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Indian Railways

WAG9 Locomotive

31000 – 31021

Maintenance and Repair Manual

D-1

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22			1		C	3EHW411420	12.2001	Roof line	D1	3.2	28		
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Preface

Introduction

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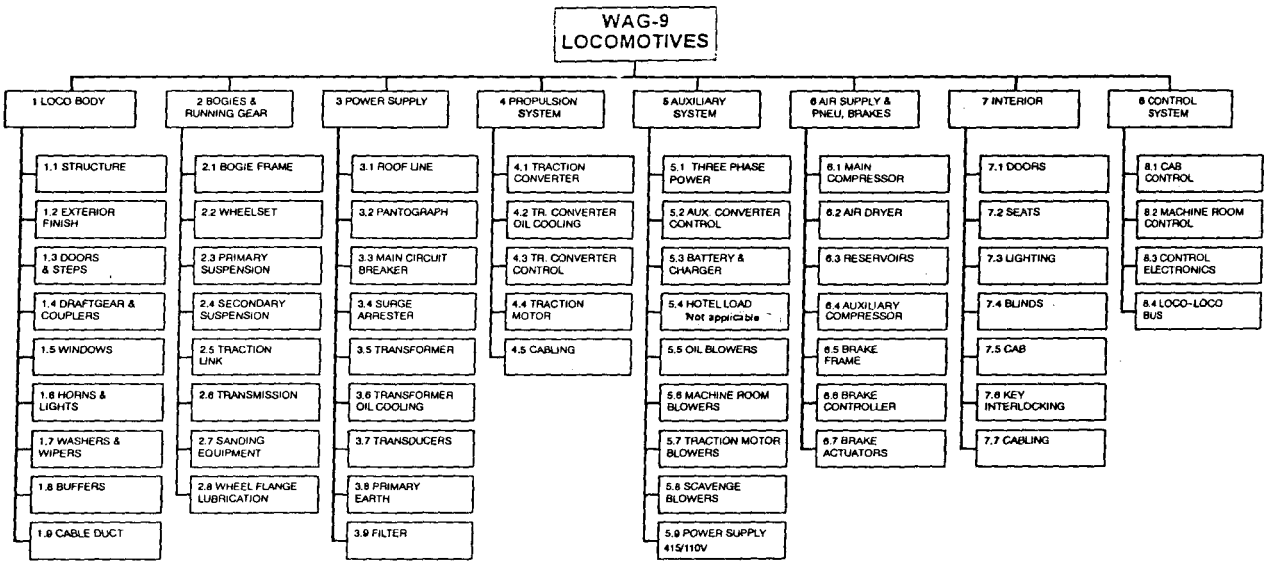
These Maintenance & Repair Manuals of technical documentation for the Indian Railways WAG-9 locomotives are divided into Chapters; each of which contains information pertinent to a specific area of the locomotive. The Chapter numbers correspond to the Breakdown Structure of the Locomotive (GAPL), shown on the inside front cover of this binder. The same delineation of Chapters is used throughout the technical documentation for the WAG-9 locomotives.

Information in each Chapter is divided into various Sections which describe the locomotive equipment and procedures required for maintenance. See Section Description, as follows.

The Maintenance & Repair Manuals span more than one binder. For ease of identification, each Volume is labelled on its spine and front cover, indicating the Volume and binder number, and the Chapters contained within.



Section Description

Section **Group Summary** describes the equipment covered by the Chapter. Figures show the various components and a legend beneath identifies the items.

Section **Functional Description** explains the function that the equipment performs on the locomotive.

Section **Technical Data** contains technical information and specifications on the equipment covered in the chapter. The information varies according to the type of equipment. In some instances, specifications for equipment may be located in the appropriate chapter of Volume F, Suppliers Documentation.

Section **Tolerances and Wear Limits List** contains information regarding the allowable in service wear or tolerance specifications for the equipment covered in the chapter. In some instances the service tolerances for equipment may be located in the appropriate chapter of Volume F, Suppliers Documentation.

Section **Tools & Special Tools** provides information of any non-standard tools and apparatus that are required to undertake the procedures described in the chapter. Throughout this documentation it is assumed that conventional railways workshop tools and equipment are available. As such, these items are not listed.

Section **Miscellaneous Materials** lists the materials required for the operations described in this chapter. Materials needed for the procedures in the chapter, such as sealants, thread locking agents, oil binding agents, solvents, cleaners and alike are listed in this section. It is assumed that normal workshop consumables and materials are available. As such, these items are not listed.

Section **Before Removal Operations** provides a list of procedures necessary prior to the removal of the equipment described in the chapter.

Many before removals operations require procedures described in other chapters or documents. The necessary references are given, see References.

Some before removals operations require isolation of other equipment. Details are provided as necessary, along with appropriate references. Isolation of equipment must always be carried out in accordance with the prevailing workshop safety regulations. Any equipment that is isolated as part of the before removals operations must be reconnected after the work is completed and the associated equipment tested to ensure it functions correctly.

Section **Removal** describes the procedures for removal of the entire equipment assemblies from the locomotive. Some equipment can be serviced in situ:-it may not be necessary to remove the entire assembly from the locomotive. See Scope of Work.

Section **Disassembly** describes procedures for the disassembly of equipment; generally once it is removed from the locomotive. However, some equipment can be serviced in situ. See Scope of Work.

Section **Inspection and Repair** describes how to inspect equipment for wear, defects or damage. Where appropriate, repairs may also be described in this section. In some instances, details of inspection and/or repair are given in Volume F, Suppliers Documentation. In such cases, the appropriate Volume and Chapter of Volume F is given in this Section, see References. Some equipment cannot be repaired. These items are replaced as an assembly, if unserviceable.

Section **Waste Disposal** provides information regarding special disposal requirements for particular items due to their composition or contents.

Section **Assembly** describes procedures for reassembly of equipment.

Section **Installation** describes the procedures for the reinstallation of entire equipment assemblies to the locomotive.

Section **After Installation Operations** provides a list of procedures necessary after reinstalling equipment to the locomotive.

Any equipment that is isolated or disconnected as part of the before removals operations must be reconnected and tested.

Section **Adjustments** describes any adjustments that are required for the equipment covered in the chapter.

Associated Volumes

Volume A:	Driver's Manual
Volume B:	Scheduled Maintenance Manual
Volume C:	Fault Finding
Volume E:	Spare Parts Catalogue
Volume F:	Suppliers Documentation
Volume G:	Cable Schematics

Repair Competencies

The procedures in this manual expect the user to have the appropriate competencies and skills. The scope of work associated with the procedures described should only be carried out by suitably qualified and properly trained railway engineers. Personnel must have an ap-

propriate level of technical and engineering understanding before undertaking any operations on the locomotive. This manual describes the technical procedures required to service and maintain the specifics of the WAG-9 series locomotives, not general locomotive engineering practices. Workshop procedures and practices are not covered within these instructions.

Scope of Work

Due to the complex nature of locomotive engineering, every instance in which equipment can be removed or installed cannot be taken into consideration in these Volumes.

Some equipment can be serviced in situ:-it may not be necessary to remove the entire assembly from the locomotive. For example, the valve sets can be removed from the traction converter without removing the traction converter from the locomotive. Before undertaking any work on the locomotive, the entire chapter must be read, and the user acquainted with all aspects of the procedures. The scope of work is then to be established.

General Information

Throughout this preface, the term 'equipment' refers to the components and systems that comprise the locomotive.

All figures in these volumes are graphical representations intended as general illustrations to represent the situation. They may not be dimensionally or otherwise accurate. Figures should not be used for scaling. Only the items numbered in an illustration are referenced in the associated text passages. No additional information should be inferred from the figure.

Figures, photographs and drawings may appear pictorially different from the physical situation being represented. Extraneous components may not be shown in the illustration for clarity. Others may be shown redundantly to provide a frame of reference for the situation.

References

Maintenance, removal or installation of some equipment on the locomotive can require interaction with other components described in different chapters, or volumes. In these cases, a reference is given directing the user to the appropriate documentation. For example, "refer to Chapter 3, Primary Suspension" directs the user to another chapter in Volume D where the necessary procedures are described. References, such as, "refer to Chapter 5, Oil Blowers of Volume F10, Suppliers Documentation." direct the user to the appropriate volume and chapter of the Suppliers Documentation, Volume F. Or "refer to Section Actual value Detection, Sheet 12A, Catenary & Battery Voltage of Volume G1, Cabling Documentation" directs the user to the appropriate sheet in the locomotive schematics, Volume G.

Safety Information

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Workshop Safety

All employees must take care to avoid the risk of injury to themselves and others. Precautions and care should be taken in accordance with the prevailing workshop regulations.

Caution signs, stating personal working on locomotive, are to be located at both ends of the locomotive whenever any maintenance procedures are undertaken.

Before carrying out maintenance or repairs on the locomotive, make sure that the locomotive is safely parked with the parked brakes released. Chock wheels to prevent locomotive movement.

Many systems on the locomotives interact with other systems, eg. powering-up the auxiliary converters causes the blowers to start. Therefore, if the operation of any ancillary equipment could endanger the safety of any person, then the appropriate systems must be isolated.

Electrical Precautions

Where the scope of work requires the isolation of the overhead catenary, the overhead must be isolated in accordance with the prevailing workshop regulations, before any person works on high voltage equipment. Refer Electrical Isolation of the Locomotive.

Whenever working on the roof area, the locomotive must be shunted to a section track that contains no overhead catenary, and the traction converter must earthed. Refer Electrical Isolation of the locomotive.

Do not attempt to make repairs or adjustments in the control cubicles or drivers desk when power is on. Ensure that the battery supply is isolated.

110V binary signal trainlines are a potential electrical hazard. Before working on the systems connected to these sockets, ensure that the locomotive is electrically uncoupled at both ends, the locomotive is isolated and earthed at the main circuit breaker, and that the batteries are isolated.

Do not operate the controls of functional apparatus (eg. move contactors, actuators, relay or EP valves by hand, connect or disconnect wires, remove temporary packing or interface with pneumatic equipment) of a locomotive undergoing maintenance/testing, without first ensuring that there are no persons engaged in any work on, within or beneath that locomotive, who may be injured in any way by the operation.

Care should also be taken to ensure that capacitor systems on the locomotive have discharged prior to undertaking operations. The traction converters and the BUR cabinets contain capacitors. Voltage indicators on these cabinets warn of any residual voltage in the cabinet. Always ensure that indicator LEDs are flashing slower than once every 15 seconds. See Electrical Isolation of the Locomotive, Chapters 4.1, Traction Converter and 5.1, Auxiliary Three-Phase Power for more information on voltage indicators. The filter cubicle also contains capacitors, but these are automatically discharged whenever the main circuit breaker is opened.

The gases generated by a battery are highly flammable. Where a battery is found to be or suspected to be overheated, extreme caution should be taken to prevent ignition until the gases have been allowed to disperse. Keep flames, lighted cigarettes and welding operations away from batteries.

Electronics Precautions

Do not use a buzzer, bell, megger, or flash test equipment until all circuits which include semiconductor devices have been isolated. Ensure the manufacturers directions are followed whenever testing electrical and electronic devices. Special tools and testing procedures may be required.

Whenever working with electrical equipment, it is good practice to become familiar with the related schematics. Volume G, Cabling Documentation contains the electrical schematics for the locomotive. Always ensure that any removed wiring is reconnected correctly, as incorrect wiring can cause irreparable damage to equipment and incomprehensible error messages from the control electronics.

When electrical and electronic equipment is to be removed, all wiring should first be tagged before it is disconnected. This will aid in the correct reinstallation and reconnection of the equipment.

In many chapters, references are given to the appropriate Sheet in Volume G, Cabling Documentation. Otherwise, wiring should be reconnected as tagged during removal. The wiring and terminal numbers located on equipment are referenced in the electrical schematics in Volume G.

Cabinets and Equipment Cubicles

WARNING:

Extreme care must be taken when approaching equipment which has been live, and could remain live for a short period of time because of the delayed discharge time of capacitors.

The following systems have covering panels to prevent accidental contact with electrical systems.

- Control Cubicles (SB1, SB2)
- Auxiliary Cubicles (HB1, HB2)
- Filter Cubicle (FB)
- Traction Converters (SR1, SR2)
- Auxiliary Converters (BUR1, BUR2, BUR3)
- Driver's Desk, including Cubicle F and Panels A, B, C and D

These systems contain high-power AC systems connected to the main transformer and/or DC systems connected to the battery. Electrical systems must be isolated and earthed, and the capacitor systems discharged prior to removing any panels from these areas or working on any of these systems. See Electrical Precautions. Covers on the HB, FB, SR (traction converters) and BUR cabinets require keys from the key interlocking system for access. See Electrical Isolation of the Locomotive.

Handling Precautions

Most locomotive equipment is heavy. Generally, the weight of equipment is listed in Section Technical Data. Care must be taken to avoid personal injury or damage to adjacent equipment. Heavy items must be lifted in accordance with the prevailing workshop safety regulations using suitable lifting equipment. Such lifting equipment must be rated to carry the weight involved. Always ensure that the weight of the item to be lifted is known before commencing the procedure. For example, some equipment contains oil or other fluids, which may not be included in the listed weight for the equipment. Operate the lifting equipment in accordance with the manufacturers recommendations. Always ensure that the item to be lifted is transported in accordance with its manufacturers directions.

Fluids Precautions

When handling lubricants, sealants, paints, adhesives, cleaning fluids or similar, the local workshop regulations or the manufacturer's instructions must be strictly observed.

Ensure that appropriate cleaning materials and preparations are used whenever cleaning any equipment. Ensure the manufacturers documentation for the equipment is consulted prior to cleaning any equipment, as some cleaning agents and solvents may cause damage to some equipment.

Always observe the cleaning solvent manufacturer's instructions. Some solvents may be toxic or flammable.

Lubrication Precautions

Clean lubricating points before applying the recommended lubricant, and remove any excess after applying new lubricant.

