------------------

Tightening torques

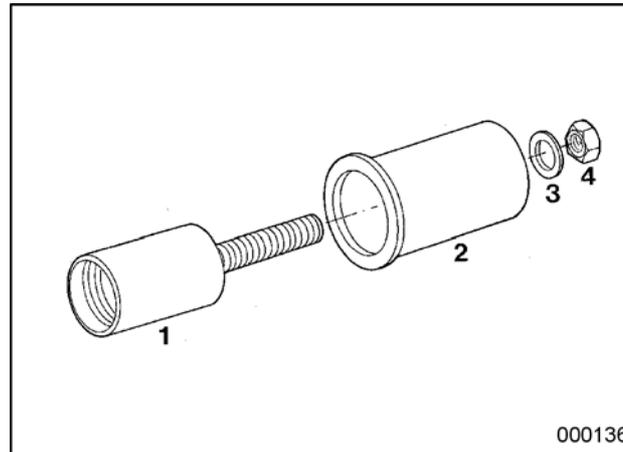
Refer to "Technical data" at the end of this chapter.

Figure:
section
through wheel
hub



- 1 Hub nut
- 2 Washer
- 3 Screw retaining brake disc and wheel flange to hub unit
- 4 Steering knuckle
- 5 Hub unit
- 6 Brake disc
- 7 Wheel flange
- 8 Hexagonal socket screw

Figure: tool set



Tool set to install the hub unit on the steering knuckle spindle

- 1 Guide sleeve
- 2 Press sleeve
- 3 Washer
- 4 Nut

Procedure

Step	Action
1	Apply thin film of "Never Seez" to steering knuckle spindle (4).
2	Screw guide sleeve (1) of tool set onto the steering knuckle spindle
3	Slide hub unit on the guide sleeve (1) of the tool set.
4	Slide press sleeve (2) of the tool set on the guide sleeve.
5	Install washer (3) and nut (4) of the tool set on the threaded rod of the guide sleeve.
6	Turn nut (4) of the tool set clockwise to install the hub unit on the steering knuckle spindle.
7	Remove the tools.
8	Install washer (2).
9	<div style="display: flex; align-items: center;">  <div> <p>WARNING!</p> <p>Never refit an old hub nut after removal, since it is self-locking.</p> <p>Install a new hub nut on the steering knuckle spindle. Tighten the nut to the prescribed torque and simultaneously rotate the hub unit in both directions to settle the roller bearings.</p> </div> </div>

Step	Action
10	Apply a thin film of NLGI No. 2 grade high temperature lithium grease to the contact surfaces between brake disc (6) and hub unit (5).
11	Put brake disc (6) on a flat surface. Position wheel flange (7) on brake disc (6) in such a way that the holes for screw (8) coincide. Secure wheel flange (7) to brake disc (6) with hexagonal socket screw (8).
12	Position the wheel flange/brake disc assembly to the hub unit in such a way that the screw holes coincide. Install twelve securing screws (3) and tighten them crosswise in steps.
13	Install the brake caliper/brake carrier assembly. Refer to "To install brake caliper/brake carrier" in chapter 5.10.

To grease king-pin bearings

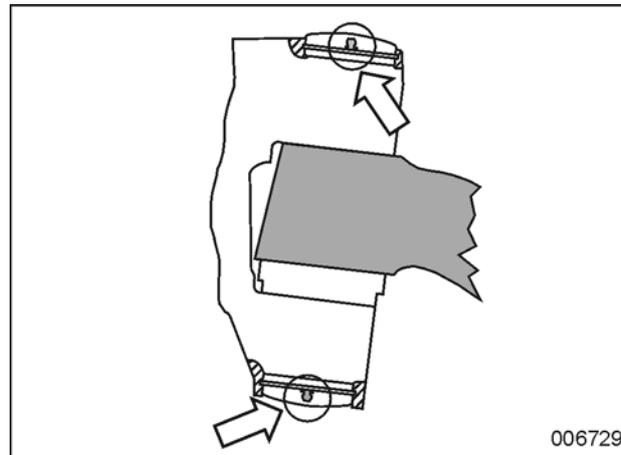
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Grease type

Refer to chapter 1.1, "Fluids and lubricants".

Figure: grease nipples of king-pin bearings



On some vehicles, the grease nipples are located under a protective cover.

Number of grease nipples

Each steering knuckle has two grease nipples.

Procedure

Step	Action
1	Remove the wheel.
2	Remove the protective covers if present.
3	Press grease into each of the grease nipples until fresh grease comes out of the gaps between the steering knuckle and the axle end/steering knuckle carrier.

To check play between steering knuckle and axle center

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

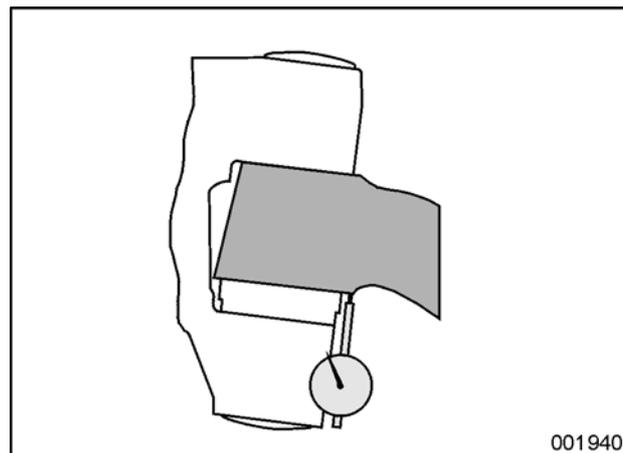
Checking values

Refer to "Technical data" at the end of this chapter.

Equipment condition

- Vehicle over inspection pit
- Wheels remaining on the ground chocked

Figure: measurement setup



Procedure

Step	Action
1	Attach dial indicator to lower steering knuckle yoke. Position stylus of dial indicator to lower edge of axle center. Distance between stylus and dial indicator support should be as short as possible.
2	Jack up axle, until wheels clear ground.
3	Set the dial indicator to zero.
4	Lower axle onto ground.

continued on next page

Step	Action
5	Note variation shown by dial indicator. Is variation smaller than maximum permissible value? <ul style="list-style-type: none"><li>• If so, axial clearance is correct.<li>• If not, remove steering knuckle and replace all damaged parts.

Technical data: front axle

Make Van Hool

Geometry

Caster	$3^{\circ} \pm 15'$
Camber	$+15' \pm 15'$
King-pin inclination	7°
Toe-out (degrees)	$-5' \pm 2'$
Toe-out (inch)	-0.02 ± 0.006 in/ft
Maximum steering angle, inner wheel	
<ul style="list-style-type: none"> • 22.5" x 8.25" wheel 	57°
<ul style="list-style-type: none"> • 22.5" x 9" wheel 	55°

Wheel hub

Wheel bearing end-play	maximum 0.01 in
------------------------	-----------------

Steering knuckle

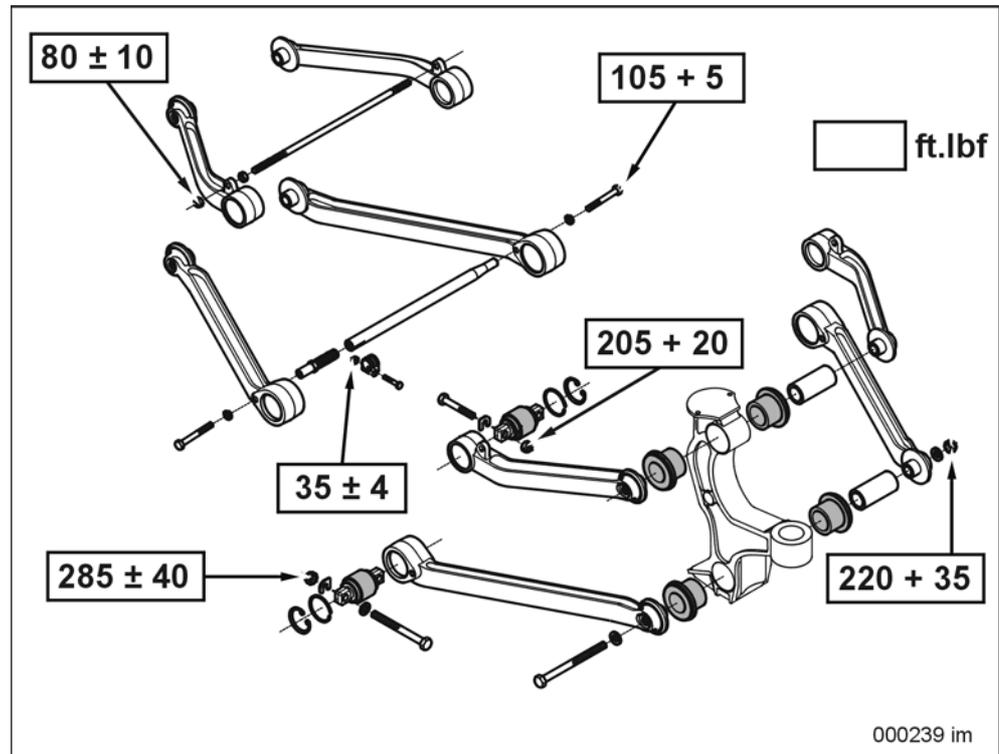
Axial clearance	
<ul style="list-style-type: none"> • new 	maximum 0.008 in
<ul style="list-style-type: none"> • at routine checks according to maintenance schedule 	maximum 0.016 in

Tightening torques

Hub nut	545 ± 30 ft.lbf
Hexagonal socket screw for securing wheel flange to brake disc (M12 x 1.5)	55 ± 7 ft.lbf
Screws for securing wheel flange/brake disc to hub unit (M18 x 1.5 -10.9)	320 ± 20 ft.lbf
Air spring piston to steering knuckle carrier	52 ± 7 ft.lbf
Shock absorber nut	70 ft.lbf
Nut of tie-rod clamping bolt	60 ± 7 ft.lbf

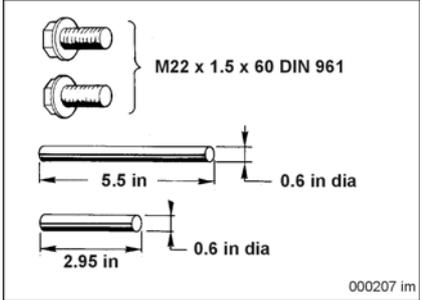
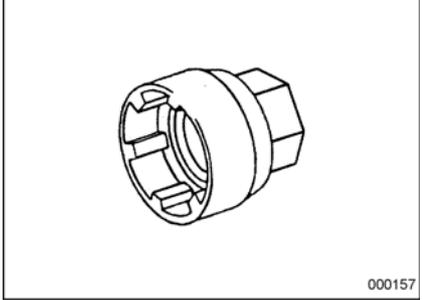
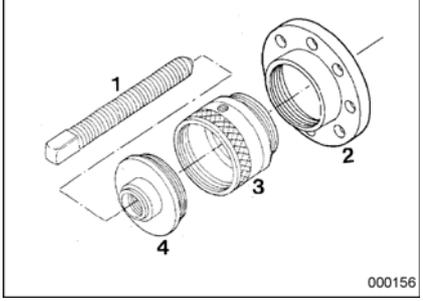
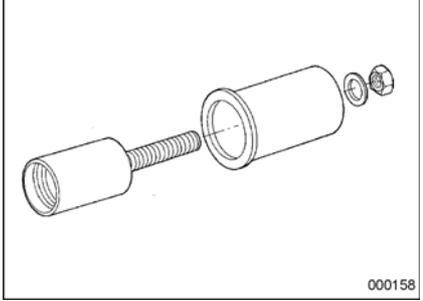
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Figure:
tightening
torques



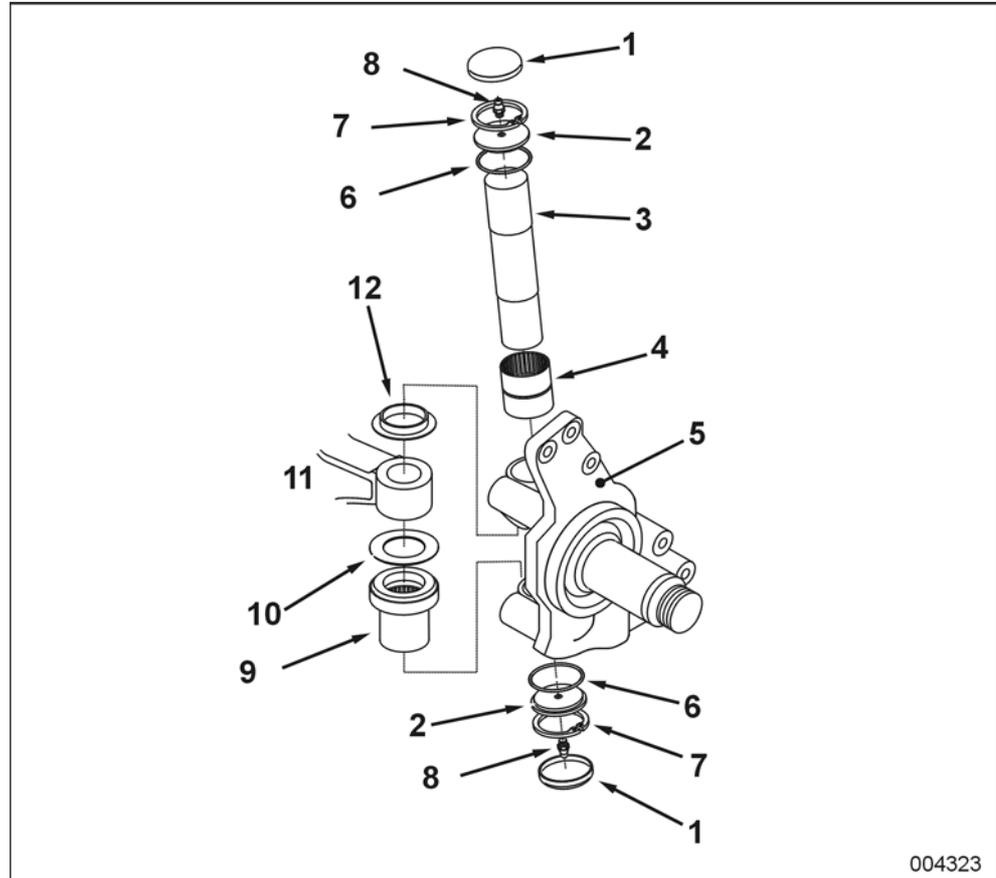
Security of control arms.

Special tools: front axle

Ordering number	Description	Figure
Van Hool 10695670	Tool set to remove the rubber bushings from the control arm	 <p>000207 im</p>
Van Hool A996030253	Hub nut wrench	 <p>000157</p>
Van Hool A996060240 Van Hool A996060464 Van Hool A996060251 Van Hool A996060238	Tool set to remove hub unit from steering knuckle spindle 1 Spindle 2 Flange 3 Threaded bush 4 Cover	 <p>000156</p>
Van Hool 10678700	Tool set to install the hub unit on the steering knuckle spindle	 <p>000158</p>

Front axle, exploded view

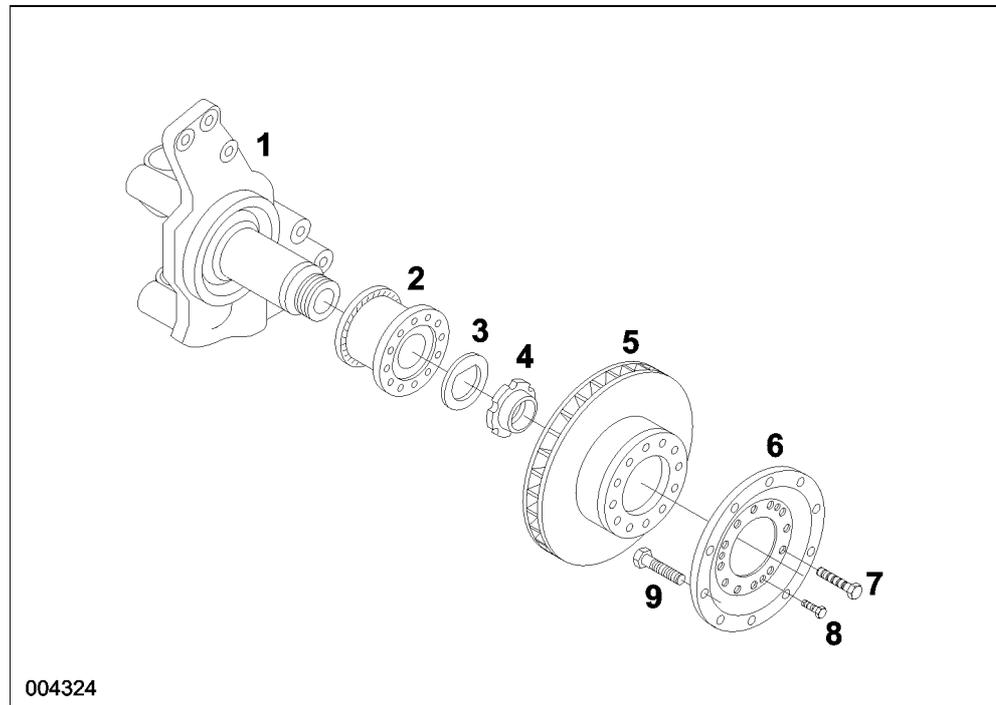
Steering knuckle, exploded view



004323

- 1 End cap
- 2 Plug plate
- 3 King-pin
- 4 Upper needle bearing
- 5 Steering knuckle
- 6 O-ring
- 7 Snap ring
- 8 Grease nipple
- 9 Lower needle bearing
- 10 Spacer
- 11 Axle end
- 12 Grease seal

continued on next page

**Hub, exploded
view**

- 1 Steering knuckle
- 2 Hub unit
- 3 Washer
- 4 Hub nut
- 5 Brake disc
- 6 Wheel flange
- 7 Screw retaining brake disc and wheel flange to hub unit
- 8 Hexagonal socket screw
- 9 Wheel bolt

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Chapter 10: Drive axle

Overview

Introduction This chapter deals with the drive axle.

Number of pages 12

Chapter publication date 19 September 2006

Contents

Topic	See page
To check oil level	12.10-2
To change oil	12.10-4
To remove wheel bearing	12.10-5
To install wheel bearing	12.10-7
To check breather	12.10-10
Technical data: drive axle	12.10-11
Special tools: drive axle	12.10-12

To check oil level

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

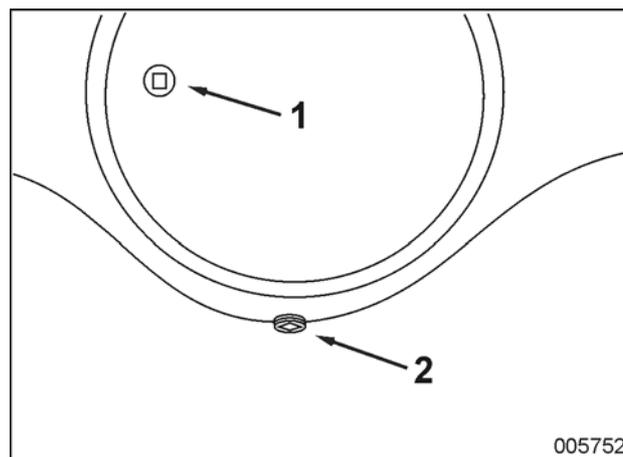
Oil type

Refer to chapter 1.1, "Fluids and lubricants".

All brand oils that meet the MIL-L-2105D specification are suitable and can be mixed provided they belong to the same viscosity class.

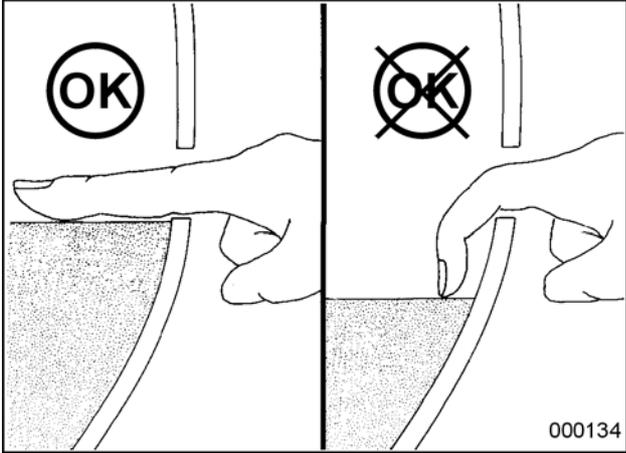
Equipment condition

- Cold oil
- Vehicle on level ground

**Figure:
housing bowl**

- 1 Filler/level plug
2 Drain plug

Procedure

Step	Action
1	<p>Unscrew cap (1).</p> <p>The oil must reach the edge of the opening.</p> <div></div>
2	<p>If necessary, top up with oil through the same opening.</p>

To change oil

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Oil capacity and oil type

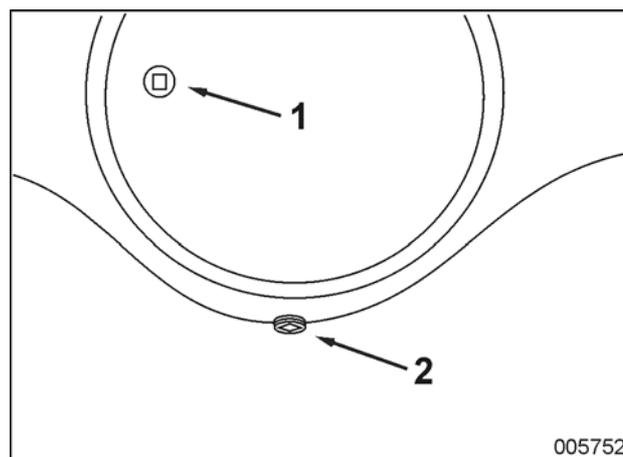
Refer to chapter 1.1, "Fluids and lubricants".

- The specified oil capacity is only a guideline; only the level determines the exact amount of oil needed for a correct operation of the axle.
- The axle manufacturer does not allow that you add additives of any kind.

Equipment conditions

- Warm oil (service temperature)
- Vehicle on level ground

Figure: housing bowl



- 1 Filler/level plug
2 Drain plug

Procedure

Step	Action
1	Unscrew plug (2).
2	Clean the magnetic drain plug and put it back when all the oil has drained.
3	Fill the axle through orifice (1), until oil begins to flow from orifice edge.

To remove wheel bearing

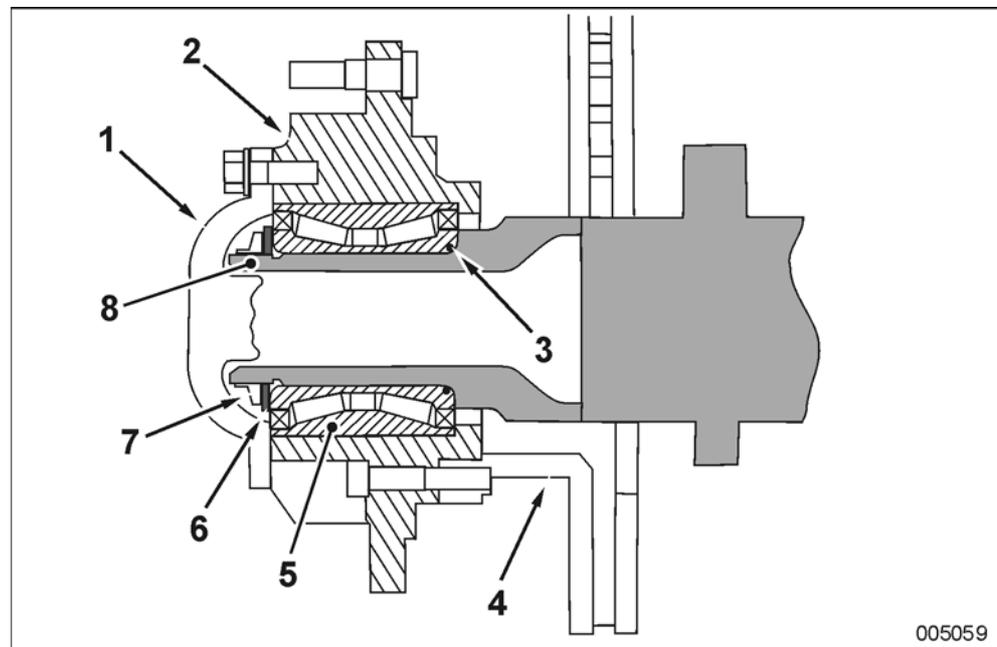
Special tool

Hub nut wrench	Van Hool No. 10732280
----------------	-----------------------

Equipment condition

- Wheels remaining on the ground chocked
- Drive axle jacked up
- Road wheel removed

Figure: section through axle end



005059

- 1 Axle shaft
- 2 Wheel hub
- 3 Sealing ring (part of wheel bearing)
- 4 Brake disc
- 5 Wheel bearing
- 6 Washer
- 7 Hub nut
- 8 Axle spindle

Procedure

Step	Action
1	Release parking brake using mechanical release system, see further on.
2	Remove brake caliper/brake carrier assembly. Refer to "To remove brake caliper/brake carrier" in chapter 5.10.
3	Remove axle shaft (1).
4	 <p>CAUTION! Not fully undoing the locking by staking of hub nut (7) may cause damage to thread of axle spindle (8), when you remove hub nut further on.</p> <p>Fully undo the locking by staking of hub nut (7) using a pointed tool.</p>
5	Remove hub nut (7) using special hub nut wrench.
6	 <p>WARNING! The hub/brake disc assembly is heavy. Be sure it is well supported, before removing it.</p> <p>Pull hub/brake disc assembly off axle spindle.</p>
7	Remove brake disc (4) from hub (2).
8	Push wheel bearing (5) out of hub (2) using a press tool.

To release
parking brake
mechanically

Step	Action
1	Remove dust cover from release bolt at parking brake cylinder rear side.
2	Unscrew release bolt until stop.

To install wheel bearing

Consumables

Wheel bearing	Van Hool No. 10875658
Hub nut + washer	Van Hool No. 10963147

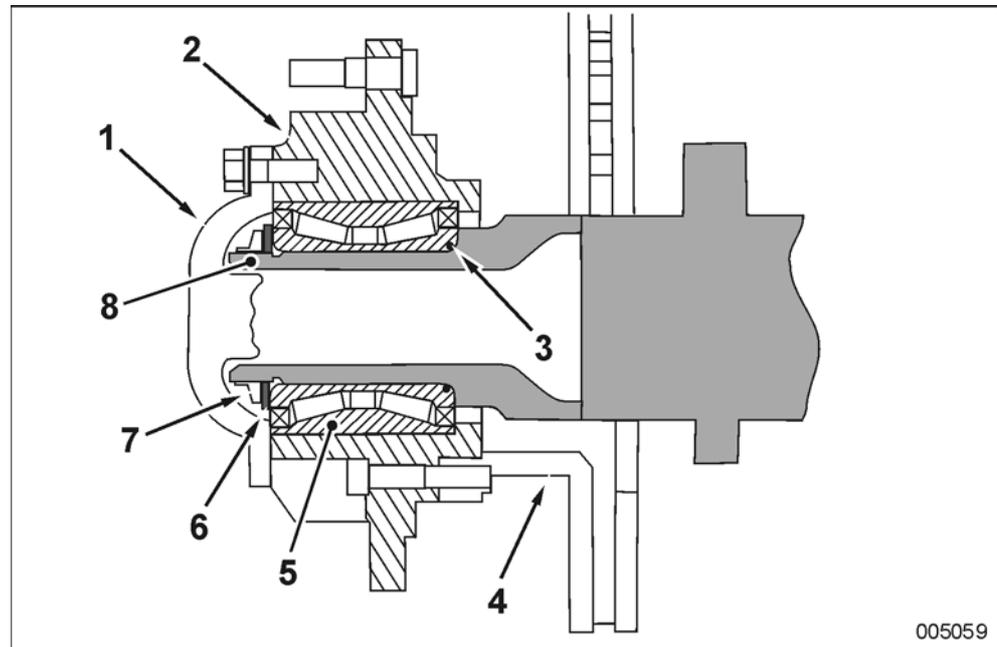
Special tool

Hub nut wrench	Van Hool No. 10732280
Drift to press wheel bearing in hub	Van Hool No. 10914289
Guide sleeve to slide hub on axle spindle	Van Hool No. 10920992

Tightening torques

Refer to "Technical data" at the end of this chapter.

Figure:
section
through axle
end



- 1 Axle shaft
- 2 Wheel hub
- 3 Sealing ring (part of wheel bearing)
- 4 Brake disc
- 5 Wheel bearing
- 6 Washer
- 7 Hub nut
- 8 Axle spindle

Procedure

Step	Action
1	Position wheel bearing (5) on hole in hub (2) so that sealing ring (3) is located at the bottom.
2	Press wheel bearing (5) into hub (2) using special drift.
3	Position brake disc (4) onto hub (2). Install fixing screws and tighten them to the prescribed torque.
4	Clean axle spindle (8).
5	Check thread of axle spindle (8) for damage. If necessary, repair thread.
6	Apply a thin film of "Never Seez" onto axle spindle (8).
7	Screw special guide sleeve onto axle spindle (8).

Step	Action
8	 WARNING! The hub/brake disc assembly is heavy. Slide hub/brake disc assembly onto axle spindle (8).
9	Remove special guide sleeve.
10	Install washer (6).
11	Install a new hub nut on axle spindle. Tighten hub nut to a torque of 280 ± 15 ft.lbf.
12	Turn hub (2) ten turns in direction of travel so that wheel bearings can set.
13	Tighten hub nut (7) to prescribed torque.
14	Lock hub nut (7) by staking its collar in the slot of axle spindle (8).
15	Clean contact surfaces of axle shaft (1) and hub (2).
16	Apply Loctite 518 onto contact surfaces between axle shaft (1) and hub (2).
17	Slide axle shaft into axle housing. Install fixing screws and tighten them to the prescribed torque.
18	Install brake caliper/brake carrier assembly. Refer to "To install brake caliper/brake carrier" in chapter 5.10.
19	Restore parking brake operation by screwing release bolt home as far as it will go and tightening it with a torque of 23 tot 26 ft.lbf.

To check breather

**To be carried
out when?**

Refer to chapter 1.1, "Maintenance schedule".

Procedure

Check whether breather passage is open (clean if necessary).

Technical data: drive axle

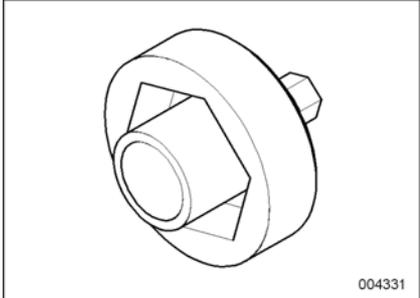
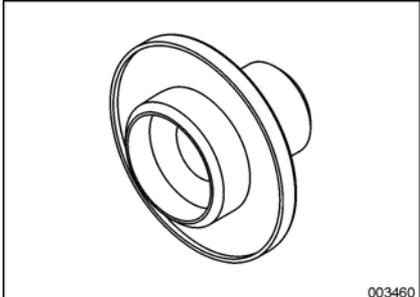
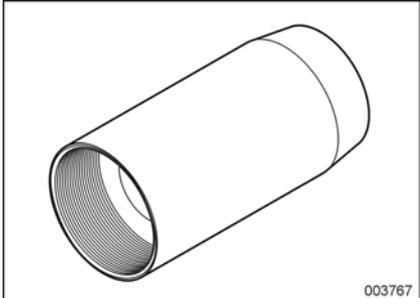
Make DANA

Type G171

**Tightening
torques**

Hub nut	1st step: 175 ± 5 ft.lbf 2nd step: 700 ± 35 ft.lbf
Bolts for securing half shaft to wheel hub	245 ± 10 ft.lbf

Special tools: drive axle

Ordering number	Description	Figure
Van Hool 10732280	Hub nut wrench	 <p>004331</p>
Van Hool 10914289	Drift to press wheel bearing in hub.	 <p>003460</p>
Van Hool 10920992	Guide sleeve to slide hub on axle spindle.	 <p>003767</p>

Chapter 14: Trailing axle

Overview

Introduction This chapter deals with the trailing axle.

Number of pages 26

Chapter publication date 19 September 2006

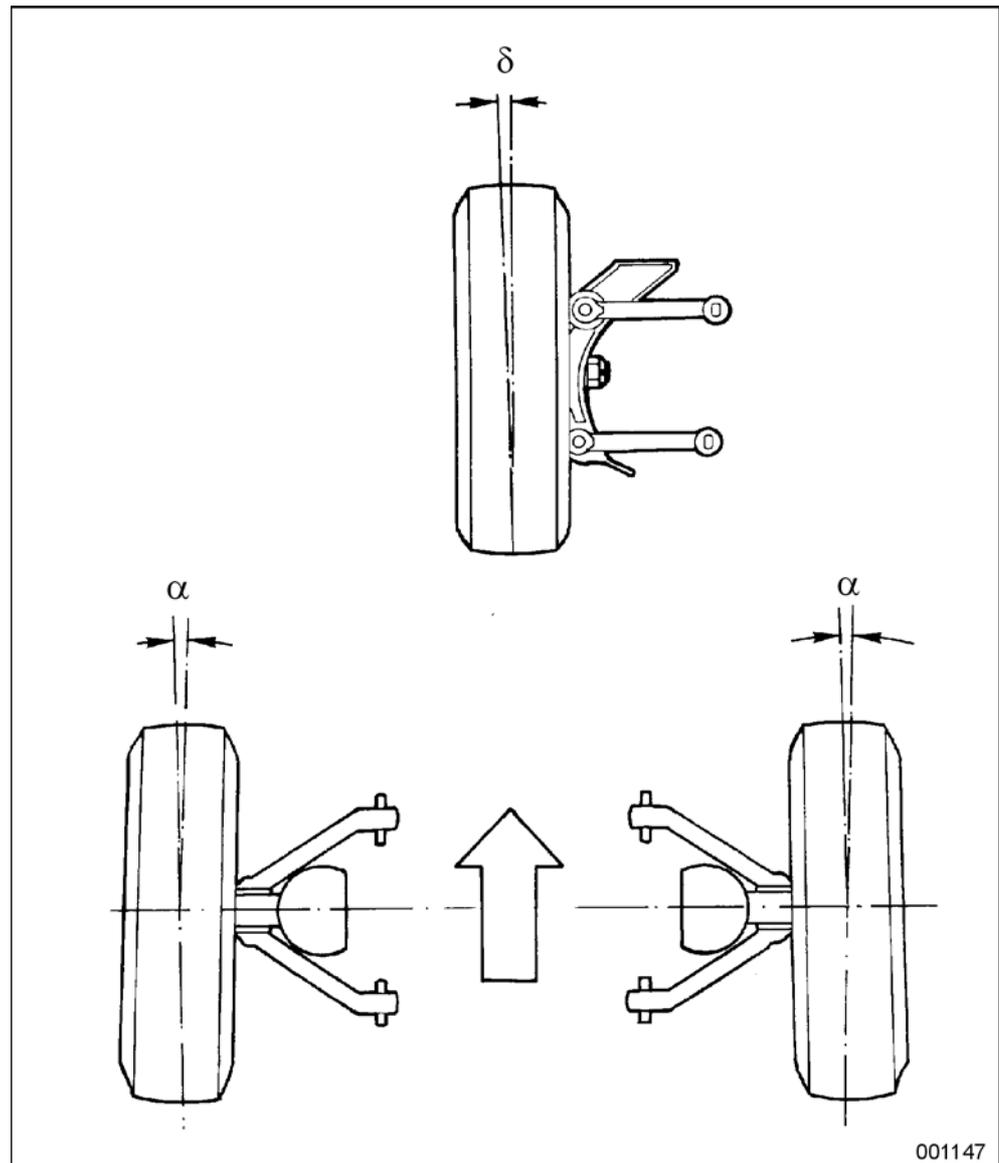
Contents

Topic	See page
Geometry	12.14-2
To check/adjust toe	12.14-3
To remove axle half	12.14-5
To install axle half	12.14-7
To check control arms for security	12.14-9
To replace control arm	12.14-10
To remove rubber bushings of control arm	12.14-11
To install rubber bushings of control arm	12.14-12
To replace flexible ball-joint of control arm	12.14-13
To adjust length of control arms tie rod	12.14-14
To check wheel bearing end-play	12.14-15
To remove wheel hub	12.14-16
To install wheel hub	12.14-20
Technical data: trailing axle	12.14-23
Special tools: trailing axle	12.14-25
Trailing axle, exploded view	12.14-26

Geometry

Setting values Refer to "Technical data" at the end of this chapter.

Figure:
geometry



α Toe
 δ Camber

To check/adjust toe

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking/setting values

Refer to "Technical data" at the end of this chapter.

Tightening torques

Refer to "Technical data" at the end of this chapter.

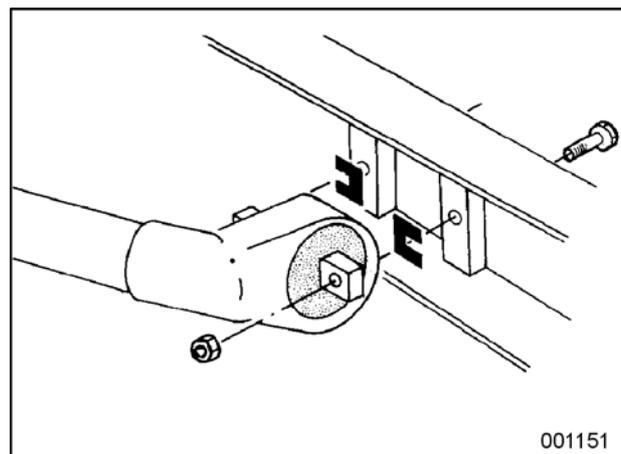
Equipment condition

- Unladen vehicle;
- Wheels on the ground;
- Correct tire inflation pressure;
- Correct air spring height;
- No excessive out-of-balance on the road wheels;

To check toe

Check toe for each wheel separately with optical equipment. Follow the instructions by the manufacturer of the equipment.

Figure: to adjust toe



To adjust toe

You can alter the toe by changing the number or the thickness of the shims between the chassis and control arms.

NOTE: The adjustment of the toe affects the camber. Check the camber after each adjustment of the toe.

continued on next page

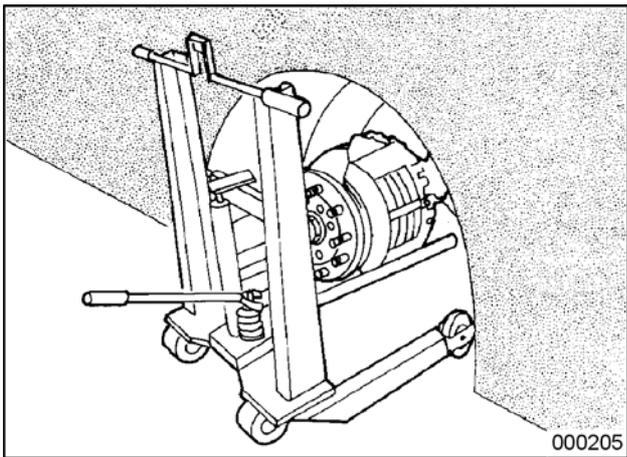
To remove axle half



WARNING!

Ensure that the axle half is well supported before you loosen the fixing bolts.

Procedure

Step	Action
1	Apply the parking brake and place chocks in front of and behind the wheels of the front axle.
2	Fully deplete the air suspension by means of the drain valve on the auxiliaries tank.
3	Slacken the wheel nuts on the side of the axle half that has to be removed by half a turn.
4	Put two jacks under the chassis. Raise the front of the vehicle until wheels clear ground. Support the chassis with axle stands or wooden blocks.
5	Mark the position of the wheel in relation to the hub (these parts are balanced together). Remove wheel.
6	Disconnect the control rod of the two leveling valves on the drive axle. Pull the control rod downward to deplete the air from the air bags.
7	Roll a lifting device under the axle half. 
8	Discharge the air from the brake system. Disconnect the compressed-air hose from the brake chamber.
9	Disconnect the shock absorber from the hub carrier.

continued on next page

Step	Action
10	Remove the bolts securing the air bag piston to the hub carrier.
11	<i>NOTE: Make note of the number and the position of the camber adjustment shims for re-use during assembly.</i> Unscrew the nuts of the four bolts securing the upper control arms to the chassis, then remove the four nuts of the lower control arms.
12	Withdraw the axle half from the vehicle.

To install axle half

Tightening torques

Refer to "Technical data" at the end of this chapter.



CAUTION!

If it is difficult to insert the fixing bolts of the control arms through the holes in the chassis, you need to extend or shorten the tie-rods of the arms until the bolt holes in the control arms exactly line up with the holes in the chassis. This way you prevent that the flexible ball joints will be preloaded when the bolts are tightened.

Procedure

Step	Action
1	Use a mobile lifting device to place the complete axle half under the vehicle.
2	<p>Secure the control arms - upper ones first, then the lower ones - to the chassis, but only hand-tighten the bolts.</p> <p>Ensure that you install the shims for the wheel alignment, the ones you found while removing the axle half, at the original place. The shims must be placed with the opening horizontally and to the outside, see figure.</p> <div> </div>
3	<p>Finally tighten the fixing nuts of the control arms.</p> <p><i>NOTE: Tighten the assembly bolt rubber bushings at the hub side only while the control arms are horizontal (refer to "To install rubber bushings of control arms").</i></p>

continued on next page

Step	Action
4	Secure air spring piston to the hub carrier. Tighten the screws to the prescribed torque.
5	Secure shock absorber to the hub carrier. Tighten self-locking nut to prescribed torque.
6	Secure compressed-air hose to the brake chamber.
7	Reconnect the control rod of the two leveling valves to its connection support.
8	Place the wheel and lower the vehicle.
9	Pressurize the air system and adjust the height of the air springs as described in "To adjust air spring height" in chapter 3.6.
10	Adjust toe, refer to "To check/adjust toe".
11	Road-test vehicle and recheck the toe.

To check control arms for security

Tightening torques

Refer to "Technical data" at the end of this chapter.

Procedure

Visually check those bolts, screws and nuts that are locked by means of a cotter pin, a locking plate or locking adhesive (Loctite). The security of all others must be checked mechanically. Retighten, if necessary.



WARNING!

Do not retighten bolts, screws or nuts that have been locked by means of locking adhesive (Loctite), as this would destroy the locking properties.

To replace control arm

**CAUTION!**

Control arms are not interchangeable.

Location of the control arms

A(n)... is located correctly	if...
upper control arm	the cast rib with the hole for the tie rod is on top.
lower control arm	the cast rib with the hole for the tie rod is at the bottom.

To remove rubber bushings of control arm

**Cross-
reference**

Refer to chapter 12.6, "To remove rubber bushings of control arm".

To install rubber bushings of control arm

**Cross-
reference**

Refer to chapter 12.6, "To install rubber bushings of control arm".

To replace flexible ball-joint of control arm

**Cross-
reference**

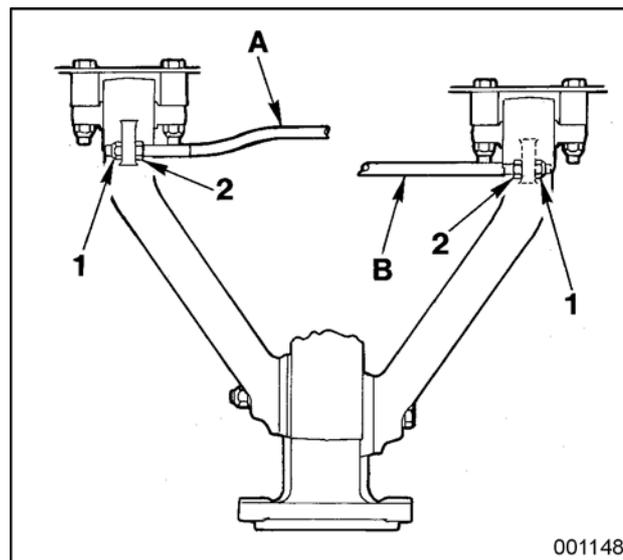
Refer to chapter 12.6, "To replace flexible ball-joint of control arm".

To adjust length of control arms tie rod

Introduction

Before the controls arms are finally tightened to the chassis, the length of the tie rods has to be adjusted in such way that the bolt holes of the control arms line up exactly with those in the chassis. The tightening of the fixing nuts should not preload the flexible ball joints of the control arms.

Figure: left axle half, view from above



- 1 Self-locking nut
- 2 Nut to adjust the tie rod
- A Upper tie rod
- B Bottom tie rod

Procedure

Step	Action
1	Loosen nuts (1).
2	Turn nuts (2) to change the length of the tie rod.
3	Tighten nuts (1).

To check wheel bearing end-play

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking values

Refer to "Technical data" at the end of this chapter.

Procedure

Step	Action
1	Jack up hub carrier, until wheels clear ground.
2	Place a dial indicator with a magnetic support on the brake disc. Place the indicator stylus square to the hub carrier. Set the dial indicator to zero. 
3	Grab wheel and move it as far as possible inwards and outwards (pull and push). At the same time an assistant notes the total variation shown by the dial indicator.
4	Compare measured end-play with maximum permissible value.

End-play out-of-limit?

Bearing end-play is not adjustable. If the measured value is out-of-limit, the entire hub unit must be changed.

To remove wheel hub

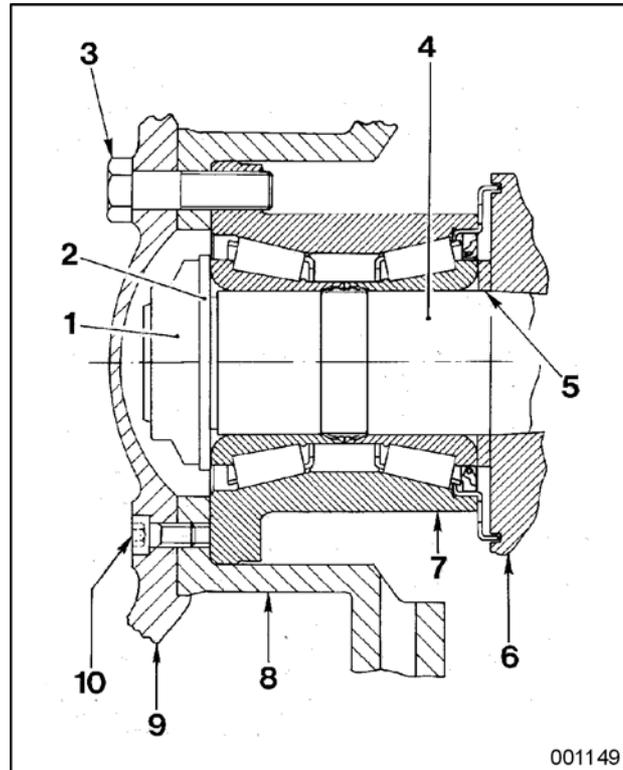
Special tools

Hub nut wrench	Van Hool No. A996030253
Tool set to remove hub unit from axle spindle	
<ul style="list-style-type: none"> • Spindle • Flange • Threaded bush • Cover 	<ul style="list-style-type: none"> • Van Hool No. A996060240 • Van Hool No. A996060464 • Van Hool No. A996060251 • Van Hool No. A996060238

Equipment condition

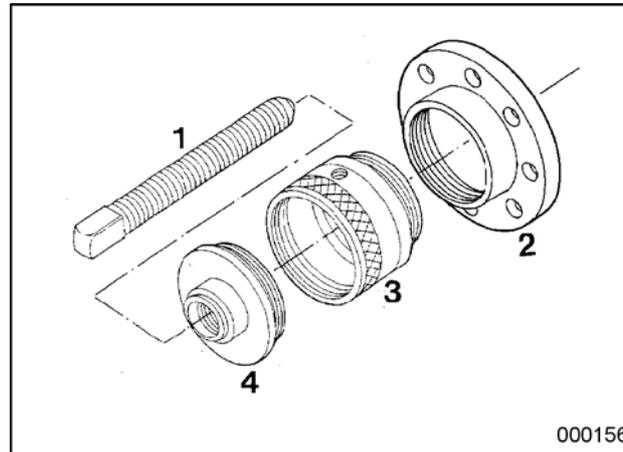
- Wheels remaining on the ground chocked
- Trailing axle jacked up
- Road wheel removed
- Brake caliper/brake carrier removed, refer to "To remove brake caliper/brake carrier" in chapter 5.10.

Figure:
section
through wheel
hub



- 1 Hub nut
- 2 Washer
- 3 Screw retaining brake disc and wheel flange to hub unit
- 4 Axle spindle
- 5 Spacer
- 6 Hub carrier
- 7 Hub unit
- 8 Brake disc
- 9 Wheel flange
- 10 Hexagonal socket screw

Figure: tool set



Tool set to remove hub unit from axle spindle

- 1 Spindle
- 2 Flange
- 3 Threaded bush
- 4 Cover

Hub unit

The hub unit combines two bearings, a grease seal and an ABS pulse ring. If one of these components is damaged, the entire unit must be replaced by a new one.



WARNING!

The wheel flange and the brake disc are heavy. Be sure they are well supported, before undoing the fixing screws.

Procedure

Step	Action
1	Remove hexagonal socket screw (10).
2	Remove the twelve screws (3) retaining wheel flange and brake disc to hub unit.
3	Remove wheel flange (9)
4	Thread puller screws into the three M12 x 1.5 tapped holes in brake disc. Free brake disc from hub unit using puller screws. Remove brake disc.
5	Remove hub nut (1) using hub nut wrench.
6	Remove washer (2).

continued on next page

Step	Action
7	Secure flange (2) of tool set to hub unit with three screws.
8	Screw threaded bush (3) of tool set into flange (2).
9	Screw cover (4) of tool set into threaded bush (3).
10	Screw spindle (1) of tool set into cover (4).
11	Remove hub unit by turning spindle (1) of tool set clockwise.

To install wheel hub

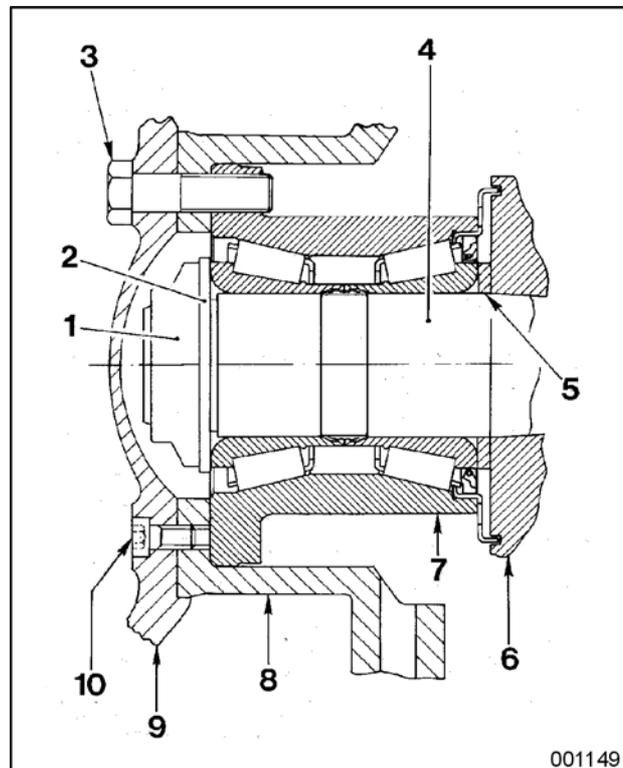
Special tools

Tool set to install the hub unit on the axle spindle	Van Hool No. 10678700
--	-----------------------

Tightening torques

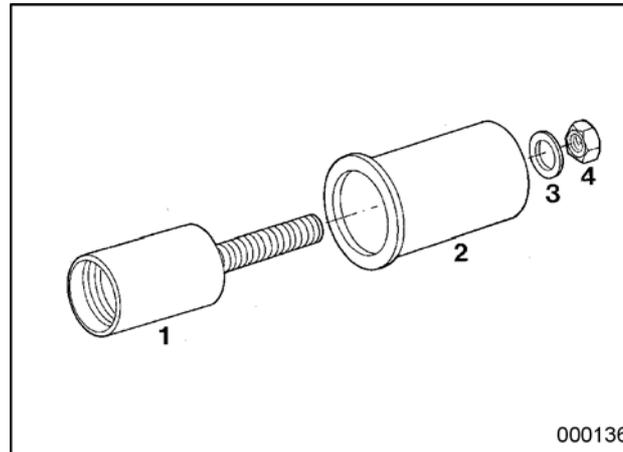
Refer to "Technical data" at the end of this chapter.

Figure:
section
through wheel
hub



- 1 Hub nut
- 2 Washer
- 3 Screw retaining brake disc and wheel flange to hub unit
- 4 Axle spindle
- 5 Spacer
- 6 Hub carrier
- 7 Hub unit
- 8 Brake disc
- 9 Wheel flange
- 10 Hexagonal socket screw

Figure: tool set



Tool set to install the hub unit on the axle spindle

- 1 Guide sleeve
- 2 Press sleeve
- 3 Washer
- 4 Nut

Step	Action
1	Apply thin film of "Never Seez" to axle spindle (4).
2	Slide spacer (5) on axle spindle.
3	Screw guide sleeve (1) of tool set onto the axle spindle
4	Slide hub unit on the guide sleeve (1) of the tool set.
5	Slide press sleeve (2) of the tool set on the guide sleeve.
6	Install washer (3) and nut (4) of the tool set on the threaded rod of the guide sleeve.
7	Turn nut (4) of the tool set clockwise to install the hub unit on the axle spindle.
8	Remove the tools.
9	Install washer (2).
10	Screw hub nut (1) on the axle spindle, tighten to the prescribed torque and simultaneously rotate the hub unit a couple of times in both directions to settle the roller bearings.
11	Apply a thin film of NLGI No. 2 grade high temperature lithium grease to the contact surfaces between brake disc (8) and hub unit (7).

continued on next page

Step	Action
12	Put brake disc (8) on a flat surface. Position wheel flange (9) on brake disc (8) in such a way that the holes for screw (10) coincide. Secure wheel flange (9) to brake disc (8) with hexagonal socket screw (8).
13	Position the wheel flange/brake disc assembly to the hub unit in such a way that the screw holes coincide. Install twelve fixing screws (3) and tighten them crosswise in steps.
14	Install the brake caliper/brake carrier assembly. Refer to "To install brake caliper/brake carrier" in chapter 5.10.

Technical data: trailing axle

Make Van Hool

Geometry

Camber	+15' ± 15'
Toe (degrees)	0° ± 3'
Toe (inch)	0 ± 0.012 in/ft

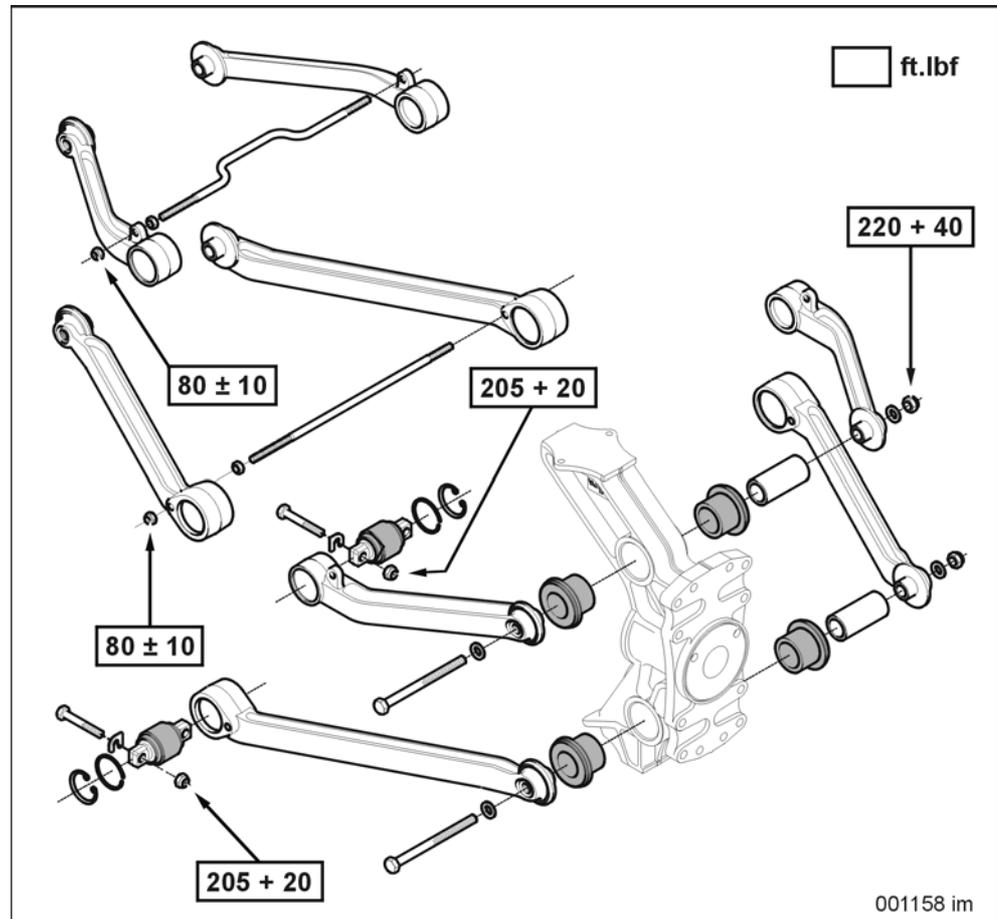
Wheel hub

Wheel bearing end-play	maximum 0.01 in
------------------------	-----------------

Tightening torques

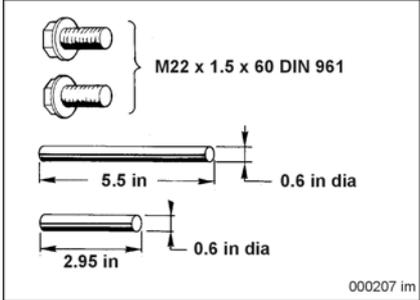
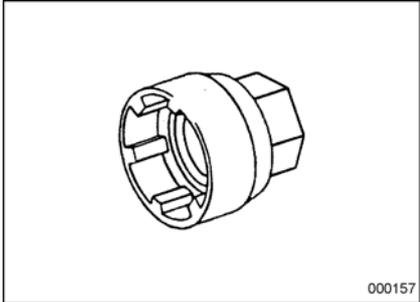
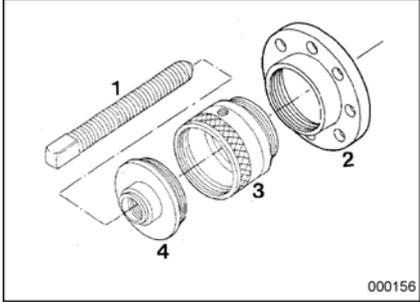
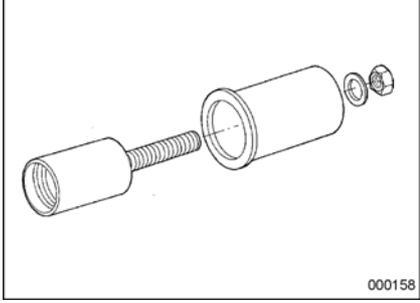
Hub nut	545 ± 30 ft.lbf
Hexagonal socket screw for securing wheel flange to brake disc (M12 x 1.5)	55 ± 7 ft.lbf
Screws for securing wheel flange/brake disc to hub unit (M18 x 1.5 -10.9)	320 ± 20 ft.lbf
Air spring piston to hub carrier	52 ± 7 ft.lbf
Shock absorber to hub carrier	70 ft.lbf

Figure:
tightening
torques



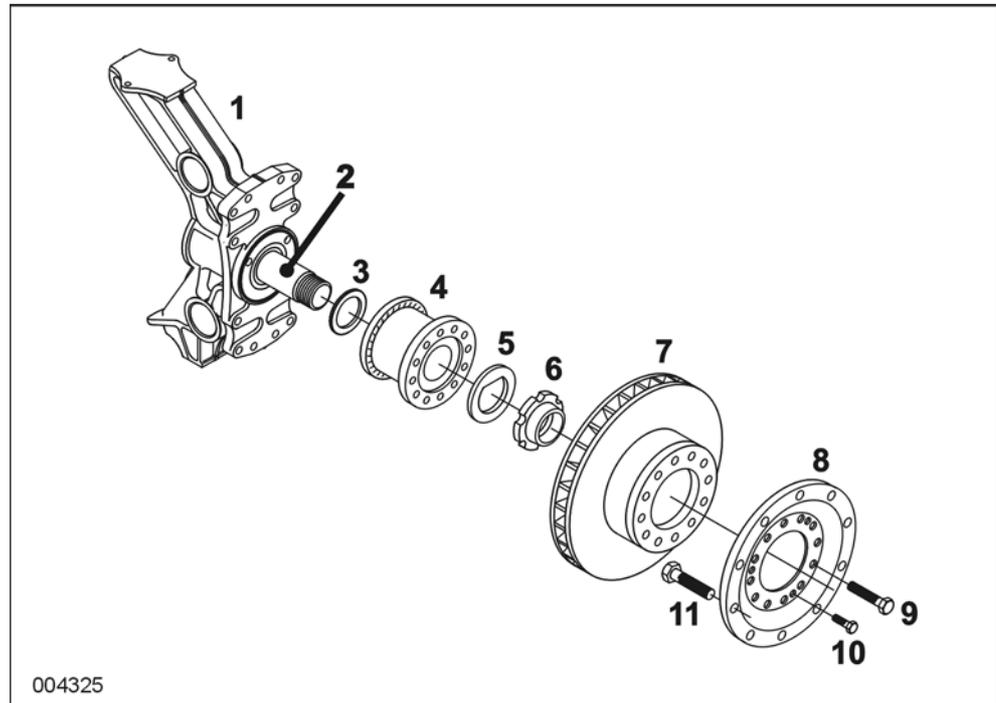
Security of control arms.

Special tools: trailing axle

Ordering number	Description	Figure
Van Hool 10695670	Tool kit to remove rubber bushings from the control arm	 <p>000207 im</p>
Van Hool A996030253	Hub nut wrench	 <p>000157</p>
Van Hool A996060240 Van Hool A996060464 Van Hool A996060251 Van Hool A996060238	Tool set to remove hub unit from axle spindle 1 Spindle 2 Flange 3 Threaded bush 4 Cover	 <p>000156</p>
Van Hool 10678700	Tool set to install the hub unit on the axle spindle	 <p>000158</p>

Trailing axle, exploded view

Hub, exploded view



- 1 Hub carrier
- 2 Axle spindle
- 3 Spacer
- 4 Hub unit
- 5 Washer
- 6 Hub nut
- 7 Brake disc
- 8 Wheel flange
- 9 Screw retaining brake disc and wheel flange to hub unit
- 10 Hexagonal socket screw
- 11 Wheel bolt

Part 13 - Compressed-air feed system

Overview

Contents

Chapter	See page
Chapter 1: Complete compressed-air system	13.1-1
Chapter 9: Air purifying devices	13.9-1
Chapter 13: Valves	13.13-1
Chapter 17: Tanks	13.17-1
Chapter 21: Pressure switches and pressure sensors	13.21-1
Chapter 25: Air lines	13.25-1

Chapter 1: Complete compressed-air system

Overview

Introduction This chapter deals with the complete compressed-air system.

Number of pages 4

Chapter publication date 19 September 2006

Contents

Topic	See page
Safety precautions concerning compressed air	13.1-2
Layout	13.1-3
To charge compressed-air tanks externally	13.1-4

Safety precautions concerning compressed air

**WARNING!**

Always wear safety goggles, when you are working with compressed air. Never look into a stream of escaping air.

**WARNING!**

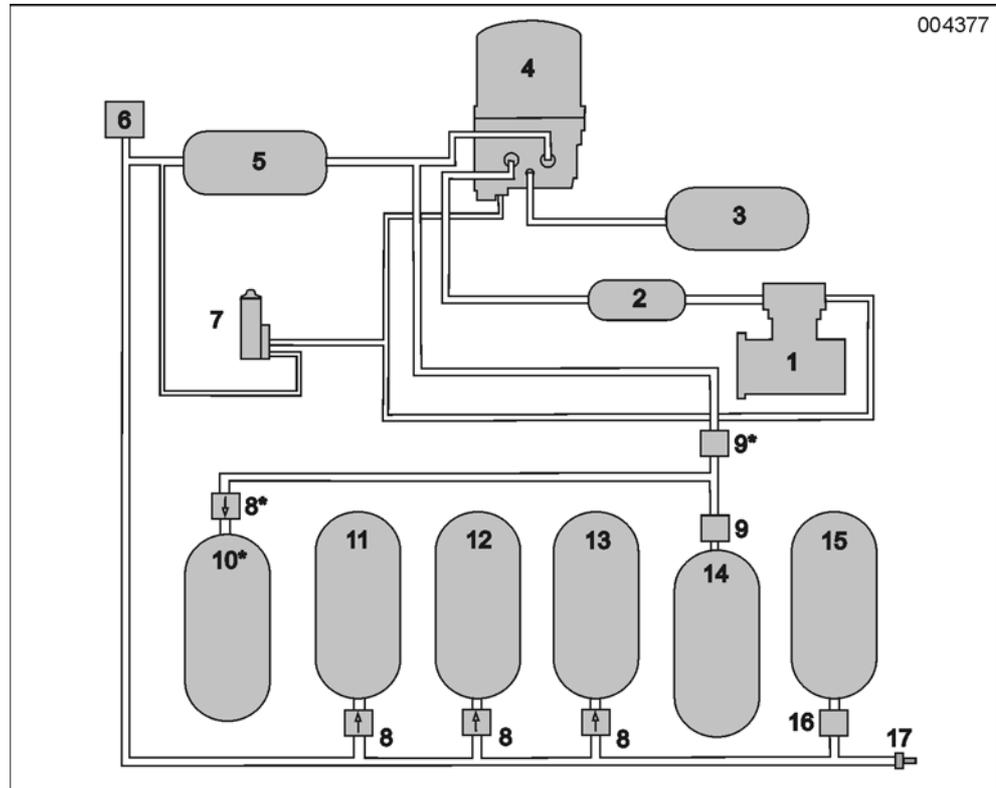
It is dangerous to disconnect lines, while the compressed-air system is still pressurized: disconnected lines through which air is escaping can be slung about.

**WARNING!**

It is dangerous to unscrew plugs or to open compressed-air apparatuses, while the system is pressurized. Parts that are slung about by compressed air can cause serious injuries.

Layout

Figure: layout



* Only for ZF Astronic

- 1 Air compressor
- 2 Damper tank
- 3 Purge tank
- 4 Air dryer
- 5 Wet tank
- 6 Safety valve
- 7 Governor
- 8 Single check valve
- 9 Overflow valve with limited return
- 10 ZF Astronic tank
- 11 Trailing axle brakes tank
- 12 Drive axle service brakes tank
- 13 Front axle brakes tank
- 14 Auxiliaries tank
- 15 Emergency parking brake release tank
- 16 Overflow valve without return
- 17 Fill coupling

To charge compressed-air tanks externally

**CAUTION!**

Make sure the air is dry and clean. In addition, air pressure should not exceed 130 psi.

Fill coupling

As to the location of the fill coupling, refer to "Access doors and controls at the outside".

If necessary, you can charge the entire compressed-air system of the vehicle via the fill coupling.

Chapter 9: Air purifying devices

Overview

Introduction

This chapter deals with the air purifying devices.

Number of pages

2

Chapter publication date

19 September 2006

Contents

Topic	See page
To change air dryer element	13.9-2

To change air dryer element

To be carried out when?

Change the element at the intervals indicated in the maintenance schedule (chapter 1.1) and whenever a check of the compressed-air tanks reveals that there is too much condensation in it.

Equipment condition

- Vehicle on a flat level surface, over an inspection pit;
- Chocks in front of and behind wheels.

Consumables

Air dryer element	Van Hool No. 10898619
-------------------	-----------------------

Location of air dryer

Refer to chapter 1.1, "Maintenance schedule".

Procedure

Step	Action
1	Depressurize the air dryer circuit completely by opening the drain valve on the wet tank. For the location of the air tanks refer to "Location of compressed-air tanks" in chapter 13.17.
2	Wait until no more air escapes from the drain valve.
3	Follow the Haldex instructions provided with the new air dryer element.

Chapter 13: Valves

Overview

Introduction This chapter deals with the valves.

Number of pages 6

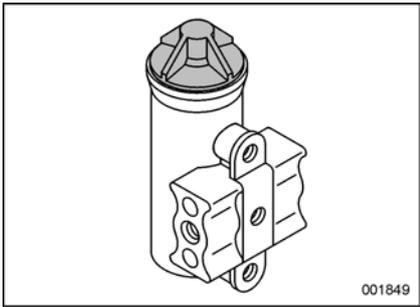
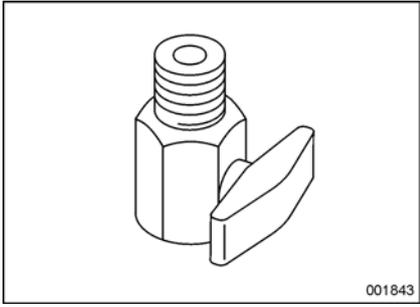
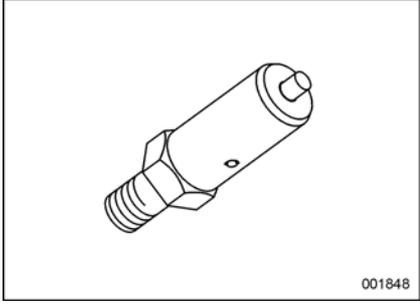
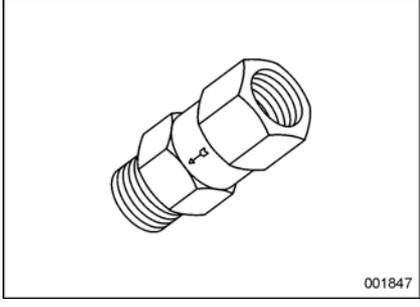
Chapter publication date 19 September 2006

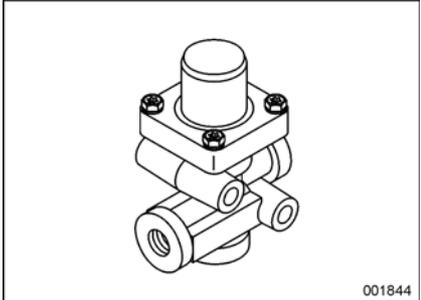
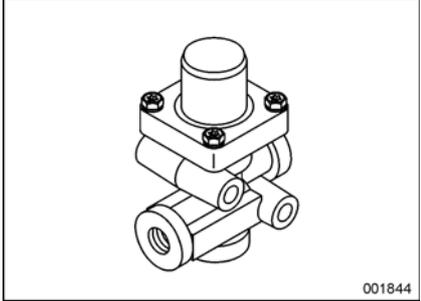
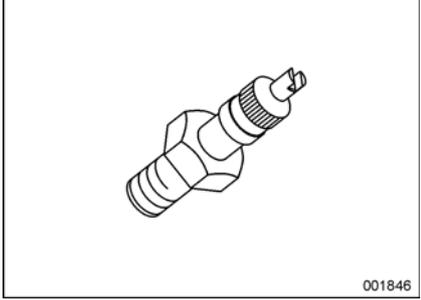
Contents

Topic	See page
Visual identification of valves	13.13-2
To check governor operation	13.13-4
Technical data: valves	13.13-5

Visual identification of valves

Components

Name	Figure
Governor	 <p style="text-align: right;">001849</p>
Compressed-air tank drain valve	 <p style="text-align: right;">001843</p>
Pressure-relief valve	 <p style="text-align: right;">001848</p>
Single check valve	 <p style="text-align: right;">001847</p>

Name	Figure
Overflow valve without return	 <p style="text-align: right;">001844</p>
Overflow valve with limited return	 <p style="text-align: right;">001844</p>
Fill coupling	 <p style="text-align: right;">001846</p>

To check governor operation

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Checking values

Refer to "Technical data" at the end of this chapter.

Location of governor

The governor is mounted on the air compressor.

Procedure

Step	Action
1	Connect a class 0.6 pressure gauge with a range of 145 psi to the fill coupling of the compressed-air system. As to the location of the fill coupling, refer to "Access doors and controls at the outside".
2	Start engine to have pressure build-up in compressed-air tanks. Filling should be effected at 1 000 to 1 500 rpm. Follow pressure build-up on the gauge.
3	Make note of pressure reading at point where governor switches off (you will hear air dryer blow off).
4	Compare value with cut-out pressure value in technical data.
5	Have engine idle and keep an eye on pressure gauge. Try and get pressure in tanks to drop back to 105 psi by pumping brake pedal. Wait for a few seconds after each time you have depressed brake pedal.
6	At one point compressor begins to fill compressed-air tanks (governor cuts in). Make note of pressure gauge reading, exactly at point where pointer starts to climb.
7	Compare value with cut-in pressure value in technical data.

Technical data: valves

Governor

Make	Allied Signal
Type	D2
Cut-out pressure	130 to 140 psi
Cut-in pressure	110 to 115 psi

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Chapter 17: Tanks

Overview

Introduction

This chapter deals with the compressed-air tanks.