Pneumatic Precautions

Before performing any operations on systems incorporating pneumatic components, ensure the locomotive pneumatic system is isolated and vented, as described in Chapter 6.3, Main Reservoirs.

Before operating any pneumatic cocks, check the direction in which any air may be vented and ensure that the blast of compressed air cannot cause injury or damage.

Before attempting to dismantle or remove any equipment that is connected to a compressed air system, isolate it from the air supply and exhaust all air from it and the associated system.

When blowing out pipes with compressed air, wear goggles and take care to avoid any openings from which the air may blow out, as blown particles can be harmful.

During brake testing involving application and release of the brakes, ensure that no other personnel are in positions where they could be endangered by the movement of the brake blocks, rigging etc. Warning signs must be located at both ends of the locomotive during brake testing or brake maintenance. If the brake system is isolated, warning indicators must also be in position at each end of the locomotive and on both driver's desks.

Welding Precautions

When welding operations are being carried out on a vehicle, the welding return lead shall be secured as near as possible to the point of welding. All electronic devices shall be individually grounded. The locomotive structure is a critically stressed unit, and welding should only be carried out to an Approved Welding Procedure by suitably qualified technicians.

Technical Information

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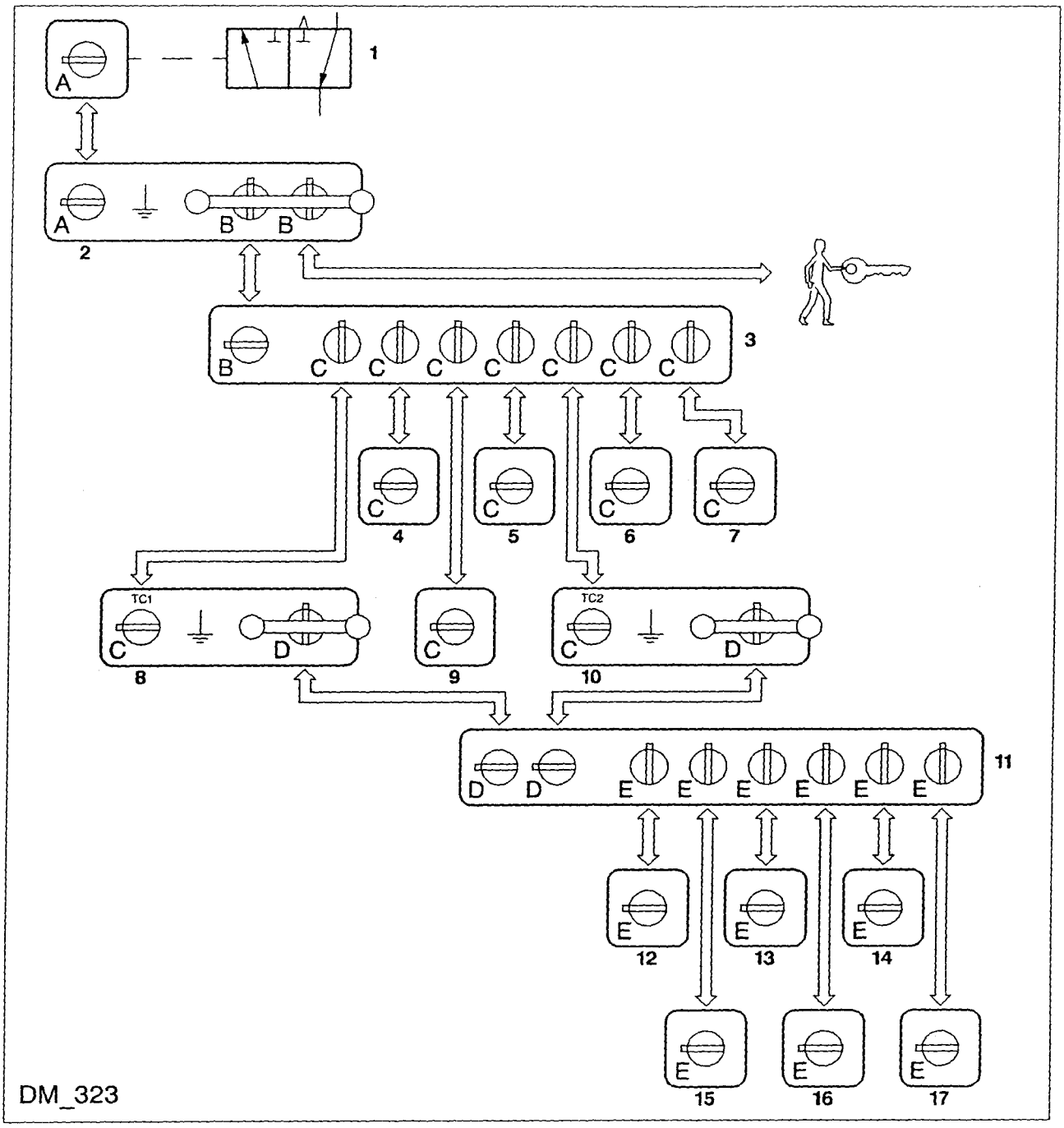
Electrical Isolation of the Locomotive



1	Pantograph air supply isolating cock	10	Earthing switch on traction converter 2
2	Earthing switch of main circuit breaker	11	Key multiplier 2
3	Key multiplier 1	12	Door lock, traction converter 1
4	Door lock auxiliary circuits, Block 1	13	Door lock, traction converter 1
5	Door lock auxiliary circuits, Block 2	14	Door lock, traction converter 1
6	Door lock auxiliary converter 1	15	Door lock, traction converter 2
7	Door lock auxiliary converter 2	16	Door lock, traction converter 2
8	Earthing switch on traction converter 1	17	Door lock, traction converter 2
9	Door lock on filter block		

When carrying out repairs or testing of electrical equipment (unless specifically authorised otherwise), the locomotive high voltage equipment must be isolated by using the Key Interlocking System. The key interlocking system isolates and earths various parts of the locomotive electrical system. The key interlocking system comprises five different key types; A, B, C, D and E. Each key type is coloured distinctly;

Key	Colour	Qty.	Location
A	Light Blue	1	Pantograph air supply isolating cock
B	Yellow	2	Main circuit breaker earthing switch
C	Green	7	Key Multiplier No. 1
D	Black	2	1 on each traction converter earthing switch
E	White	6	Key multiplier No. 2

The following steps describe how to earth and isolate the locomotive using the key interlocking system.

- Shut down the locomotive as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.
- Turn off the air supply to the pantographs by switching Key A on the air supply isolating cock, located on the brake frame (pneumatic panel). The air in the system will be exhausted, locking the pantograph in the lowered position.
- To release Keys B, insert and turn key A in the main circuit breaker Earthing Switch. A bolt will be released, unlocking the arm of the main circuit breaker. Move the arm to the EARTH position then turn and remove the Keys B.
- One Key B should be held by the maintenance supervisor. The other is used in the key multiplier No. 1 to release Keys C. The seven Keys C are used for:

- Unlocking the earthing switch on traction converter 1
- Unlocking the earthing switch on traction converter 2
- Opening the auxiliary circuit block 1
- Opening the auxiliary circuit block 2
- Opening the auxiliary converter 1
- Opening the auxiliary converter 2
- Opening the filter block

Move the battery isolating switch to the Off position, as required.

The Keys C are used to unlock the earthing switches on each traction converter. Before operating the traction converter earthing switches, ensure the master switch on the driver's desk is in the "0" position and that the "Control Circuits Locomotive" (112.1) cir-

cuit breaker is in the "OFF" position. Circuit breaker 112.1 is situated in SB2. Ensure that there is no fault message, "Fault DC_Link Discharge", on display terminal in the cabin, and the voltage indicator LED is OFF for at least 15 seconds. From the time the locomotive is powered down, it can take approximately 5 minutes to completely discharge the DC-Link capacitors. Always ensure that indicator LED is flashing slower than once every 15 seconds before earthing the traction converter.

- To release Keys D from the traction converter, insert and turn a Key C in the traction converter earthing switch. A bolt will be released, unlocking the traction converter earthing switch arm. Move the arm to the EARTH position then turn and remove the Key D from the traction converter. Repeat the procedure on the other traction converter.
- Once both of the Keys D have been removed from the traction converters, they are used to release Keys E from key multiplier No. 2, located in the machine room behind the cab. The six keys E are used unlock:

- Traction converter 1, door locks 1 - 3
- Traction converter 2, door locks 1 - 3

Steam Cleaning

Steam cleaning equipment uses high pressure, high temperature steam and cleaning preparations to blast dirt, debris and other built up deposits from surfaces. Care must be taken to ensure that the nozzle of the steam cleaning equipment does not spray onto persons or sensitive equipment, as severe damage may occur. Always operate steam cleaning equipment in accordance with the manufacturers recommendations.

Some equipment contains air vents for cooling and venting, such as the vents in the axle boxes and traction motors. Steam cleaning of such equipment must be performed in a careful and controlled manner to ensure that the cleaning jet is not directed into such vents. Refer to Chapter 2.6, Transmission.

Non-Destructive Testing & Inspection

Non-Destructive Testing (NDT) is required in many areas of locomotive maintenance and repair. There are many forms of NDT that can be used as an aid to identify cracks, holes, flaws or other discontinuities in components. This section outlines the basic principals of five forms of NDT: visual inspection, penetrant, ultrasonic, magnetic and radiographic.

Information given in this section is intended as a guide only and is in no way an exhaustive list of NDT procedures, operation or techniques. All non-destructive testing must be performed by a qualified operator and the resulting data must be interpreted by qualified personnel.

Visual Inspection

Visual inspection is usually the first form of testing or evaluation performed. Many defects, cracks and points of corrosion may be quickly discovered through a visual inspection.

Impact or stress damage, flaking, scratches and other conditions may also be apparent during a visual inspection. This type of damage is usually specific for each component. The Inspection and Repair Sections in these Maintenance and Repair volumes give more specific details of the visual inspections necessary to identify likely damage or faults which may occur some of components and systems covered in these volumes.

The following information discusses some forms of damage that may be apparent during a visual inspection.

Corrosion

Corrosion is common on metallic surfaces and can be readily identified through discolouration, scaling and flaking. While certainly indicators of corrosion, these symptoms may be caused by a means other than corrosion and must not be used solely as confirmation of corrosion. Overheating may appear to be similar to corrosion, both giving a brown colour and a similar texture.

Overheating

Overheating can appear similar in colour and texture to corrosion. Discolouration from heat usually appears to fade at the edges, whereas corrosion generally has defined edges of a more constant colour. Overheating may also result in a bluish colouring, quite distinct from corrosion that fades towards the edges.

Cracking

Cracks may appear in many surfaces. A crack may appear to run along the surface or to be coming out from inside the component. In either case, the source of the crack and the extent of the crack must be evaluated, possibly by use of another NDT technique, to establish the best course of action regarding the repair or rejection of the cracked component.

Penetrant Testing

Cracks that penetrate the surface of a material may not always be visible to the naked eye. Dye penetrants can aid in identifying discontinuities in components.

Penetrants must always be used only by qualified personnel, in accordance with equipment manufacturers recommendations and within the prevailing workshop regulations.

When a penetrant is applied to a clean surface containing a crack, hole or other flaw, the penetrant is drawn into the discontinuity through capillary action. When the excess penetrant is cleaned from the surface, the penetrant within the discontinuity remains visible. If the penetrant and the cleaned surface provide sufficient visual contrast, the penetrant can be easily observed, revealing the discontinuity. Some penetrants may be fluorescent to provide a stark contrast, others require a specialised ultraviolet or laser light source to highlight the penetrant against the material.

Ultrasonic Testing

Ultrasonic testing uses high frequency sound waves to locate discontinuities in a component.

Ultrasonic testing must always be performed by personnel fully qualified in the particular type of equipment. Testing must be performed in accordance with the equipment manufacturers recommendations and within the prevailing workshop regulations.

A typical ultrasonic testing machine displays a graph representing discontinuities in a component on a Cathode Ray Oscilloscope (CRO). Peaks or spikes in the graph indicate the severity of the discontinuity; the bigger the spike, the greater the discontinuity.

When using ultrasonics to test for discontinuities, it is good engineering practice to maintain accurate records to develop a history of test results. The graph should be approximately the same for all items of a particular component type. This information can be used to develop a standard for a particular component type. For comparison purposes, reference can then be made to the standard to evaluate the condition of an individual component against a known standard. For example, axles should always produce a similar graph when tested. Each end of the axle, along with edges and shoulders machined into the axle will appear as spikes on the CRO. Variations may be an indication of a difference in a particular axle to the standard axle. Additional spikes, where no shoulder, edge or end exists on the axle, are indicators of discontinuities in the axle, such as cracks. Such a variation may indicate that a further, or a more in depth, test is required to fully evaluate the axles condition.

Magnetic Testing

When a discontinuity is present in a material, the magnetic flux within the material changes greatly as it approaches the discontinuity. This noticeable change in magnetic flux can be useful for finding and evaluating flaws and cracks in a material.

Magnetic testing equipment must always be operated by fully qualified personnel in accordance with equipment manufacturers recommendations and within the prevailing workshop regulations.

Some materials are ferromagnetic (eg. iron, steel, cobalt, nickel) and can be magnetised to provide a suitable magnetic flux for testing. Other materials, such as aluminium, copper and some stainless steels are not ferromagnetic and do not possess a magnetic flux suitable for testing. However, by inducing a current in such materials, a magnetic flux is also induced. This induced magnetic flux can be suitable for testing for discontinuities in the material.

Any item that has been magnetically tested must be demagnetised after the testing procedure, before re-use in service.

Radiographic Testing

Radiographic, or x-ray, testing involves exposing a component to a radiographic source (such as x-rays or gamma rays) and measuring the change in the source after it has passed through the material. Voids, porosity and cracks are shown as a change in radiographic distribution within the material. The distribution through a discontinuity is noticeably different than for the surrounding, continuous material.