Number of pages

4

Chapter publication date

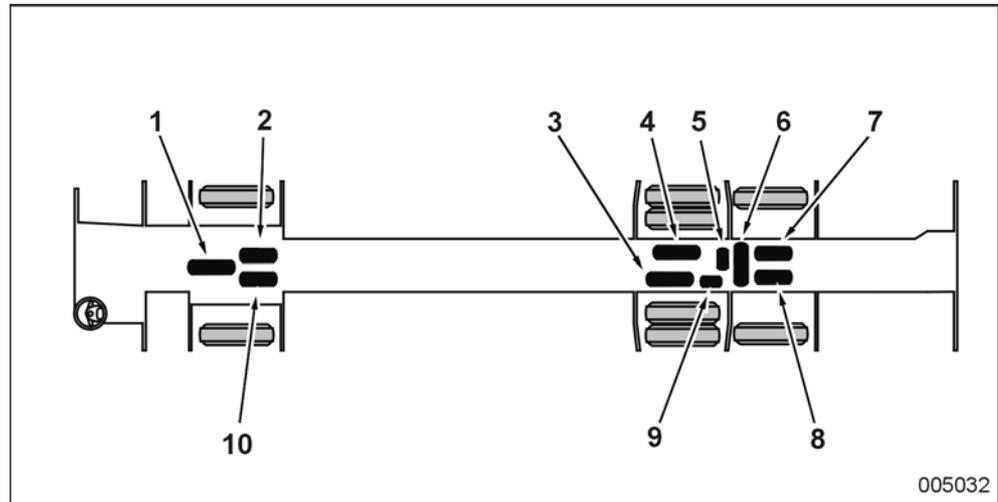
19 September 2006

Contents

Topic	See page
Location of compressed-air tanks	13.17-2
To check compressed-air tanks for absence of moisture	13.17-3
To check security of compressed-air tanks	13.17-4

Location of compressed-air tanks

Figure:
location of
compressed-
air tanks



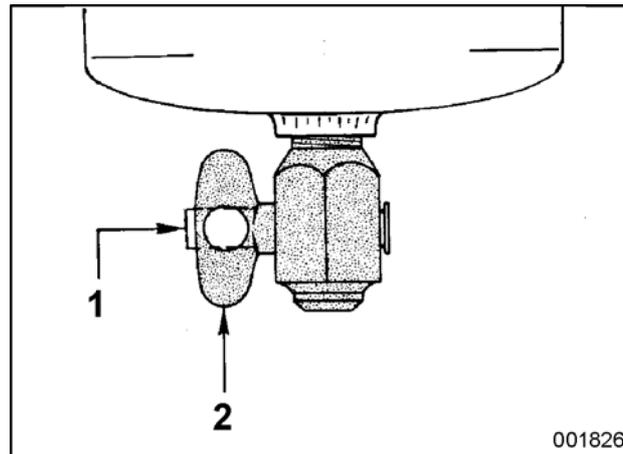
- 1 Front axle brakes
- 2 Kneeling system
- 3 Drive axle service brakes
- 4 Accessories
- 5 Wet tank
- 6 Rear raising
- 7 Trailing axle brakes
- 8 ZF Astronic (vehicles with ZF Astronic transmission only)
- 9 Air dryer purge
- 10 Parking brake emergency release

To check compressed-air tanks for absence of moisture

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Figure:
compressed-air tank drain valve



1 Closed
2 Open

Procedure

Momentarily open drain valve of each tank.

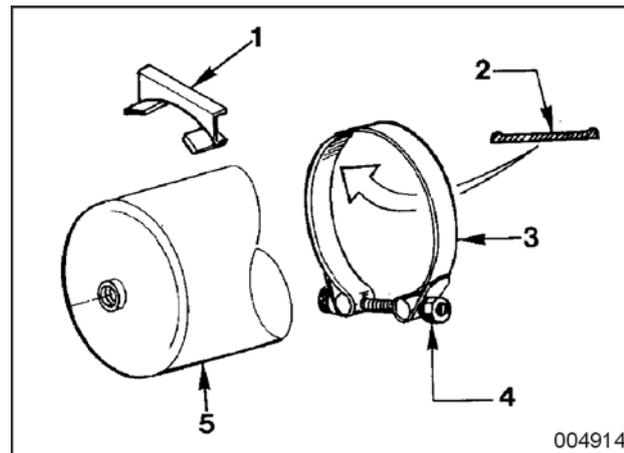
If...	then...
only some light mist escapes with the air,	system air dryer is functioning properly.
a lot of water or other impurities come out,	drain compressed-air tanks completely and change air-dryer element.

To check security of compressed-air tanks

To be carried out when?

Refer to chapter 1.1, "Running-in service".

Figure: security of compressed- air tank



- 1 Support
- 2 Rubber profile
- 3 Clamping ring
- 4 Fixing bolt
- 5 Compressed-air tank

To check security

Mechanically check the fixing bolts for tightness. If necessary, hand-tighten the fixing bolts.

Chapter 21: Pressure switches and pressure sensors

Overview

Introduction This chapter deals with the pressure switches and pressure sensors.

Number of pages 4

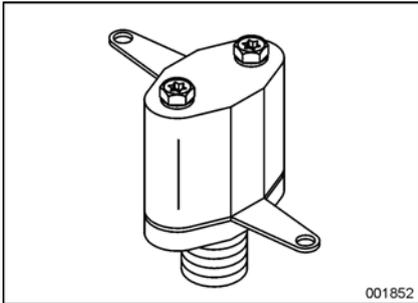
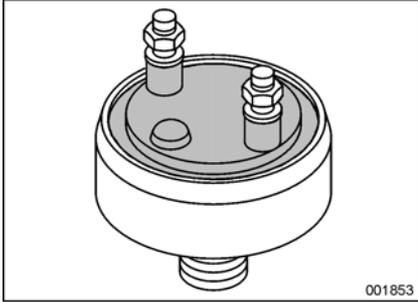
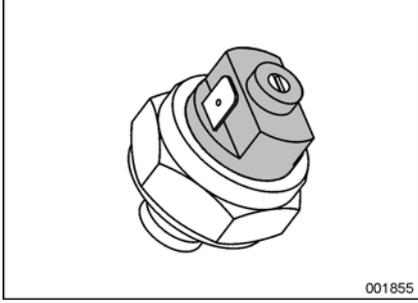
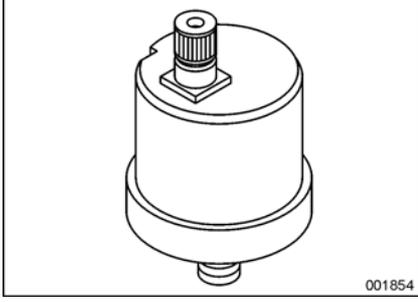
Chapter publication date 19 September 2006

Contents

Topic	See page
Visual identification of pressure switches and pressure sensors	13.21-2

Visual identification of pressure switches and pressure sensors

Components

Name	Figure
Pressure switch (Bendix LP-3)	 <p style="text-align: right;">001852</p>
Pressure switch (Bendix SL-5)	 <p style="text-align: right;">001853</p>
Pressure switch (Wabco 441014....)	 <p style="text-align: right;">001855</p>
Pressure sensor	 <p style="text-align: right;">001854</p>

continued on next page

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Chapter 25: Air lines

Overview

Introduction This chapter deals with the air lines.

Number of pages 4

Chapter publication date 19 September 2006

Contents

Topic	See page
Air line color codes	13.25-2
To check air-compressor discharge line for carbon deposit	13.25-3

Air line color codes

Introduction

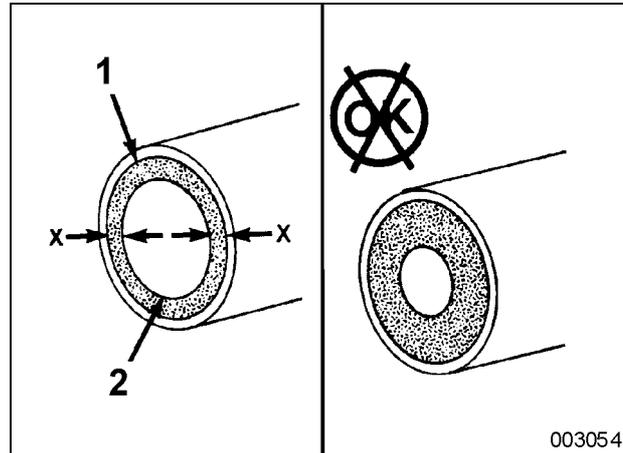
The end of each air line bears one or two color rings. You can tell by these color rings what is the function of the line. The table below lists the meaning of the colors.

Color codes

Van Hool color code	Letter representation on compressed-air diagram	Function
2 x red	R-R	General pressure supply
1 x red, 1 x green	R-GN	Tank pressure, service brake 1st axle
1 x green	GN	Braking pressure, service brake 1st axle
1 x red, 1 x yellow	R-GE	Tank pressure, service brake 2nd axle
1 x yellow	GE	Braking pressure, service brake 2nd axle
1 x red, 1 x white	R-W	Tank pressure, bus stop brake and parking brake
1 x white	W	Pressure in parking brake cylinders
1 x brown	BR	Pilot pressure for bus stop brake
1 x red, 1 x gray	R-GS	Tank pressure, accessories
1 x gray	GS	Accessories (air suspension, door control, etc.)
1 x red, 1 x blue	R-B	Tank pressure, parking brake cylinders emergency release
1 x blue	B	Emergency release pressure for parking brake cylinders
1 x orange	O	Bleeding

To check air-compressor discharge line for carbon deposit

Figure: air-compressor discharge line



- 1 Inner diameter discharge line
2 Inner diameter carbon deposit

Procedure

Step	Action
1	Release pressure from air system by actuating drain valve on wet tank.
2	Disconnect the discharge line from the air compressor.
3	Measure the total thickness (X + X) from the carbon deposit in the discharge line.
4	Is the carbon discharge thicker than 1/16 in? If yes, go to step 5. If not, go to step 6.
5	Check: <ul style="list-style-type: none"> the condition of the air compressor; the lines and couplings further up in the compressed-air system (up to the air dryer and the governor) for excessive carbon deposit. If necessary, clean/replace lines and couplings.
6	Install the discharge line to the air compressor.

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Part 14 - Electrical

Overview

Contents

Chapter	See page
Chapter 2: Electric power supply	14.2-1
Chapter 6: Junction boxes	14.6-1
Chapter 10: Wiring	14.10-1
Chapter 18: Electric circuit diagrams	14.18-1

Chapter 2: Electric power supply

Overview

Introduction This chapter deals with the electric power supply.

Number of pages 18

Chapter publication date 19 September 2006

Contents

Topic	See page
General safety instructions	14.2-2
To retrofit electrical equipment	14.2-3
Alternator: general	14.2-4
Alternator: to carry out a charge test	14.2-6
Alternator: to check alternator brush wear	14.2-7
Alternator: to fit a new or exchange alternator	14.2-9
Safety precautions concerning batteries	14.2-10
Batteries: general	14.2-11
Batteries: general maintenance	14.2-13
Batteries: to check charge	14.2-15
Jump starting instructions	14.2-16

General safety instructions

**WARNING!**

The use of mobile phones and transmitting equipment inside the vehicle may disturb the operation of vehicle electronics and therefore jeopardize vehicle operational safety. In order not to jeopardize vehicle operational safety, mobile phones and transmitting equipment must not be used inside the vehicle, unless they are connected to an external vehicle antenna.

**CAUTION!**

Never remove battery clamps while engine is running or with battery switch closed. If you have to remove the battery clamps, always start with the negative terminal (marked with “-” or a blue or green plastic ring). The other way round, always connect the positive terminal first (“+” or red plastic ring), before connecting the negative terminal. Connecting the wrong polarity will damage the electrical system.

**CAUTION!**

Van Hool cannot be held liable for the consequences of others adding electrical devices or modifying electrical circuits.

**CAUTION!**

Never test an electrical circuit by applying voltage.

**CAUTION!**

Never use an external electrical source to power or test devices on the vehicle.

To retrofit electrical equipment

Introduction

If you want to add electrical devices to the vehicle equipment yourself, you should proceed in such a way that the original electrical system is not interfered with.

Conditions

-
- To power the additional devices, you will have to fit electrical wires of your own. The wiring you installed yourself will have to be protected with fuses that you will have to provide yourself as well.
 - If the combined power consumption of the additional devices exceeds 25 A, you will have to install an additional main fuse with the vehicle batteries.

What equipment is allowed?

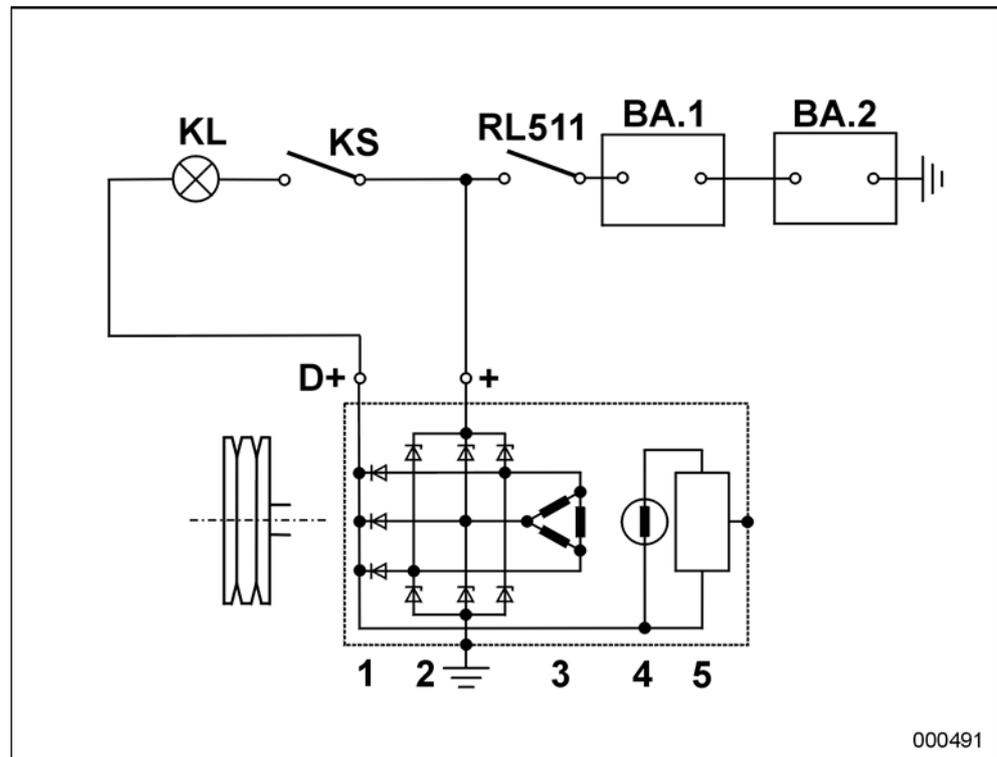
If electrical or electronic systems are being modified, replaced or added, the devices or systems involved must comply with the requirements outlined in the European directive 72/45/EEC. This directive relates to electromagnetic compatibility (EMC).

Alternator: general

Introduction

The vehicle's batteries supply the power for starting the engine. The function of the batteries ends as soon as the engine is running. From this moment onwards the alternator takes over the function of electric power supply for the vehicle. Its ability is such that it not only supplies all of the electrical units with power, but it also charges the batteries.

Figure:
alternator
circuit
diagram
(example)



RL511: Master switch

+: Direct to battery plus

D+: Voltage with running engine

BA: Battery

KL: Alternator indicator light

KS: Ignition switch

1: Field diodes

2: Power Zener diodes

3: Stator winding

4: Field coil

5: Voltage regulator

Parts of the alternator

The three phase current coil (3) is in the stator of the alternator and the field coil (4) is in the rotor. The stator winding (3) is permanently connected with the batteries (BA.1) and (BA.2). The D+ terminal is connected with the field coil through sliprings with carbon brushes. Six Zener diodes (2) serve to rectify the generated three phase alternating current in the stator for usage in the vehicle system. Three ordinary diodes (1) serve to rectify a smaller part of the generated current for feeding the field coil. An electronic voltage regulator (5) is under the cap at the end of the alternator.

Operation

Stage	Description
1	When the alternator is engaged it cannot power itself. The batteries (BA.1) and (BA.2) must power the field coil (4) first of all.
2	With a closed master switch (RL511) and ignition switch (KS) the battery current runs through the alternator indicator light (KL) and the D+ terminal to the field winding (4) through the current regulator to the ground. <i>NOTE: In some vehicles the alternator indicator light is replaced by a simple resistor.</i>
3	The alternator voltage increases as the number of revolutions increases. With this a rectified current runs through the field diodes (1). The voltage difference between the the D+ point and the batteries decreases. Because of this the current that runs through the indicator light (KL) decreases and the latter lights less brightly.
4	As soon as the alternator voltage is of the same value as the battery voltage the indicator light (KL) will go out. All of the field current is then generated by the alternator itself and rectified by the field diodes (1).
5	When the alternator voltage increases even more, the alternator begins to charge the batteries.

Voltage Regulator

The task of the electronic voltage regulator is to upwardly limit the current generated by the alternator, even with strongly varying revolutions and varying load. This limit value is not adjustable. A defective regulator cannot be fixed and must be replaced.

Limitation of voltage peaks

Voltage peaks are limited by the use of Zener diodes as power rectifiers.

Alternator: to carry out a charge test

Equipment condition

Ambient temperature between 65 and 85 °F.

Vehicle with two alternators

If your vehicle is equipped with two alternators, it is sometimes difficult, in case of a failure, to determine which alternator is defective. Removing the drive belts of one of the alternators might be helpful in this case.

Procedure

Step	Action
1	Before the test, check whether the batteries are in good condition and fully charged. Also check the security of the battery terminal clamps.
2	Connect an accurate voltmeter to the battery group.
3	Let the engine turn at a speed of 1 000 rpm.
4	Connect all current consumers. The voltmeter should now indicate a tension of more than 27 V. <i>NOTE: If the test is carried out with an engine at operating temperature, the charge value is allowed to be 0.5 V lower.</i>
5	If the charge is too low, replace the voltage regulator of the alternator and repeat the test.
6	If there is no improvement after carrying out step 5, remove the alternator for repair.

Alternator: to check alternator brush wear

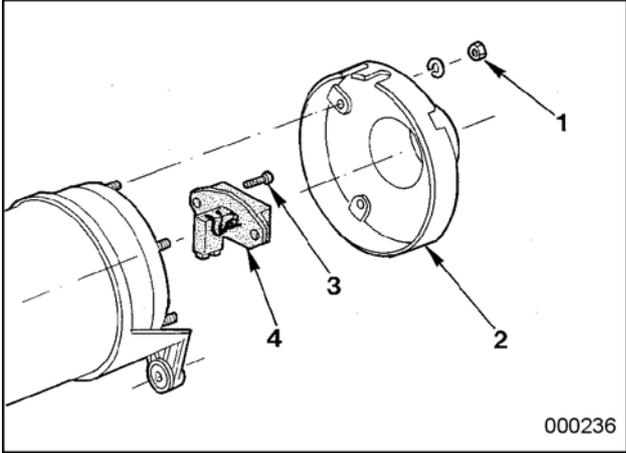
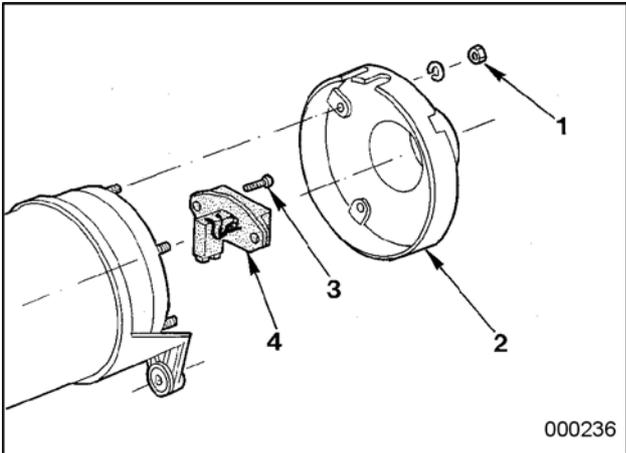
To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

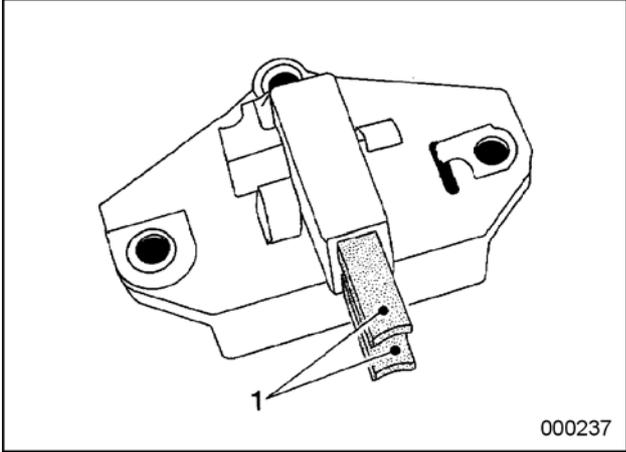
Location of the alternator brushes

The alternator brushes are mounted on the electronic voltage regulator in the rear part of the alternator.

Procedure

Step	Action
1	<p>Remove nuts (1) securing cover (2) to the alternator and pull cover to the rear.</p> 
2	<p>Remove screws (3) and detach voltage regulator (4) from rear bearing end frame.</p> 

continued on next page

Step	Action
3	<p>Measure the length of brushes (1).</p> <p>Replace the brushes at the latest when their length has diminished to 0.28 in. Also when a brush is broken, mount a new pair of brushes.</p> <div><p>000237</p></div>

**In case of a
second brush
renewal**

If a new brush is mounted for the second time, it is advisable to demount the alternator in order to be revised (to reduce the risk of failure when in service).

Alternator: to fit a new or exchange alternator

Compensating sleeve

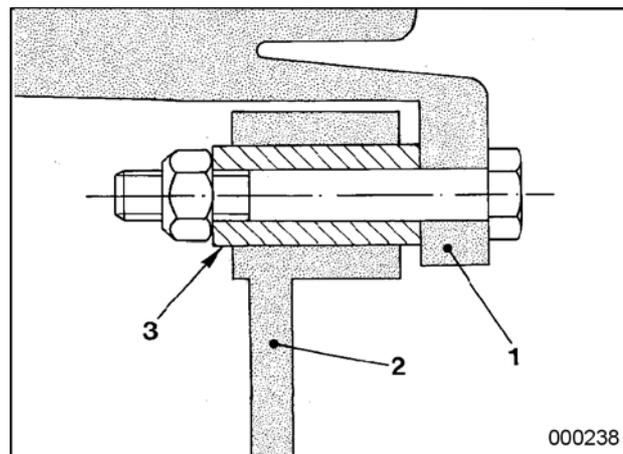
The distance between the front and back alternator-swinging arm is never exactly the same on alternators of the same model. A compensating sleeve may be necessary when installing the alternator to compensate for the differences. This sleeve is located in the eye of the swinging arm or in the alternator support (depending on the way the alternator is attached on your vehicle).



CAUTION!

Check, before installing the alternator, that the compensating sleeve is sufficiently loose for it to shift while the pivot bolt is tightened. If the sleeve is stuck, loosen it, otherwise you run the risk that the swinging arms are stressed and break off.

Figure:
alternator
mounting



Example of rear alternator mounting (sectional view)

- 1 Alternator (swinging arm in detail)
- 2 Alternator support
- 3 Compensating sleeve

Safety precautions concerning batteries

**WARNING!**

Battery fluid is a corrosive acid. Avoid any contact with the eyes, skin, clothing and painted surfaces. In the event of contact, immediately rinse the affected area with ample water; have a doctor attend to the eyes immediately. Avoid spilling battery fluid. Always hold a battery upright, when moving it.

**WARNING!**

Take care that no flames or sparks get in the vicinity of batteries. Do not smoke near batteries. Battery fumes are flammable and explosive. Prolonged inhalation of these fumes is harmful. Wear gloves and safety goggles. Work in a well-ventilated space.

**WARNING!**

Take care that no metal tools touch the positive battery terminal (or parts attached to it) and the body metal at the same time. After all, this will trigger a short circuit, which can cause burn injuries and explosions.

**CAUTION!**

Never remove battery clamps while engine is running or with battery switch closed. If you have to remove the battery clamps, always start with the negative terminal (marked with “-” or a blue or green plastic ring). The other way round, always connect the positive terminal first (“+” or red plastic ring), before connecting the negative terminal. Connecting the wrong polarity will damage the electrical system.

Batteries: general

Introduction	Your vehicle features two 12-volt batteries (or four 6-volt batteries), connected in series.
Battery type	The batteries are of the "starter battery" type. As the name suggests, this type can only be used to start the engine, i.e. to provide a large supply of energy very briefly. Starter batteries are not appropriate for use that implies extended discharges on a repeated basis. If the battery has to supply power for long periods, its useful life will be greatly reduced.
Role of alternator	The energy taken from the battery to start the engine is recharged by the alternator, while the engine is running.
Disruptions of charging process	<p>If disruptions occur in the charging process, the battery will be recharged inadequately. Insufficient charging for a longer period will cause irretrievable loss of capacity. Disruptions of the charging process can occur, when:</p> <ul style="list-style-type: none">• the vehicle is operated for short trips mainly and the big power consumers are used intensively at the end of the trip; The batteries are not fully recharged, which can cause problems next time you try to start the engine;• you make a 12-volt tap from the batteries to power a 12-volt system (such as a communications system). The batteries become imbalanced, which will lead to defective batteries in the short run.• you connect extra devices directly to the batteries. The power used with open battery switch will be greater in this case, which will cause the batteries to drain more quickly.• power is drained with the engine off on a regular basis (for example by turning on interior lighting to clean the vehicle).
With high ambient temperature	The batteries of a vehicle that is parked in the garage discharge due to a phenomenon known as "self-discharge". In the tropics self-discharge progresses exceptionally fast. After one month without recharging for instance, charge will have dropped to about 50% of normal charge. 50% of normal charge. If the battery discharges even further, it will become unusable on a permanent basis. Therefore, in order to prevent premature loss of batteries, they have to be recharged on a regular basis (by driving the vehicle or using an external battery charger).
Electronic engine control system	Contemporary engines with electronic engine-control systems are very "voltage sensitive": the engine-control electronics do not function, if voltage

continued on next page

is too low. In such case starting is impossible, even when the starter motor is running properly.

To recharge batteries from external source

If you have to recharge the battery group with an external source, preferably work with an amperage equaling one tenth of the capacity stated on the batteries (expressed in Ah: amp hours). Before charging "low-maintenance" batteries, unscrew all plugs to allow for the fumes to escape.

To use a quick charger

Using a so called quick charger is not good for the battery. In general they supply too high an output voltage. If you want to use a quick charger after all, at least remove the clamp from the negative terminal of the battery group before charging. If you neglect to do this, there is a risk of damage to vehicle electronic equipment. As soon as the battery begins to gas, stop quick charging.

Frost protection

Always keep the batteries properly charged. Their frost resistance depends on how well their charging conditions are. A fully charged battery does not freeze until -25 °F, a drained battery on the other hand freezes at 23 °F. Never attempt to charge a battery that is frozen; it has to be defrosted first.

Batteries: general maintenance

To be carried out when?

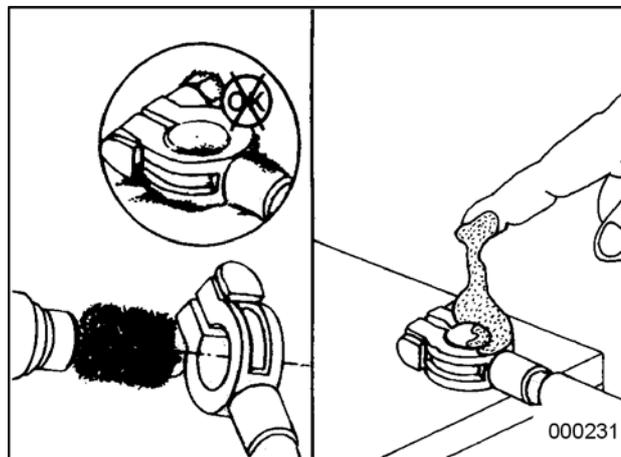
Refer to chapter 1.1, "Maintenance schedule".



CAUTION!

Never disconnect battery terminals, while the engine is running.

**Figure:
terminals
maintenance**

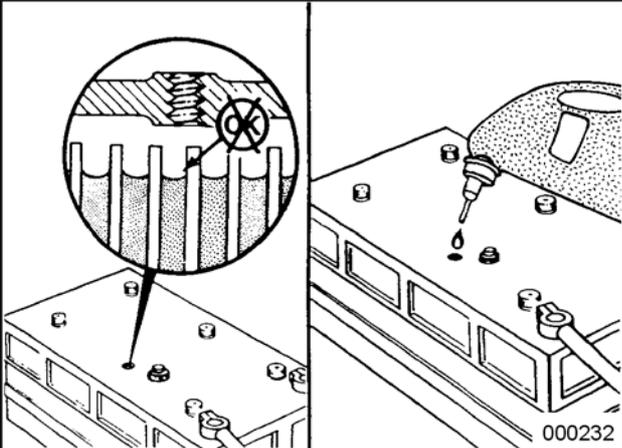


Clean and smear terminals with acid-free vaseline.

Procedure

Step	Action
1	Switch off master switch.
2	Remove the two terminal clamps (start with negative terminal) and clean them inside and outside with metal brush.
3	Clean battery compartment and top of batteries.
4	Re-attach clamps to terminals (positive clamp first).
5	Brush terminals and clamps with thin layer of acid-free vaseline to combat oxidation.

continued on next page

Step	Action
6	<p>If there are caps on top of batteries, as is the case with non-maintenance-free batteries, check electrolyte liquid level.</p> <p>Liquid should be about 0.4 in above metal plates in battery.</p> 
7	<p>Top up with distilled or completely demineralized water, if necessary.</p>

Batteries: to check charge

To be carried out when?

Refer to chapter 1.1, "Maintenance schedule".

Acid tester

The acid tester indicates the specific gravity of the battery fluid.

Specific gravity

Specific gravity will increase during charging and decrease during discharging.

To check charge with acid tester

Measure the charge of non-maintenance-free batteries using an acid tester. Check each battery cell individually. The reading should be approximately the same for all cells. A difference of 0.05 between two cells of the same battery indicates that the battery is defective.

The values in the table below apply for an ambient temperature of 68 to 80 °F. If temperature is higher or lower, make the following correction:

- Add 0.004 to the acid tester reading for each 10 °F above 80 °F;
- Subtract 0.004 from the acid tester reading for each 10 °F below 68 °F.

Specific gravity at 68 °F to 80 °F	Charging condition
1.265 to 1.280	Battery fully charged
1.220 to 1.265	Battery 3/4 charged
1.190 to 1.220	Battery half charged
1.120	Battery drained

To check charge with voltmeter

A quick but less accurate method to check charge is the one using a voltmeter. A prerequisite for correct measurement is that the battery be completely at rest. This means that no charging or discharging should have taken place within one hour prior to measurement. Perform a separate measurement for each battery.

Voltage measured for a 12-volt battery	Charging condition
approx. 12.60 V	Battery fully charged
approx. 12.40 V	Battery 3/4 charged
approx. 12.20 V	Battery half charged
approx. 11.70 V	Battery drained

Jump starting instructions



WARNING!

Before jump starting through another vehicle, check whether that vehicle has a negative ground 24 volt electrical system. Also check whether the batteries of that vehicle have sufficient capacity. Do not jump start unless both of these conditions have been met. This is necessary in order to prevent injuries as well as material damage.



CAUTION!

First check fluid level of all batteries. Top up if necessary.



CAUTION!

Use jumper cables with a minimum cross section size of 3/0 AWG.

Before connecting jumper cables

First:

- apply parking brake;
- put transmission in neutral;
- stop engine;
- switch off all power consumers;
- turn off vehicle ignition;
- switch off master switch.

NOTE: If jump starting involves the assistance of a host vehicle, these instructions apply to both vehicles.



WARNING!

Do not attach jumper cable to pipes or moving parts.

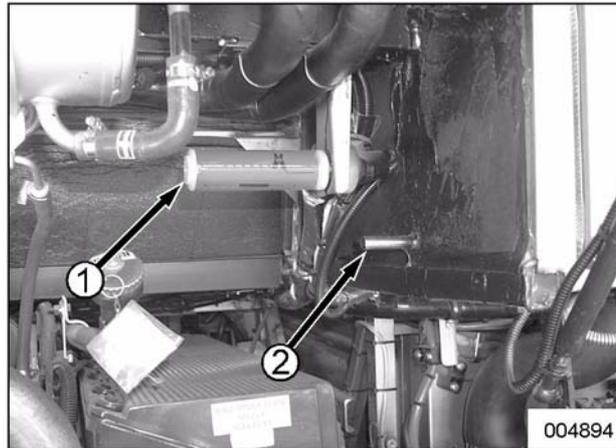
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WARNING!

Do not lean over batteries (neither while starting).

Figure: jump-starting terminals

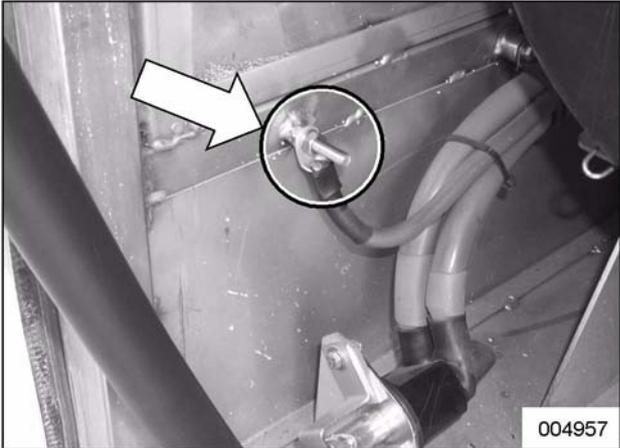


In engine compartment

1 "+" terminal

2 Ground terminal

To connect jumper cables

Step	Action
1	<p>Disconnect the ground cable of the battery equalizer from the "GROUND VANNER" bolt. The "GROUND VANNER" bolt is located behind the exterior door on left-hand side at very rear.</p> 

continued on next page

Step	Action
2	With the first jumper cable, connect the positive terminal of the host battery set (positive terminals marked with "+" or red plastic collar) with terminal (1). To be able to connect the cable to terminal (1), first pull the spring-loaded protection back.
3	Connect one end of the second jumper cable to the negative terminal (marked with "-" or either blue or green plastic collar) of the host battery set.
4	 WARNING! Never connect other cable end directly to the negative terminal of the depleted battery set. Clamp the other end of the negative cable to the jump starting ground terminal (2) of the vehicle requiring jump starting.
5	Start the engine of the vehicle requiring assistance.
6	Let the engine idle for a few minutes to allow the voltage of both battery sets to stabilize. This will reduce sparking when disconnecting the jumper cables.

To remove the jumper cables

Step	Action
1	Disconnect the negative jumper cable from the jump-starting ground terminal.
2	Disconnect the other end of the negative jumper cable from the batteries.
3	Remove the positive jumper cable.
4	Secure the ground cable to the "GROUND VANNER" battery-equalizer bolt.

Battery equalizer fuses

After jump starting, check the battery equalizer fuses. For location of fuses, refer to "Circuit breakers and fuses".

Chapter 6: Junction boxes

Overview

Introduction This chapter deals with the junction boxes.

Number of pages 2

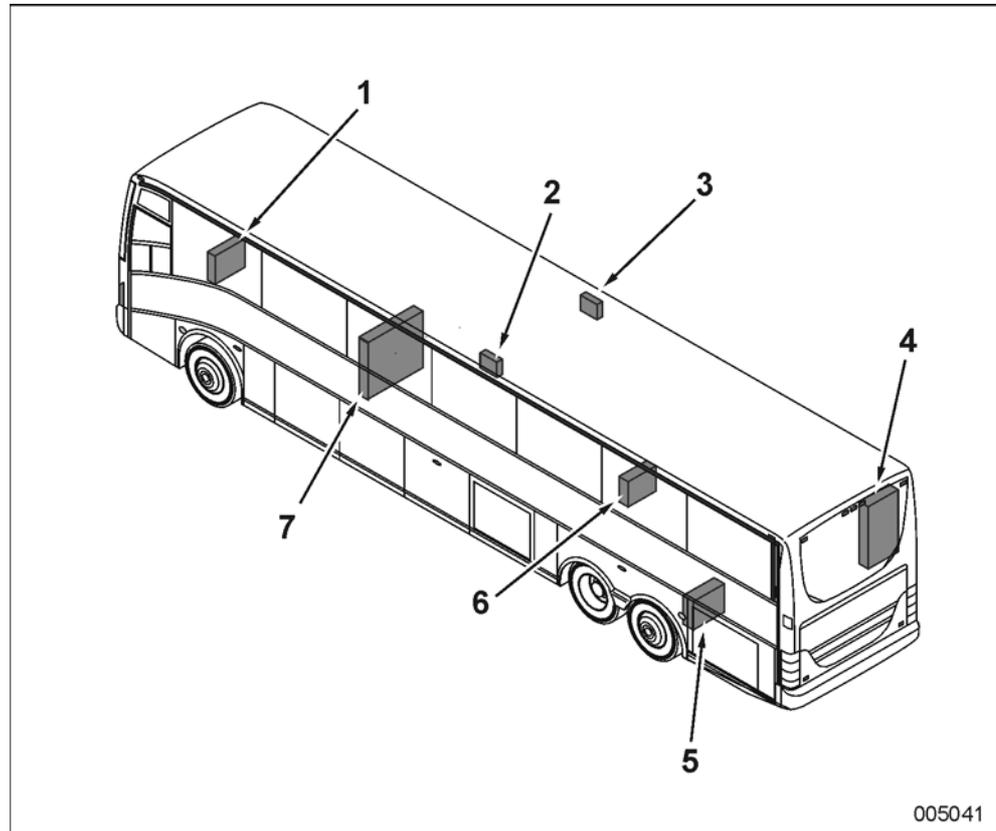
Chapter publication date 19 September 2006

Contents

Topic	See page
Location of junction boxes	14.6-2

Location of junction boxes

Figure:
location of
junction boxes



005041

- 1 Front junction box (EKF)
- 2 Junction box of left-hand roof fans
- 3 Junction box of right-hand roof fans
- 4 Junction box in toilet compartment (EKS)
- 5 Battery junction box (EKB)
- 6 Engine junction box (EKE)
- 7 Main junction box (EKV)

Chapter 10: Wiring

Overview

Introduction This chapter deals with the wiring.

Number of pages 12

Chapter publication date 19 September 2006

Contents

Topic	See page
Battery switch: general	14.10-2
Mechanical battery isolating switch	14.10-5
Circuit breakers and fuses	14.10-6

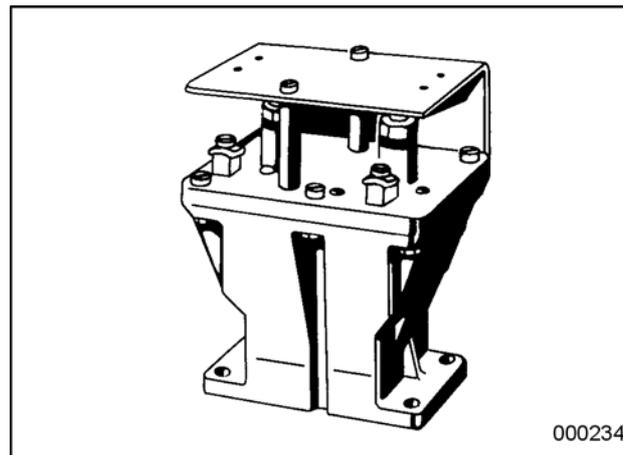
Battery switch: general

Types of battery switches

The two types that may occur are:

- an electric remote-controlled battery relay;
 - a mechanically operated battery switch near the batteries.
-

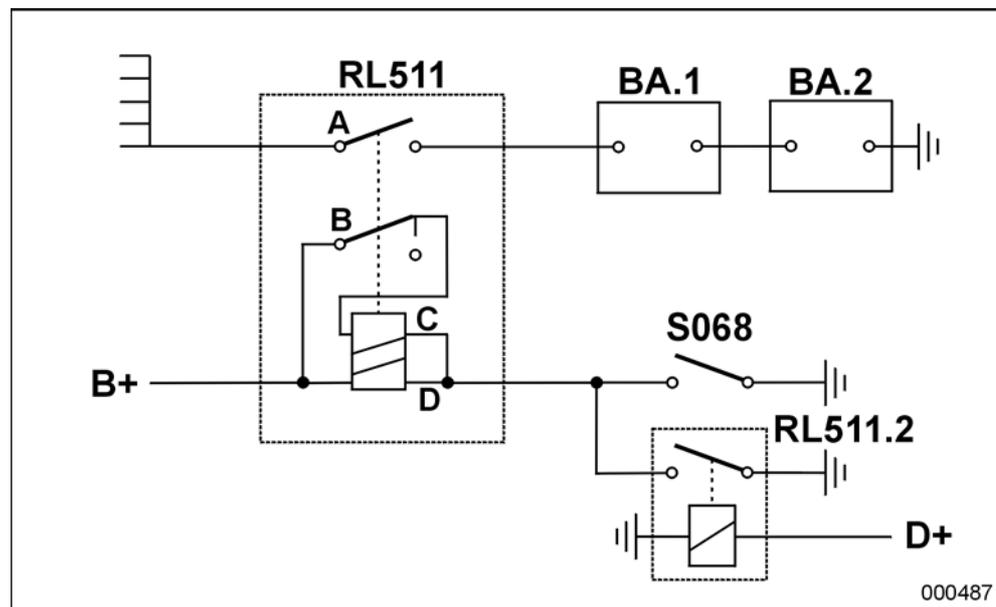
Figure: remote relay of electric battery switch



Parts of electric battery switch

The electric battery switch consists of a remote relay near the batteries, which is operated by a switch on the dashboard. Depending on vehicle model the operating switch is either the key contact or a separate switch.

Figure: circuit diagram of electric battery switch (example)



B+: Directly to battery plus
 D+: Voltage with running engine
 BA: Battery
 RL511: Remote relay
 RL511.2: Safety relay
 S068: Operating switch

How electric battery switch operates

The table below describes how the electric battery switch is closed.

Stage	Description
1	Someone closes S068.
2	Current flows through attractive coil (C) and holding coil (D) of remote relay (RL511).
3	Armature of remote relay (RL511) is attracted and main contact (A) closes.
4	Auxiliary contact (B) interrupts current flow to attractive coil (C); holding coil (D) remains powered. <i>NOTE: As holding coil only remains powered, less power is consumed to keep remote relay engaged.</i>

Safety relay

Safety relay (RL511.2) prevents remote relay (RL511) from being switched off with the engine running.

continued on next page

Cut-off delay

Some vehicles have a delay circuit that triggers a cut-off delay after (S068) has been opened. This time is needed for the self-testing of electronic controls such as EDC.

Mechanical battery isolating switch

Introduction

With the mechanical battery isolating switch, it is possible to immediately cut off all current consumers in your vehicle, including the consumers with "B+" power supply (which is impossible with the electrical battery isolating switch, see operating manual, chapter 5, under "To operate the battery isolating switch").

Location of mechanical battery isolating switch

Refer to chapter 1.1, under "Access doors and controls at the outside".

Pay attention to what before opening the mechanical battery isolating switch?

Take the following precautions into account to avoid damage to the vehicle alternator or deranging any electronic systems.



CAUTION!

Never open the mechanical battery isolating switch while the engine is running.



CAUTION!

Never open the mechanical battery switch, when the electrical battery switch is on.

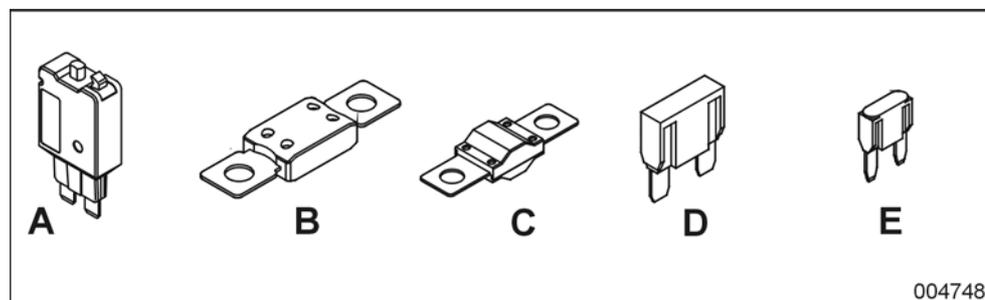


CAUTION!

After switching off the electric battery isolating switch, wait until the on-board voltage is cut off before opening the mechanical battery isolating switch.

Circuit breakers and fuses

Figure: circuit breakers and fuses



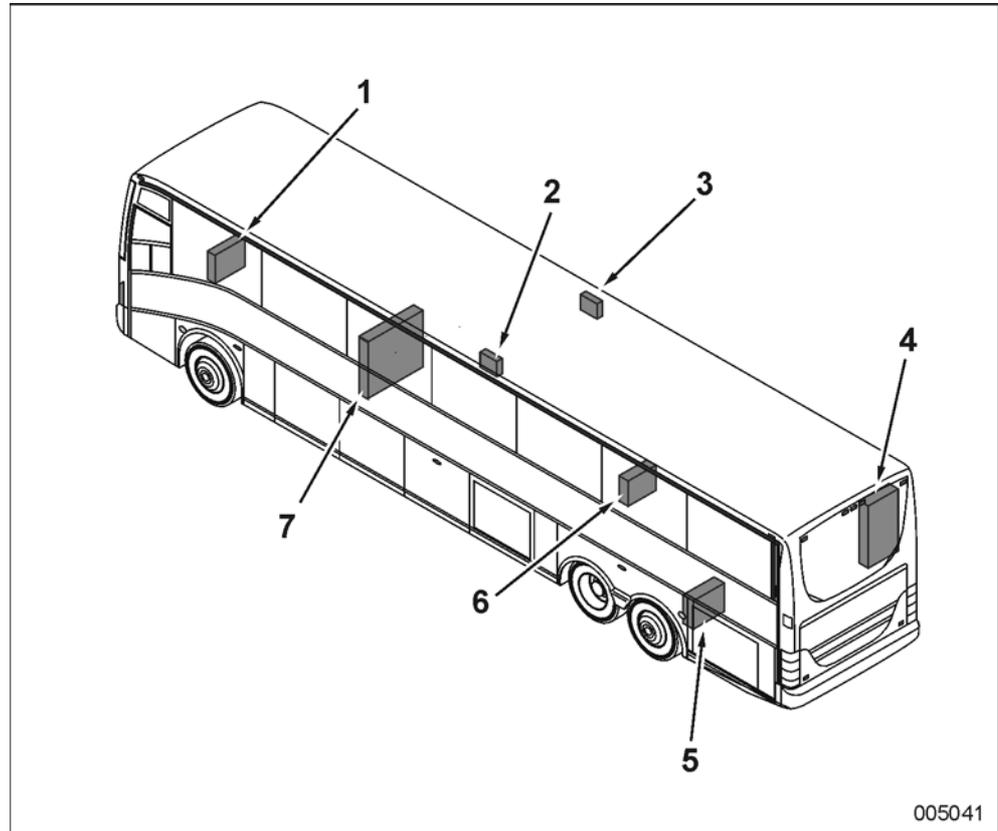
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Overview

Type	Ampere	Van Hool No.	Letter in figure	
Circuit breaker	6	10521076	A	
	8	10521077		
	10	10599052		
	15	10521078		
	25	10521079		
Fuse	150	10531356	B	
	125	10531355		
	100	10531354		
	80	10772049	C	
	50	10774226		
	40	10930133		
	30	10930132		
	80	10605973	D	
	50	10531352		
	40	10703212		
	30	10531351		
	20	10583491		
	E	25	660746316	E
		15	660746315	
		10	660746317	
7.5		660746314		
5		660746319		
3		660746318		

continued on next page

Figure:
location of
junction boxes



- 1 Front junction box (EKF)
- 2 Junction box of left-hand roof fans
- 3 Junction box of right-hand roof fans
- 4 Junction box in toilet compartment (EKS)
- 5 Battery junction box (EKB)
- 6 Engine junction box (EKE)
- 7 Main junction box (EKV)

**In main
junction box
(EKV)**

Number	Ampere	Circuit	Letter in figure
02	50	Climate control master fuse	C
22.1	15	Driver's cab climate control unit fan	A
23	15	Driver's cab climate control unit fan	A
25	8	Socket for portable light in engine compartment, windshield sun blinds	A
26	15	Luggage compartment lighting	A
29.2	8	Amplifier for loudspeakers	A

continued on next page

Number	Ampere	Circuit	Letter in figure
32	10	ABS system	A
33	10	ABS system	A
35	8	Guide reading light, video box lighting	A
36	8	Exterior mirrors adjustment	A
37	8	ZF-Intarder	A
38	8	Guide seat	A
39	8	Reference voltage, cigarette lighter	A
42	8	Trip computer (Cummins), starter motor, EDC engine management system, high idle safety circuit, Jake Brake (Caterpillar)	A
43	3	Trip computer (Detroit Diesel)	E
44	15	Refrigerator	A
46.1	8	Toilet, flash light and buzzer at passenger door to indicate that the vehicle is raising/lowering, raising/lowering system	A
47	8	12 volt master relay, exterior lighting, battery equalizer	A
49	8	Engine diagnostics socket (Cummins)	A
80	8	Emergency switch	A
81.1	10	Hazard warning flasher, trip computer (Cummins), engine diagnostics socket (Cummins)	A
81.2	10	Turn signals, master switch	A
82	8	Digital clock, coolant heater programmable control	A
83.2	15	Coolant heater	A
84.1	8	Multiplex system computer module	A
85	8	Dashboard node	A
95	8	Low beam, right-hand	A
96	8	Low beam, left-hand	A
97	8	High beam, right-hand	A
98	8	High beam, left-hand	A
130	50	Node 1	C
131	8	Driver's cab climate control unit	A
151	30	12 volt master fuse	C

continued on next page

Number	Ampere	Circuit	Letter in figure
152	8	Radio communication system socket (12 volt), trip computer (Detroit Diesel)	A
153	15	Audio/video (12 volt)	A
154	10	Audio/video	E
155	10	Flash light and buzzer at passenger door to indicate that the vehicle is raising/lowering, audio/video (12 volt), back-up camera	E
156	3	Antenna amplifier	E
158	15	Front fog lamps	E
159	8	Radio communication system socket (12 volt)	A
185	8	Passenger door, luggage compartment central locking system	A
200	15	Node 2	A
201	15	Node 2	A
202	15	Node 2	A
203	15	Node 2	A
204	15	Node 2	A
300	15	Node 3	A
301	15	Node 3	A
302	15	Node 3	A
303	15	Node 3	A
304	15	Node 3	A
F21M	10	Climate control	A
F22M	10	Climate control	A
F23M	10	Climate control	A
F24M	10	Climate control	A
F25M	10	Climate control	A
F26M	10	Climate control	A

In toilet compartment junction box (EKS)

Number	Ampere	Circuit	Letter in figure
05	100	Wheelchair lift	B
08	125	Kitchenette	B
400	15	Node 4	A

continued on next page

Number	Ampere	Circuit	Letter in figure
401	15	Node 4	A
402	15	Node 4	A
403	15	Node 4	A
404	15	Node 4	A
405	8	Wheelchair lift system lighting	A
500	15	Node 5	A
501	15	Node 5	A
502	15	Node 5	A
503	15	Node 5	A
504	15	Node 5	A
505	8	Climate control	A
600	15	Node 6	A
601	15	Node 6	A
602	15	Node 6	A
603	15	Node 6	A
604	15	Node 6	A
605	8	Climate control	A
F1M	50	Climate control right-hand roof fans	C
F2M	50	Climate control left-hand roof fans	C

In battery junction box (EKB)

Number	Ampere	Circuit	Letter in figure
06	125	Main junction box master fuse	B
10	30	Starter motor	C
15	30	Audio/video master fuse	C
70	8	Alternator 1	A
71	8	Alternator 2	A
84	80	12 volt battery equalizer	C
85	40	24 volt battery equalizer	C
88	30	Master fuse B+	C
89.1	40	Engine master fuse	C
89.2	30	Allison WTB500(R) transmission master fuse	C
	10	ZF Astronic transmission master fuse	A
150	50	12 volt master fuse	C

continued on next page

Number	Ampere	Circuit	Letter in figure
F1	6	EDC engine management system	A
F4	30	EDC engine management system (Cummins, Detroit Diesel)	C
	10	EDC engine management system (Caterpillar)	A
F5	10	EDC engine management system (Caterpillar)	A
F6	10	EDC engine management system (Caterpillar)	A

In front junction box (EKF)

Number	Ampere	Circuit	Letter in figure
31	15	Windshield wipers	A
100	15	Node 1	A
101	15	Node 1	A
102	15	Node 1	A
103	15	Node 1	A
104	15	Node 1	A
105	8	Multiplex system diagnostics socket	A

In junction box of right-hand roof fans

Number	Ampere	Circuit	Letter in figure
F1M	10	Roof fan	A
F2M	10	Roof fan	A
F3M	10	Roof fan	A
F4M	10	Roof fan	A
F5M	10	Roof fan	A
F6M	10	Roof fan	A

In junction box of left-hand roof fans

Number	Ampere	Circuit	Letter in figure
F1M	10	Roof fan	A
F2M	10	Roof fan	A

continued on next page

Number	Ampere	Circuit	Letter in figure
F3M	10	Roof fan	A
F4M	10	Roof fan	A
F5M	10	Roof fan	A
F6M	10	Roof fan	A

**In junction box
near
wheelchair lift**

Number	Ampere	Circuit	Letter in figure
16	10	Wheelchair lift system	A

Chapter 18: Electric circuit diagrams

Overview

Introduction This chapter deals with the electric circuit diagrams.

Number of pages 16

Chapter publication date 19 September 2006

Contents

Topic	See page
Electrical wiring diagram booklet	14.18-2
Subdiagrams	14.18-4
Components	14.18-7
Power supply	14.18-11
Situation to which diagram applies	14.18-12
Electrical wires	14.18-13
Cross-references	14.18-15
Connector designation	14.18-16

Electrical wiring diagram booklet

Introduction

For convenience purposes the electrical wiring diagram for your vehicle has been divided into subdiagrams on A4 format. Each subdiagram combines a number of electrical components, the function of which is related. The subdiagrams have been compiled into an “Electrical wiring diagram booklet”, which is supplied separately with the vehicle.

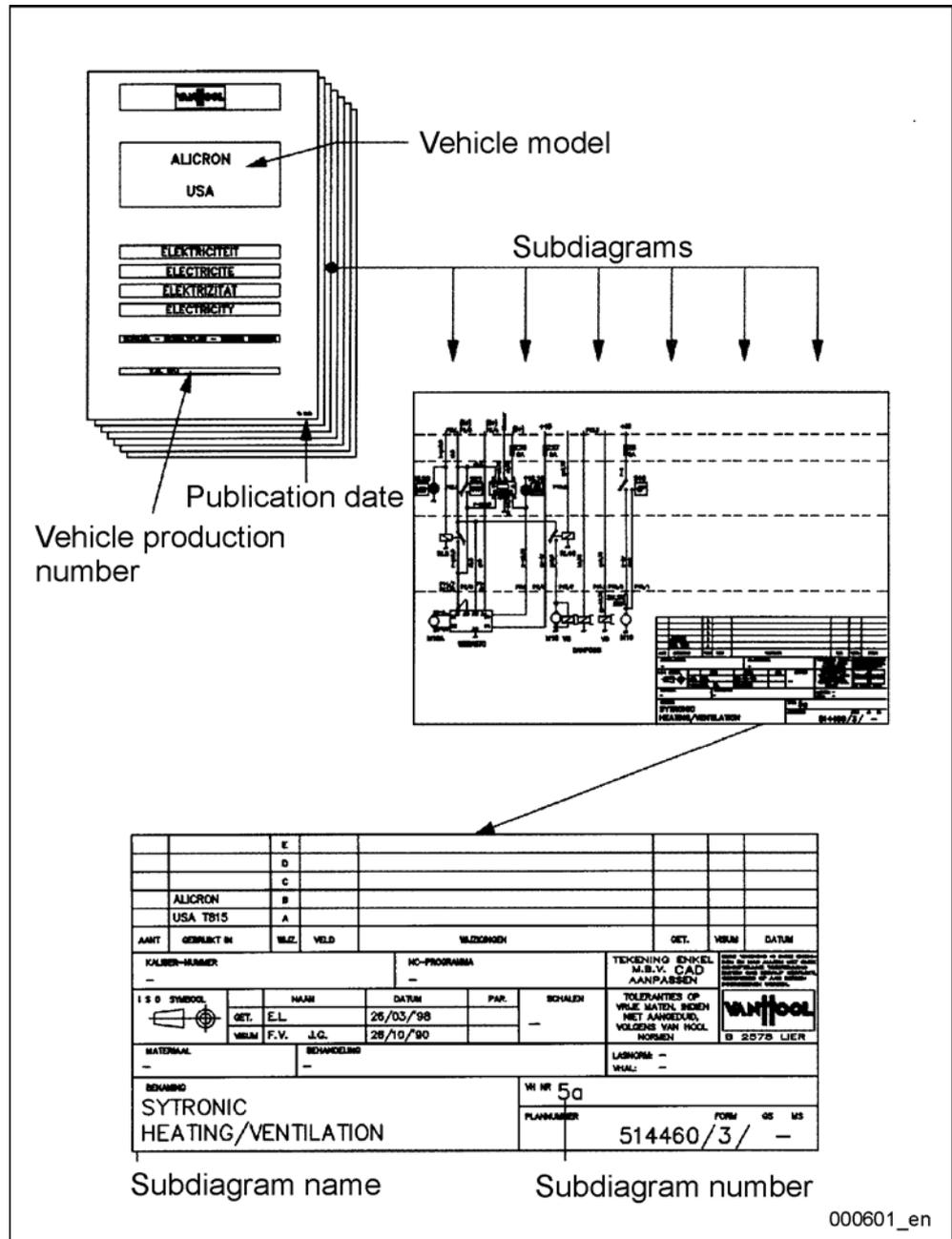
Data on front page of wiring diagram booklet

The front page of the wiring diagram booklet contains the following data:

- Name of the vehicle model the wiring diagram booklet applies to;
- Publication date;
- Production number(s) of the vehicle – or the vehicle model series – the wiring diagram booklet applies to.

NOTE: Before using the wiring diagram booklet, check the data on the front page so as to make sure the booklet you are holding actually goes with your vehicle.

Figure:
structure of
wiring diagram
booklet



000601_en

Subdiagrams

Subdiagram number

The subdiagrams have been numbered according to their contents. The subdiagram number consists of numbers and letters. It is stated in the title corner of the subdiagram.

The table below represents a list of all possible subdiagrams for a Van Hool vehicle. The numbering in the list corresponding with the numbering in the wiring diagram booklet, the list will help you to find the subdiagram you are looking for more quickly. Your wiring diagram booklet does include only those subdiagrams from the list that apply to your vehicle.

Subdiagram no.	Circuit
05A	Current distribution, starting
05E	12V system
05F	220V system
19B	Indicator lights
19C	Instruments
19D	Engine equipment
19E	Transmission
19F	Retarder
19H	Electric horn, air horn, air dryer
19I	Height control
19K	Fuel heating
19L	Extra fuel tank
19M	Consumption meter
19N	ABS/ATC
19O	Auxiliary steering pump
19P	Emergency circuit
19Q	Third axle
19S	Vehicle articulation protection
19T	Central lubrication
19U	Soot filter
19W	Snow chains
19X	Brake wear indicators
26B	Door control
26D	Lift
26F	Wheelchair ramp
26G	Central locking

continued on next page

Subdiagram no.	Circuit
26H	Driver's gate
26U	Door 1
26V	Door 2
26W	Door 3
26X	Door 4
30A	Route indicators
30B	Payment system
30C	Counting system
36A	Exterior lighting
36B	Turn signals
36D	Alarm systems
36F	Ski box lighting
37A	Interior lighting
37B	Digital clock, cigarette lighter, interior accessories
37D	Driver's sleeping compartment
37E	Crew call system, stop request
38A	Windshield wipers and washer
40A	Public address system
40B	Audio, video
40C	Speakers
40D	Intercom
40E	Camera system
40F	Communication system
40G	Navigation system
42A	Adjustable mirrors
44A	Toilet
44B	Water heater, oven
45A	Refrigerator
46A	Electric driver's window
46B	Heated windshield (top)
46C	Electric roof hatches
50A	Heating, ventilation
50B	Interior heating
50C	Roof heating
50D	Temperature gauges
50E	Climate control
50F	Driver's climate unit

continued on next page

Components

Component location

The subdiagrams have been divided into sections by means of horizontal dotted lines. Most of the sections have been named with letters (EKV, IB,...). They are mentioned in the diagram right margin.

Each section named corresponds with a particular location in the vehicle. The components depicted in such a named section are actually found in the location represented by that section.

There is also an unnamed diagram section. This section contains the components that are not grouped in one place in the vehicle. In most cases the location of a component from the unnamed section can be deduced from its name or function description.

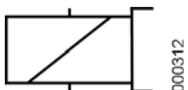
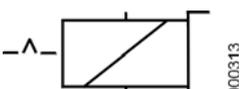
The table below lists the section names and their meaning.

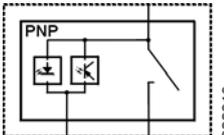
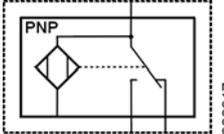
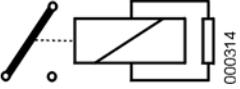
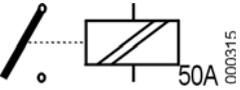
Letters	Location within vehicle
EKV	Main junction box
EKF	Front junction box
EKS	Junction box in toilet compartment
EKB	Junction box near batteries
EKE	Junction box near engine
IB	Instrument panel

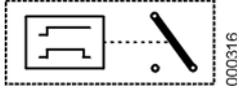
Component symbols

In the diagrams all electrical components (lights, relays, switches...) have been represented by a standard symbol. The table below lists the symbols used and their explanations.

Symbol	Explanation
	Glow plug
	Chime
	Buzzer

Symbol	Explanation
 000310	Loudspeaker
 000303	Microphone
 000296	Pressure switch
 000299	(Temperature) sensor
 000297	Thermal switch
 000298	Float contact
 000305	Diode
 000306	Resistor
 000307	Fuse
 000312	Permanently energized valve
 000313	Impulse valve
 000302	Indicator light

Symbol	Explanation
 000301	Light
 000304	Instrument
 000295	Microswitch
 000318	Photo-electric cell
 000317	Proximity switch
 000294	Reed contact
 000300	Engine
 000314	Relay with resistor
 000315	High-power relay
 000293	Key switch
 000292	Change-over switch

Symbol	Explanation
	Time switch

Component numbers

Each component has been designated by its own number in the diagram. This designation is right next to the component symbol. The letter in the number designation indicates the nature of the component (switch, relay, light, etc.).

You can look up the function of the component in the components list on the page opposite the diagram by using the component number.

Power supply

Designation of power supply

In the drawings power circuits start at the top, with the circuit fuse. The designation of the power connection is found at the starting point of the circuit (B+, +30...). Thus you can see the path along which the circuit is connected to the power source (battery, alternator), which allows you to know, when it is conducting.

The table below lists the distinguishing marks of the power connection.

Connection mark	Explanation
B+	Direct to battery plus. The circuit is always live with power. Used for coolant heater, hazard warning flashers, memory of electronic control units.
+30	Voltage after battery switch. Used for all body equipment, such as: climate control, lighting, audio system.
+15	Voltage after turning on ignition. Used for all components that are important for driving.
D+	Voltage with running engine. Used for circuits with high-power equipment, to spare batteries.
+58	Voltage with side marker lights turned on.
+56	Voltage with low beam or high beam lights turned on.

Situation to which diagram applies

Rest state

Some component symbols have been conceived in such a way that the position of the symbol parts represents the state the component is in (switch on or off, relay powered or not...). Symbols in Van Hool diagrams always represent the position that corresponds with vehicle rest state. The conditions for this rest state are:

- batteries disconnected;
 - 115 psi pressure in compressed-air tanks;
 - all doors and hatches closed;
 - transmission in neutral;
 - all brakes released;
 - engine off;
 - all systems switched off, control switches in rest position;
 - temperature 70 °F.
-

Electrical wires

Wire colors

Van Hool use differently colored electrical wires to connect junction boxes and devices. There are wires with single-color insulation and wires with two-color insulation. The two-color wires have a strip lengthwise in a contrasting color running over the main color of the insulation material.

In the diagram the connection represented bears a letter code, which refers to the wire color. The table below lists the meaning of the colors.

If a wire has two colors, this is indicated in the diagram as follows:

GE-R= yellow wire with red stripe

NOTE: Nowadays the regular color for ground wires is brown. In older vehicles, however, black ground wire has been used.

Letter code	Wire color
Z	Black
BR	Brown
R	Red
O	Orange
GE	Yellow
GN	Green
B	Blue
V	Violet
GS	Gray
W	white
T	Transparent
RO	Pink

Wire cross-section

The diagram mentions the wire section, expressed in square millimeters (mm^2), after the wire color code. If the section is not mentioned, it is 1 mm^2 (in older vehicles: 1.5 mm^2).

Example:

BR2.5 = brown wire with 2.5 mm^2 section

“American Wire Gauge (AWG)”

Consult the table below, when using "AWG" electrical wires when replacing electrical wires.

continued on next page

Indication of wire cross-sections on the electrical diagram (mm ²)	"AWG" equivalent
0.75	18
1	16
1.5	14
2.5	12
6	8
16	4
35	1
70	3/0

Cross-references

Cross-reference "XY" within same subdiagram

In a subdiagram a connecting line can be represented interruptedly; only the beginning and the end have been drawn. The corresponding locations that have been segmented bear cross-reference marks. The mark consists of the pair of letters "XY", followed by a number. To find where the line continues, look in the same subdiagram for an XY designation with the same number.

Cross-reference "XX" to another subdiagram

There are also connecting lines that proceed from one subdiagram to another one. On the first subdiagram this type of line stops at a cross-reference mark; on the second subdiagram it continues starting from the same mark. In such case the cross-reference mark consists of a box containing the reference number of the subdiagram the line proceeds to and, either below or above that, two Xs followed by a number.

Example:

Cross-reference	Explanation
	Go to diagram 05A and find XX10

Connector designation

Introduction

All connectors, except for component connections, have been designated with the letter "P" in the diagram, followed by the reference of the connector, followed by a dot and the reference number of the connector contact the conductor that has been represented passes through.

Example: P223.5

P= connector

223= connector number

5= contact number

Figure:
contact
numbering of
connector
P223

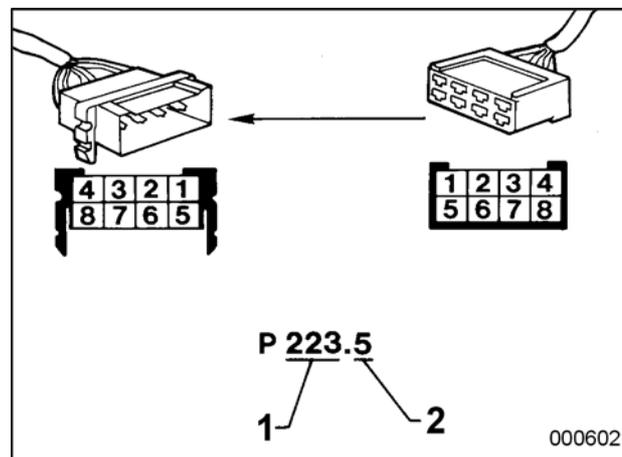


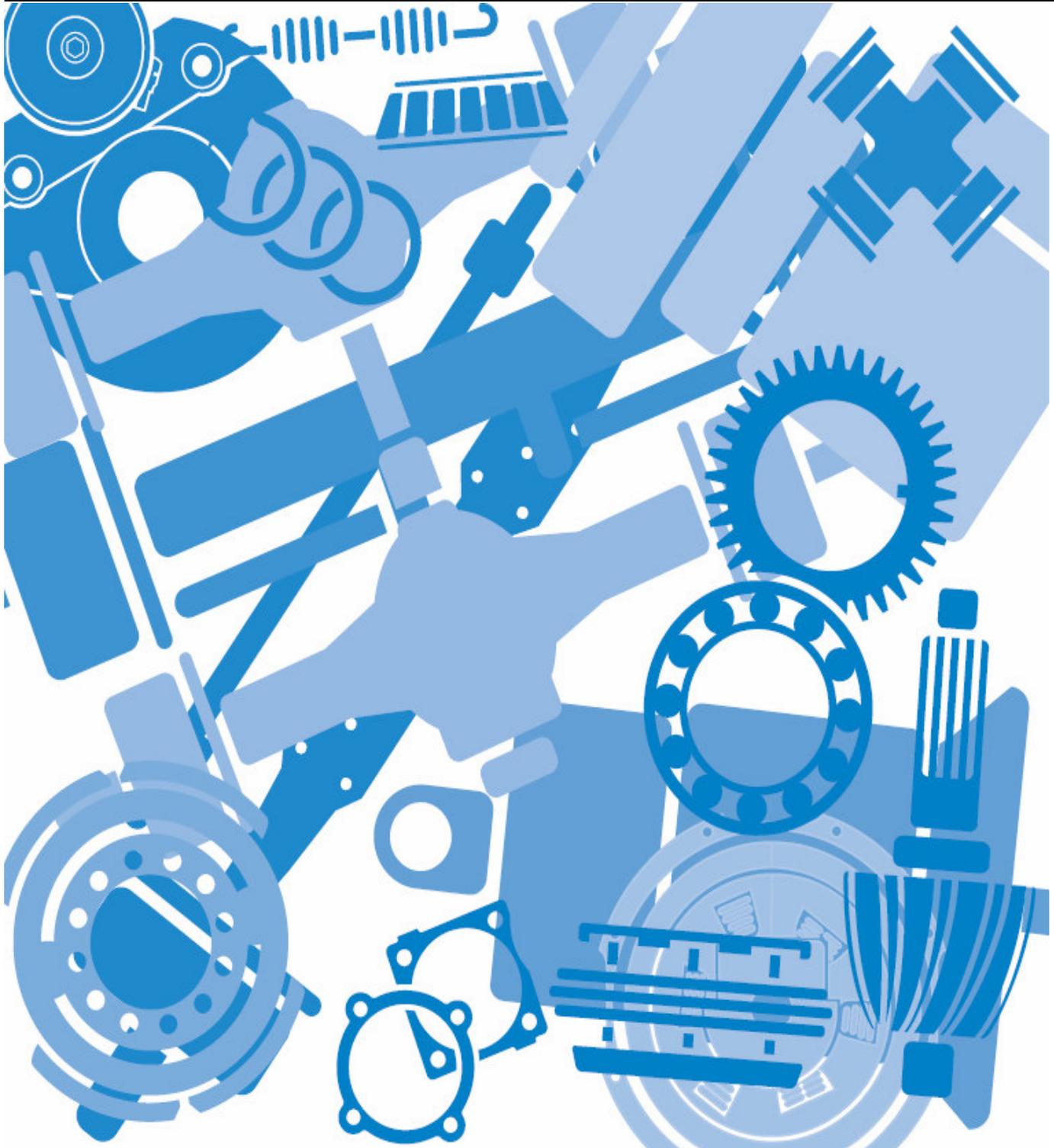
Figure shows plug on the left, socket on the right. The contact numbers have been considered from wire input side.

1 Connector number

2 Contact number



**- GENERAL INFORMATION -
SINGLE REDUCTION DRIVE AXLES**



SERVICE MANUAL General Information



Last Modification	Date	Approved by	Date	Level	Reference	Eng. Change
C. Costa	20.10.05	V. Badiola	20.10.05	A	613505	NC05801
O. Maraña	17.01.07	V. Badiola	17.01.07	B	613505	NC07437
O. Maraña	24.01.07	V. Badiola	25.01.07	C	613505	NC07465



The description and specifications contained in this service publication are current at the time of printing.

Dana Spicer Corporation reserves the right to discontinue or to modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand names in this publication is made simply as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents, if available, may be used.

Important Notice

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.



Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.



WARNING: Failure to follow indicated procedures creates a high risk of personal injury to the servicing technician.



CAUTION: Failure to follow indicated procedures may cause component damage or malfunction.



IMPORTANT: Highly recommended procedures for proper service of this unit.

NOTE: Additional service information is not covered in the service procedures.

TIP: Helpful removal and installation procedures to aid in the service of this unit.



OEM: Refer to the OEM vehicle specifications

Always use genuine Dana Spicer replacement parts.



GENERAL INFORMATION INDEX

1. Axle Identification

Axle Housing Identification.....	5
Axle & Drive Head Identification.....	5
Ring Gear & Pinion Identification.....	5

2. Lubrication

Approved Lubricants.....	6
Viscosity/Ambient Temperature Recommendations.....	6
Lube Change Intervals.....	7
Changing Lube.....	7
Wheel End Lubrication.....	8

3. Inspection

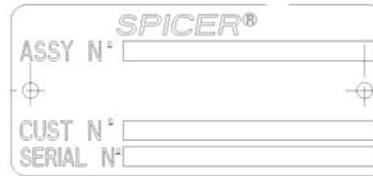
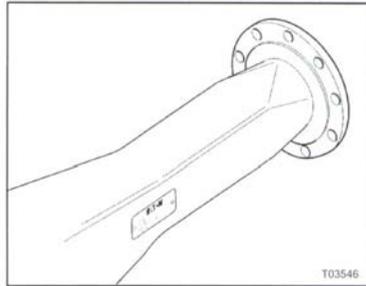
Failure analysis.....	9
How to diagnose a Failure.....	9
Prepare the parts for inspection.....	10
Find the cause of the failure.....	10
Correct the cause of the problem.....	10
Inspection.....	10



1. AXLE IDENTIFICATION

▪ Axle Housing Identification

All axle housings include a metal identification tag which only identifies the housing. It does not identify the differential carrier assembly



Axle identification tag

▪ Ring Gear and Pinion Identification

Ring Gear and Drive Pinion are matched parts and must be replaced in sets.

To aid in identifying gear sets, parts are stamped with such information as number of pinion and ring gear teeth, individual part number and matched set number (refer to drawing).

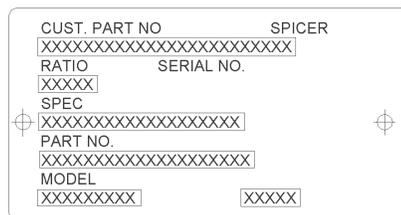
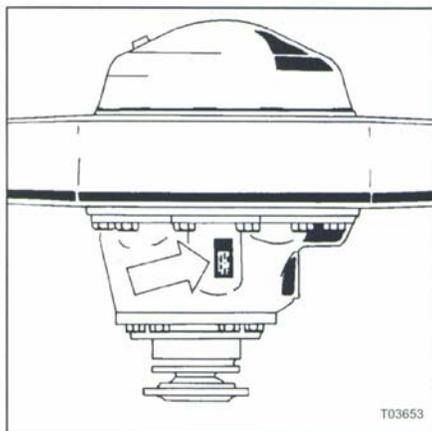
components.