Radiographic testing equipment must always be operated by fully qualified personnel in accordance with equipment manufacturers recommendations and strictly within the prevailing workshop regulations.

Sealant Preparation

Surfaces to be sealed and joined with Sikaflex 221, Sikalastomer 710 or Sikaflex 15LM must first be prepared in accordance with the sealant manufacturers directions. If the proper preparations are not performed, the integrity of the sealant can not be guaranteed.

Some sections of this volume require that sealed joins be cut in order that some components may be removed from the loco. When reinstalling such components, a new seal must also be achieved. Any traces of the previous seal must be completely removed and the surfaces prepared accordingly so that a new seal may be achieved.

The following table shows the preparations required for particular surface types and finishes prior to the application of Sikaflex 221.

Painted Surfaces	Painted surfaces must be cleaned with Sikacleaner 205.
Bare Metallic Surfaces	All unfinished metallic surfaces require three stages of preparation; surface scuffing, cleaning with Sikacleaner 205 and priming with Sikaprimer 210T.
Powder-coated Surfaces	Powder-coated surfaces must be cleaned with Sikacleaner 205 and then primed with Sikaprimer 210T.
Fibreglass Surfaces	Fibreglass (GRP or GFRP) must be cleaned with Sikacleaner 205 and then primed with Sikaprimer 210T. New fibreglass components must be ground down approximately 0.5 mm on the area to be sealed prior to cleaning. Gel-coats, waxes and other release agents present on the surface must be removed, as the sealant will not bond to these coatings.

Surface Preparations

The following table shows the preparation required prior to the application of Sikaflex 221.

Surface Scuffing	Using a suitable steel wool pad or equivalent, gently scour the surface area to be sealed. Gentle scuffing of the surface enables the sealant to adhere more fully with the surface.
Cleaning	Surfaces to be cleaned with Sikacleaner 205 must first be dry and clean of any loose paint flakes, oxides, grease, lubricants, release agents and other contaminants. Cleaning with Sikacleaner 205 should be done in two stages. First, apply Sikacleaner 205 with a clean cloth to the area to be sealed, wiping thoroughly. Allow this to dry, then clean area again with a clean cloth, wiping in one direction only. This is to prevent recontaminating the area just wiped by wiping over it again. Allow the cleaner to dry for the recommended time before applying sealant. If thirty minutes is exceeded before the sealant has been applied, lightly reapply Sikacleaner 205 as previously described.
Priming	Sikaprimer 210T is to be applied over an area already cleaned using Sikacleaner 205, as described previously. Once cleaned, allow to dry for 10 minutes then apply a thin, even coat of Sikaprimer 210T using a suitable brush. Allow to dry before applying sealant. If 5 hours is exceeded before sealant has been applied, lightly sand the surface, remove any dust and prime again.
Sealing	All areas to be sealed must first be cleaned and/or primed. Once the sealant has been applied to the surface to be joined, joining must take place as quickly as possible to avoid the sealant curing. As a general guide, Sikaflex 221 has a tack-free time of approximately 50 minutes at 20 °C and 50% relative humidity. This time is likely to be shorter in increased temperature and/or humidity. Once the sealant has been applied and the two surfaces joined, clamping must be applied if no other fixing method is used on the sealed components. Refer to the manufacturers documentation for details regarding tack-free times and curing rates.

Water Test

In various chapters throughout these Maintenance and Repair Volumes, a water test is required after work has been performed. The test is to be performed to ensure the locomotive is water tight. Any water leaks on the locomotive pose an operational hazard, as the ingress of water to the locomotive can cause damage to electrical components and corrosion of metallic parts.

The locomotive must be in full operational condition for the water test. All equipment is to be installed and all sealant curing times observed. All blowers are to be running during the water test.

Do not spray water directly into breather ports on axle boxes or traction motors, or into roof vents on the cab or the mushrooms on the machine room roof hatches.

The locomotive should be positioned below a spray gantry, consisting of horizontal top rows of nozzles, each with two vertical rows of nozzles, one on each side of the locomotive. Each row of nozzles should be capable of uniformly delivering 500 litres of water per minute at 200 kPa with 90° solid cone nozzle spray patterns. With all blowers running (traction motor, oil cooler and machine room blowers, complete with scavenge blowers), the locomotive should be tested under the gantry for a period of 15 minutes. During this period, personnel within the locomotive cabs and machine room should be inspecting the locomotive for leaks. Typical areas to inspect would be seals, through bolt holes, areas where equipment passes from the outside to the inside of the locomotive, and opening with covers/doors and windows.

Tightening Torques

The tightening torques in the following tables only apply to the grade and size of bolt listed, unless otherwise specified in the procedure described in these volumes, or Volume F, Suppliers Documentation.

As a general rule, a locking compound, such as Loctite, should be used when assembling fasteners, except on the bogies. A thread sealing compound should be used on all threads opening into any compartment of the locomotive structure, and on all pipe fittings. Some compounds and coatings may alter the required tightening torque. Use the compound manufacturer's recommendations for modification of the tightening torques to avoid mechanical failure.

Steel Hexagon Head Bolts and Screws

Size	Thread	Pitch (mm)	Tightening Torque (Nm)				
			Grade 4.6	Grade 5.8	Grade 8.8	Grade 10.9	Grade 12.9
M 1.6	Coarse	0.35	0.1	0.1	0.2	0.2	-
M 2	Coarse	0.4	0.1	0.2	0.3	0.5	-
M 2.5	Coarse	0.45	0.3	0.4	0.6	0.9	-
M 3	Coarse	0.5	0.4	0.7	1.1	1.6	1.9
M 4	Coarse	0.7	1	1.7	2.7	3.8	4.4
M 5	Coarse	0.8	2.1	3.5	5	8	8.9
M 6	Coarse	1	3.5	5.9	9	13	15
M 8	Fine	1	-	-	24	34	40
M 8	Coarse	1.25	8.5	14	22	32	37
M 10	Fine	1.25	-	-	46	66	77
M 10	Coarse	1.5	17	29	44	63	73
M 12	Fine	1.25	-	-	83	119	139
M 12	Coarse	1.75	30	49	77	109	128
M 14	Fine	1.5	-	-	132	189	220
M 14	Coarse	2	47	79	122	174	203
M 16	Fine	1.5	-	-	202	189	336
M 16	Coarse	2	73	124	190	270	316
M 18	Fine	1.5	-	-	304	418	493
M 18	Coarse	2.5	101	171	269	371	436
M 20	Fine	1.5	-	-	424	588	688
M 20	Coarse	2.5	143	242	372	528	620
M 22	Fine	1.5	-	-	572	788	924
M 22	Coarse	2.5	195	329	519	722	840
M 24	Fine	2	-	-	720	994	1162
M 24	Coarse	3	248	418	640	914	1066
M 27	Fine	2	-	-	1048	1447	1690
M 27	Coarse	3	361	610	967	1339	1561
M 30	Fine	2	-	-	1452	2010	2346
M 30	Coarse	3.5	491	828	1314	1817	2124
M 33	Fine	2	-	-	1960	2713	3168
M 33	Coarse	3.5	667	1135	1782	2449	2884
M 36	Fine	3	-	-	2426	3362	3924
M 36	Coarse	4	864	1454	2297	3173	3708
M 42	Coarse	4.5	1378	2327	3671	-	-
M 48	Coarse	5	2064	3485	5500	-	-
M 56	Coarse	5.5	3338	5611	8870	-	-
M 64	Coarse	6	5030	8473	13376	-	-

Steel Socket Head Cap Screws

Size	Tightening Torque (Nm)
M 1.4	0.2
M 1.6	0.3
M 2	0.7
M 2.5	1.3
M 3	2.4
M 4	5.7
M 5	11.4
M 6	19
M 8	46
M 10	88
M 12	162
M 14	257
M 16	397
M 18	552
M 20	772
M 24	1324
M 30	2685
M 36	4707
M 42	7539

Stainless Steel (304 & 316) Bolts and Screws

Size	Pitch (mm)	Tightening Torque (Nm)		
		Grade PC 50	Grade PC 70	Grade PC 80
M 1.6	0.4	0.1	0.2	0.4
M 2	0.4	0.3	0.3	0.4
M 2.5	0.5	0.5	0.6	0.7
M 3	0.5	1.0	1.1	1.6
M 4	0.7	1.3	2.6	3.5
M 5	0.8	2.4	5.1	6.9
M 6	1.0	4.1	8.8	11.8
M 8	1.3	10.1	21.4	29.0
M 10	1.5	20.3	44.0	58.0
M 12	1.8	34.8	74.0	100.0
M 14	2	56	119	159
M 16	2	86	183	245
M 18	2.5	133	260	346
M 20	2.5	173	370	494
M 22	2.5	234	-	-
M 24	3	298	-	-
M 27	3	421	-	-
M 30	3.5	571	-	-
M 33	3.5	779	-	-
M 36	4	998	-	-

BOMBARDIER TRANSPORTATION

IR WAG9

Volume D1

Loco Body

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1.02	Exterior Finish	3
1.03	Doors & Steps	4
1.04	Draftgear & Couplers	5
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1 Loco Body

For complementary information see following Chapters in Volume D1:

Structure	1.01
Exterior Finish	1.02
Doors and Steps	1.03
Draftgear and Couplers	1.04
Windows	1.05
Horns and Lights	1.06
Wipers and Washers	1.07
Buffers	1.08
Cable Duct	1.09

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1.1 Structure

General Notes on Hazards in the Work Area

@.1040

WARNING:

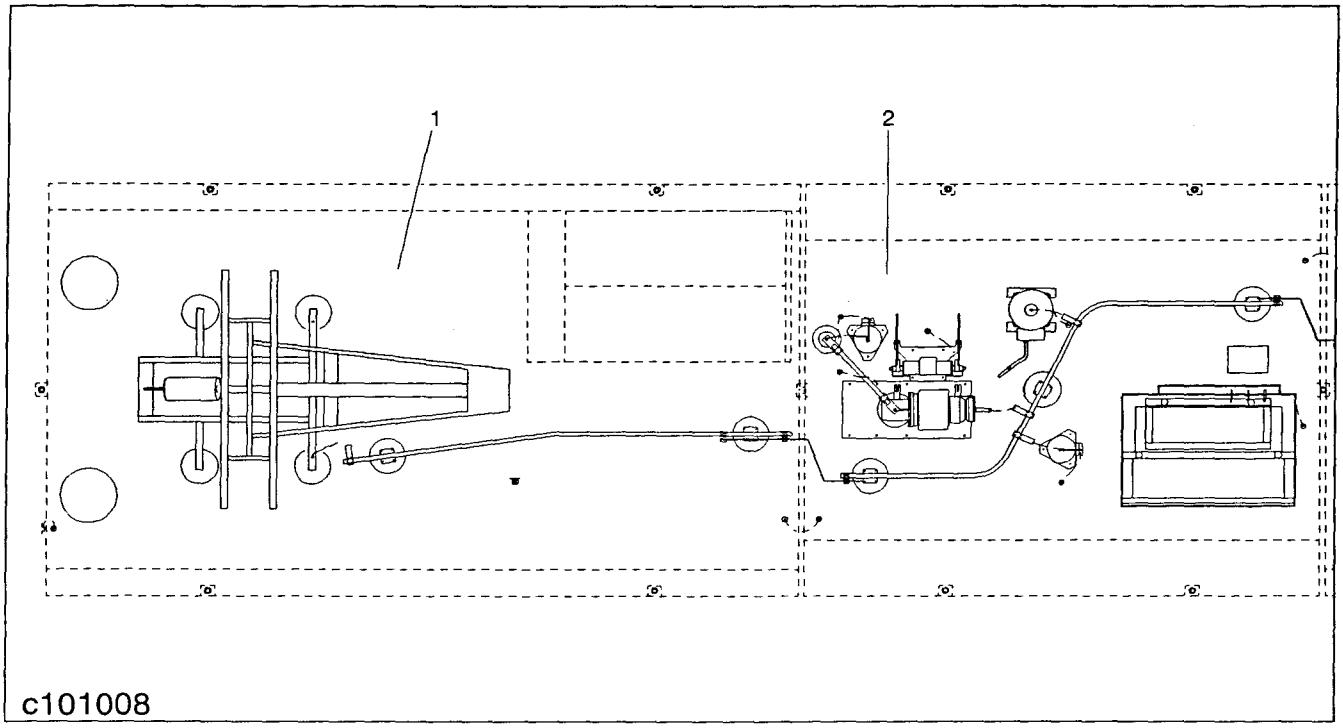
HIGH VOLTAGE! DANGER OF ELECTROCUTION. Some of the components are live when the locomotive is connected to an active overhead. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVERHEAD.

Disconnect the pantograph from the overhead and isolate the overhead whenever working on the roof, or with high voltage components.

Group Summary

@.1120

This group contains information for the locomotive body structure. Information in this group covers surface coatings.



1 Pantograph roof hatch

2 Converter roof hatch

Functional Description

.1140

The converter and pantograph roof hatches are sealed around the entire perimeter. The roof beam can be removed for ease of access during maintenance. Lugs are provided on the roof hatches for attaching lifting equipment.

Technical Data

.1160

Welding Equipment

ES4S Welding Wire Mechanical Properties

– Type	ES4S, Copper Coated
– C (carbon)	0.10%
– P (phosphorous)	0.015%
– Si (silicon)	0.75%
– Mn (magnesium)	1.3%
– Yield Strength	390 MPa
– Tensile Strength	500 MPa
– Elongation	32%

Argoshield 51 Welding Gas Properties

– CO^2 (carbon dioxide)	16% ± 0.2%
– H (hydrogen)	2.5% ± 0
– Ar (argon)	81.5% approximately, remainder

Tolerances and Wear Limits List

@.1170

[Not required]

Tools and Special Tools

@.1180

These maintenance procedures in this Chapter require conventional workshop equipment.