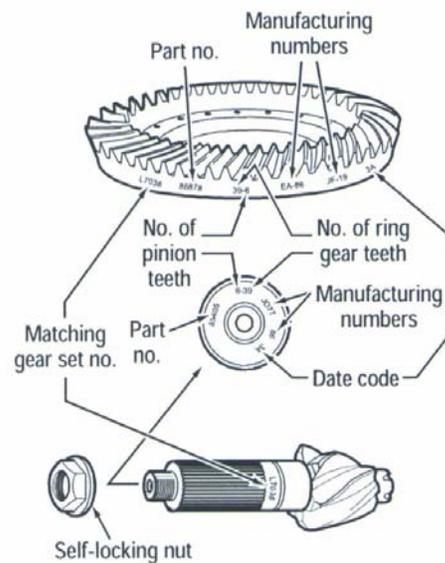
Housing identification tag

▪ Axle & Drive Head Identification

Axle identification is stamped on a metal tag affixed to the housing and differential carrier identification is stamped on a metal tag affixed to the carrier.



Drive Head identification tag





2. LUBRICATION

The ability of a drive axle to deliver quiet, trouble-free operation over a period of years is largely dependent upon the use of good quality gear lubrication in the correct quantity. The most satisfactory results can be obtained by following the directions contained in this manual.

The following lubrication instructions represent the most current recommendations from the Axle & Brake Division of DANA Corporation.

▪ Approved Lubricants

General - Gear lubrications acceptable under military specification (MILSPEC) MIL-L-2105D (Lubricating Oils, Gear, Multipurpose) are approved for use in Dana Spicer Drive Axles. The MIL-L-2105D specification defines performance and viscosity requirements for multigrade oils. It supersedes both MIL-L-2105B, MIL-L-2105C and cold weather specification MIL-L-10324A. This specification applies to both petroleum-based and synthetic-based gear lubricants if they appear on the most current "Qualified Products List" (QPL-2105) for MIL-L-2105D.

NOTE: The use of separate oil additives and/or friction modifiers are not approved in DANA Drive Axles.

Synthetic-based - Synthetic-based gear lubricants exhibit superior thermal and oxidation stability and generally degrade at a lower rate when compared to petroleum-based lubricants. The performance characteristics of these lubricants include extended change intervals, improved fuel economy, better extreme temperature operation, reduced wear and cleaner component appearance.

The family of Dana Spicer Roadranger™ gear lubricants represents a premium quality synthetic lube which fully meets or exceeds the requirements of MIL-L-2105D. These products, available in both 75W-90 and 80/W-140, have demonstrated superior performance in comparison to others qualified under the MILSPEC, as demonstrated by extensive laboratory and field testing. For details of Roadranger® approved synthetic lubricants contact your local Dana Spicer representative.

Makeup Lube - Maximum amount of non-synthetic makeup lube is 10%.

▪ Recommendations for Viscosity/Ambient Temperature

The following chart lists the various SAE Grades covered by MIL-L-2105D and the associated ambient temperature range from each. Those SAE grades shown with an asterisk (*) are available in the Roadranger family of synthetic gear lubricants.

The lowest ambient temperatures covered by this chart are -40°F and -40°C. Lubrication recommendations for those applications which consistently operate below this temperature range must be obtained through Dana Spicer Corporation by contacting your local Dana Spicer representative.

Grade	Ambient Temperature Range
75W	-40°F to -15°F (-40°C to -26°C)
75W-80	-40° F to 80°F (-40°C to 21°C)
75W-90*	-40°F to 100°F (-40°C to 38°C)
75W-140	-40° F and above (-40°C and above)
80W-90	-15°F to 100°F (-26°C to 38°C)
80W-140*	-15°F and above (-26°C and above)
85W-140	10° F and above (-12°C and above)



▪ Lube Change Intervals

This product combines the latest manufacturing and part washing technology. When filled with a Dana Spicer approved synthetic lubricant at the factory, the initial drain is not required.

Change the lubricant within the first 5,000 miles (8000Km) of operation when not using a Roadranger approved synthetic lubricant in either a new axle or after a carrier head replacement. Base subsequent lubricant changes on a combination of the following chart and user assessment of the application and operating environment.

Severe Service Lubrication Change Intervals

- Severe service applications are those where the vehicle consistently operates at or near its maximum GCW or GVW ratings, dusty or wet environments, or consistent operation on grades greater than 8%. For these applications, the ON/OFF HIGHWAY portion of the chart should be used. Typical applications are construction, logging, mining and refuse removal.

NOTE: Clean metallic particles from the magnetic filler plug and drain plugs. Clean or replace the breather yearly to avoid lube contamination due to water ingestion.

GUIDELINES-LUBE CHANGE INTERVALS FOR DRIVE AXLES				
Lubricant Type	On-Highway Miles	Maximum Change Interval	On/Off Highway Severe Service Miles	Maximum Change Interval
Mineral Based	100,000	Yearly	40,000	Yearly
Dana Spicer Approved Synthetic*	250,000	3 Years	100,000	Yearly
Lubricant Type	On-Highway Km	Maximum Change Interval	On/Off Highway Severe Service Km	Maximum Change Interval
Mineral Based	160,000	Yearly	65,000	Yearly

*This guideline applies only in North America. For European applications, contact your local Dana Spicer representative

▪ Change Lube

DRAIN:

1. Drain into a suitable container with lube at normal operating temperature (66°-93°C). It will run freely and minimize the time necessary to fully drain the axle, this also ensures that the axle is flushed.
2. Remove the bottom two carrier to housing capscrews and allow the lube to drain into a suitable container. This applies on the following axle models:-

Model
G110
G130

Or, remove the oil drain plug and allow the lube to drain into a suitable container. This applies on the following axles models:-

Model
8.18
9.24/10.24
11.26
11.36
13.44
G150
G171/G190

NOTE: Dispose of all used lubricant properly by following disposal method approved for mineral or synthetic based oils.

3. Inspect the breather for clogging or corrosion. Clean or replace as necessary.

LUBRICANT VOLUMES (ONLY FOR REFERENCE):

Model	Volume (Litres)
8.18	10
9.24/10.24	12
11.26	13
11.36	19
13.44	25.5
G110/G130	--
G150	--
G171/G190	17

FILL:

1. Reinstall the bottom two carrier to housing capscrews, use Loctite 270 and torque to 142-158 lbs.ft (193-214 N.m).

Or, reinstall the oil drain plug (if fitted) to housing and torque to 40-60 lbs.ft (54-81 N.m).

2. Remove the filler hole plug from the side of the carrier and fill the axle with approved lubricant until level with bottom of the hole.
3. If wheel end were removed, follow instructions in the wheel end servicing section.



Always use the filler hole as the final reference. If lube is level with the bottom of the hole, the axle is properly filled.

NOTE: Lube fill capacities are basic guidelines and will vary based on the angle the axle is installed in a particular chassis.

Axles installed at angles exceeding 6° or operated regularly on grades exceeding 12% may require stand-pipes to allow proper fill levels. Contact your local Dana Spicer representative.

Wheel End Lubrication

To prevent failure, lubricate the wheel hub cavities and bearings following any wheel end servicing.

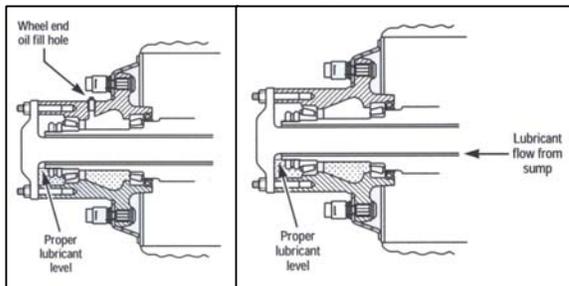


CAUTION: Make sure the wheel ends are well lubricated with the same axle lubricant used in the axle sump. Do not pack the bearings with grease before installation as grease will prevent the proper circulation of axle lubricant and may cause wheel seal failure.

Dana Spicer axles may be equipped with either of three wheel end designs:

- Wheel ends **with** oil fill hole
- Wheel ends **without** oil fill hole
- Wheel ends with **Unitized bearing**

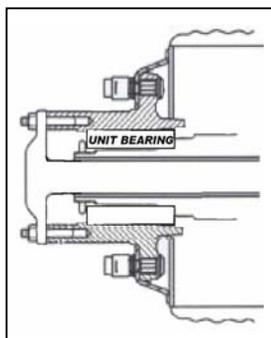
See illustration for cutaway views of the two different designs.



Wheel ends with oil fill hole and without oil fill hole

Unitized Bearing Wheel end

No specific action is required as hub unit bearing, is lubricated by grease for life and sealed from the outside.



Wheel ends with unitized bearing

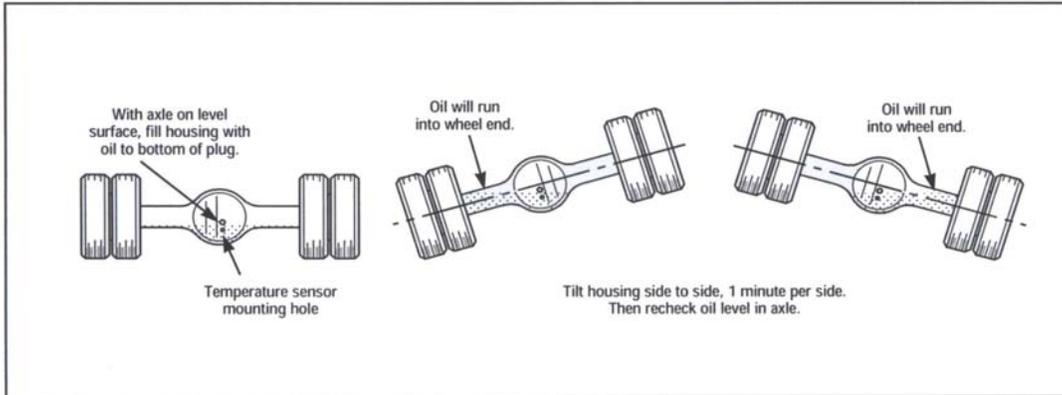
Wheel ends with oil fill hole

1. Rotate the wheel end hub until the oil fill hole is uppermost.
2. Remove the oil fill plug.
3. Pour ¼ litre of axle sump lubricant into each hub through the wheel end fill hole.
4. Install oil fill plug and tighten to specified torque.

Wheel ends without oil fill hole

1. With axle level and wheel ends assembled, add lubricant through the filler hole in axle housing cover until fluid is level with the bottom of filler hole.
2. Raise the left side of the axle 150 mm or more. Hold axle in this position for one minute.
3. Lower the left side.
4. Raise the right side of the axle 150 mm or more. Hold axle in this position for one minute.
5. Lower the right side.
6. With axle on a level surface, add additional lubricant through the housing cover oil filler hole to raise lube to required level.

TIP: The use of ramps or making a full lock figure eight turning maneuver at low speed will guarantee the wheel end is charged with lube. Refill axle to proper lube level. (Follow illustrated procedure).



3. INSPECTION

▪ Failure Analysis

Failure analysis is the process of determining the original cause of a component failure in order to keep it from happening again. Too often, when a failed component is replaced without determining its cause, there will be a recurring failure. If a carrier housing is opened, revealing a ring gear with a broken tooth, it is not enough to settle on the broken tooth as the cause of the carrier failure. Other parts of the carrier must be examined. For a thorough understanding of the failure and possible insight into related problems, the technician needs to observe the overall condition of the vehicle.

No one benefits when a failed component goes on the junk pile with the cause unknown. Nothing is more disturbing to a customer than a repeat failure. Systematically analyzing a failure to prevent a repeat occurrence assures quality service by avoiding unnecessary downtime and further expense to the customer.

The true cause of a failure can be better determined by knowing what to look for, determining how a piece of the equipment was running and learning about previous problems. In the case of a rebuilt rear axle, mismatched gears may have been installed. The more successful shops prevent repeat equipment failures by developing good failure analysis practices. Knowing how to diagnose the cause of a premature failure is one of the prerequisites of a good heavy-equipment technician.

▪ How to Diagnose a Failure

The following five steps are an effective approach to good failure diagnostics.

1. Document the problem.
2. Make a preliminary investigation.
3. Prepare the parts for inspection.
4. Find the cause of the failure.
5. Correct the cause of the problem.

Document the Problem

Here are some guidelines for starting to learn about a failure, including questions to ask:

1. Talk to the operator of the truck.
2. Look at the service records.
3. Find out when the truck was last serviced.
4. Ask: In what type of service is the truck being used?
5. Ask: Has this particular failure occurred before?
6. Ask: How was the truck working prior to the failure?

You need to be a good listener. Sometimes, insignificant or unrelated symptoms can point to the cause of the failure:

7. Ask: Was the vehicle operating at normal temperatures?
8. Ask: Were the gauges showing normal ranges of operation?
9. Ask: Was there any unusual noise or vibration?

After listening, review the previous repair and maintenance records. If there is more than one driver, talk to all of them and compare their observations for consistency with the service and maintenance records. Verify the chassis Vehicle Identification Number (VIN) number from the vehicle identification plate, as well as the mileage and hours on the vehicle.

Make a Preliminary Investigation

These steps consist of external inspections and observations that will be valuable when combined with the results of the parts examination.

1. Look for leaks, cracks or other damage that can point to the cause of the failure.
2. Make note of obvious leaks around plugs and seals. A missing fill or drain plug would be an obvious cause for concern.
3. Look for cracks in the carrier housing (harder to see, but sometimes visible).
4. Does the general mechanical condition of the vehicle indicate proper maintenance or are there signs of neglect?
5. Are the tires in good condition and do the sizes match?
6. If equipped with a torque-limiting device, is it working properly?

During the preliminary investigation, write down anything out of the ordinary for later reference. Items that appear insignificant now



may take on more importance when the subassemblies are torn down.

▪ Prepare the Parts for Inspection

After the preliminary investigation, locate the failure and prepare the part for examination. In carrier failure analysis, it may be necessary to disassemble the unit.

1. When disassembling subassemblies and parts, do not clean the parts immediately since cleaning may destroy some of the evidence.
2. When tearing down the drive axle, do it in the recommended manner. Minimize any further damage to the unit.
3. Ask more questions when examining the interior of the carrier. Does the lubricant meet the manufacturer specifications regarding quality, quantity and viscosity? As soon as you have located the failed part, take time to analyze the data.

▪ Find the Cause of the Failure

Here begins the real challenge to determine the exact cause of the failure. Keep in mind that there is no benefit to replacing a failed part without determining the cause of the failure. For example, after examining a failed part and finding that the failure is caused by a lack of lubrication, you must determine if there was an external leak. Obviously, if there is an external leak, just replacing the failed gear is not going to correct the situation.

Another important consideration is to determine the specific type of failure which can be a valuable indicator for the cause of failure. The following pages show different types of failures and possible causes. Use this as a guide in determining types of failures and in correcting problems.

▪ Correct the Cause of the Problem

Once the cause of the problem has been determined, refer to the appropriate service manual to perform the repairs.

▪ Inspection

As the drive axle is disassembled, set all parts aside for thorough cleaning and inspection. Careful inspection will help determine whether parts should be reused. In many cases, the causes of pre-mature wear or drive axle failure will also be revealed.

Clean

1. Wash steel parts with grpond or polished surfaces in solvent. There are many suitable commercial solvents available. Kerosene and diesel fuel are acceptable.



WARNING: Gasoline is not an acceptable solvent because of its extreme combustibility. It is unsafe in the workshop environment.

2. Wash castings or other rough parts in solvent or clean in hot solution tanks using mild alkali solutions.

NOTE: If a hot solution tank is used, make sure parts are heated thoroughly before rising.

3. Rinse thoroughly to remove all traces of the cleaning solution.
4. Dry parts immediately with clean rags.
5. Oiled parts.
 - If parts are to be used immediately: Lightly oil.
 - If parts are to be stored: Coat with oil, wrap in corrosion resistant paper and store in a clean, dry place.

Inspect Axle Housing

Axle housing inspection and repairs are limited to the following checks or repairs:

- Visually inspect axle housing for cracks, nicks and burrs on machined surfaces.
- Check carrier bolt holes and studs for foreign material.
- Replace damaged fasteners. Look for loose bolts or cross-threaded holes.



WARNING: Any damage which affects the alignment or structural integrity of the housing requires housing replacement. Do not repair by bending or straightening. This process can affect the material's properties and cause it to fail completely under load.

- Check all seals and gaskets.

Inspect Components

Inspect all the steel parts for:

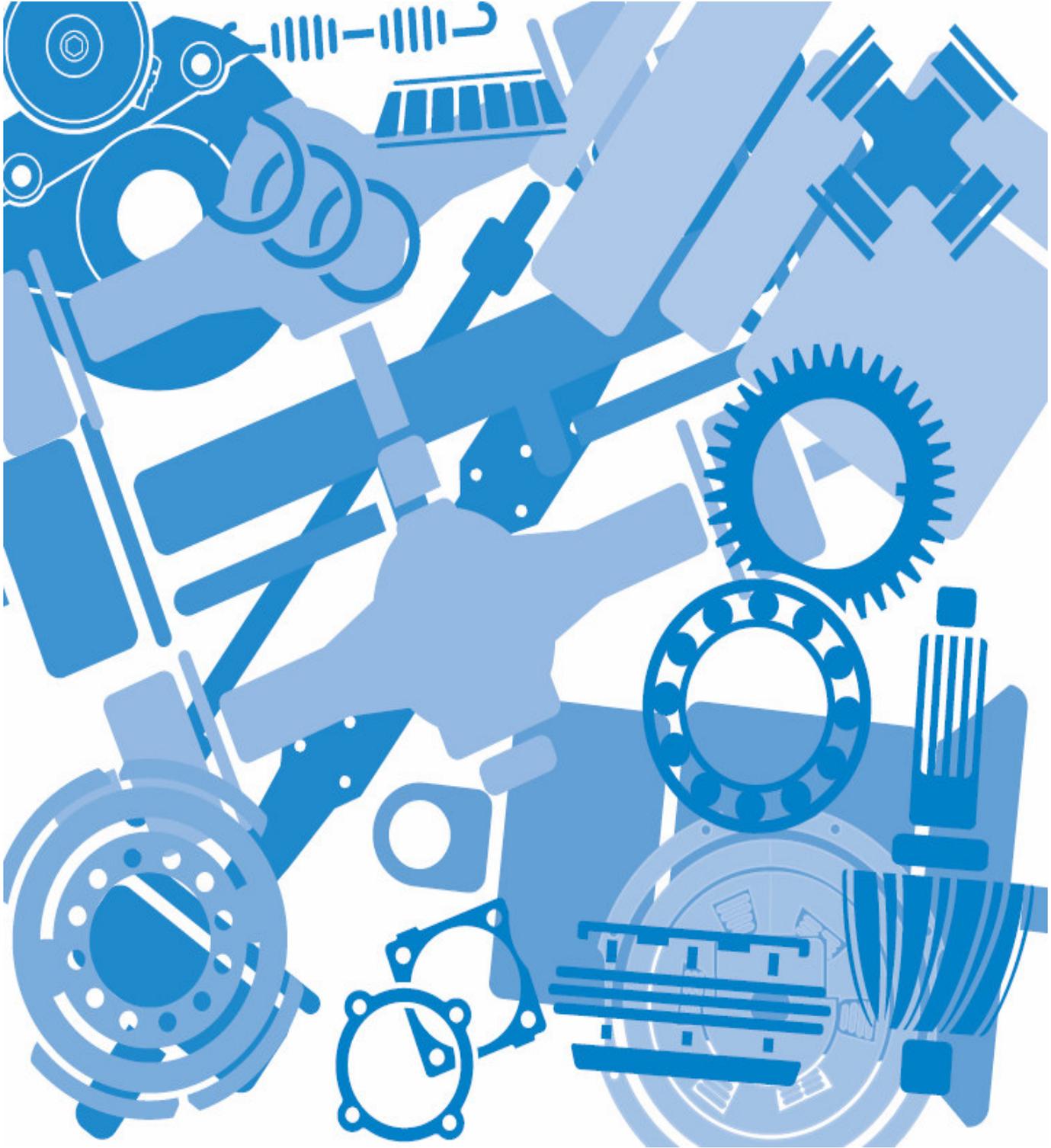
- Notches, visible steps or grooves created by wear.
- Pitting or cracking along gear contact lines.
- Scuffing, deformation or discoloration are signs of excessive heat in the axle, usually related to low lubricant levels or improper lubrication practices.

In addition, inspect the following for damage:

- Differential gearing
- Bearings for loose fit on drive pinion, and differential bearings.
- All fasteners for rounded heads, bends, cracks or damaged threads.
- Inspect machined surfaces of cast or malleable parts. They must be free of nicks, cracks, scoring and wear.
- Look for elongation of drilled holes, wear on surfaces machined for bearing fits and nicks or burrs in mating surfaces

Inspect Primary Gearing

Before reusing a primary gear set, inspect teeth for signs of excessive wear. Check tooth contact pattern for evidence of incorrect adjustment. (see Adjustment Section for correct pattern).



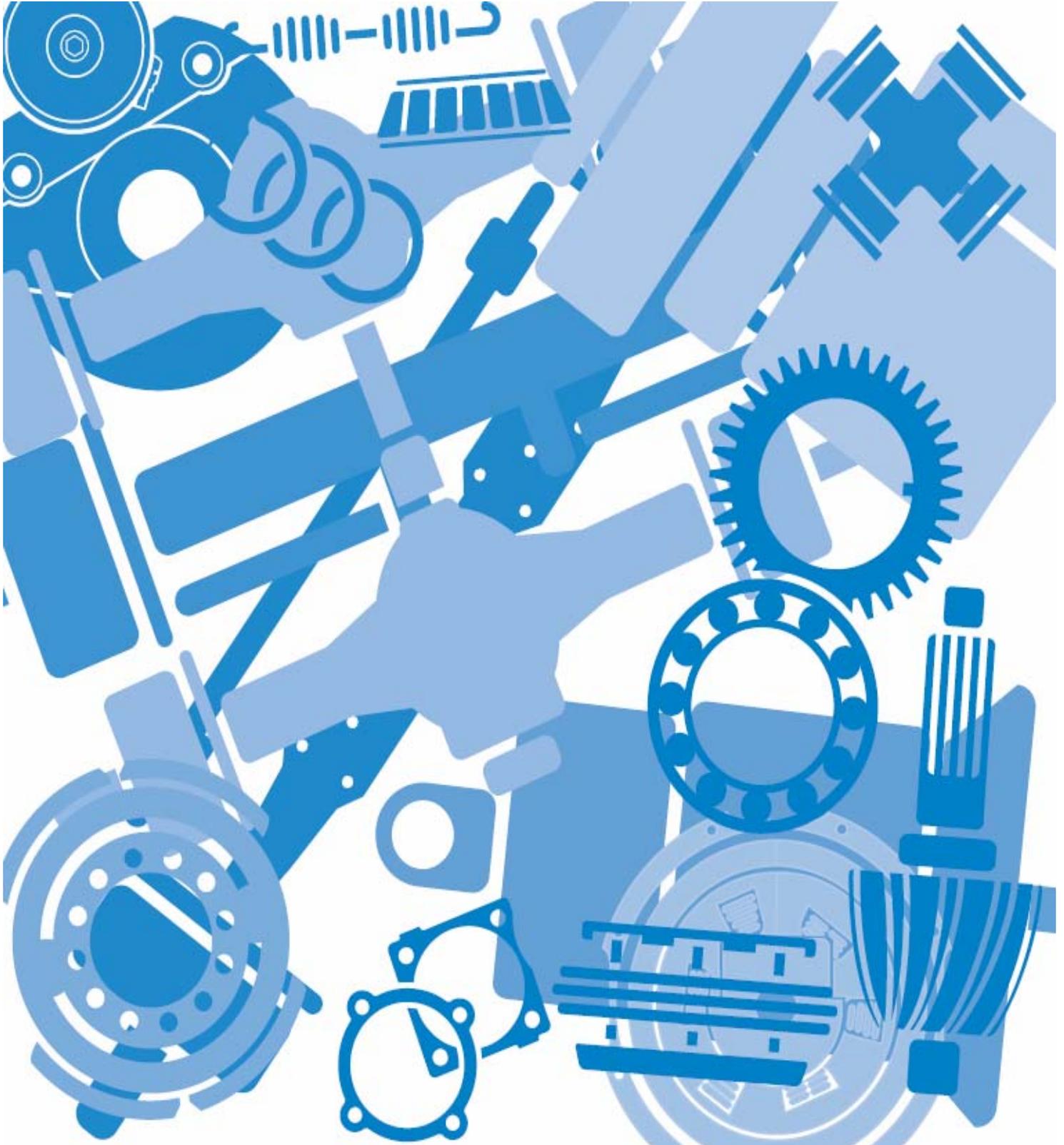
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People Finding A Better Way®

APPLICATION POLICY

Capability ratings, features and specifications vary depending upon the model type of service. Applications approvals must be obtained from Dana Spicer Europe Limited. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.

G170 / G171 / G190 - DRIVE HEAD



SERVICE MANUAL G170/G171/G190



Last Modification	Date	Approved by	Date	Level	Reference	Eng. Change
O. Maraña	12.06.06	V. Badiola	12.06.06	A	613509	NC06823
G.Gainza	06.09.06	V. Badiola	12.06.06	B	613509	NC06939
O. Maraña	22.01.07	V. Badiola	23.01.07	C	613509	NC06939A



The description and specifications contained in this service publication are current at the time of printing.

Dana Spicer Corporation reserves the right to discontinue or to modify its models and/or procedures and to change specifications at any time without notice.

Any reference to brand names in this publication is made simply as an example of the types of tools and materials recommended for use and should not be considered an endorsement. Equivalents, if available, may be used.

Important Notice

This symbol is used throughout this manual to call attention to procedures where carelessness or failure to follow specific instructions may result in personal injury and/or component damage.

Departure from the instructions, choice of tools, materials and recommended parts mentioned in this publication may jeopardize the personal safety of the service technician or vehicle operator.



WARNING: Failure to follow indicated procedures creates a high risk of personal injury to the servicing technician.



CAUTION: Failure to follow indicated procedures may cause component damage or malfunction.



IMPORTANT: Highly recommended procedures for proper service of this unit.

NOTE: Additional service information is not covered in the service procedures.

TIP: Helpful removal and installation procedures to aid in the service of this unit.



OEM: Refer to the OEM vehicle specifications

Always use genuine Dana Spicer replacement parts.



DRIVE HEAD INDEX

1. Drive Head – Exploded View

Drive Head Assembly - Parts Exploded View.....	5
Wheel Differential Lock Assembly – Cross Section.....	6

2. Differential Carrier Assembly

Remove Differential Carrier.....	7
Install Differential Carrier.....	7

3. Carrier Assembly

Remove Wheel Differential (All Standard Models).....	8
Carrier Disassembly.....	8

4. Drive Pinion

Pinion Removal.....	9
Drive Pinion Overhaul and Assembly.....	10

5. Wheel Differential

Wheel Differential Disassembly – Carrier Assembly.....	15
Wheel Differential Assembly – Carrier Assembly.....	16
Install Wheel Differential Assembly - Carrier Assembly.....	18

6. Ring Gear

Adjust Ring and Pinion Tooth Contact Pattern.....	22
New Gearing – Correct Pattern.....	22
Used Gearing – Correct Pattern.....	22
Adjust Contact Pattern.....	22
Adjust Ring Gear Position (backlash).....	23

7. Wheel Differential Lock

Install and Adjust Wheel Differential Lock.....	23
Theory of Operation.....	24
Differential Lock Engaged.....	24
Differential Lock Disengaged.....	24
Differential Lock Engagement Indicator.....	24

8. Seal - Replace

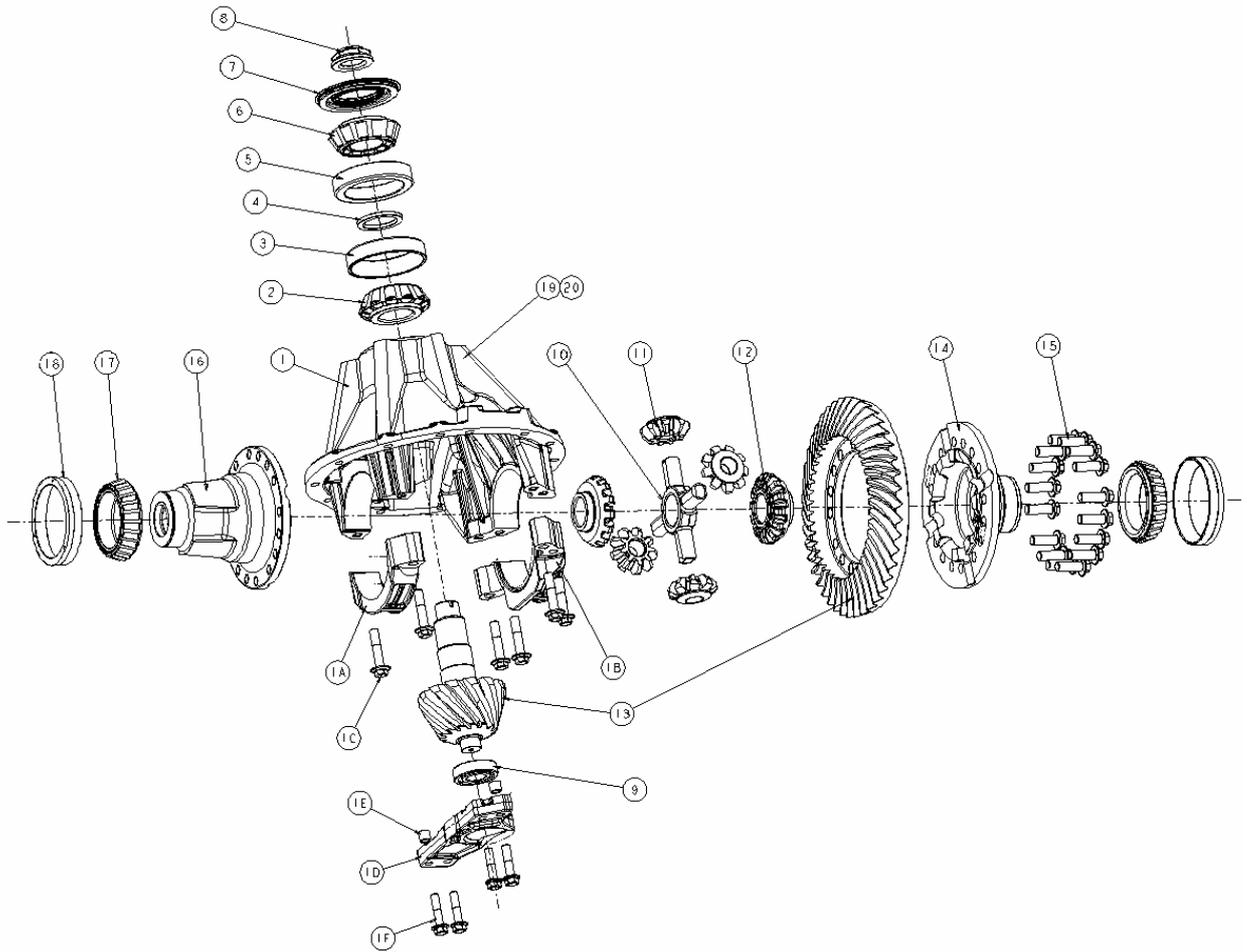
Replace Seal.....	25
Service Kit.....	26

Torque Chart

Fastener Torque Specifications.....	27
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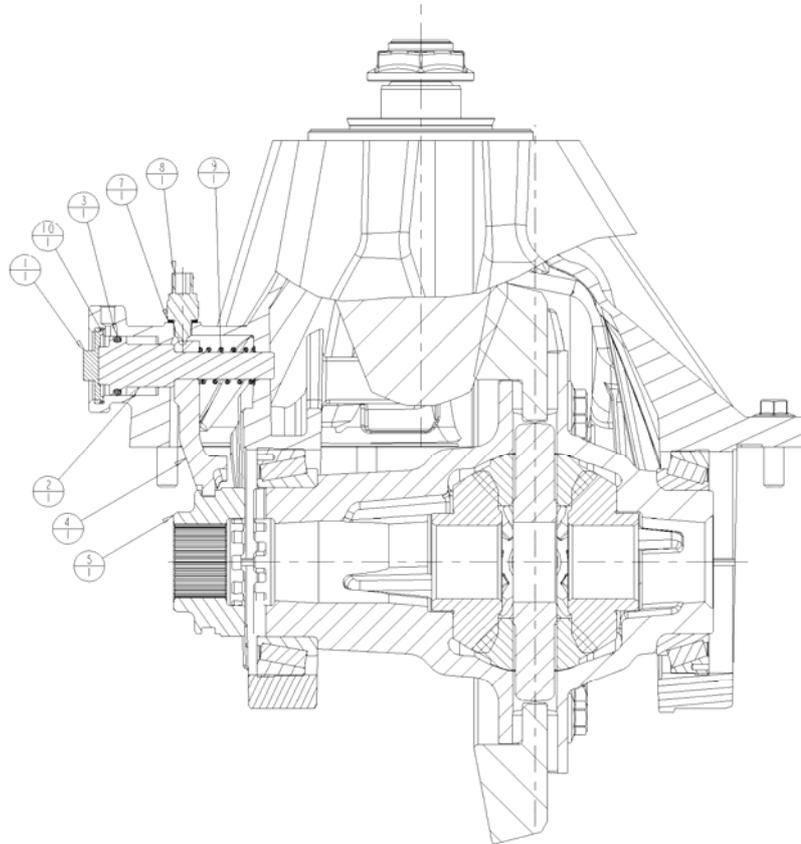
1. DRIVE HEAD – EXPLODED VIEW

▪ Drive Head Assembly – Parts Exploded View



1.- Carrier Sub-assembly	7.- Pinion Seal	19.- Identification Tag
1A.- Bearing Cap	8.- Pinion Nut	20.- Rivet
1B.- Bearing Cap	9.- Pilot Brg (Pinion)	21.- Loctite#518
1C.- Capscrew	10.- Diff. Spider	22.- Loctite#540
1D.- Pilot Bearing Web	11.- Diff. Pinion	23.- Loctite#510
1E.- Dowell sleeves	12.- Diff. Side Gear	
1F.- Capscrew	13.- Gearset	
2.- Brg Cone (Pinion Inner)	14.- Diff. Case, Flange Half	
3.- Brg Cup (Pinion Inner)	15.- Crownwheel Capscrew	
4.- Bearing Spacer	16.- Diff. Case, Plain Half	
5.- Brg Cup (Pinion Outer)	17.- Diff Bearing Cone	
6.- Brg Cone (Pinion Outer)	18.- Diff Bearing Cup	

▪ Wheel Differential Lock



1.- Diff Loc Cap	6.- Roll pin(not shown)
2.- Push Rod	7.- Washer
3.- O-ring	8.- Switch
4.- Shift Fork	9.- Compression Spring
5.- Sliding Clutch	10.- O-ring



2. DIFFERENTIAL CARRIER ASSEMBLY

Remove Differential Carrier

Standard Differentials

1. Block the vehicle
2. Drain axle lubricant.
3. Disconnect driveline.
4. Disconnect lead wires to the selector switch and air line at shift cylinder.
5. Remove axle shaft.

WARNING: Do not lie under carrier after fasteners are removed. Use transmission jack to support differential carrier assembly prior to loosening fasteners.

6. To remove axle shaft, remove axle stud nuts. (If used, remove lock washers and taper dowels.)
7. Remove axle shafts.

NOTE: All models in this publication use axle shafts with unequal lengths. Axle shafts may also be location specific with various wheelequipment. Do not misplace axle shafts from their intended location. Identify left and right shafts for reference during reassembly.

TIP: If necessary, loosen dowels by holding a brass drift in the center of the shaft head and striking drift with a sharp blow with a hammer.

CAUTION: Do not strike the shaft head with a steel hammer. Do not use chisels or wedges to loosen shaft or dowels.

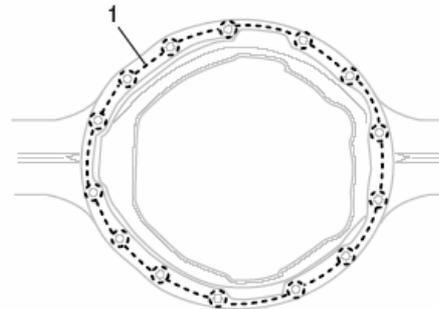
8. Remove carrier capscrews, nuts, and lock washers.
9. Remove differential carrier assembly.

Install Differential Carrier



IMPORTANT: Before installing carrier assembly, inspect and thoroughly clean interior of axle housing using an appropriated solvent and clean rag.