Miscellaneous Materials

@.1200

[Not required]

Before–Removal Operations

@.1220

[Not required]

Removal

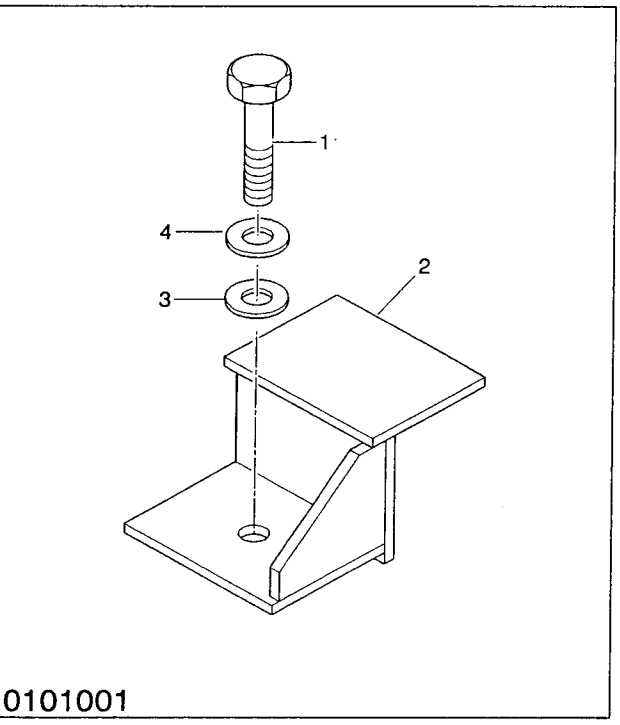
@.1230

Pantograph Roof Hatch

Isolate the electrical equipment, as required.

Isolate the pneumatic supply from the auxiliary compressor to the pantograph.

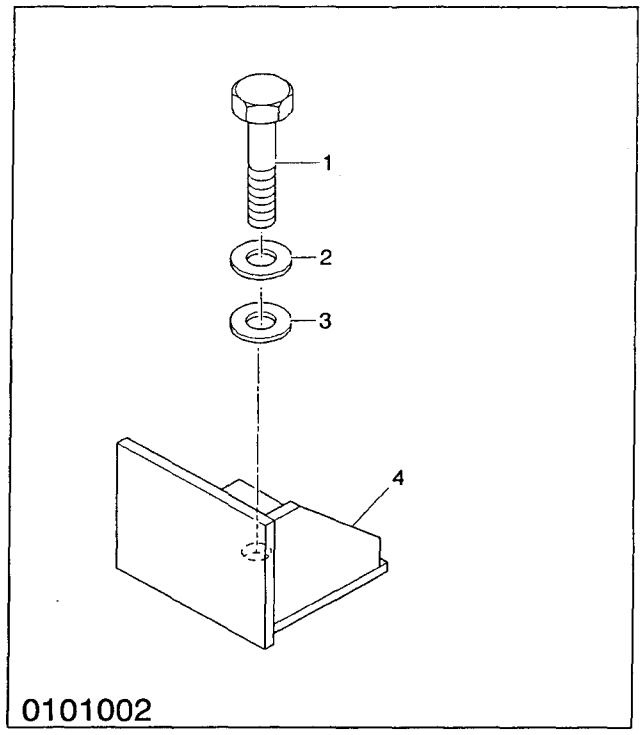
From inside the machine room, disconnect the pneumatic and electrical equipment connected to the pantograph roof hatch as required.



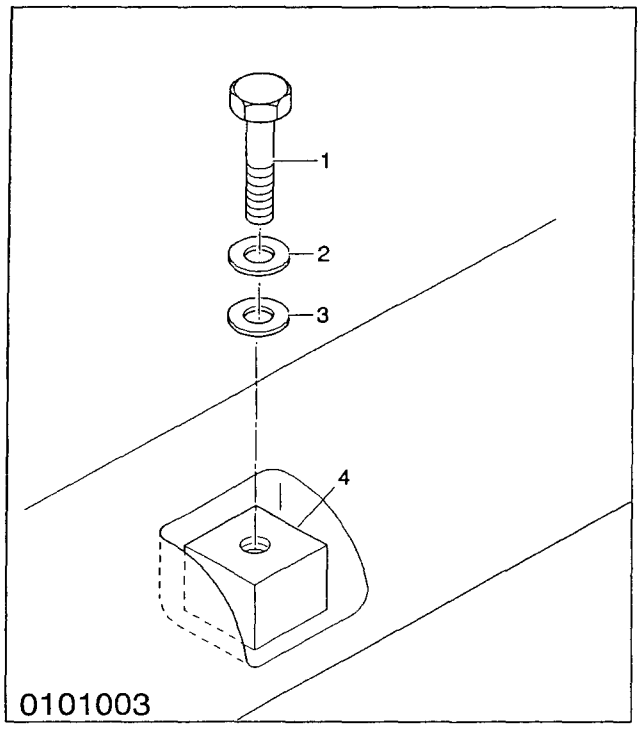
0101001

Remove the bolts (1) securing the bracket (2) at the roof centre line between the pantograph and converter hatches.

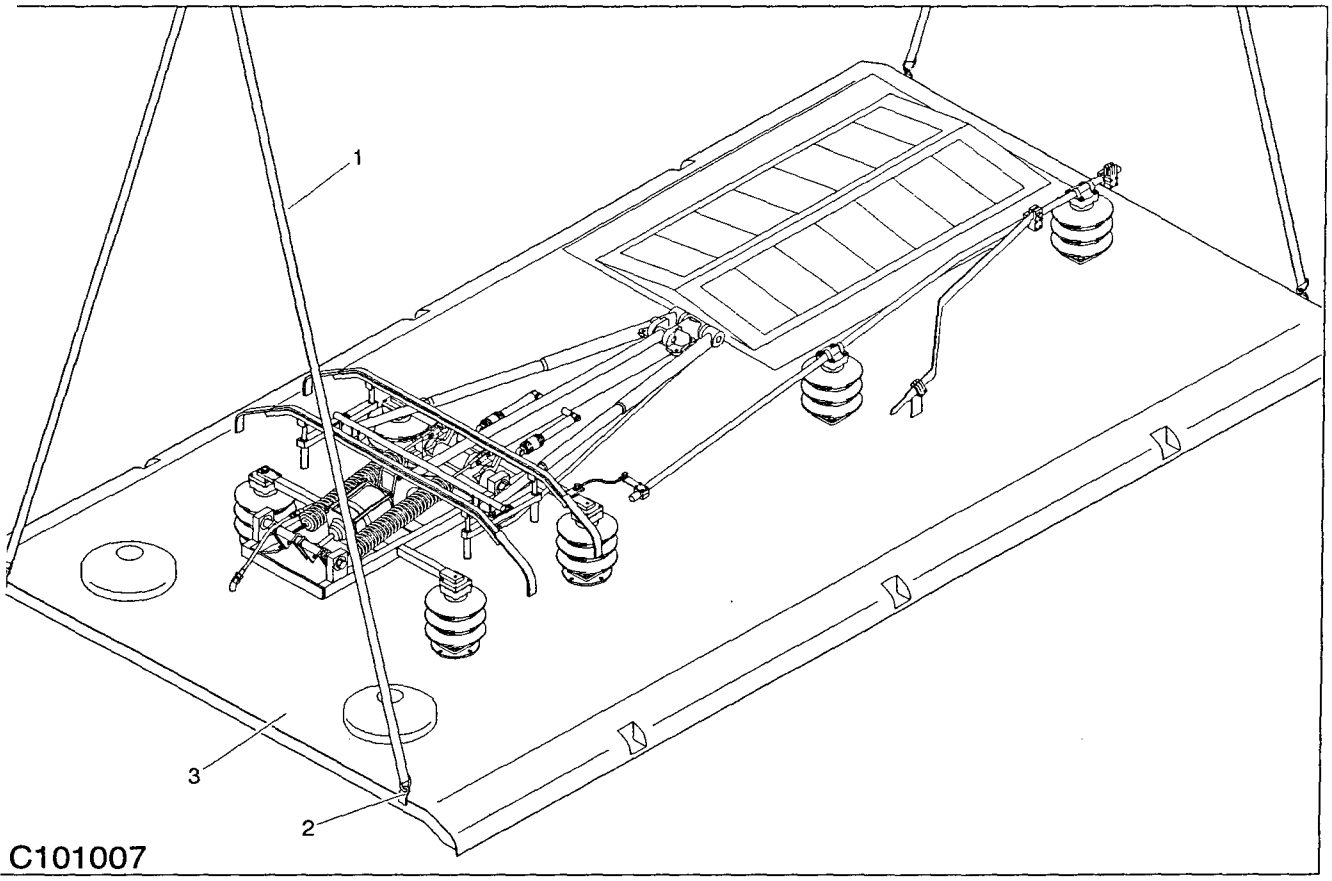
Remove the bracket (2), bolts (1) spring (4) and plain (3) washers from the roof.



Remove the bolts (1), spring (2) and plain (3) washers securing the bracket (4) at the roof centre line between the pantograph roof hatch and locomotive roof, then remove the bracket (4).



Loosen the bolts (1) along the sides of the pantograph roof hatch. Remove the bolt (1), spring (2) and plain (3) washers. If necessary, press the bush from the roof hatch using a suitable hydraulic press.



C101007

Attach suitable lifting equipment (1) to the lugs (2) on the pantograph roof hatch (3).

Raise the roof hatch (3) slightly and check to ensure nothing is entangled or still connected to the roof hatch. Remove any entanglements.

Lift the pantograph roof hatch (3) from the locomotive.

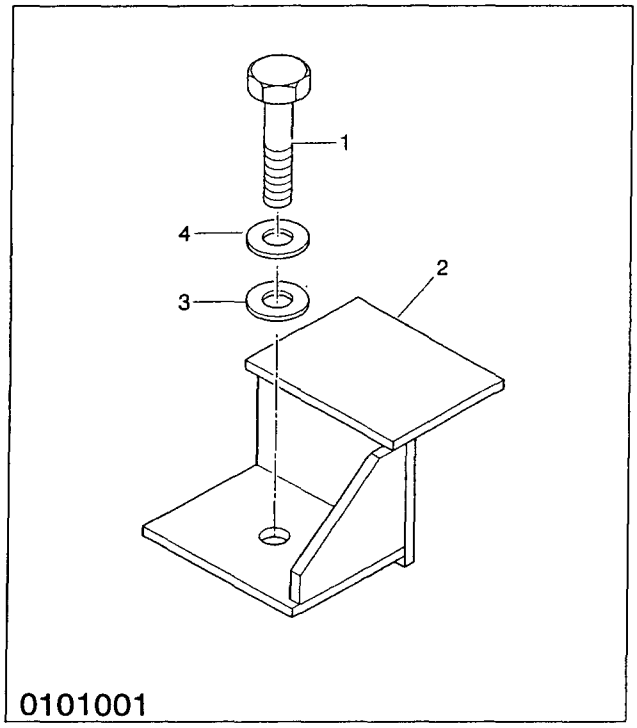
Inspect the roof hatch and seal as described in Section Inspection and Repair.

Converter Roof Hatch

Isolate the electrical equipment, as required.

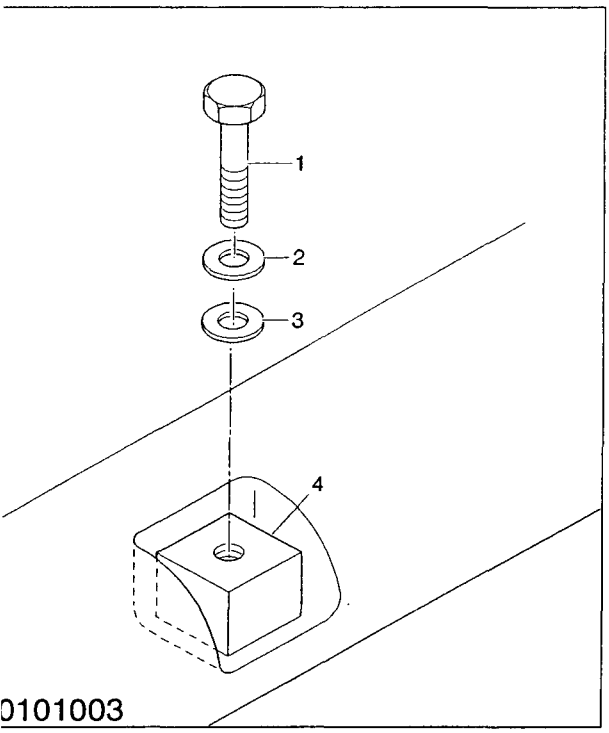
Isolate the pneumatic supply.

From inside the machine room, disconnect the pneumatic and electrical equipment connected to the converter roof hatch as required.



Remove the bolts (1) securing the bracket (2) at the roof centre line between the converter and pantograph hatches.

Remove the bracket (2), bolts (1) spring (3) and plain (4) washers from the roof.



Loosen the bolts along the sides of the converter roof hatch. Remove the bolt (1), spring (2) and plain (3) washers. If necessary, press the bush (4) from the roof hatch using a suitable hydraulic press.

Attach suitable lifting equipment to the lugs on the converter roof hatch.

Raise the roof hatch slightly and check to ensure nothing is entangled or still connected to the roof hatch. Remove any entanglements.

Lift the converter roof hatch from the locomotive.

Inspect the roof hatch and seal as described in Section Inspection and Repair.

Roof Beam

Remove the pantograph roof hatch as previously described.

Remove the converter roof hatch as previously described.

Attach suitable lifting equipment to the roof beam. Raise the equipment to support the weight.

Disconnect any electrical or pneumatic equipment from the roof beam.

Disassembly

@.1240

[Not required]

Inspection and Repair

@.1250

Roof Hatches

Inspect the condition of the roof hatches. Rectify any wear or damage found.

Repair any chipped or damaged paint on the roof hatches.

Inspect the condition of the roof hatch seals. Replace the seals if worn, damaged or torn.

Check the roof hatch seals are correctly positioned on body side panel. Reposition the seal if necessary.

After the roof hatches are installed, conduct a water test on the roof hatches. Ensure the seals prevent the ingress of water. Rectify any faults found.

Roof Beam

Check the condition of the roof bow. The bow must be smooth and without any damage.

Inspect the roof beam for bend or twist.

Inspect the roof beam for evidence of corrosion.

Rectify any faults found, or replace the roof bow if necessary.

Roof Beam Seal

Inspect the condition of the roof beam seals. Replace the seals if worn, damaged or torn.

Check the roof beam seals are correctly positioned on each side of the roof beam. Reposition the seal if necessary.

Conduct a water test after the roof hatches are installed. Ensure the seals prevent the ingress of water. Rectify any faults found.

Sanitation Parts/Operating Material

@.1260

[Not required]

Assembly

@.1270

[Not required]

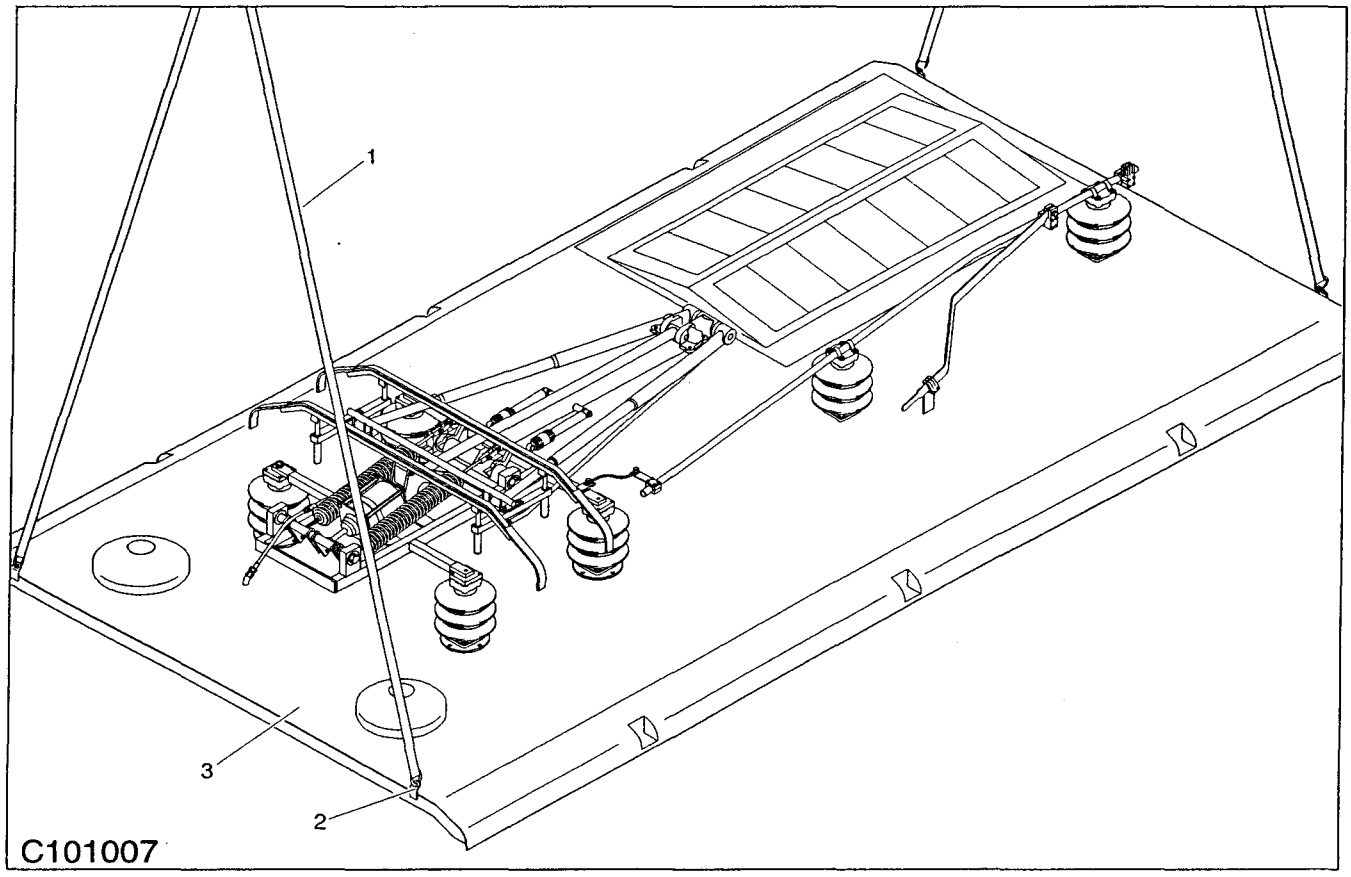
Installation

@.1280

Pantograph Roof Hatch

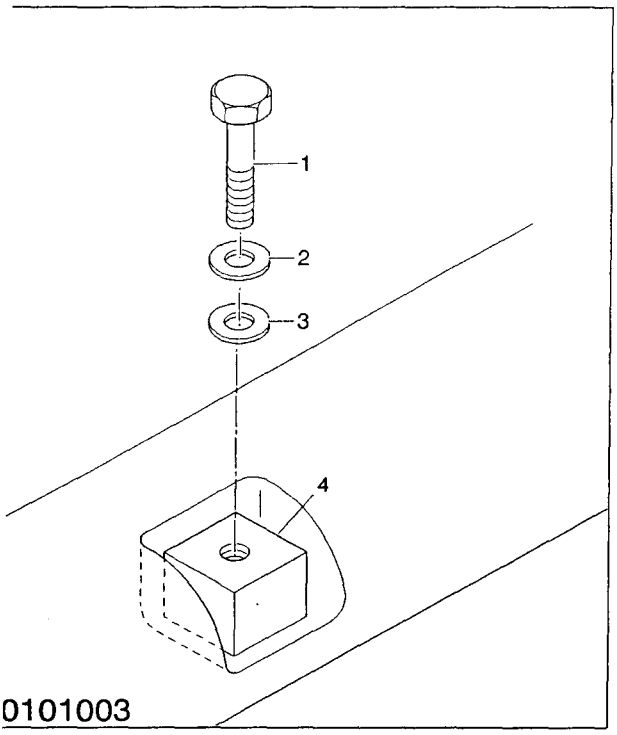
Install the roof beam as described in ROOF BEAM.

Install the converter hatch as described in CONVERTER ROOF HATCH.



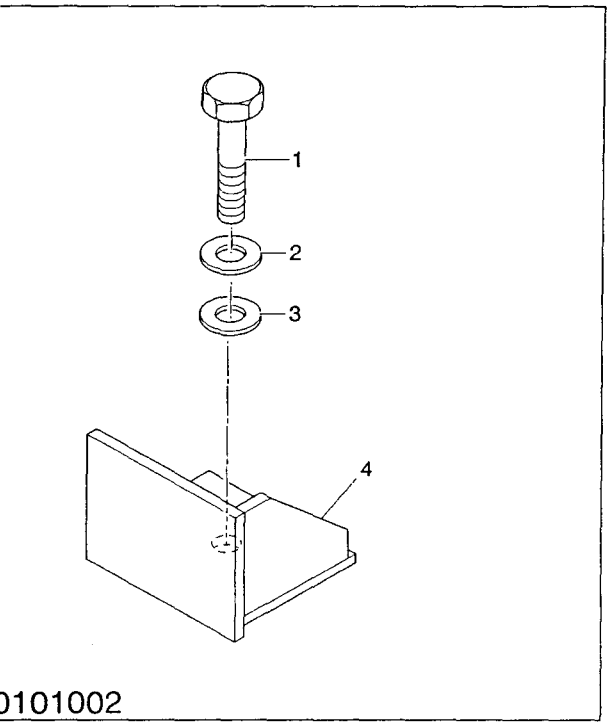
Attach suitable lifting equipment (1) to the lugs (2) on the pantograph roof hatch (3).

Lift the pantograph roof hatch (3) into position on the locomotive.



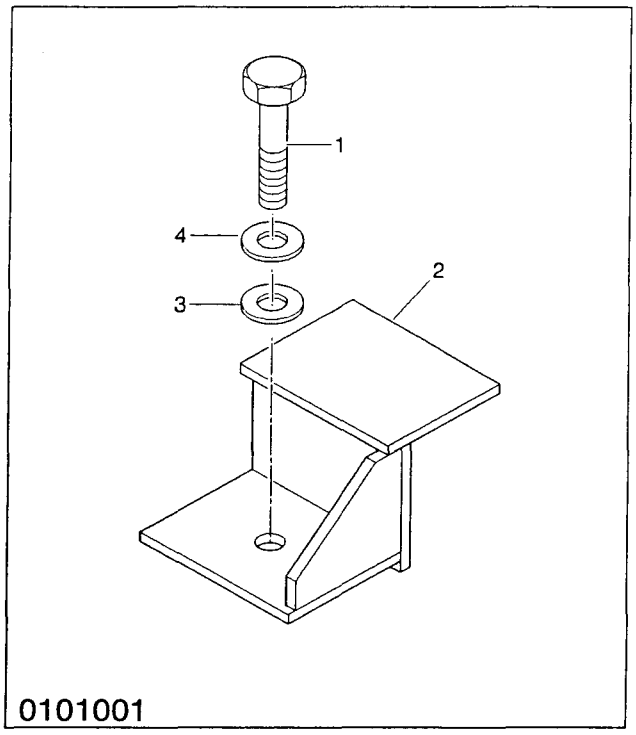
0101003

Install the bolts (1), spring (2) and plain washers (3) into the sides of the pantograph roof hatch. If necessary, press the bush (4) into the roof hatch using a suitable hydraulic press.



0101002

Install the bracket (4), bolt (1) spring (2) and plain washers (3) at the roof centre line between the pantograph hatch and locomotive roof.



Install the bracket (2), bolt (1) spring (4) and plain washers (3) at the roof centre line between the pantograph roof hatch and converter roof hatch.

Tighten the bolts along the sides of the roof hatch, then tighten the bolts securing both the brackets at the roof centre line.

From inside the machine room, connect the pneumatic and electrical equipment to the pantograph roof hatch as required.

Test the pantograph roof hatch for water leaks. Rectify any faults found.

Open the pneumatic supply from the auxiliary compressor to the pantograph.

Close the circuit breakers to the electrical equipment, as required.

Test the operation of the pneumatic and electrical equipment. Rectify any faults found.

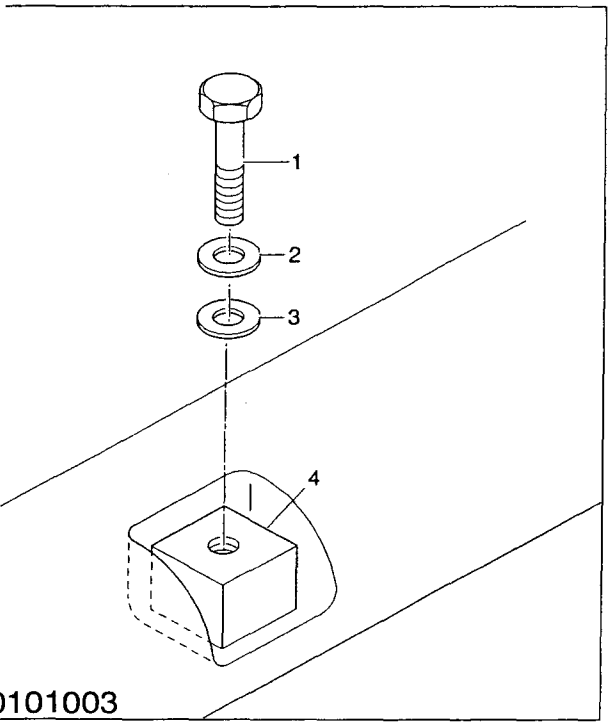
onverter Roof Hatch

ıstall the roof beam as described in ROOF BEAM.

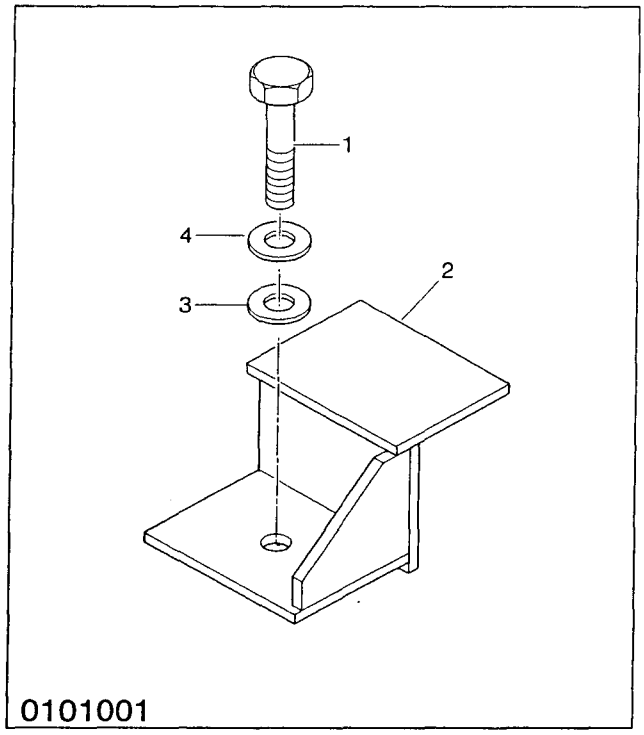
ıstall the pantograph roof hatch as described in PANTOGRAPH ROOF HATCH.

ttach suitable lifting equipment to the lugs on the converter roof hatch.

ift the converter roof hatch into position on the locomotive.



Install the bolts (1), spring (2) and plain washers (3) into the sides of the converter roof hatch. If necessary, press the bush (4) into the roof hatch using suitable hydraulic press.



Install the bracket (2), bolt (1) spring (4) and plain washers (3) at the roof centre line between the converter roof hatch and pantograph roof hatch.

Tighten the bolts along the sides of the roof hatch, then tighten the bolts securing both the brackets at the roof centre line.