1. Use silicone rubber gasket compound or **Loctite#518** on axle housing mating surface as shown in the illustration. Gasket compound will set in 20 minutes. Install carrier before compound sets or reapply.



1 - Apply silicone gasket in this pattern

TIP: To assist in installing complete differential carrier use two pieces of threaded rod (M16 X 1.5) threaded into carrier capscrew holes. Rod should be approximately 6" long. Use these to pilot the carrier into the housing.

NOTE: Fasteners using self-locking thread "patches" may be reused if not damaged, but should be secured by a few drops of **Loctite#518** on threaded surface of differential carrier.

Reused fasteners should be wiped clean of excess oil, but do not require special cleaning.

2. Install carrier to housing, lock washers, capscrews and nuts. Torque to proper specification. (see torque chart).
3. Install axle shafts and axle stud nuts. (If used, also install lock washers and tapered dowels.)
4. Add axle lubricant. Fill to bottom of filler hole.
5. Connect driveline, making sure all yokes are in phase. Lubricate u-joints.

NOTE: When axle has been disassembled or housing, gears, axle shafts or wheel equipment replaced, check axle assembly for proper differential action before operating vehicle. Wheels must rotate freely and independently.

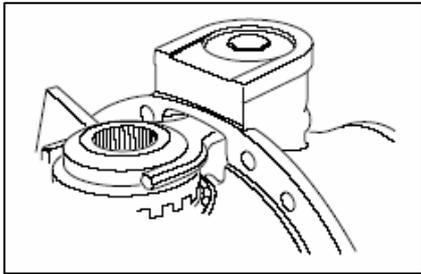
3. CARRIER ASSEMBLY

Remove Wheel Differential (All Standard Models)

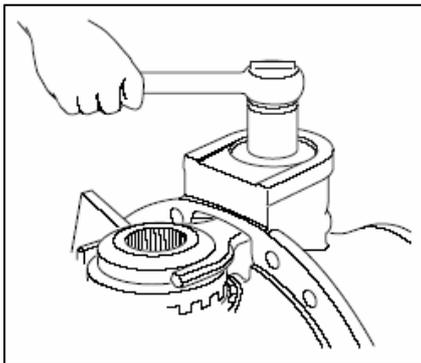
Carrier Disassembly

For models having the wheel differential lock option, refer to the following procedure. These parts must be removed first before further disassembly of the wheel differential can take place.

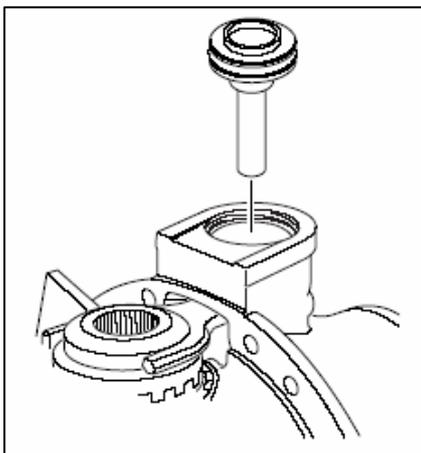
1. For ease of service, mount differential carrier in headstand with the differential lock facing up



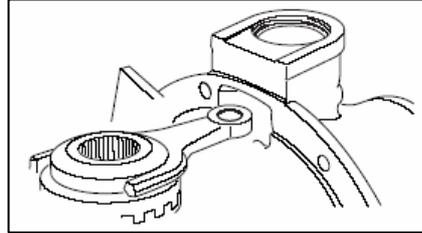
2. Remove the threaded cylinder cap.



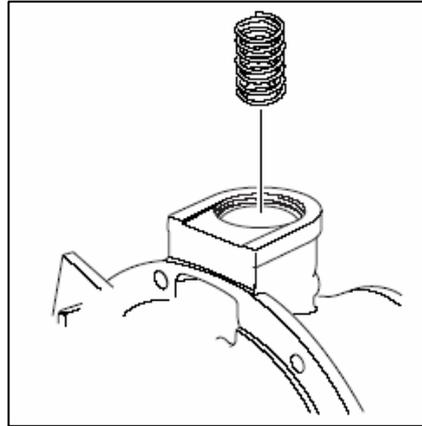
3. Remove the piston push rod from the shift fork



4. Remove the shift fork and sliding clutch assembly

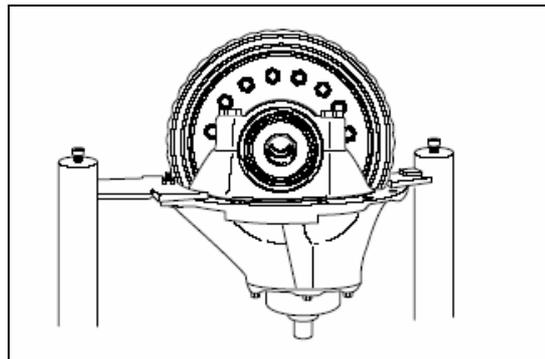


5. Remove the shift fork spring



NOTE: If gear set is to be reused, check tooth contact pattern and ring gear backlash before disassembling differential carrier. Best results are obtained when established wear patterns are maintained in used gearing. Omit this step if the gear set is to be replaced.

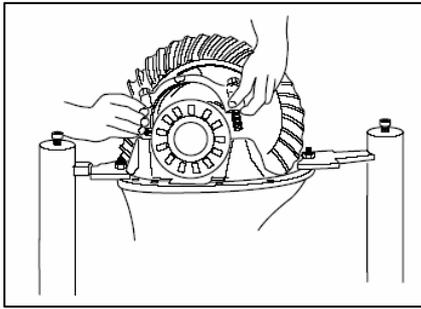
6. Mount differential carrier in a head stand. With the wheel differential facing upward.



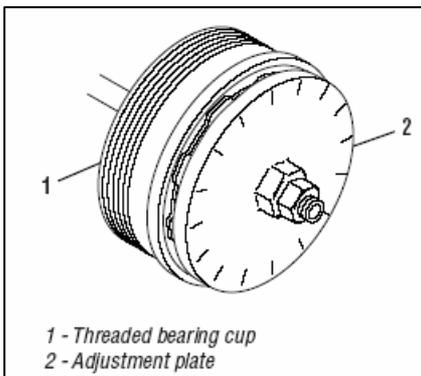
NOTE: For easier disassembly, loosen but do not remove the pinion nut.



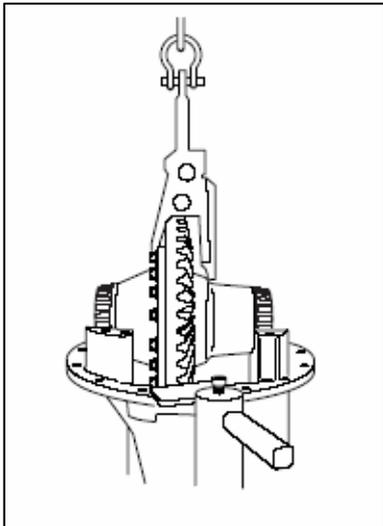
- Remove the carrier differential bearing cap screws, flat washers and bearing caps.



- Use Dana's wheel diff. bearing adjustment tool (part number 130971) to back off the threaded cups and remove.



- Using a chain hoist and the proper strap, lift the ring gear and wheel differential assembly carrier.



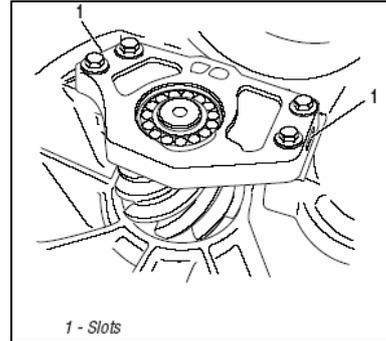
4. DRIVE PINION

Pinion Removal

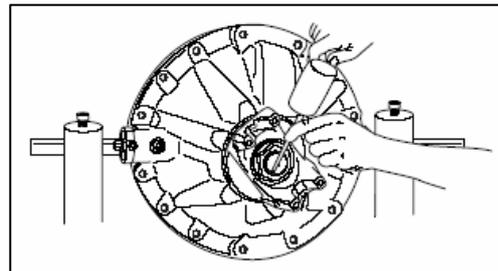


CAUTION: During the following yoke removal procedure, do not allow pinion to drop on hard surface.

- If a pilot web is used, for disassembly, use the pry slots provided at each end of the pilot web.



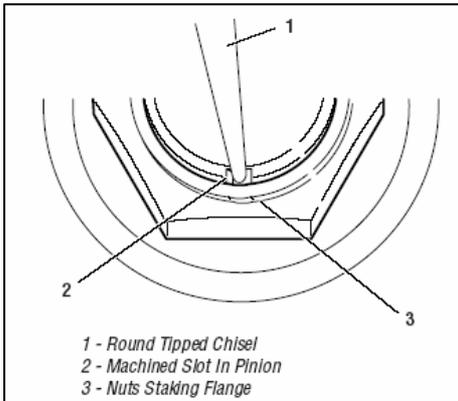
- Before the pinion nut can be loosened, you must destake the nut from the slot of the pinion.



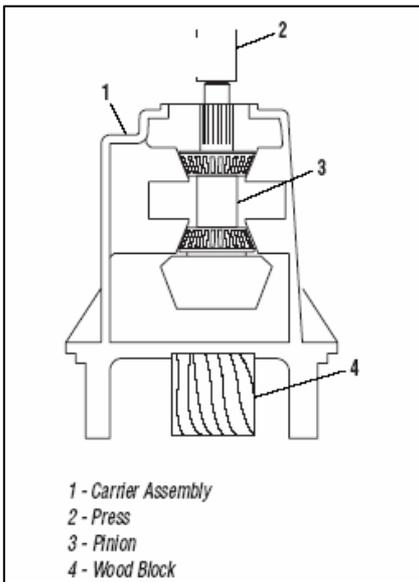
- To de-stake the nut, use a chisel or drift with a round tip. The flange of the nut must be pushed far enough outward so that the staked area will not interfere with the pinion threads when the nut is removed. See diagram below.



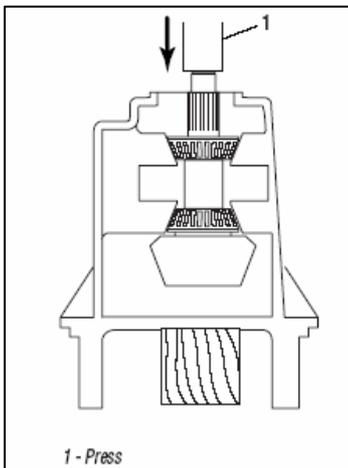
CAUTION: Failure to de-stake the pinion nut will result in damage to the drive pinion threads when removed. The pinion nut should never be reused, always replace with new.



- Remove the pinion nut
- Place carrier assembly into a press, place a 2" x 6" x 6" wood block under the pinion. This will ensure that when the pinion is pressed free from the bearings the pinion will not be damaged.



- Use a suitable pressing tool to press the end of the pinion until free from the pinion bearing



IMPORTANT: The bearing spacer will be reused or used as a starting point when resetting the pinion bearing preload. Do not discard this part.

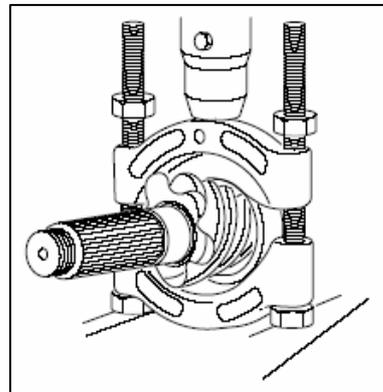
CAUTION: Use the correctly sized spacer. Do not use shim stock or grind spacers. These practices can lead to loss of bearing preload and gear or bearing failure.

Drive Pinion Overhaul and Assembly

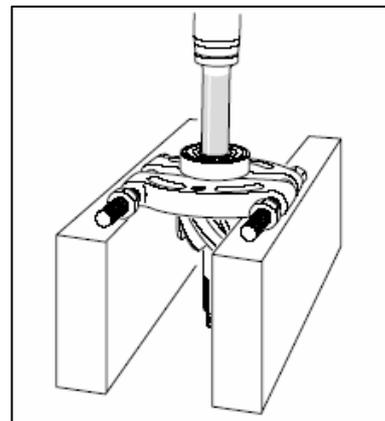
The preload of the bearings on the drive pinion is adjusted by a spacer between the inner and outer bearing cones. The preload is adjusted by changing the thickness of the spacer. A thicker spacer will decrease the preload, a thinner spacer will increase the bearing preload.

NOTE: See carrier disassembly for instructions on pinion and yoke removal.

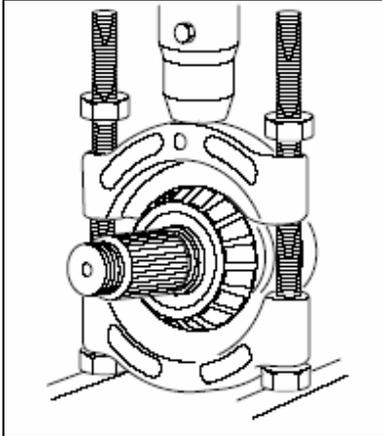
- If the model of axle uses a pilot bearing, remove the bearing using a split-type puller. Use two procedure steps to remove each bearing.
 - Mount the puller vertically to separate the bearing from the pinion. This action will force the puller halves behind the bearing race and start moving the bearing from the pinion.



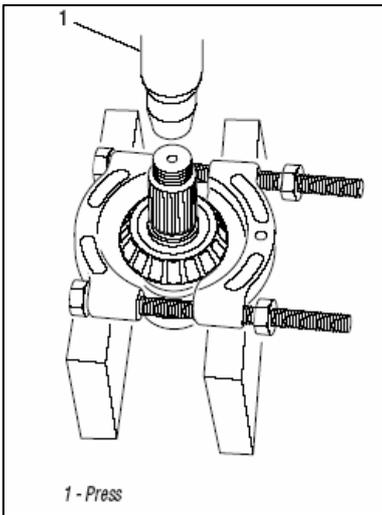
- Mount the puller horizontally to press the bearing from the pinion



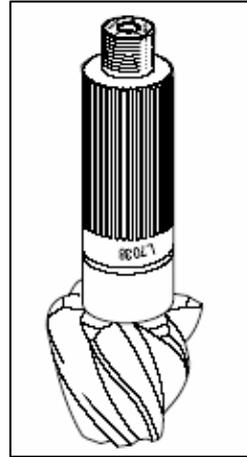
2. Remove the inner pinion bearing cone from the pinion using a split-type puller. Use two procedure steps to remove each bearing.
 - a. Mount the puller vertically to separate the bearing from the pinion. This action will force the puller halves behind the bearing race and start moving the bearing from the pinion.



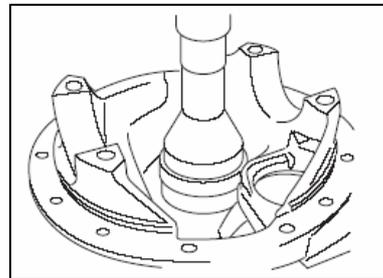
- b. Mount the puller horizontally to press the bearing from the pinion



3. Use a press sleeve to install the inner bearing cone and pilot bearing, if used, onto the pinion. Apply pressure until the bottom of the cone touches the shoulder of the pinion. Apply lubricant to the cone of the bearing.



4. If removed, install the inner and outer bearing cups into the carrier.
 - a. To install the inner bearing cup, place the carrier in a press with the bottom of the carrier facing up.
 - b. Place the cup in the bore. Use a sleeve or bearing driver tool to press the cup until it is fully seated. Use a feeler gage to make sure the cup is fully seated.



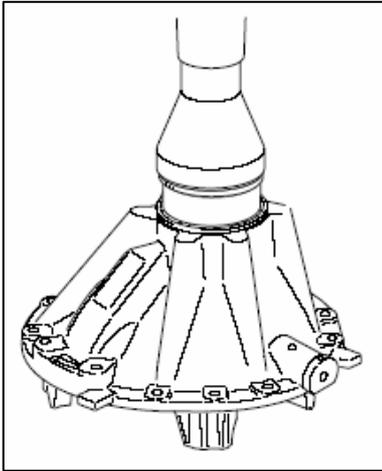
- c. To install the outer bearing cup, place the carrier in a press with the top of the carrier facing up.



IMPORTANT: Use the correctly sized spacer. Do not use shim stock or grind spacers. These practices can lead to loss of bearing preload and gear or bearing failure.

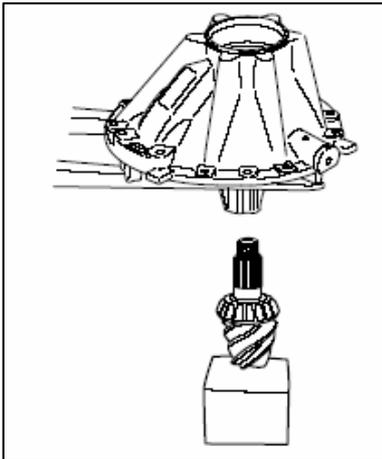
To prevent bearing damage, use suitable sleeve that only contacts the inner race of bearing cone.

- d. Place the cup in the bore, use a sleeve or bearing driver tool to press the cup until it is fully seated. Use a feeler gage to make sure the cup is fully seated.

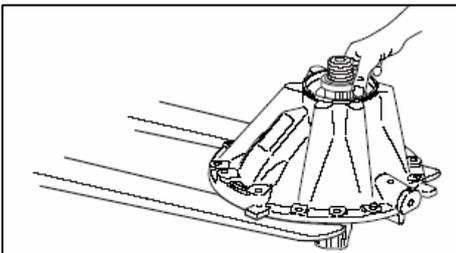


NOTE: If a press is not available, use a sleeve or bearing driver and a hammer to install the cups.

- 5. Place the pinion on a 150mm x 150mm x 150mm block of wood and lower the carrier over the pinion.

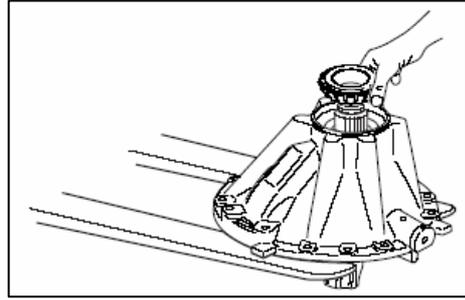


- 6. Install the pinion spacer

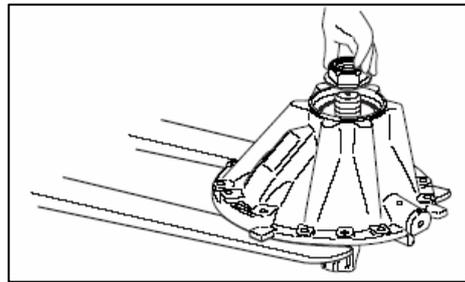


NOTE: If you are using the same drive pinion, use the same spacer that was originally installed in the assembly. If the drive pinion is to be replaced, the original spacer will be used as the starting point of adjustment.

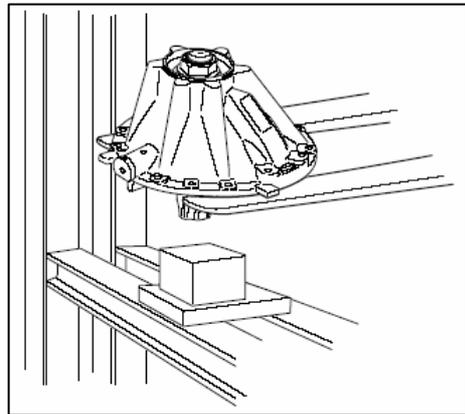
- 7. Install the outer bearing cone



- 8. Install a pinion nut finger tight. This will hold the pinion in place while it is positioned into the press

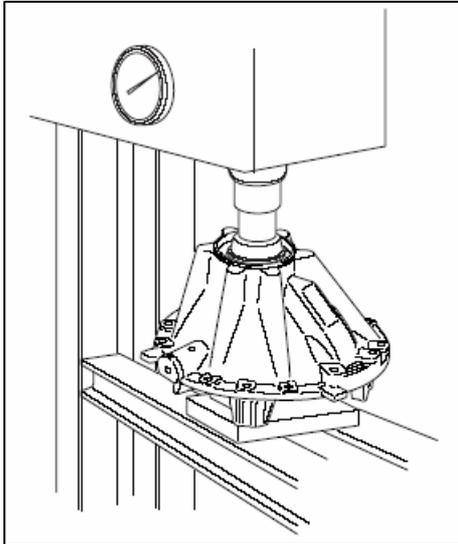


- 9. Align a 150mm x 150mm x 150mm wood block under the drive pinion, then lower the carrier and pinion assembly into a press so that it is supported by the block.

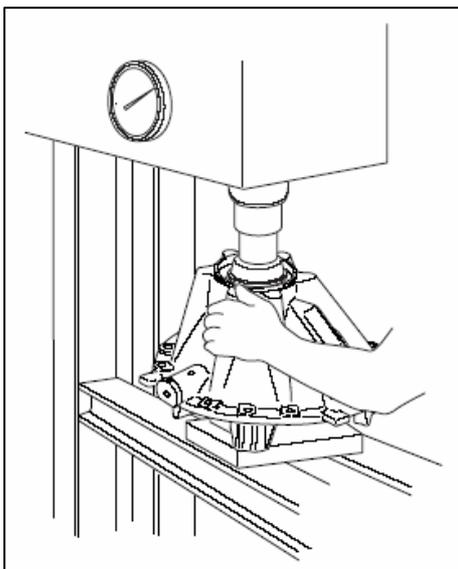


- 10. Remove the pinion nut.

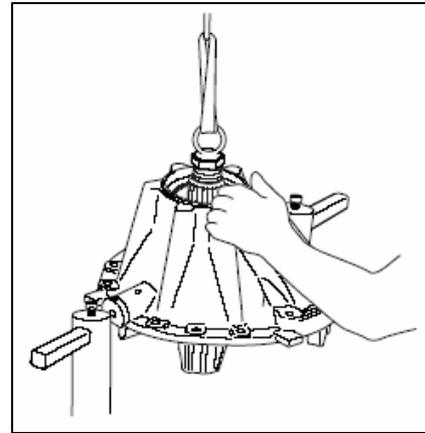
11. Place a press sleeve over the top of the outer bearing cone. Use the press to apply 5 tons of force. It is important to rotate the carrier slightly to make sure that the rollers of the bearing are properly seated.



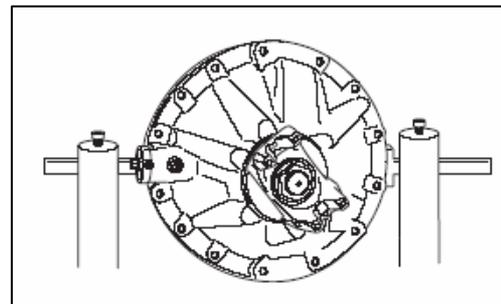
12. With 5 tons of force on the press, you should be able to feel a small amount of drag from the bearing as you rotate the carrier. If the carrier turns with no drag at all, the pinion spacer thickness should be decreased by using a thinner spacer. If the carrier is hard to turn, the spacer thickness must be increased.



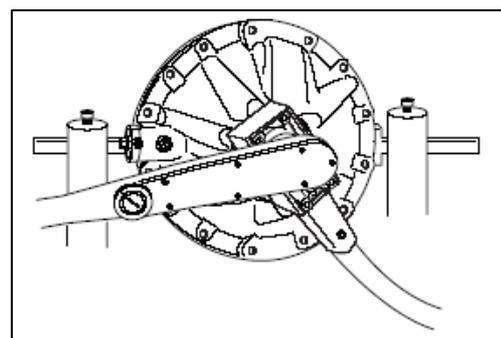
13. Remove the carrier from the press. Secure the carrier in a head stand.



14. Install the drive yoke and pinion nut.

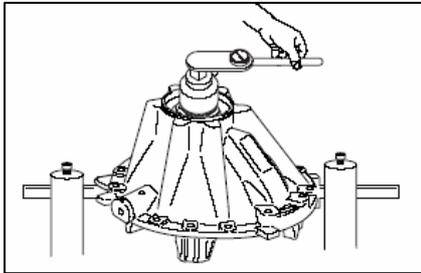


15. Torque the nut to corresponding torque. See torque chart.

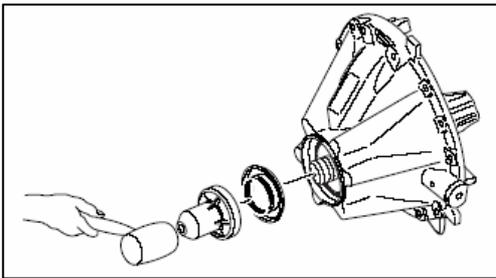




16. Use a torque wrench and correct socket to check the rolling torque of the pinion. Read torque while rotating the assembly. Record the rotating torque, not the breakaway torque. Torque must be between in the range specified in the 2.03 – 5.64 Nm (18 to 50 lbs/inch). If the torque recorded is not within the specified torque, the pinion spacer must be changed. Repeat Steps 6-17.



17. Now remove the pinion nut and yoke and install the pinion seal. Use the suitable tooling for this operation. See "Service Kit" paragraph.



Dana Spicer strongly recommends using seal drivers when installing new seals. Use the proper driver to ensure that the seal is square and installed to the proper depth.

CAUTION: Oil seals can be easily damaged prior to installation. Use care when handling the new seal to prevent damage or contamination. Leave the seal in its package until installation. On new yokes, leave the protector on the yoke until it is installed on the shaft to prevent damage or contamination

18. Reinstall the yoke and pinion nut. Torque to corresponding torque. See torque chart.

CAUTION: Do not use the yoke if it has any damage on the seal surface (nicks or scratches).

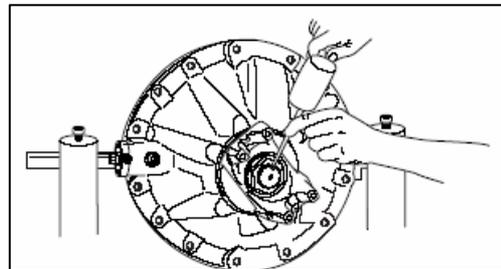
The surface of the yoke and the lips of the seal form a critical interface which retains the axle's lubricant while sealing the axle from outside contaminants. The condition of the yoke hub's surface is a very important factor in determining seal life.

Carefully inspect the seal surface area of the yoke hub for signs of wear and damage. Do not reuse the yoke if there is noticeable wear such as heavy grooving, beyond normal polishing from the seal lips.

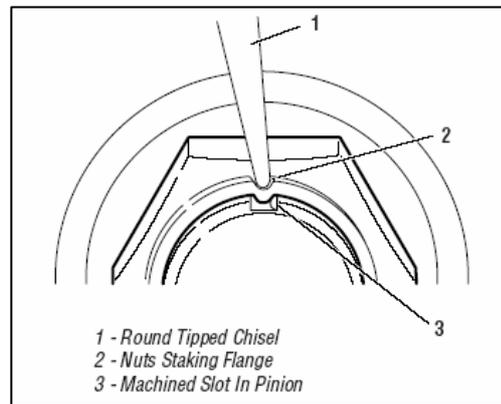
NOTE: Do not rework the yoke with abrasives such as emery paper or crocus cloth. Clean the surface of the yoke as necessary using chemical cleaners. Remove all trace of the chemicals from the yoke after cleaning.

Do not use wear sleeves. Wear sleeves increase the yoke hub surface diameter and cause premature seal wear and repeat seal failure.

19. Once the proper rolling torque is achieved, use a punch with a round tip to stake the pinion nuts flange into the machined slot in the pinion shaft. See diagram below.

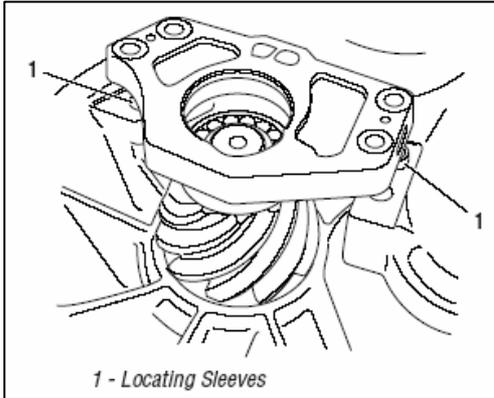


CAUTION: The stake must be deep enough to enter the machined slot of the pinion.

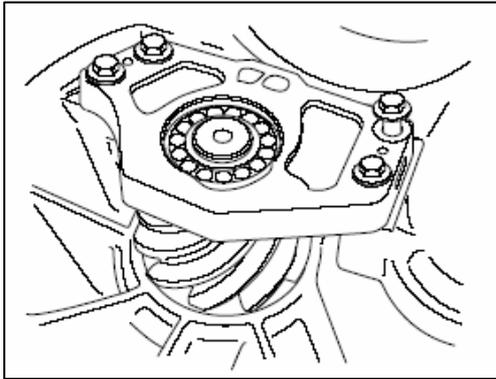


WARNING: Failure to stake the pinion nut properly may result in the nut coming loose during service. The pinion nut should never be reused, always replace with new.

20. If a pilot bearing web is used, line up the web to the dowel sleeves and tap in place with a rubber mallet.



21. Install capscrews and torque to the proper specifications. See the torque chart



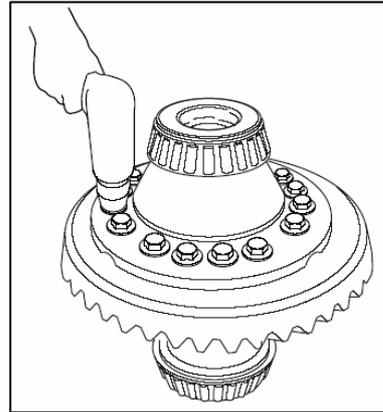
5. WHEEL DIFFERENTIAL

Wheel Differential Disassembly –Carrier Assembly

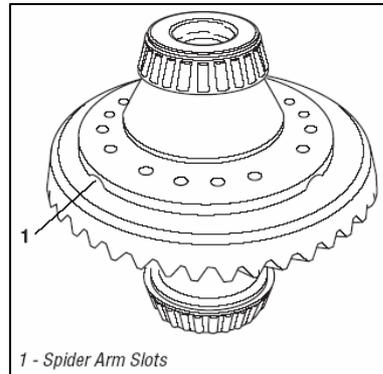


IMPORTANT: During following procedure, place differential assembly on malleable surface to prevent damage when removing components.

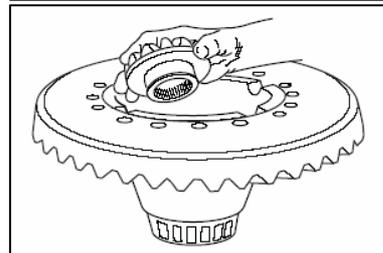
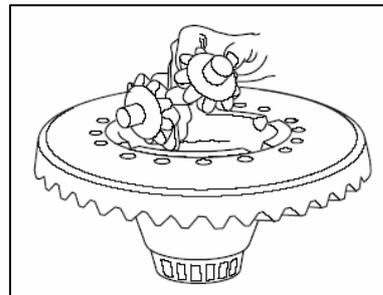
1. Remove cap screws fastening ring gear to differential case.



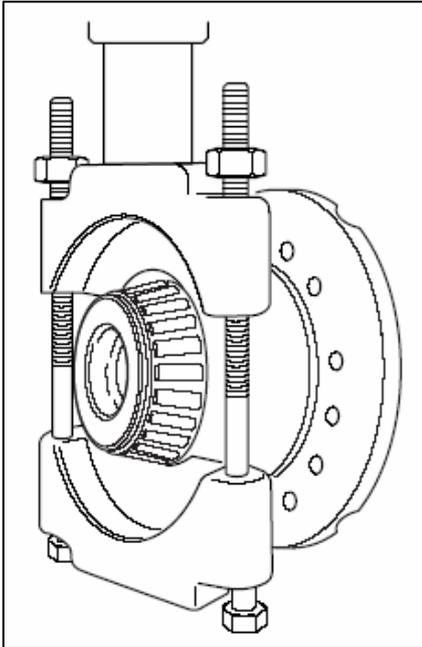
2. Remove the flange half differential case and bearing assembly. Use a screwdriver at the spider arm machined slots of the case to loosen the flange from the ring gear.



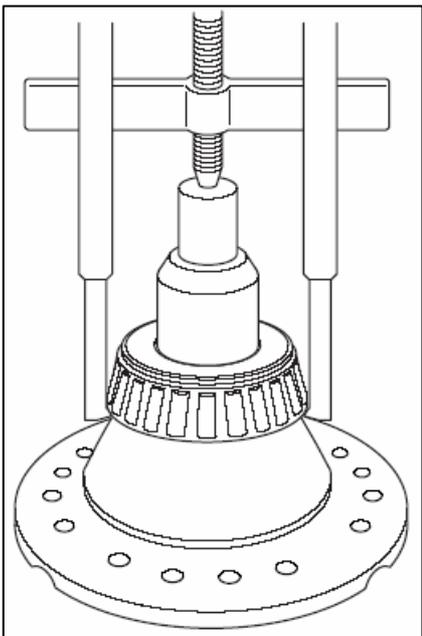
3. Remove the side gears, pinion gears and differential spider from the plain half case.



4. Place a block under the plain half, use a rubber mallet to remove the ring gear.
5. Remove the bearing cones from the case halves using suitable pullers
6. Remove the bearing cones from the plain and flange halves in two steps:
 - a. Mount the puller vertically to split the bearing. This action will start the bearing moving off the differential case.



- b. Mount the puller horizontally to remove the cone.

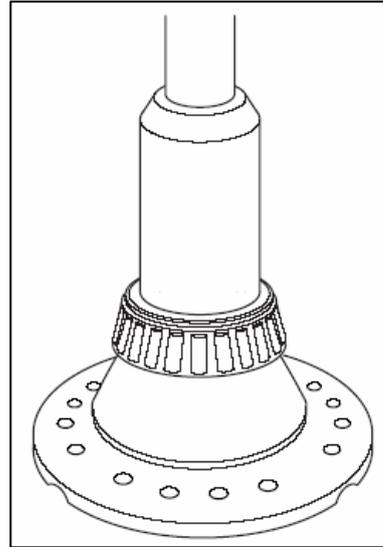


Wheel Differential Assembly – Carrier Assembly

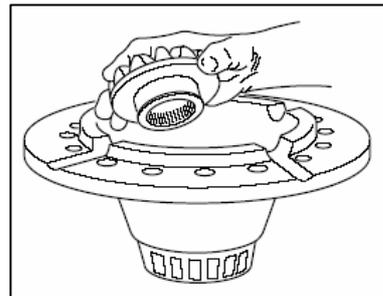


IMPORTANT: To prevent bearing damage, use suitable sleeve that only contacts the inner race of the cone. A used bearing race would be a suitable tool. This tool should have a slit cut if the ID is the same as the flange OD.

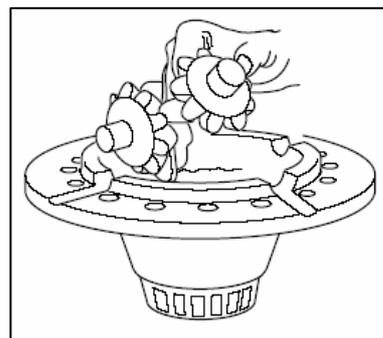
1. Press the new bearing cone on the plain half and flange half bearing boss using the proper press sleeve or bearing installation tool.



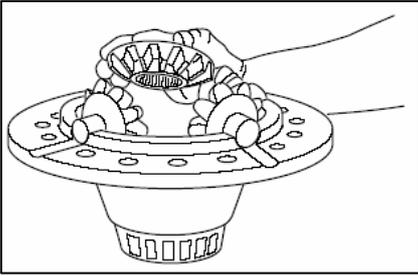
2. Place the plain half side of the differential case on a malleable surface.
3. Install the side gear. Apply a thin coat of oil to the mating surface of the side gear and plain half.



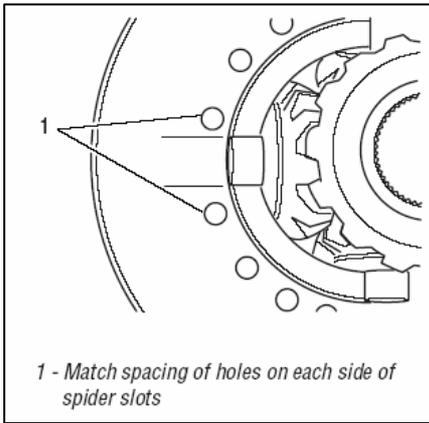
4. Assemble the pinion gears onto the differential spider. Apply a thin coat of oil to the mating surfaces of the pinion gears and differential spider. Install the differential nest on top of the side gear.



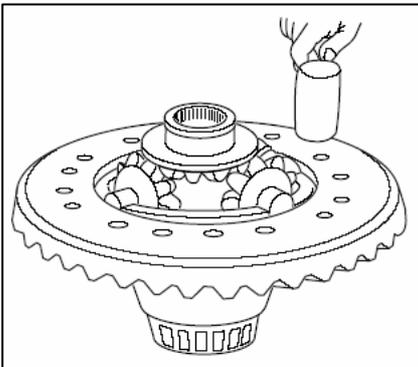
5. Install the flange half side gear. Apply a thin coat of oil to the mating surfaces



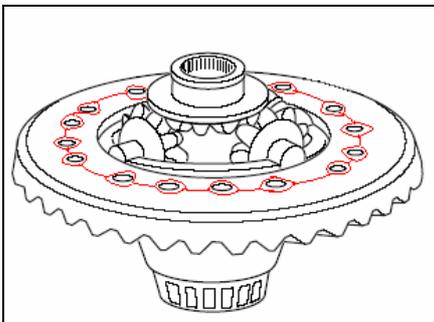
6. Install the ring gear. Align the capscrew holes.



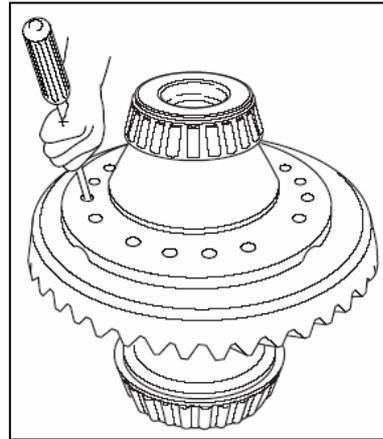
7. Use a rubber mallet to seat the ring gear to the plain half.



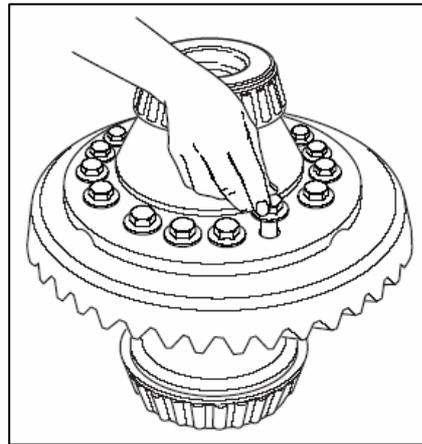
8. Apply **Loctite#510** around the ring ring gear bolt junction.



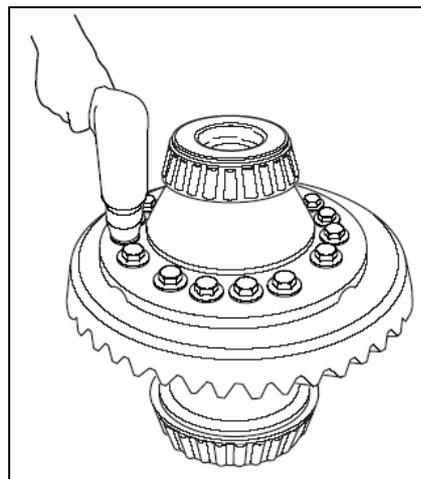
9. Install the flange half of the case. Align the capscrew holes.



10. Install the ring gear capscrew.



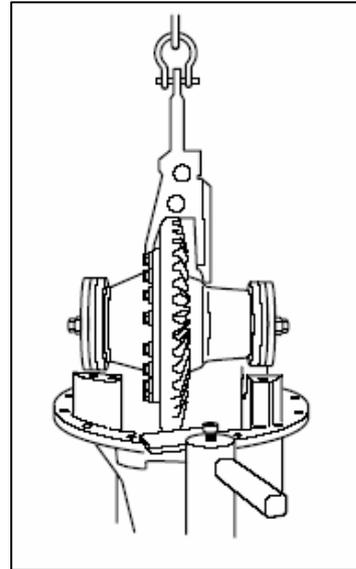
11. Tighten the ring gear capscrew with an impact gun and then use a torque wrench to torque to the proper specification. See the torque chart.



Install Wheel Differential Assembly –Carrier Assembly

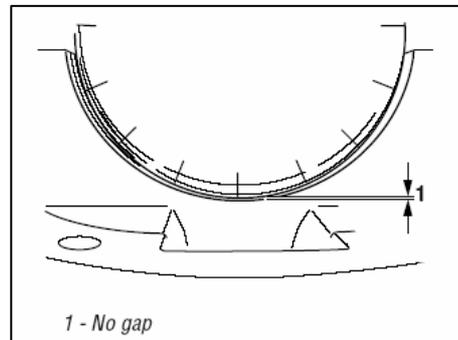
NOTE: To install the wheel differential assembly, properly setup the gear pattern and set the differential bearing preload. This will require the use of the following Dana tools or equivalent. These tools will allow you to align the bearing adjuster assembly to the carrier. This tool (part number 130971) will also gauge the adjustment for the differential bearing preload and assist in setting the backlash. Below you will find detailed instructions explaining each procedure.

1. The bearing adjustment tool is made up of a threaded rod, two nuts, two washers and two adjustment plates. Fit one adjustment plate to the plain half threaded cup. Fit the other adjustment plate to the flange half cup. The adjustment rings will fit into slots of the threaded bearing cups stamped adjustment ring.

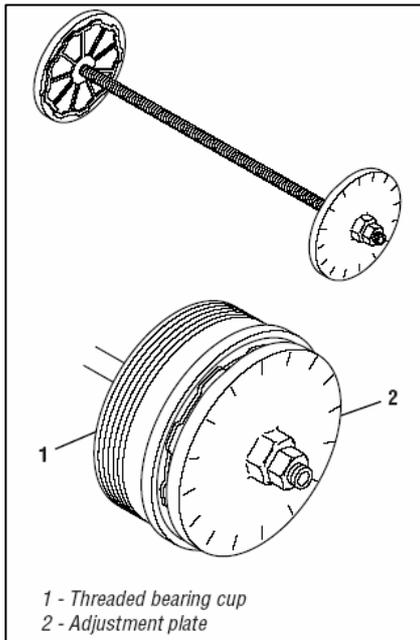
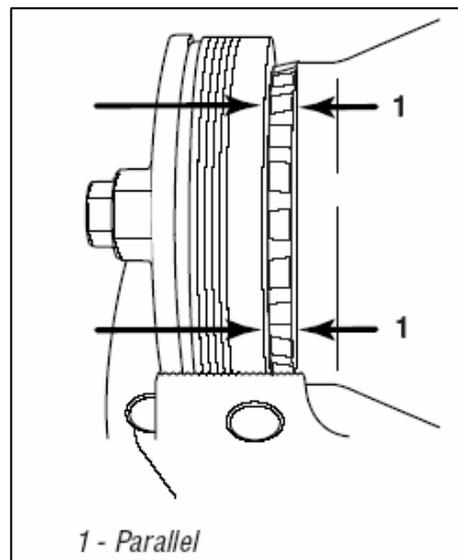


NOTE: There are two ways to make sure that the threaded cups are seated properly (see diagrams). If there is a misalignment, reinstall the differential assembly at a slightly different angle.

3. Make sure there is no gap between the carrier threads and the cup threads.

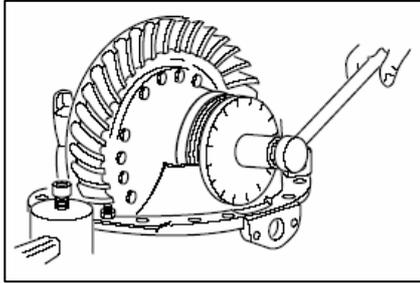


4. Make sure that bearings cage is parallel to the edge of the threaded cup.

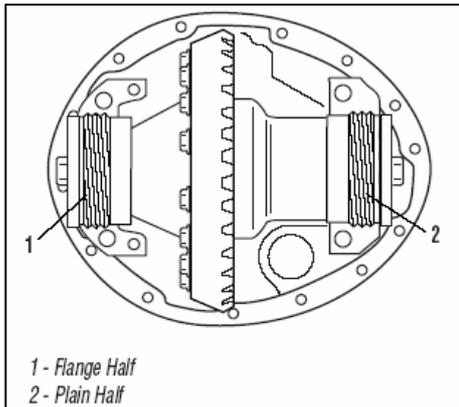


2. Connect the adjuster plates using the threaded rod, washers and nuts. Tighten the nuts on the rod to hold the threaded cups in place. Carefully lower the wheel differential and ring gear assembly into the carrier.

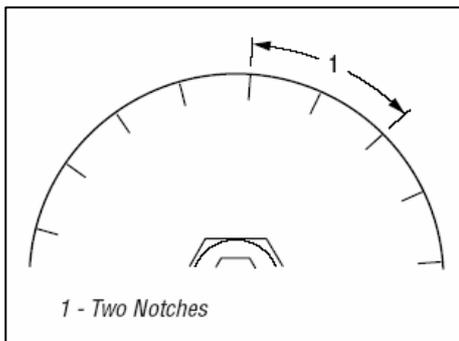
- Use a ratchet or breaker bar and a 1 ¼" deep wall socket to turn the flange half threaded bearing cup in until the ring gear contacts the pinion (zero backlash). Back the cup out two notches of the adjustment plate.



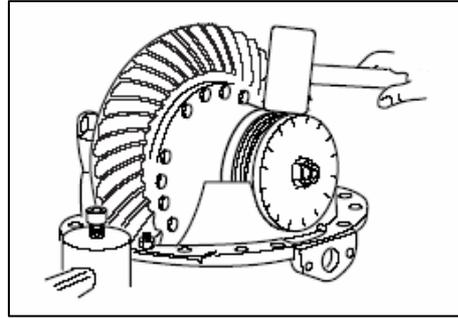
- Turn the plain half adjuster ring until there is zero preload on the bearings. This is done by turning the adjuster plate clockwise until you feel the threaded cup gain resistance. The threaded bearing cup should only be slightly snugged to achieve a zero preload condition.



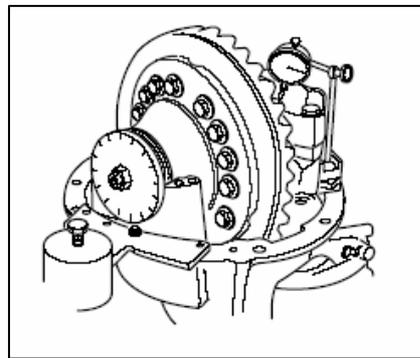
- Obtain two notches of preload by tightening the plain half adjustment ring two notches. Start with the notch at the top, count two notches counter-clockwise on the adjuster ring, turn the adjuster ring so that the notch is facing straight up.



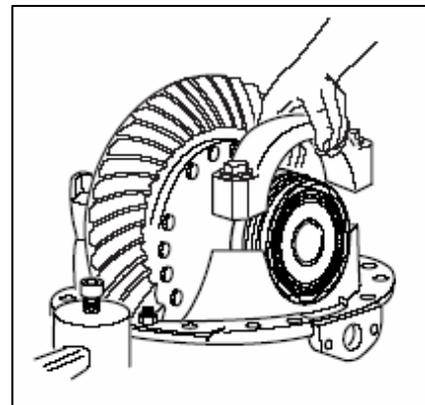
- Use a rubber mallet to fully seat the threaded bearing cups.



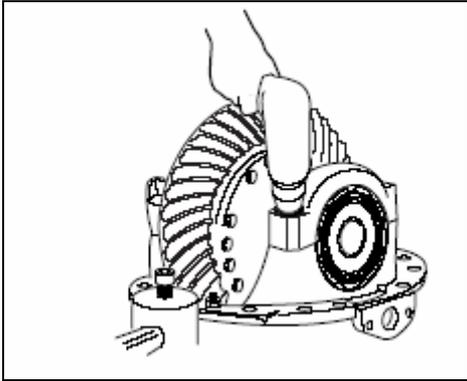
- With a dial indicator, check the ring gear and pinion backlash. Set the backlash from 0.20 – 0.46 mm (0.008" to 0.018") for lapped gears and from 0.30 – 0.40 mm (0.012" to 0.016") for ground gears. This will give sufficient tolerance to adjust the contact pattern, if necessary.



- Remove the adjuster plates and threaded rod assembly.
- Apply **Loctite#540** to the threaded cups before installing the differential bearing caps. Start applying an 1/8" (3mm) wide bead around one half of the bearing cup centred in the threaded section
- Install the carrier differential bearing caps and capscrews. Make certain there is no gap between the carrier cap and the carrier surface.



13. Use an impact gun to snug all carrier differential bearing cap fasteners.



14. Recheck the backlash. For new gearing, the backlash should be between 0.20 and 0.46 mm (0.008" - 0.018").

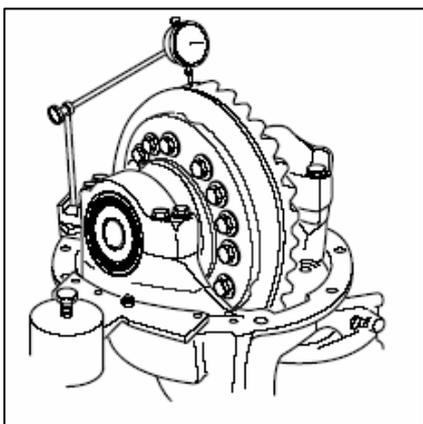
NOTE: For used gearing, the backlash should be reset to what it was at the time of disassembly.

NOTE: If you have too much backlash, move the ring gear closer to the pinion. Count the number of notches you back off the plain half threaded cup. Each notch equals about 0.003" (0.08 mm) of backlash.

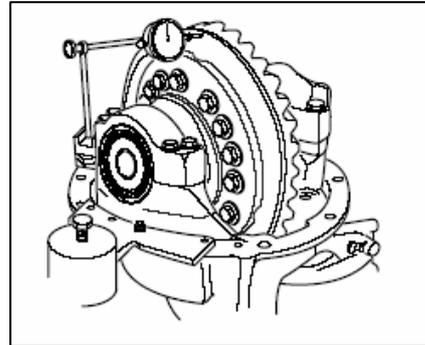


IMPORTANT: In order to maintain the differential bearing preload, you will need to turn the flange half threaded cup the same amount in the same direction. If you need more backlash, reverse the procedure.

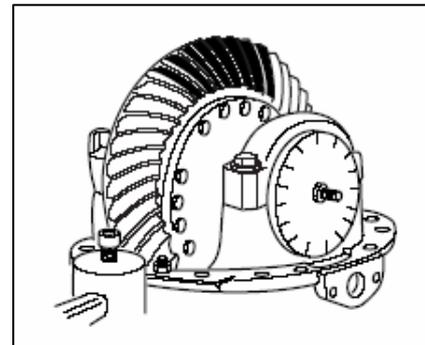
15. Measure the ring gear total radial runout. Indicator reading should not exceed 0.010" (0.25 mm).



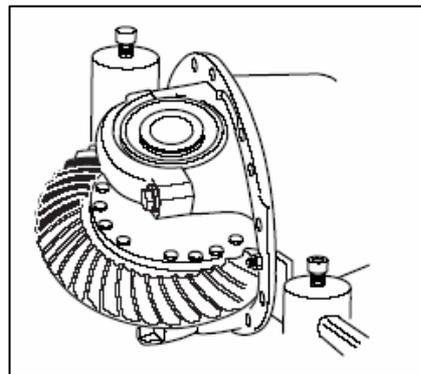
16. Measure the ring gear total backface runout. Indicator reading should not exceed 0.006" (0.15 mm).



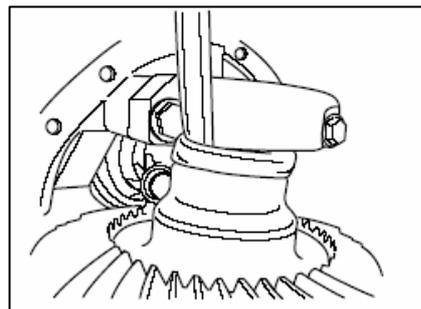
17. Check the ring gear tooth pattern. Paint 5 or 6 ring gear teeth 180 degrees apart on the ring gear.



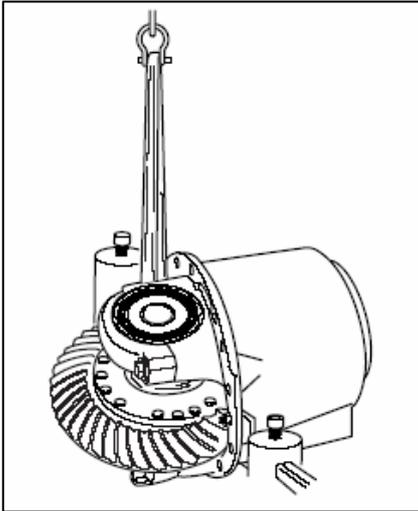
18. With the carrier mounted in a head stand, roll the carrier in its side.



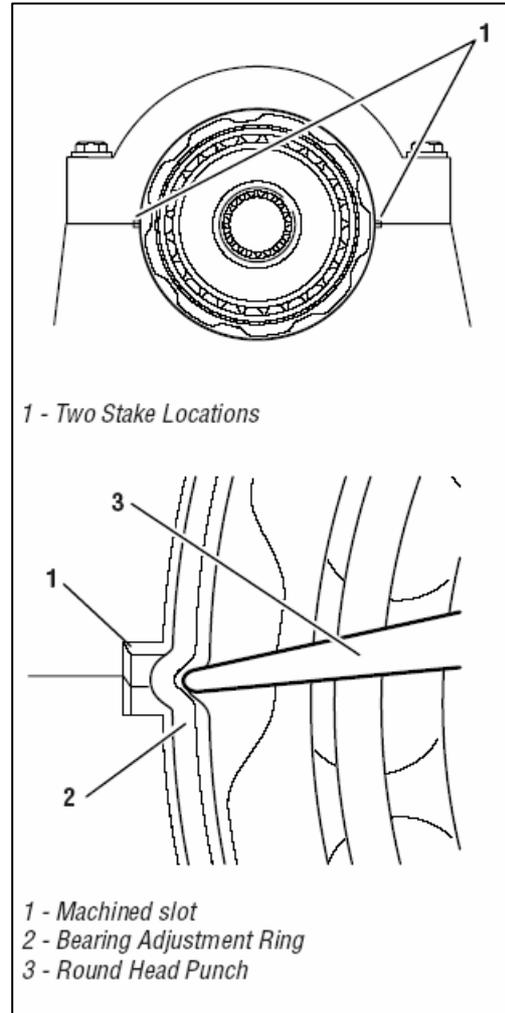
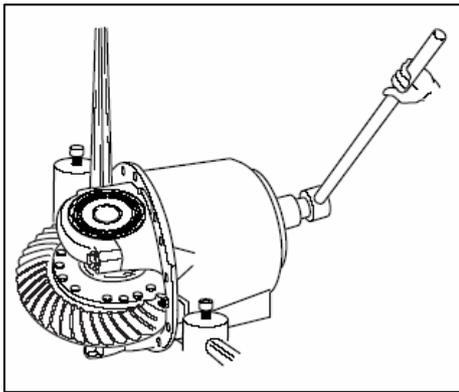
19. Make a sling out of a strap and position around the plain half of the wheel differential.



20. Connect the end of the strap to a hoist and apply pressure to the sling



21. Use the correct socket and a breaker bar to rotate the differential. The differential should be hard to turn. Rotate the pinion until the ring gear rotates 3 or 4 times in both directions. **See next pages for descriptions of correct pattern position for new and used gearing.**



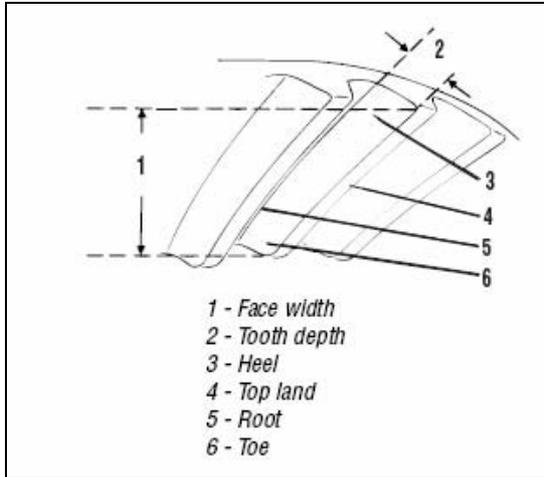
22. When contact pattern and backlash are correct. Using a torque wrench tighten both carrier differential bearing caps to the specified torque. See the torque chart. Recheck backlash and contact pattern.
23. Use a punch with a round head to stake the threaded bearing cups in place. Stake the outer edge of the bearing adjustment ring into the machined slots in the carrier bearing bore on both sides. Must be staked at two locations. Rotate cup if necessary to provide surfaces for staking.



6. RING GEAR

▪ Adjust Ring And Pinion Tooth Contact Pattern

NOTE: Rear axle gearing is shown in the following instructions.

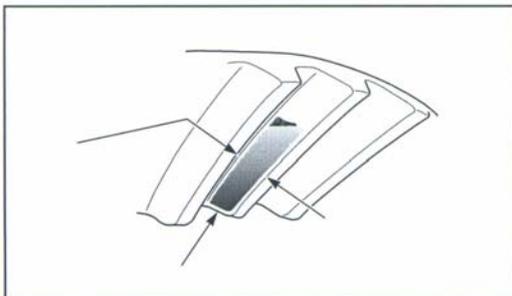


- 1.- Identify if new or used gearings
- 2.- Check tooth contact pattern (new or used gearings)

▪ New Gearing - Correct Pattern

Paint six ring gear teeth 180° apart with marking compound and roll the gear to obtain a contact pattern. The correct pattern is slightly below center on the ring gear tooth with lengthwise contact up off the toe. The length of the pattern in an unloaded condition is approximately one-half to two-thirds of the ring gear tooth in most models and ratios.

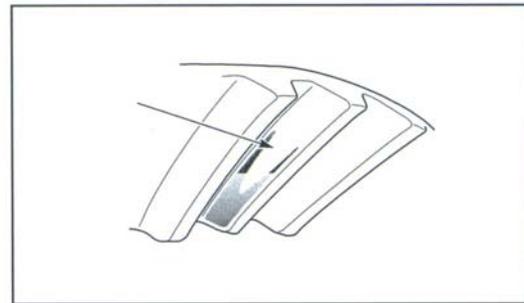
The pattern could vary in length and should cover 1/2 tooth or more (face width). The pattern should be evenly centered between tooth top land and root and should be up off the tooth toe.



▪ Used Gearing - Correct Pattern

Used gearing will not usually display the square, even contact pattern found in new gear sets. The gear will normally have a "pocket" at the heel end of the gear tooth. The more use a gear has had, the more the line becomes the dominant characteristic of the pattern.

Adjust used gear sets to display the same contact pattern observed before disassembly. A correct pattern is up off the toe and centers evenly along the face width between the top land and root. Otherwise, the length and shape of the pattern are highly variable and is considered acceptable as long as it does not run off the tooth at any point.



1. Pattern along the face width could be longer.

▪ Adjust Contact Pattern

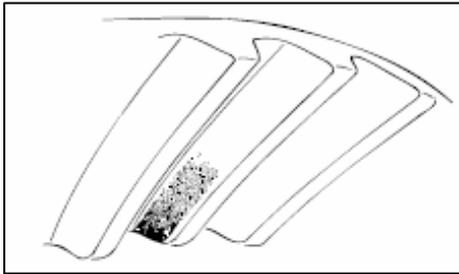
If necessary, adjust the contact pattern by moving the ring gear.

- Ring gear position controls the backlash. This adjustment also moves the contact pattern along the face width of the gear tooth.

▪ Adjust Ring Gear Position (Backlash)

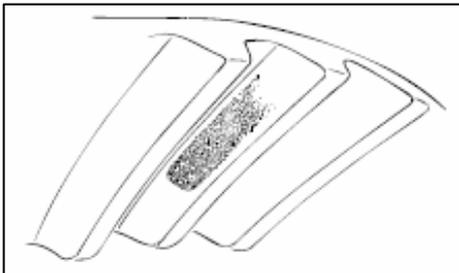
If the gear pattern shows incorrect face width contact, change backlash by adjusting the ring gear.

If the pattern is too close to the edge of the tooth toe, move the ring gear away from the pinion to increase backlash.



1. Loosen the bearing adjuster on the flange side of the ring gear several notches.
2. Tighten the opposite adjuster one notch
3. Return to adjuster on flange side of ring gear and tighten adjuster until it contacts the bearing cup.
4. Continue tightening the same adjuster two or three notches and recheck backlash.

If the pattern is concentrated at the heel (too far up the tooth), move the ring gear toward the pinion to decrease backlash.



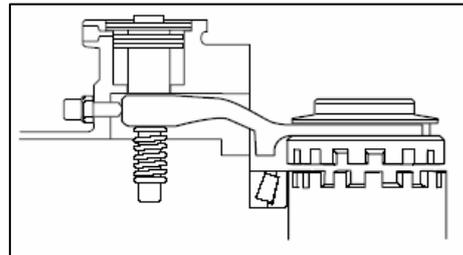
1. Loosen the bearing adjuster on the teeth side of the ring gear several notches.
2. Tighten the opposite adjuster one notch
3. Return to adjuster on teeth side of ring gear and tighten adjuster until it contacts the bearing cup.
4. Continue tightening the same adjuster two or three notches and recheck backlash.

7. WHEEL DIFFERENTIAL LOCK

▪ Install and Adjust Wheel Differential Lock

NOTE: With differential carrier completely assembled and adjusted, install differential lock as follows:

1. If shift fork and sliding clutch are disassembled, engage fork with the clutch hub and install roll pin in the fork leg. See illustration below for fork mounting position on clutch.
2. Position compression spring, shift fork and clutch in shift opening of the carrier. Align pilot hole of shift fork with the pilot hole of carrier
3. Install pushrod through shift fork, compression spring and carrier pilot hole



4. Lubricate piston and o-ring with Lubriplate No. 110. Install shift piston assembly into cylinder. Position piston with small diameter hub toward closed end of cylinder.
5. Install piston cover o-ring.
6. Install piston cover and tighten according with torque chart
7. Install selector switch and and tighten according with torque chart
8. Check selector switch operation. Check switch electrically with an ohm meter. Switch should be closed when clutches are engaged and open when disengaged.

▪ Theory of Operation

The Dana Wheel Differential Lock is an optional feature for Dana Axles. In operation, it positively locks the wheel differential, to provide improved traction under adverse road conditions.

The differential lock is driver-controlled through an electric switch or air valve mounted in the cab. The locking mechanism is air-operated to engage a mechanical clutch and lock the wheel differential. It is spring-operated to disengage the lock and permit the wheel differential to function normally.

The wheel differential lock consists of three major assemblies:

- **Shift Cylinder Assembly:** Operates a shift fork and push rod assembly.
- **Shift Fork and Push Rod Assembly:** Engages and disengages the differential lock curvic clutch assembly.
- **Curvic Clutch Assembly:** Consists of a sliding clutch splined to an axle shaft and a fixed clutch which is splined to the differential case hub.

The differential lock also includes a selector switch (electric) which senses clutch engagement and sends an electrical signal to a cab mounted indicator light (or an audible signal device).

Differential Lock Engaged

Air pressure applied to the shift cylinder moves the piston, push rod, shift fork and the sliding curvic clutch engages the fixed curvic clutch. The sliding clutch is splined to the axle shaft. The fixed clutch is splined to the differential case hub. Engaging the two clutches locks the wheel differential thus preventing wheel differential action.

Differential Lock Disengaged

When air pressure at the shift cylinder is released, a compression spring (mounted on the push rod) moves the push rod, shift fork and sliding clutch as an assembly. The sliding clutch moves out of engagement with the fixed clutch. The wheel differential is unlocked and operates normally.

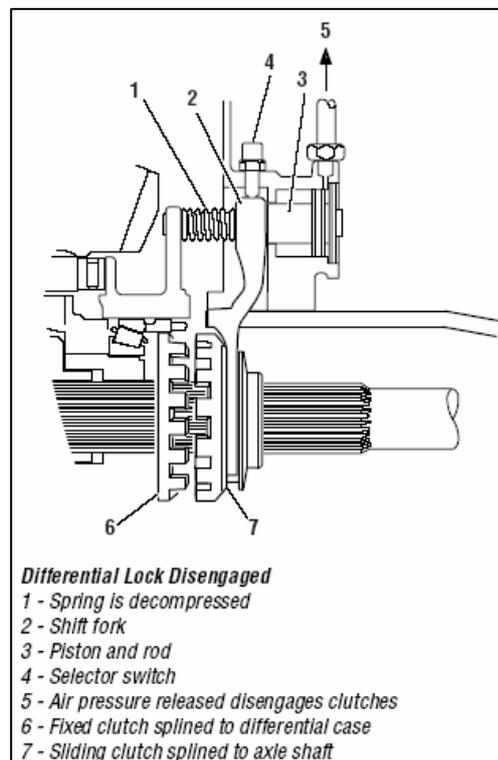
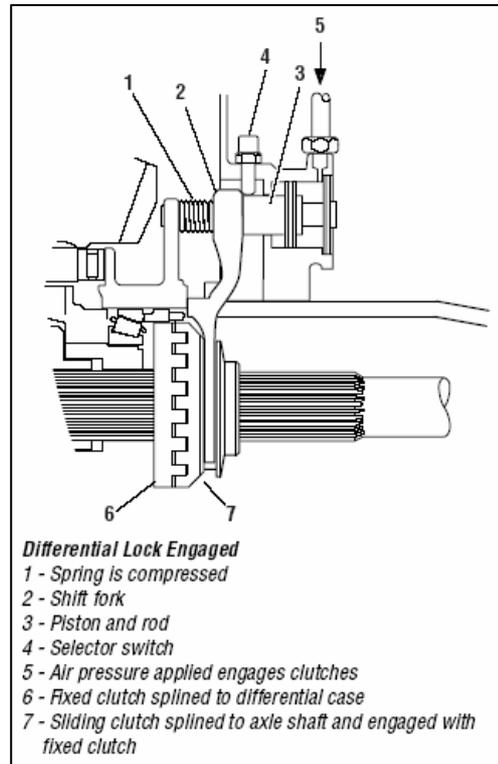
Differential Lock Engagement Indicator

Differential lock engagement is detected by a switch (electric) mounted on the differential carrier.

When the shift fork moves to engage the differential lock, the push rod actuator moves away from the switch, allows the switch to close and send an electrical signal to turn on a cab-mounted indicator light (or an audible signal).

When the shift fork moves to disengage the differential lock, the compression spring also moves the push rod actuator to contact the switch. The switch is opened and turns off the

cab-mounted indicator light (or the audible signal).





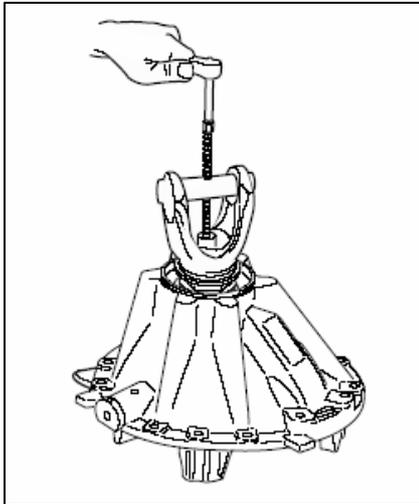
8. SEAL - REPLACE

▪ Replace Seal

Dana strongly recommends using seal drivers when installing new seals. Use the proper driver to make sure that the seal is square and installed to the proper depth.

CAUTION: Oil seals can be easily damaged prior to installation. Use care when handling the new seal to prevent damage or contamination. Leave the seal in its package until installation. On new yokes, leave the protector on the yoke until it is installed on the shaft to prevent damage or contamination.

1. Remove the old yoke using appropriate tool. A yoke puller tool may be made from the centre section of most gear puller tools, or may be purchased from your local tool distributor.



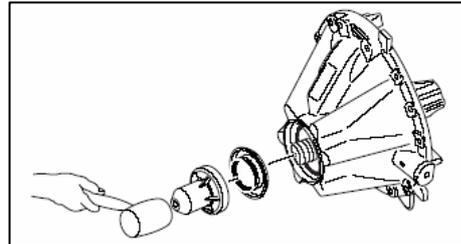
2. Remove seal. Use care when removing the old seal to prevent damage to the housing seal bore.
3. Inspect the seal bore area for any damage (nicks, gouges, corrosion). Carefully remove any slight damage with a crocus cloth. Clean the bore area to remove any loose debris.
4. Remove the new seal from its package and install with the proper driver:

R - Pinion Driver - 210749
R - Pinion Insert - 131472



WARNING: Due to the resiliency of the plastic driver, hammer rebound may occur when the seal is seated. Keep clear of the hammer rebound path!

5. Handle the seal by its outside diameter avoiding any contact with the seal lips. During installation, use the proper driver to make sure that the seal is mounted properly.
6. Use a rubber mallet to drive the seal tool in until the flange bottoms on the housing cover bore face. The flange will locate the seal at the proper depth.
7. Apply **Loctite#518** in seal outer diameter.



Guidelines for Reusing Yoke



CAUTION: Do not use the yoke if it has any damage on the seal surface (nicks or scratches).

The surface of the yoke and the lips of the seal form a critical interface which retains the axle's lubricant while sealing the axle from outside contaminants. The condition of the yoke hub's surface is a very important factor in determining seal life.

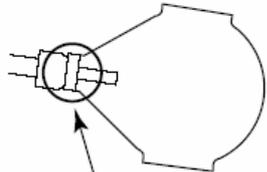
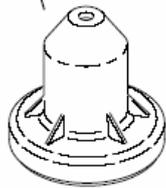
Carefully inspect the seal surface area of the yoke hub for signs of wear and damage. Do not reuse the yoke if there is noticeable wear, such as heavy grooving, beyond normal polishing from the seal lips.

NOTE: Do not rework the yoke with abrasives such as emery paper or crocus cloth. Clean the surface of the yoke as necessary using chemical cleaners. Remove all trace of the chemicals from the yoke after cleaning.



CAUTION: Do not use wear sleeves. Wear sleeves increase the yoke hub surface diameter and cause premature seal wear and repeat seal failure.

- Service Kit

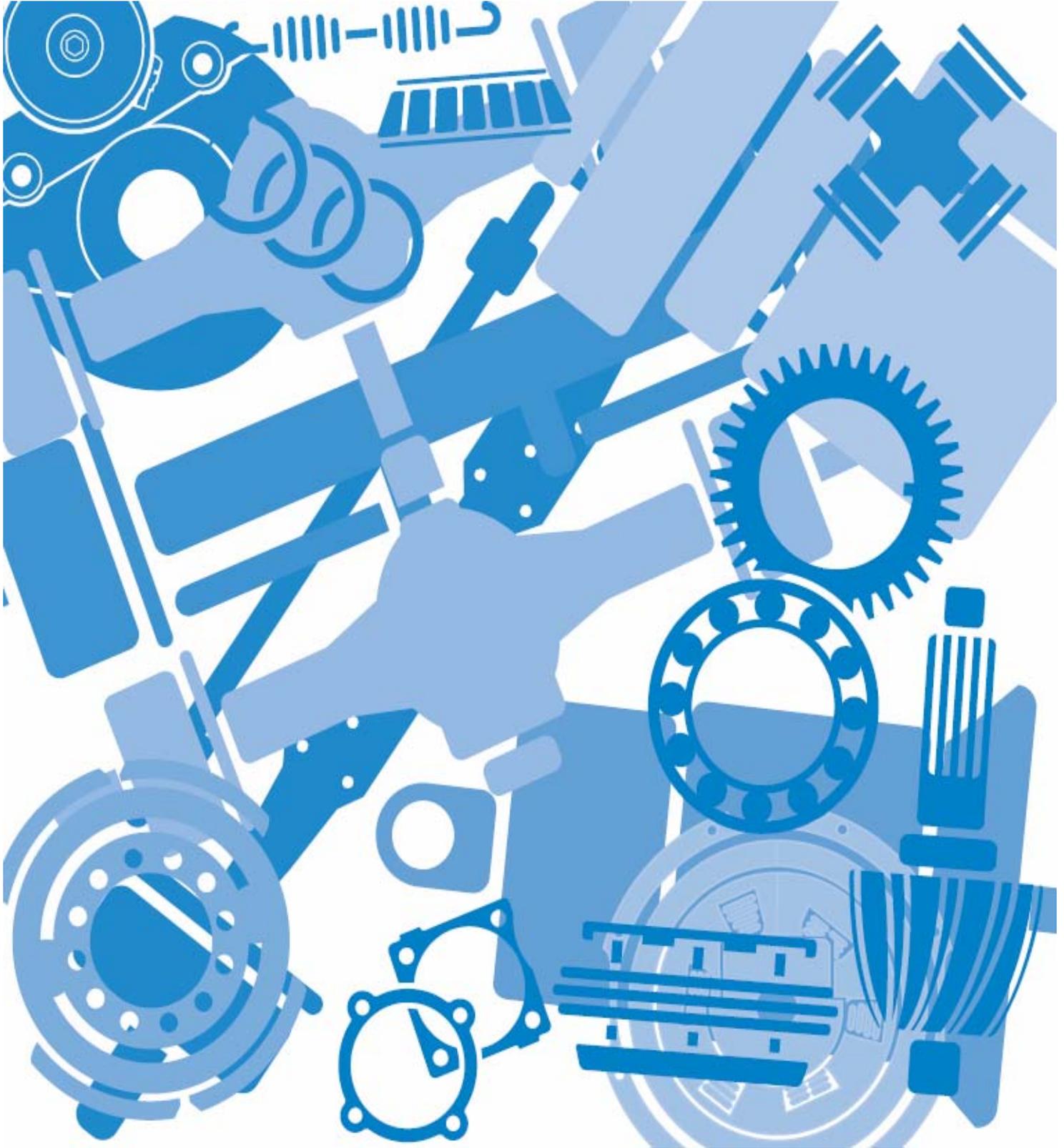
	R-Pinion
Location	
Tool	 210749  131472



TORQUE CHART

FASTENER TORQUE SPECIFICATIONS

Location	Size	Lbs. Ft.	Nm
WHEEL DIFFERENTIAL AND GEARING			
Drive Pinion Nut	M48 x 1.5	900 ± 100	1220 ± 135
Ring Gear, Diff. Case Bolts	M20 x 1.5 x 55	500 ± 25	675 ± 30
CARRIER			
Carrier Diff. Bearing Cap	M18 x 1.5 x 85	265 ± 15	360 ± 20
Carrier to Housing Capscrews	M16 x 1.5 x 85	250 ± 15	335 ± 20
	M16 x 1.5 x 55	250 ± 15	335 ± 20
Carrier to Housing Nuts	M16 x 1.5	250 ± 15	335 ± 20
Pilot Bearing Web	M16 x 1.5 x 70	210 ± 10	285 ± 15
Differential Lock Switch	M14 x 1.5	11 ± 2	15 ± 3
Differential Lock End Cap	2.375 - 16 UN - 2A	65 ± 10	85 ± 15



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Capability ratings, features and specifications vary depending upon the model type of service. Applications approvals must be obtained from Dana Spicer Europe Limited. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.