From inside the machine room, connect the pneumatic and electrical equipment to the converter roof hatch as required.

Test the converter roof hatch for water leaks. Rectify any faults found.

Open the pneumatic supply.

Close the circuit breakers to the electrical equipment, as required.

Test the operation of the pneumatic and electrical equipment. Rectify any faults found.

Roof Beam

Attach suitable lifting equipment to the roof beam. Raise the roof beam into position on the locomotive.

Align the bolt holes in the roof bow with the holes in the body side panel.

After–Installations Operations

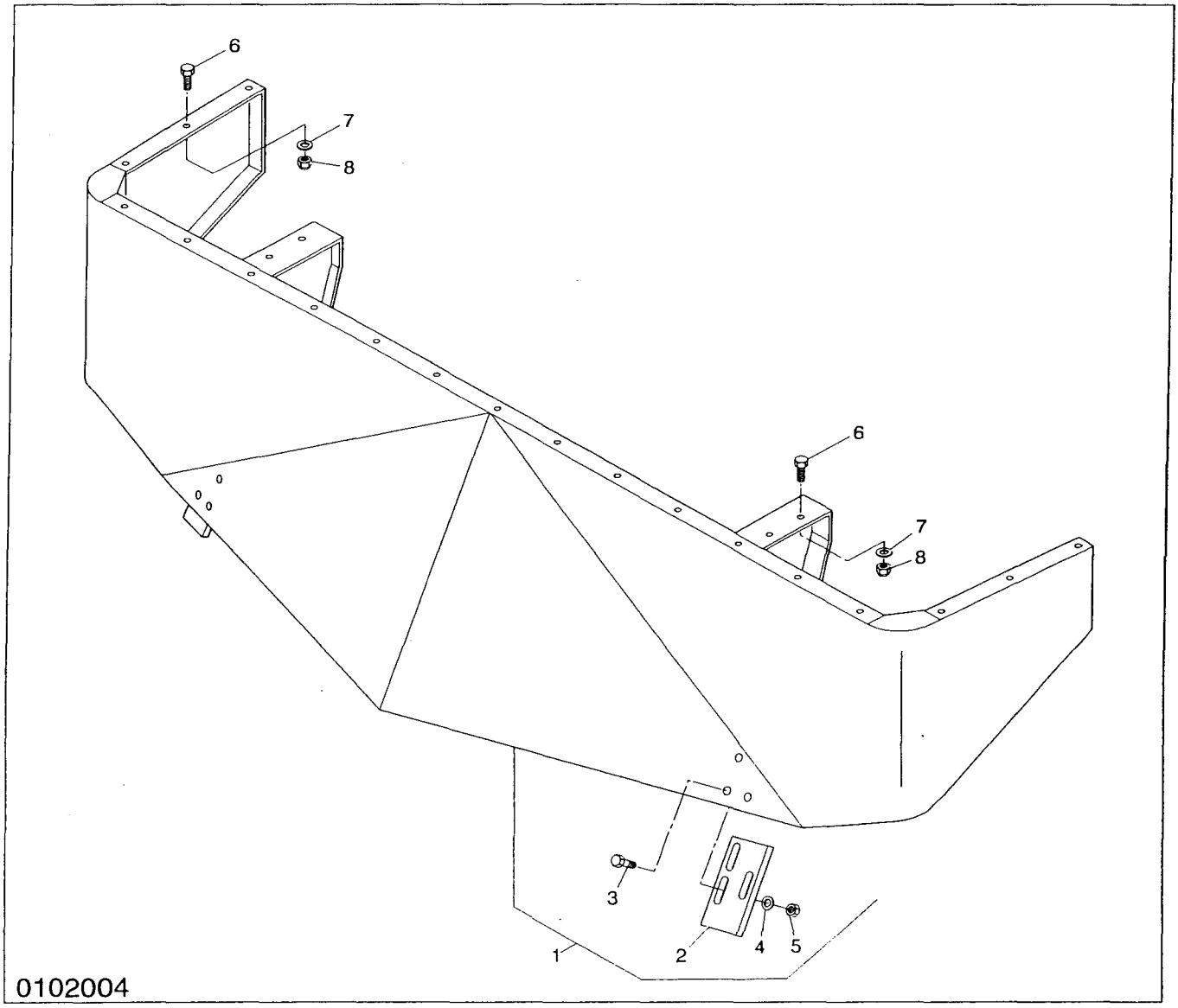
.1290
Not required]

1.2 Exterior Finish

Overview

@.1120

This group contains information for the locomotive exterior finishes. Information in this group covers surface coatings; primer and top–coat paints.



1	Cow catcher	5	Hex nut nyloc
2	Rail guard	6	Hex bolt
3	Hex bolt	7	Round flat washer
4	Round flat washer	8	Hex nut nyloc

Functional Description

).1140

Rail guard

The rail guard is used to clear obstacles from the rail. It is attached to the low catcher on the ront of the locomotive.

Technical Data

@.1160

Rail Guard

Rail clearance: 70–90 mm

Surface Coatings

Wattyl Poly–U 400 Paint

– Manufacturer	Wattyl–Sigma, Australia
– Finish type	Two part isocyanate–cured, Polyurethane finish
– Solids by volume	49%
– Coverage	20 m^2/litre @ 250 micron coat
– Drying time	2–3 hours @ 15º C
– Finish type	High Gloss
– Heat resistance	80º C
– Application temperature	> 10º C
– Spraying pressure	275– 415 kPa
– Spray nozzle orifice	0.33 mm
– Thinning, spray painting	Wattyl L707 Thinner, 20–25%
– Shelf life	12 months
– Touch dry	2–3 hours
– Recoat	after 16 hours
– Fully cured	7 days
– Coat thickness	60 microns (dry)
– Primer material	Sigmacover CM primer
– Other	Contains 0.37% monomeric disocyanate

Wattyl Sigmacover CM Primer

– Manufacturer	Wattyl–Sigma, Australia
– Finish type	Two–Pack Epoxy Primer, contains zinc phosphate
– Solids content	61%
– Coverage	18 m^2/litre @ 150 micron coat
– Spraying pressure	300–400 kPa
– Spray nozzle orifice	1.6 – 3.175 mm
– Thinning, spray painting	Wattyl Thinner 91–92, 10–15%
– Shelf life	12 months
– Coat thickness	150 microns (dry)
– Pot life	6.0 hours @ 20º C
– Other	free from lead and chromates containing pigments

Tolerances and Wear Limits List

@.1170

Not applicable

Tools and Special Tools

@.1180

Normal refinishing shop equipment is required for application of surface coatings.

Miscellaneous Material

@.1200

Not applicable

Before – Removal Operations

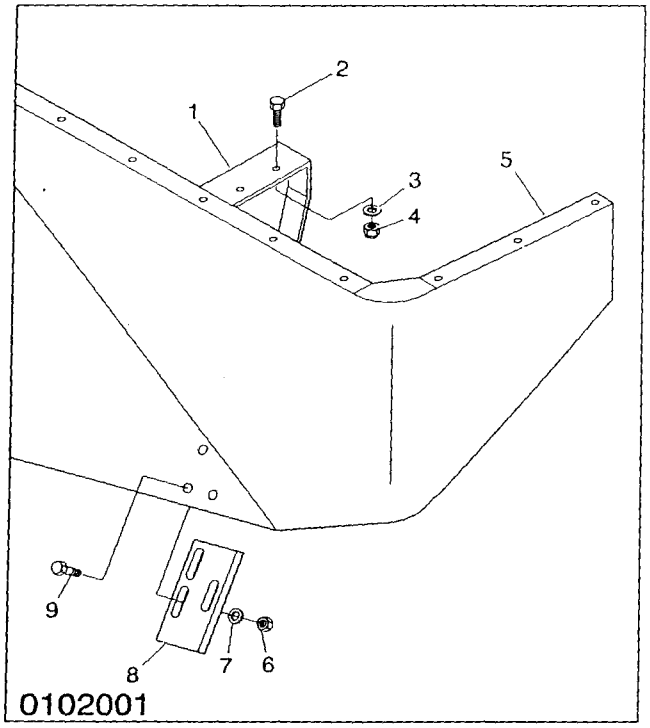
@.1220

Not applicable

Removal

@.1230

Cow Catcher



WARNING:

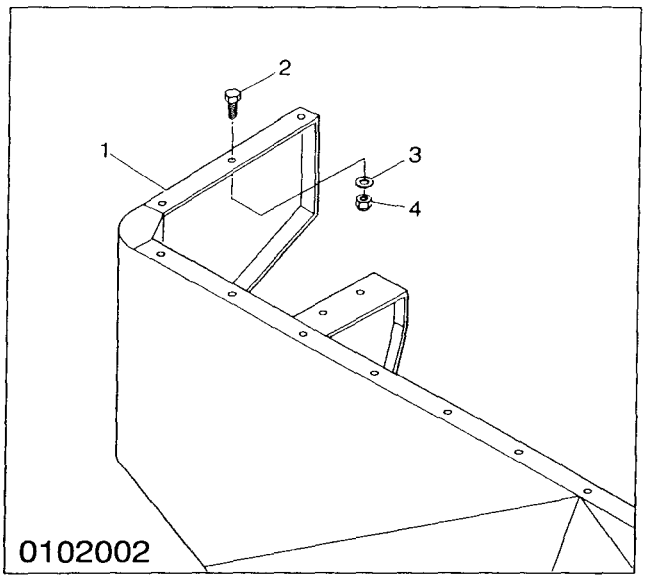
Extremely heavy component, handle with care to avoid personal injury or damage.

Support the cow catcher (5) using lifting equipment, such as a forklift. The cow catcher must be properly balanced and supported to prevent it falling during the procedure.

Raise the equipment slightly to support the weight.

Match mark the rail guards (8) to the cow catcher (5), then remove the three bolts (9), nuts (6) and washers (7) securing the guards (8) to the cow catcher (5). Removing the guards (8) will prevent them dragging during removal of the cow catcher (5).

From behind the cow catcher (5), remove the bolts (2), washers (3) and nuts (4) securing the brackets (1) to the underframe.



Ensure the cow catcher (1) is properly supported, then remove the nineteen bolts (2), washers (3) and nuts (4) securing the cow catcher (1) to the headstock.

Lower the cow catcher sufficiently to clear the buffers, then withdraw the cow catcher from the locomotive.

Disassembly

@.1240

Not applicable

Inspection and Repair

@.1250

Surface Finishes

The locomotive is coated with a two–pack polyurethane paint over an epoxy primer. This combination of surface finishes ensures full protection against corrosion.

A top coat of Wattyl Poly–U 400 is applied over two coats of Wattyl Sigmacover CM primer to protect the steel against corrosion. The locomotive must be refinished to the same specification to maintain corrosion resistance.

Always observe the warnings when handling or applying surface finishes.

WARNING:

Uncured epoxy and polyurethane paints, and their solvents can be harmful if handled incorrectly. Products of these types are FLAMMABLE. Wear protective clothing; including a particle respirator and impervious gloves. Always follow the precautions and directions of the manufacturer.

'reparation

'repare the surface to be painted:

Repair any damage or corrosion found on the locomotive. If necessary, apply a corrosion inhibitor to prevent the spread of corrosion.

Plug all threaded holes and cover exposed threads to prevent the contamination with debris or paint.

Remove any sharp edges, corners and burrs from the material.

Remove any weld slag and spatter.

If necessary, clean the surface using an abrasive blast cleaning technique as described in Section Sanitation Parts/Operating Material, then thoroughly clean the surface, remove debris, grit and foreign material.

Where the surface is not being blast cleaned, remove all loose or flaking paint. Roughen the existing paint using 400 grit emery paper.

Mask any areas not being painted.

Remove all foreign material, dirt, grease or other debris, then wipe the surface with solvent and a clean, lint–free cloth. Dry the surface with another clean, dry, lint free cloth.

Remove all surface contaminates; grease, grime and oil processing soil using white spirit, trichloroethane or other suitable solvent.

Priming

Prime the surface with Wattyl Sigmacover CM primer, or equivalent.

Mix, in a clean container, sufficient quantity of primer for the application. Mix the proportions according to the manufacturer's recommendations.

Thin the mixture according to the application and manufacturer's recommendations.

NOTE:

Epoxy primers are not suited to application in temperatures below 4º C.

Apply the first coat of primer, approximately 250 microns thick when wet, and allow to dry according to the manufacturer's directions.

Apply a second coat of primer, approximately 250 microns thick when wet, and allow to dry.

Top Coat

Coat the surface with Wattyl Poly U–400 paint, or equivalent.

Mix, in a clean container, sufficient quantity of paint for the application Mix the proportions according to the manufacturer's recommendations.

Stir thoroughly using a flat stirrer until a uniform consistency is achieved, then allow the mixture to stand as specified by the manufacturer.

Thin the mixture according to the application and the manufacturer's recommendations.

NOTE:

Premature setting may occur if freshly catalysed Polyurethane paint is added to paint that has been mixed for longer than 20 minutes.

Apply a coat of finish, 65 microns thick (wet), to the entire surface, according to the manufacturer's recommendations.

Allow the first coat to dry according to the manufacturer's specification, then apply a second coat in the same manner.

Sanitation Parts/Operating Material

@.1260

Blast Cleaning

Cover any area not being cleaned to prevent pitting the surface.

To prevent damage to the threads and a build up of abrasive material, plug all threaded holes using suitable plastic plugs.

Cover all exposed threads to prevent damage.

Blast the surface clean to Class $2^1/_2$ standard, Near White Metal Blast Cleaning. Remove all mill scale, oxidation and foreign particles from the surface. The finished surface should be pitted to 125 microns deep, but need not have a consistent colour.

Clean the surface, remove debris, grit and foreign material.

Remove the plugs and other protective measures.