People Finding A Better Way[®]

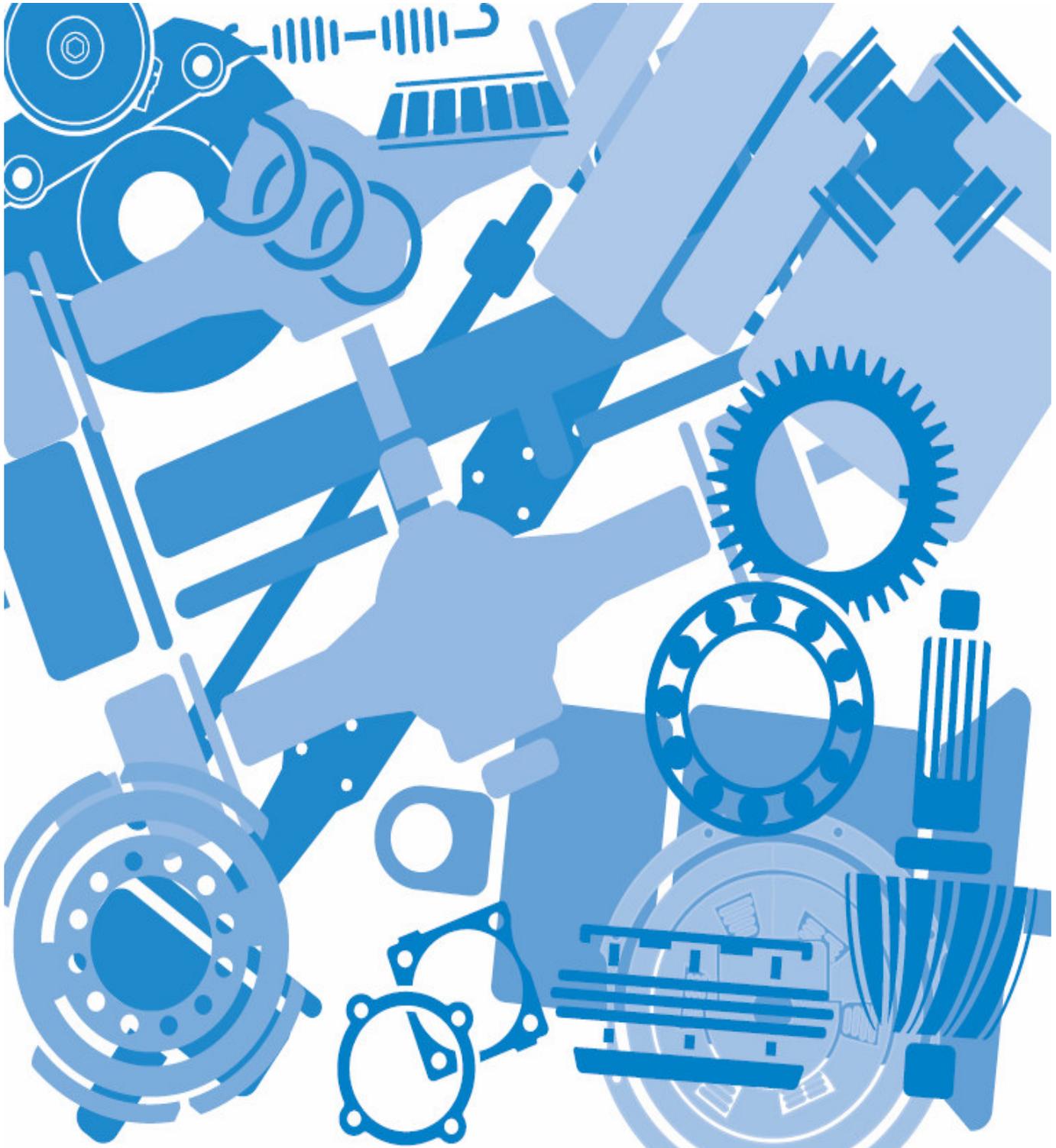
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SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



People Finding A Better Way®

SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



Last Modification	Date	Approved by	Date	Level	Reference	Eng. Change
O. Maraña	13.02.06	V. Badiola	14.02.06	A	613508	NC 06657
O. Maraña	21.04.06	V. Badiola	26.04.06	B	613508	NC 06755
O. Maraña	27.04.06	V. Badiola	27.04.06	C	613508	NC 06763
I.Ezpeleta	08.06.06	V. Badiola	22.06.06	D	613508	NC 06823

SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



Non Unitized Wheel End Adjustment

1. Identify the wheel nut system being installed. Three systems are available:
 - Three piece Dowel-type wheel nut system - Fig. 1
 - Three piece Tang-type wheel nut system - Fig. 2
 - Four piece Tang/Dowel-type wheel nut system - Fig. 3



WARNING: Do not mix spindle nuts and lock washers from different systems. Mixing spindle nuts and lock washers can cause wheel separation.

NOTE: The lock washer for a four piece tang/dowel-type wheel nut system is thinner than the lock washer for a three piece tang-type wheel nut system and is not designed to bear against the inner nut.

2. Inspect the spindle and nut threads for corrosion and clean thoroughly or replace as required.

NOTE: Proper assembly and adjustment is not possible if the spindle or nut threads are corroded.

- Inspect the tang-type washer (if used). Replace the washer if the tangs are broken, cracked, or damaged.

3. Install the hub and drum on the spindle with care to prevent damage or distortion to the wheel seal.



CAUTION: A wheel dolly is recommended during installation to make sure that the wheel seal is not damaged by the weight of the hub and drum. Never support the hub on the spindle with just the inner bearing and seal. This can damage the seal and cause premature failure.

- Completely fill the hub cavity between the inner and outer bearing races with the same lubricant used in the axle sump.

NOTE: Lubricate only with **clean** axle lubricant of the same type used in the axle sump. Do not pack the bearings with grease before installation. Grease will prevent the proper circulation of axle lubricant and may cause wheel seal failure.

4. Install the outer bearing on the spindle.
 - Install the inner nut on the spindle.
 - Tighten the inner nut to 200 lbs-ft. (271 N•m) while rotating the wheel hub.

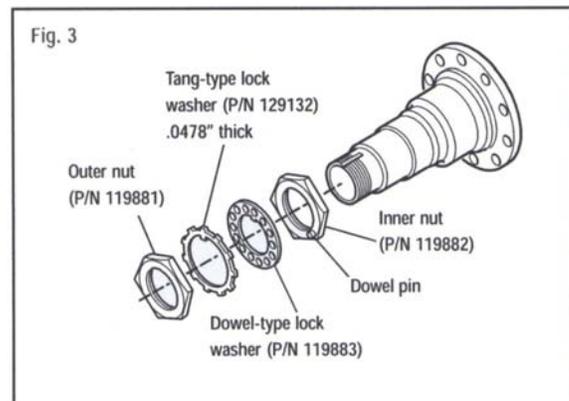
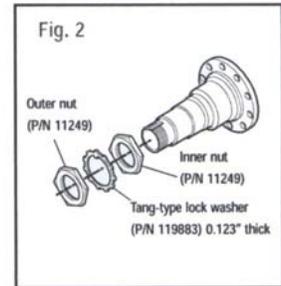
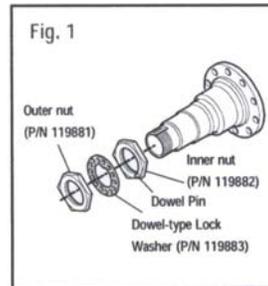


CAUTION: Never use an impact wrench to adjust wheel bearings. A torque wrench is required to assure that the nuts are properly tightened.

5. Back-off the inner nut one full turn. Rotate the wheel hub.
6. Re-tighten the inner nut to 100 lbs-ft. (135 N•m) while rotating the wheel hub.
7. Back-off the inner nut 45° to 60° of a full turn.

NOTE: This adjustment procedure allows the wheel to rotate freely with 0.001" - 0.005" (0.025 mm - 0.127 mm) end play.

8. Install the correct lock washer for the wheel nut system being used.



SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



Three Piece Dowel-Type Lock Washer System (Fig. 1)

- Install the dowel-type lock washer on the spindle.

NOTE: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, **loosen** the inner nut just enough for alignment.



IMPORTANT: Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- Install the outer nut on the spindle and tighten to 350 lbs-ft. (475 N•m).
- Verify end-play (see End Play Verification Procedure).
- Go to Step 9.

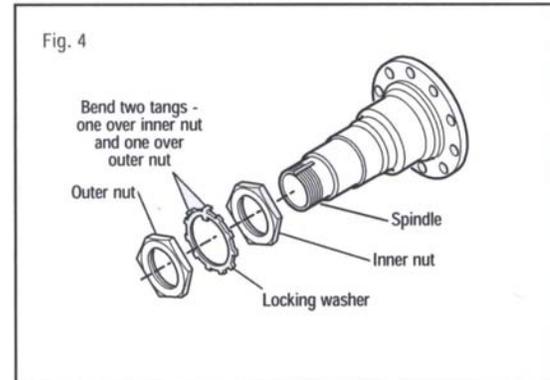
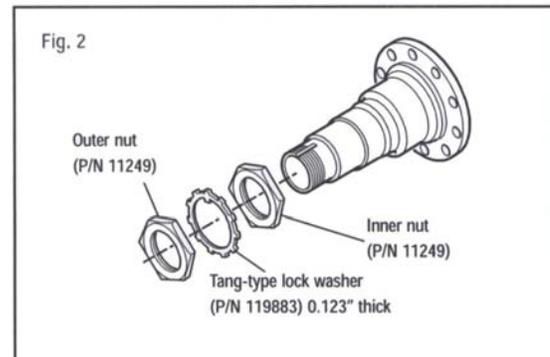
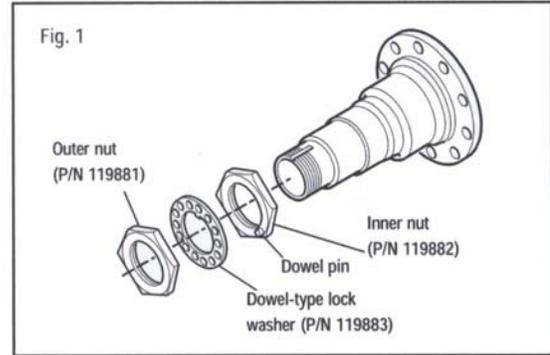
Three Piece Tang-Type Lock Washer System (Fig. 2 and 4)

- Install the tang-type lock washer on the spindle.



IMPORTANT: Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- Install the outer nut on the spindle and tighten to 250 lbs-ft. (339 N•m).
- Verify end-play (see End Play Verification Procedure).
- After verifying end play, secure wheel nuts by bending one of the locking washer tangs over the outer wheel nut and another tang over the inner wheel nut as shown in Fig. 4.
- Go to Step 9.



SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



Four Piece Tang/Dowel-Type Lock Washer System (Fig. 3 and 5)

- First, install the dowel-type lock washer on the spindle.

NOTE: If the dowel pin and washer are not aligned, remove washer, turn it over and reinstall. If required, **loosen** the inner nut just enough for alignment.



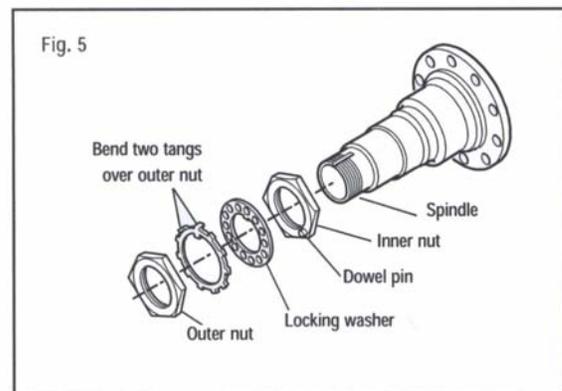
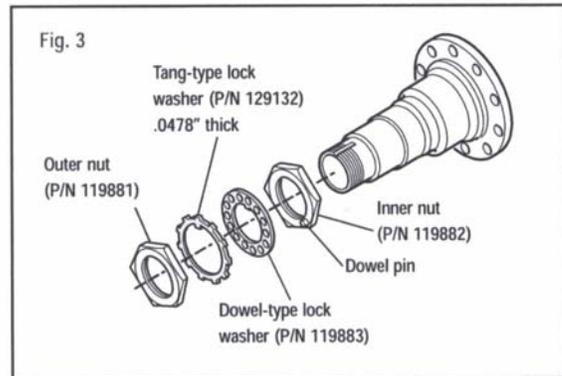
IMPORTANT: Never tighten the inner nut for alignment. This can preload the bearing and cause premature failure.

- Install the Tang-type lock washer on the spindle.
- Install the outer nut on the spindle and tighten to 250 lbs-ft. (339 N•m).
- Verify end-play (see End Play Verification Procedure).
- After verifying end play, secure outer nut by bending two opposing (180° apart) tangs of the locking washer over the outer nut as shown in Fig. 5.

9. Install:

- New gasket or sealant at axle shaft flange
- Axle shaft
- Axle flange nuts and tighten to specified torque. See fastener torque specifications on Torque Chart.

10. Lubricate axle wheel ends (see Wheel End Lubrication Procedure).

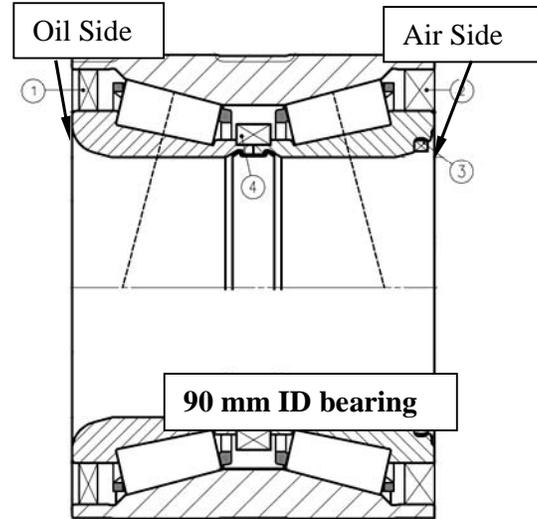
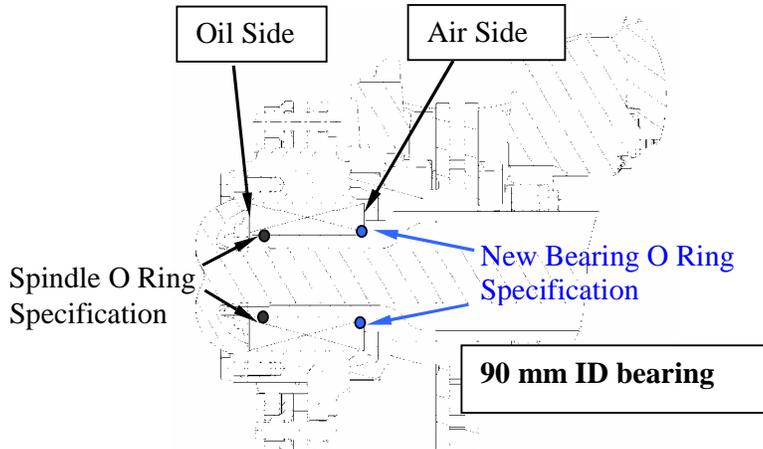


SERVICE MANUAL - WHEEL ENDS Single Drive Axles



Unitized Bearing Wheel End Adjustment

1. Make sure that all parts are clean before the assembly process.
2. Place the bearing against the hub. With the 90mm ID bearing identify the correct orientation as shown on the diagrams. **NOTE:** There is no bearing orientation on the other bearing sizes.



CAUTION: Incorrect orientation of the 90mm ID bearing may cause oil leakage.

3. Fit Unitised Bearing into the hub by using a press, (necessary force is between 29 and 43 kN), until bearing faces hub inner diameter shoulder. Keep pressing until reaching 80 kN of axial force. For assembly or disassembly, press only the outer cone using the proper tool. (See picture and chart).

CAUTION: Never press the inner cone as this could cause damage to the bearing.

4. Fit the Rotor to the Hub (see below bolt chart).

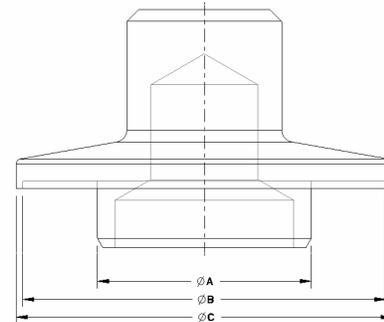
Bolt	Standard	Max. Torque (Nm)	Min. Torque (Nm)
M12 x 1.5	Din-En-Iso-4762	120	107
M12 x 1.75	Une-En-1662	132	117
M14 x 1.5	Une-En-1662	216	193
M16 x 1.5	Din-En-Iso-4762	305	273

NOTE: Din-En-Iso-4762 are Allen and Une-En-1662 are exagonal flanged bolts, 10.9, 6g, phosphated.

5. Fit "O-ring" on spindle.

CAUTION: Do not fit this "O ring" on the spindle with 90mm ID bearing axles because the "O ring" is already included into the bearing.

6. Apply anticorrosive grease onto the Spindle bearing diameter. Grease shall be applied between spindle O-ring and bearing shoulder area. In case of 90mm ID bearing, apply grease in all bearing contact race.
 - Optimol past T White (Castrol), (Ref. 613402).
 - Molycote TP 42 (Dow Corning)
 - Altemp Q NB 50 (Klüber)
 - Nomydol VI 1200 BF (Reiner/Fuchs)



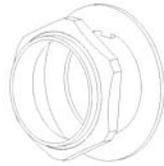
Tool	Dia A	Dia B	Dia C
67 Bearing	66.9 – 66.7	108.5	112
78 Bearing	77,9 - 77,7	122.5	128
82 Bearing	81,9 - 81,7	131,5	138
90 Bearing	89,9 - 89,7	152,5	158

SERVICE MANUAL - WHEEL ENDS

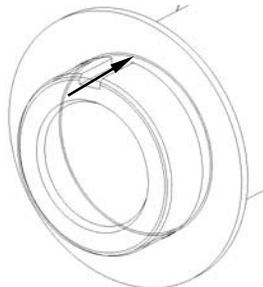
Single Drive Axles



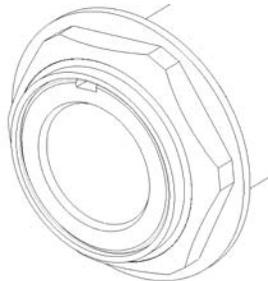
- Fit the Rotor & Hub Set onto the Spindle.
- Design corresponding to Staked Nut + Tang Washer.



- Assemble tang washer onto the spindle guided by the key way.



- Assemble new spindle nut and tighten it to initial torque as follows:

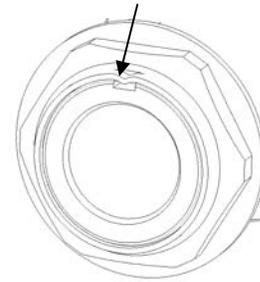


NUT SIZE	MAX. TORQUE (Nm)	MIN. TORQUE (Nm)
M58 x 1.5	120	109
M75 x 1.5	175	159
M86 x 2.0	250	225

- Spin Rotor & Hub set 10 revolutions.
- Tighten nut up to final torque values showed in the chart below:

NUT SIZE	FINAL TORQUE (Nm)	AXIAL FORCE (ton)
M58 x 1.5	435-480	5 – 6 T
M75 x 1.5	635-700	7 – 8 T
M86 x 2.0	900 - 1000	9 – 10 T

- Using a suitable chisel or punch stake the nut into the key way as indicated below.



- Apply loctite 518 between the axle shafts and the Hubs. Fit the axle shafts, (see Torque Chart below)

BOLT	MAX. TORQUE (Nm)	MIN. TORQUE (Nm)
M12x1.75	136	124
M16x2	346	314

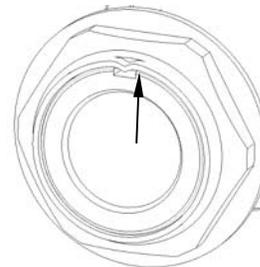
NOTE: Verbus Ripp, 10.9, 6g, phosphated.

- Fit the Brake Caliper to the Axle, (see Torque Chart below)

BOLT	STANDARD	MAX. TORQUE (Nm)	MIN. TORQUE (Nm)
M14 x 1.5	Une-En-1662	216	193
M16 x 1.5	Une-En-1662	328	293
M18 x 1.5	Une-En-1662	474	423
M20 x 2	Une-En-1662	665	593

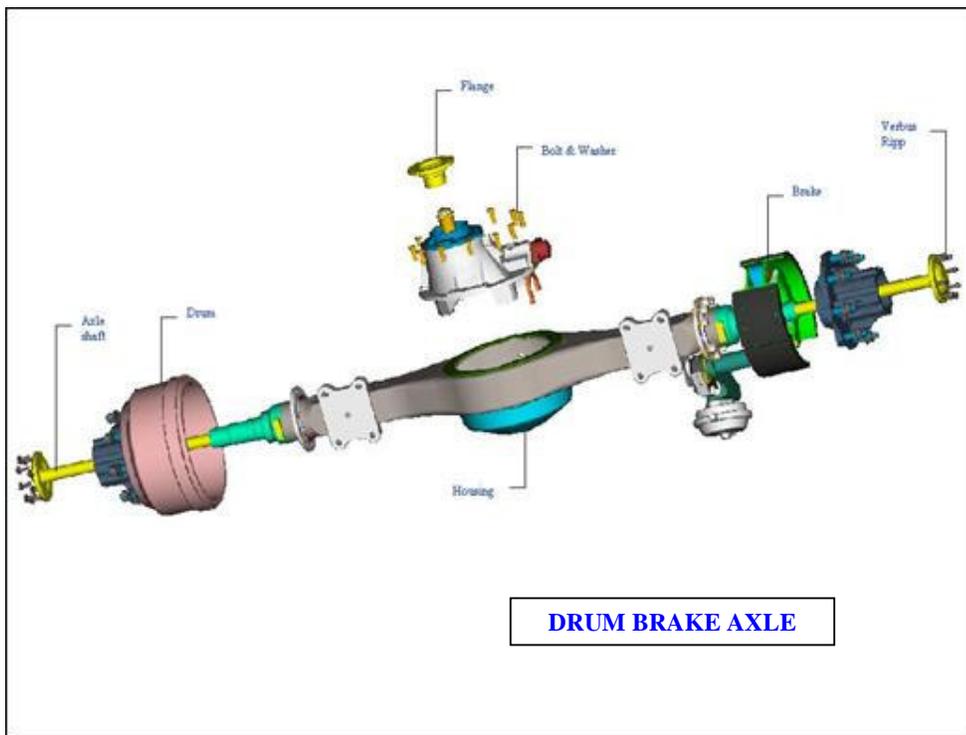
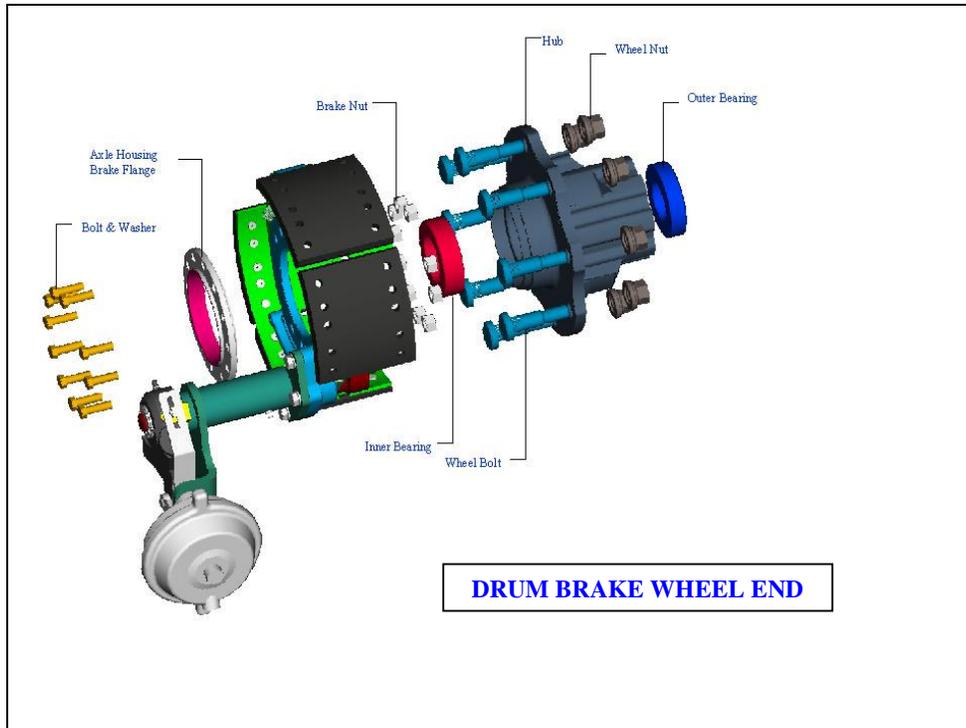
NOTE: Une-En-1662 are exagonal flanged bolts, 10.9, 6g, phosphated.

CAUTION: When disassembling bend out the staked area of the nut fully so as not to damage the threads when removing the nut.



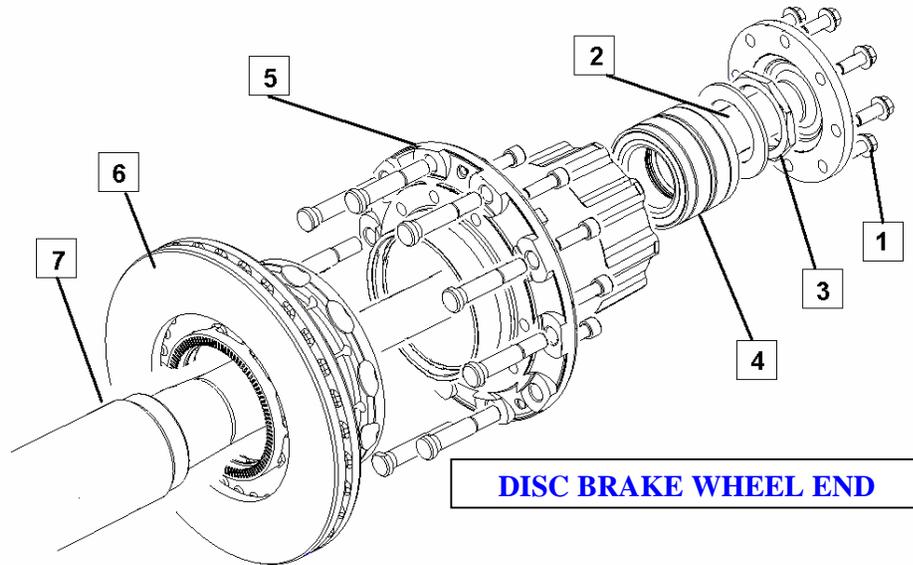
SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



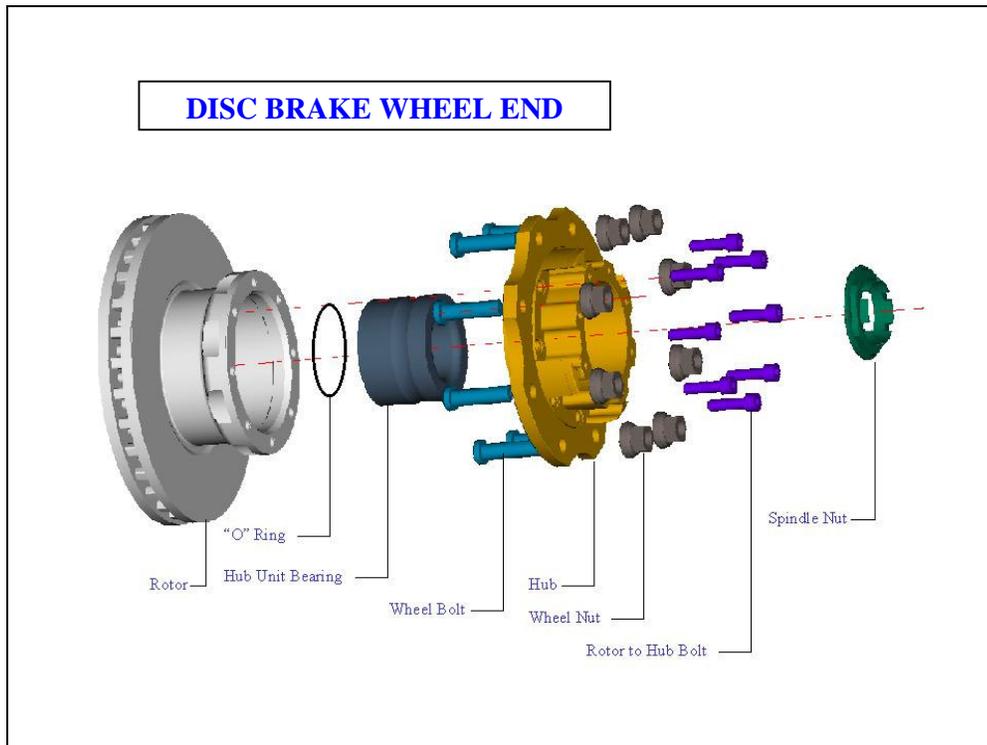
SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



DISC BRAKE WHEEL END

Disc Brake Wheel End - Superseal 90 mm ID bearing

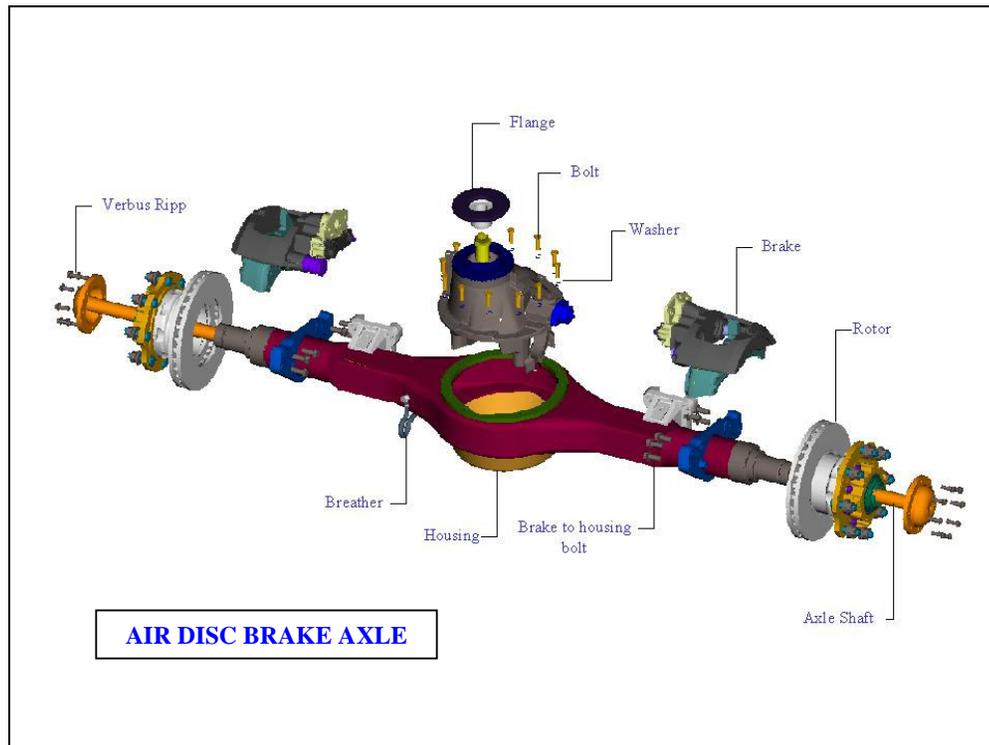


DISC BRAKE WHEEL END

Disc Brake Wheel End: Non-Superseal (other unitted bearings)

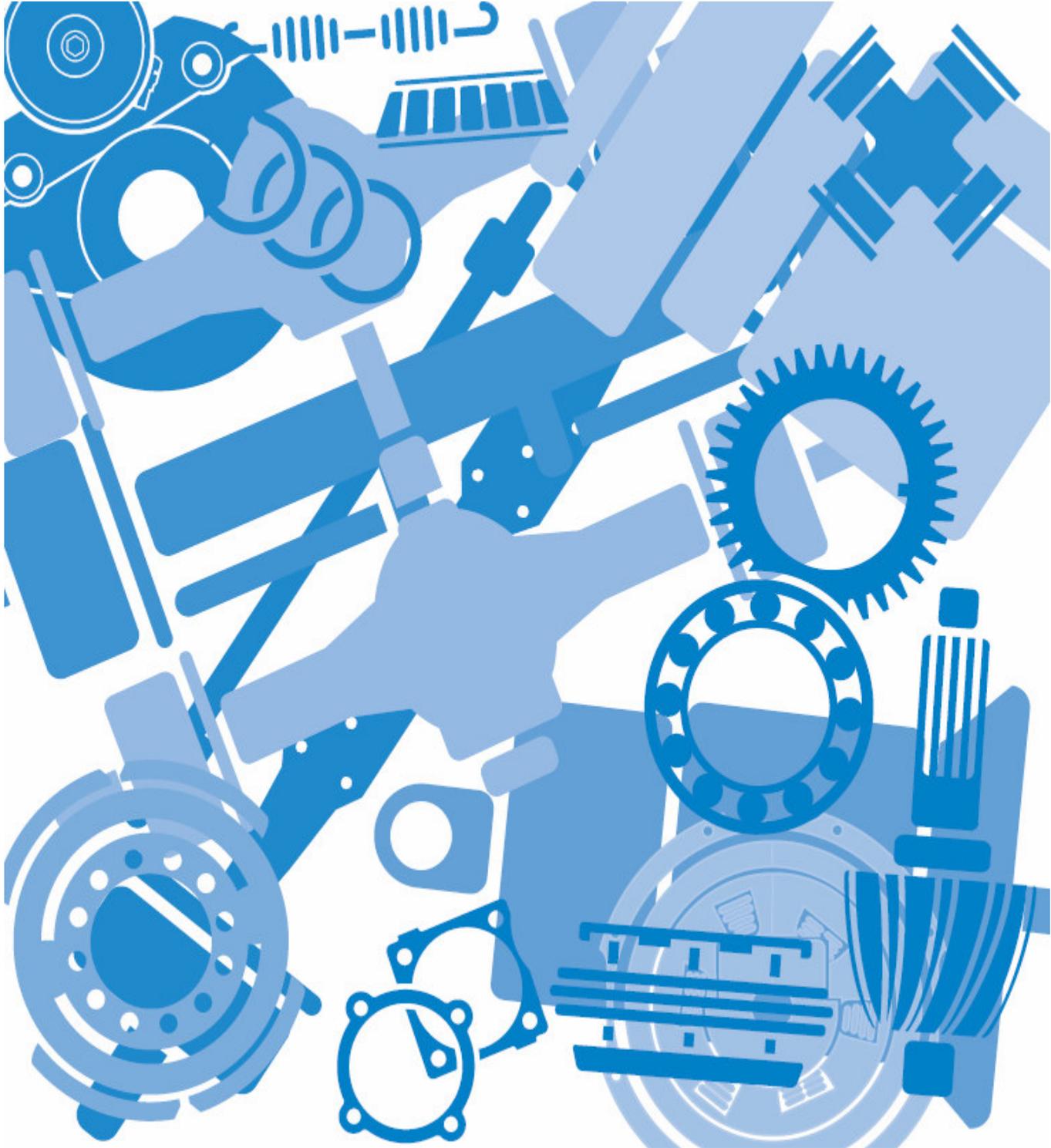
SERVICE MANUAL - WHEEL ENDS

Single Drive Axles



SERVICE MANUAL - WHEEL ENDS

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