Assembly

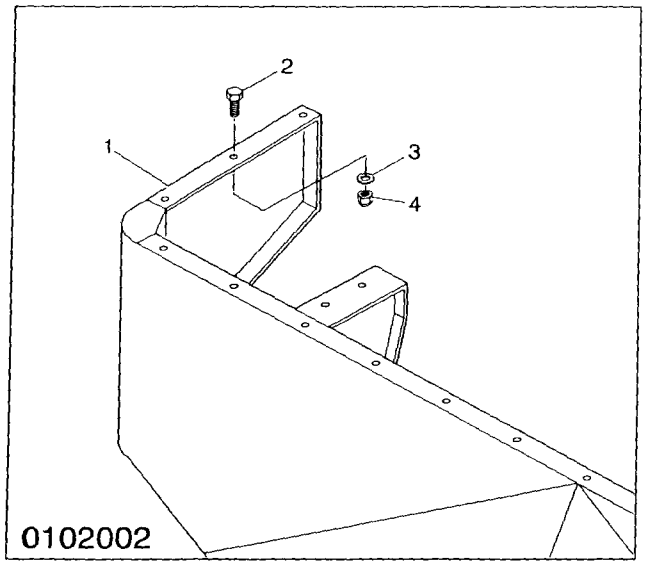
@.1270

[Not applicable]

Installation

@.1280

Cow Catcher



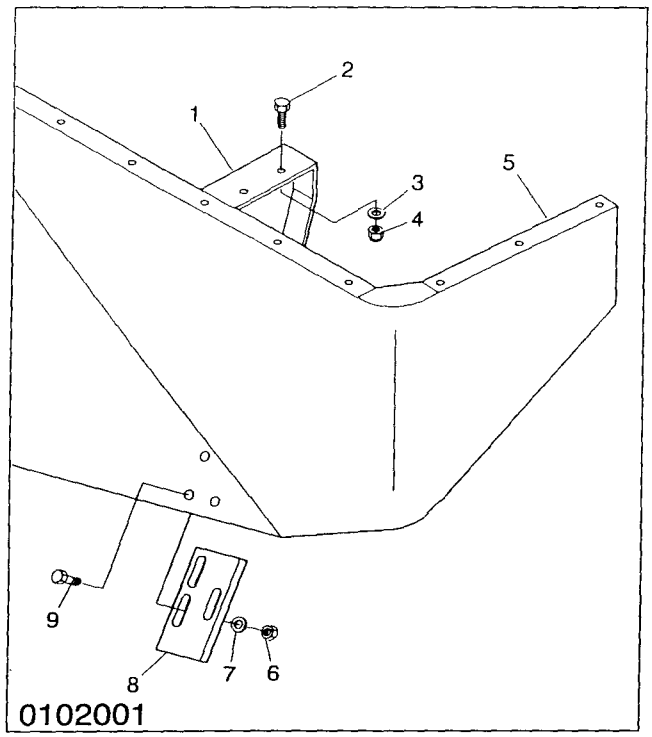
WARNING:

Extremely heavy component, handle with care to avoid personal injury or damage.

Position the cow catcher (1) on suitable lifting equipment, such as a forklift. The cow catcher must be properly balanced and supported to prevent it falling during the procedure.

Position the cow catcher (1) below the locomotive. Align the holes in the flange with those in the underside edge of the headstock.

Install the bolts (2) through the headstock and cow catcher flange, then install the washers (3) and nuts (4). Do not tighten the nuts (4) until all the bolts (2) have been installed.



From behind the cow catcher (5), install bolts (2) through the underframe and cow catcher brackets (1), then install the washers (3) and nuts (4).

Ensure the cow catcher (5) is evenly aligned across the front of the locomotive, then torque all the nuts. M_A = 77 Nm

Install the rail guards (8) to the bottom of the cow catcher (5). Align the match marks made during disassembly.

Adjust the rail clearance between the rail guards (8) and rail as described in Section Adjustments.

After–Installations Operations

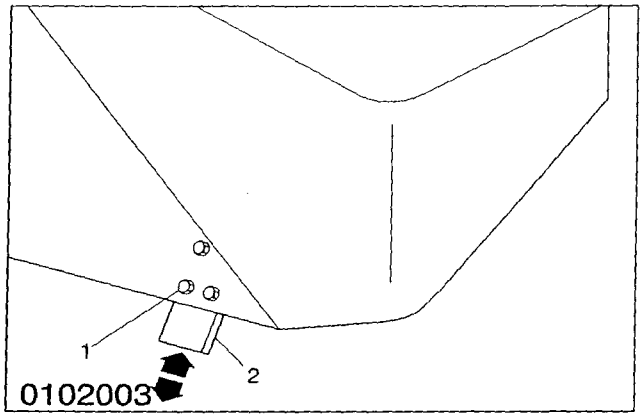
.1290

[Not applicable]

Adjustments

.1310

Rail Clearance Adjustment



Measure and note the distance between the bottom edge of the rail guards (2) and rail.

If the dimension is not within the range described in Section Technical Data adjust the rail clearance as follows.

Loosen the three bolts (1) sufficiently to allow restricted movement of the rail guards (2).

Move the rail guards (2) to the correct rail clearance height.

Check the rail guards (2) are aligned with the rails.

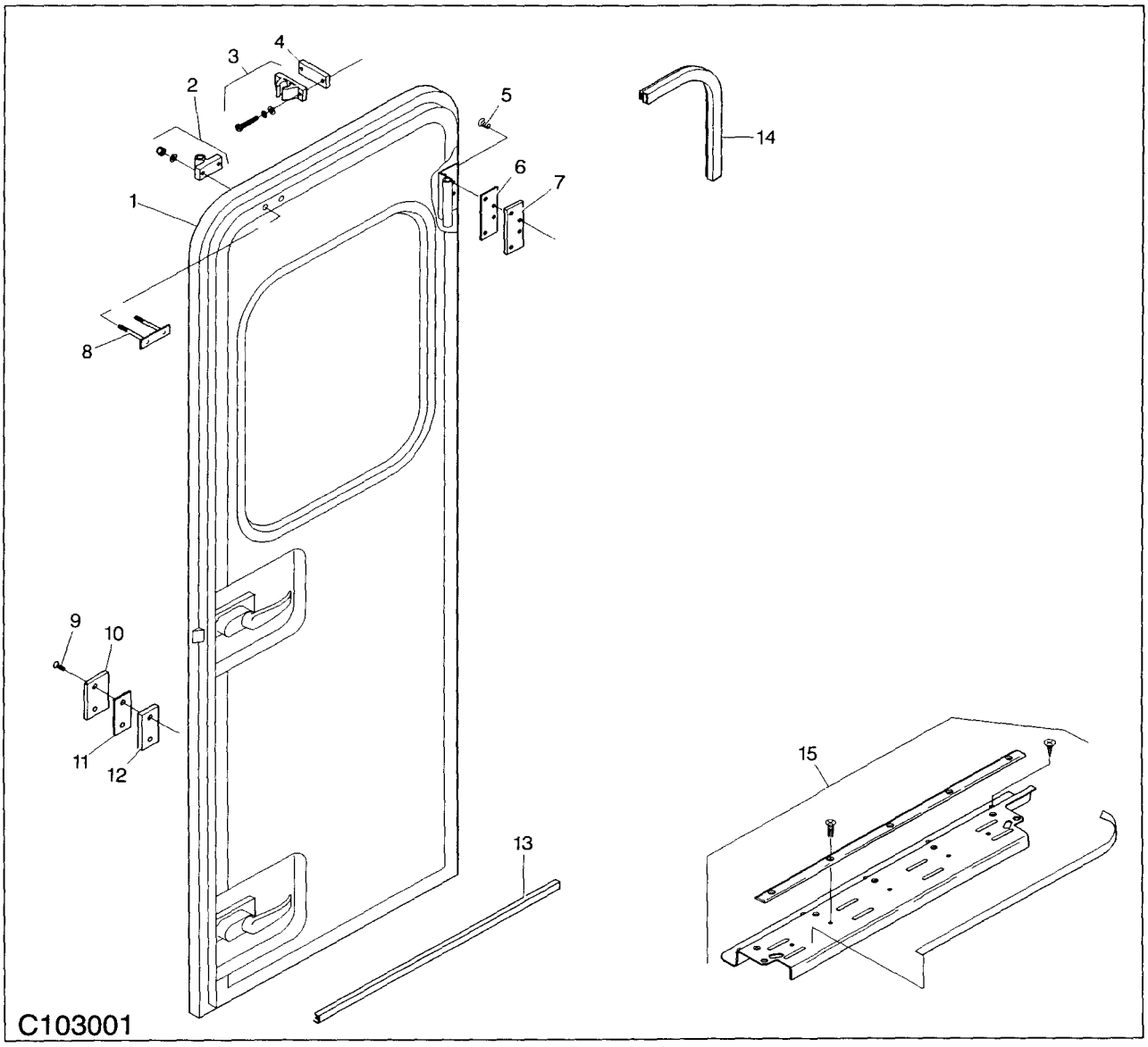
Tighten the three bolts (1) on each rail guard to specification.

1.3 Doors and Steps

Group Summary

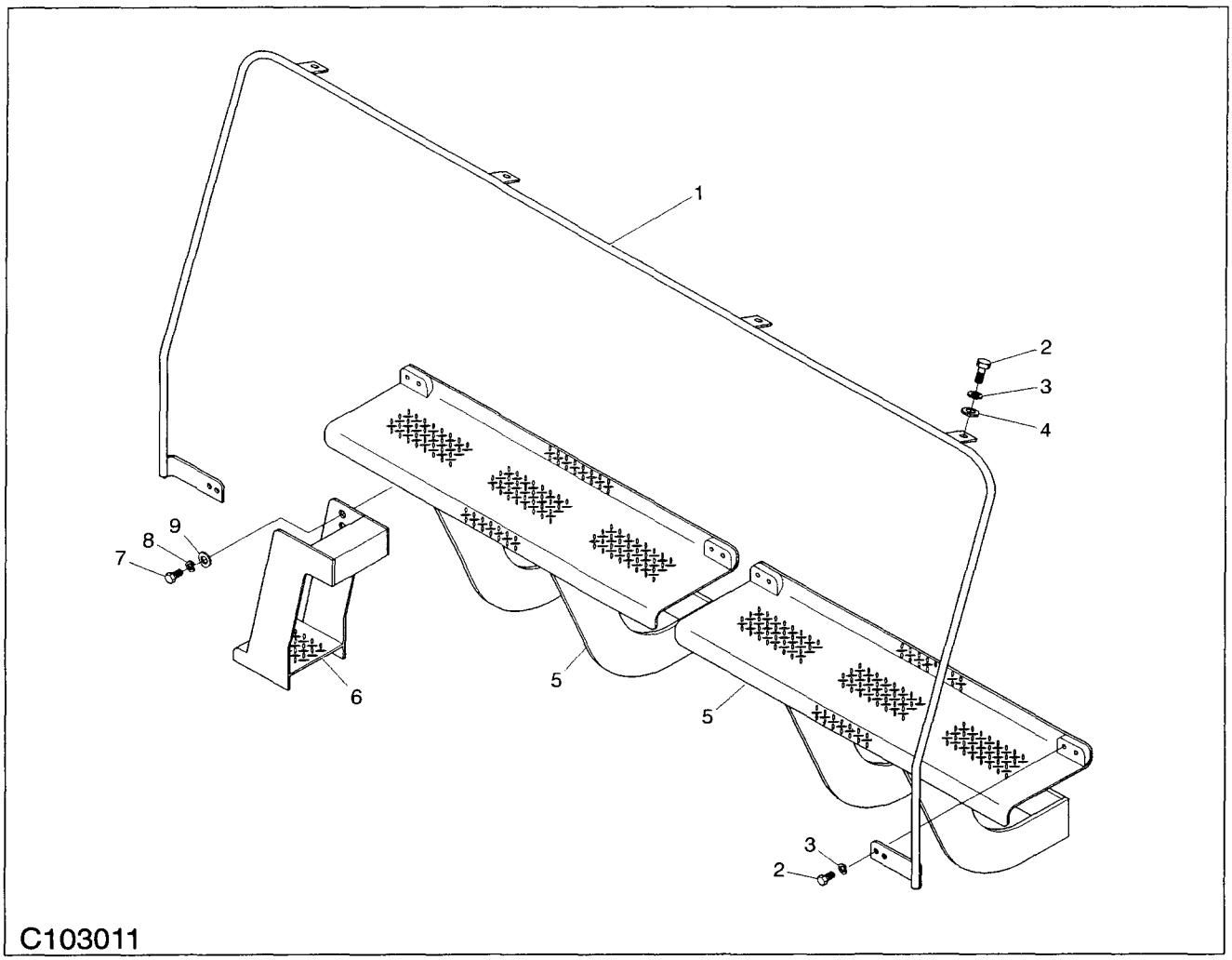
This group contains information on the cab doors, platform, handrail, side and bogie steps.

Cab Door



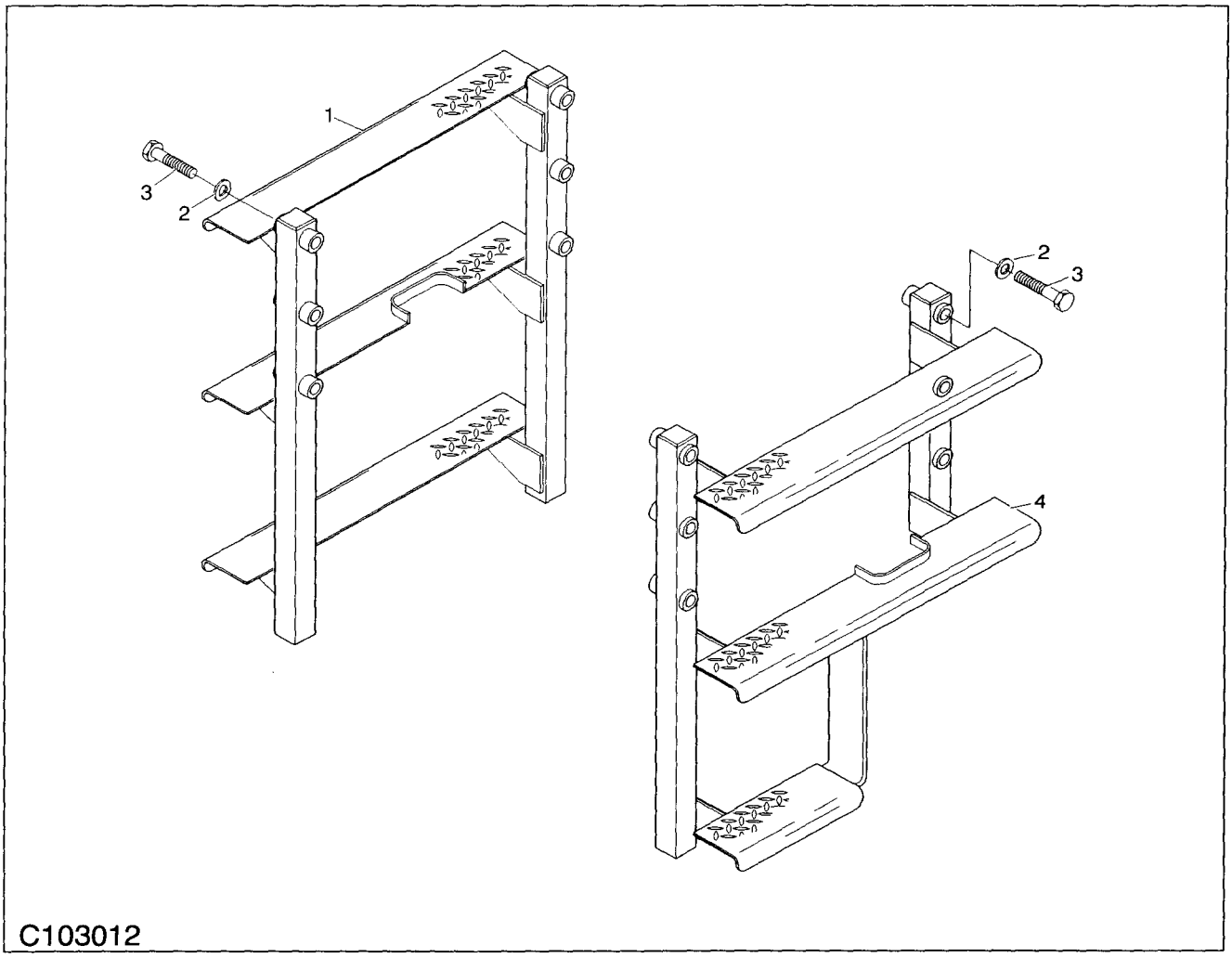
1	Door panel assembly left	9	Screw countersunk slotted head
2	Door catch	10	Striking plate
3	Door catch clamp	11	Shim
4	Packer	12	Plate
5	Screw countersunk head	13	Door seal bottom
6	Shim	14	Door seal
7	Plate	15	Tread plate
8	Bracket assembly		

Platform



1	Handrail	6	Side step
2	Bolt hex. head	7	Bolt hex. head
3	Washer spring	8	Washer spring
4	Washer plain	9	Washer plain
5	Platform		

Bogie Step



1	Bogie step right hand	3	Bolt hex. head
2	Washer plain	4	Bogie step left hand

Technical Data

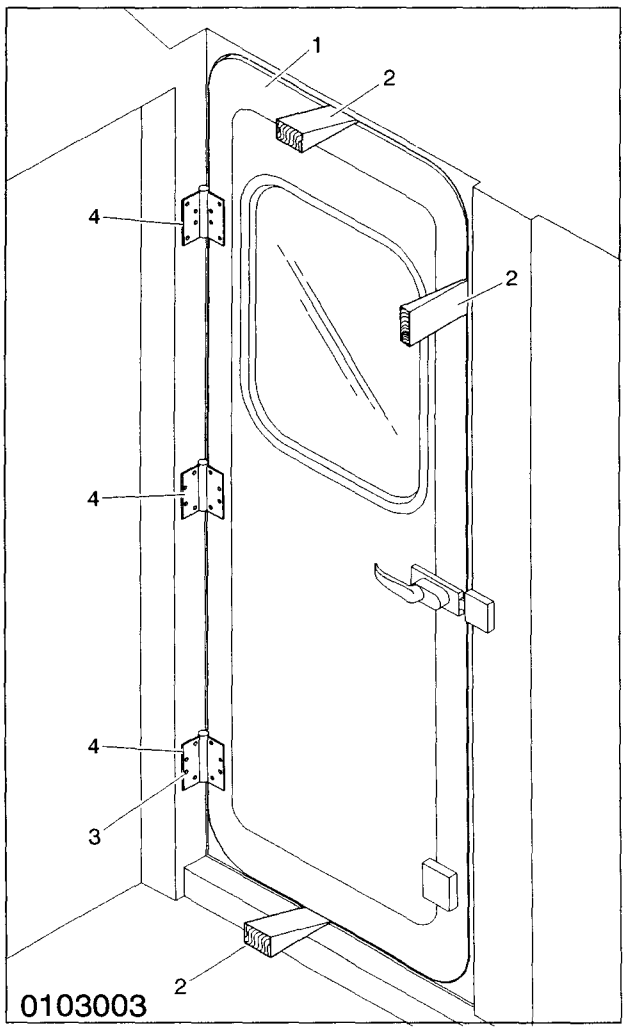
– DOOR TO FRAME CLEARANCE	5 mm (nominal)

Tools

Normal workshop equipment is required for the removal and installation of the cab side doors.

Removal

Cab Door



Unlatch the door (1).

Chock the door (1) in position using suitable wedges (2).

Loosen the screws (3) in all three hinges (4) at the door pillar.

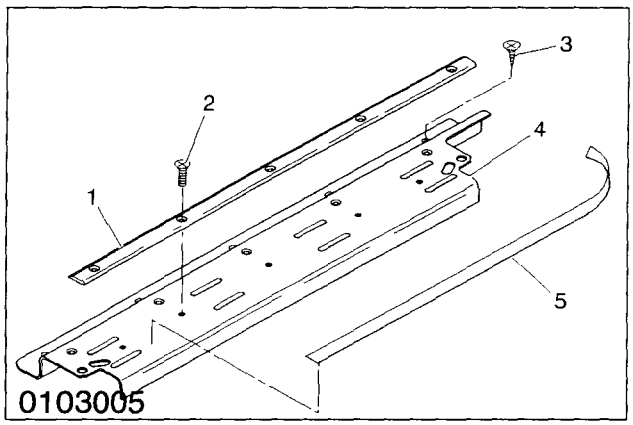
Remove the screws (3) starting at the bottom hinge (4).

NOTE:

The door assembly is heavy, over 45 kg. Have an assistant help remove the door.

With the aid of an assistant lift the door from the door opening. Lay the door horizontally, then remove the door from the cab.

Tread Plates



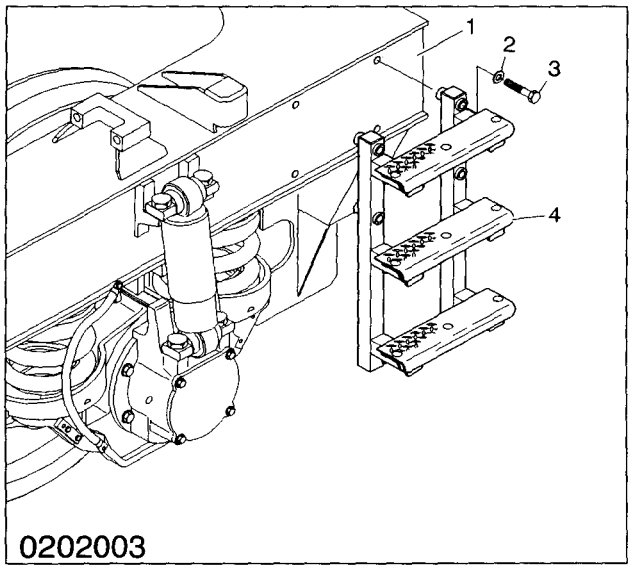
Unscrew the countersunk screws (2) securing the door strip (1) and the tread plate (4) to the door sill.

Unscrew the countersunk screws (3).

Remove the tread plate (4) from the door sill.

Clean the drainage channels and inspect the tread plate as described in Section Inspection and Repair.

Steps



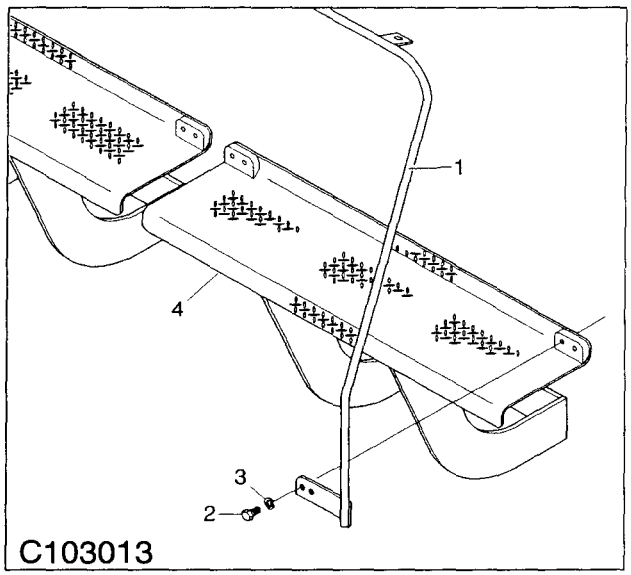
Support the step (4) using suitable lifting equipment.

Raise the equipment slightly to support the weight.

Remove the bolts (3) and the washers (2).

Remove the step from the bogie frame (1).

Platform

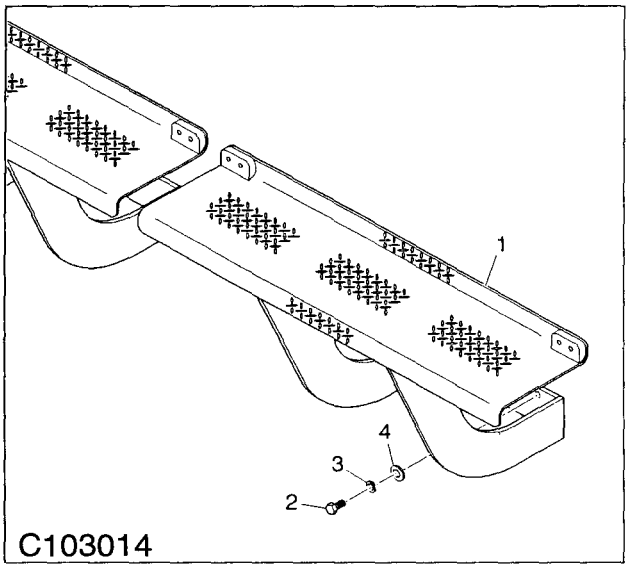


NOTE:

The platform assembly is heavy, over 32 kg. Use lifting equipment to handle the platform during maintenance procedures.

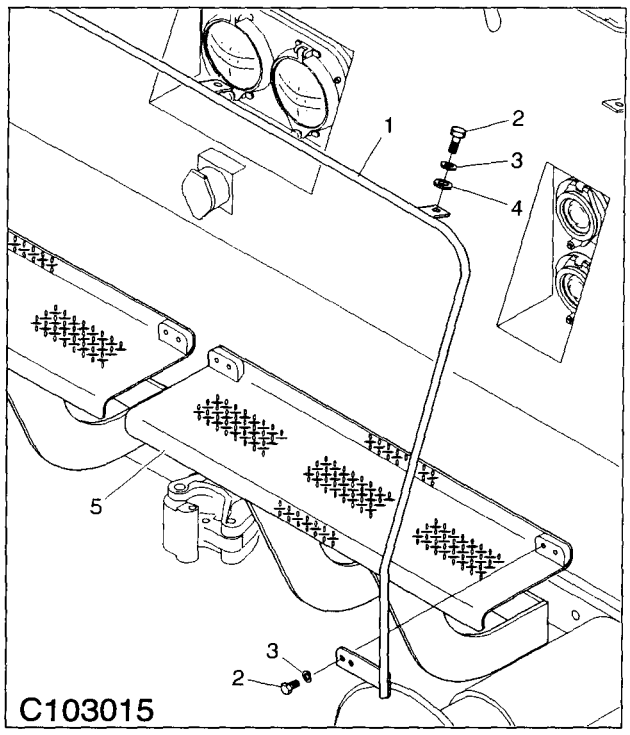
Support the platform (4) using suitable lifting equipment.

Remove the bolts (2) and washers (3) securing the handrail (1) to the platform (4), or, if necessary remove the handrail (1) as described in Handrail.



Remove the bolts (2), spring (3) and plain washers (4) securing the platform (1) to the headstock.

Handrail



NOTE:

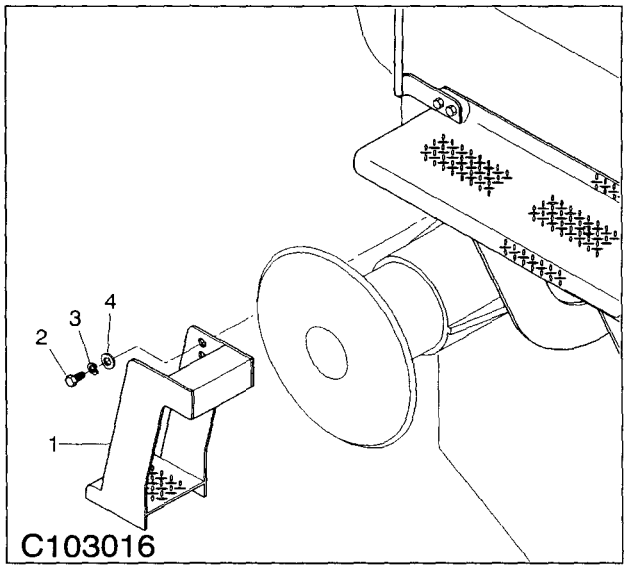
Have an assistant support the handrail during removal.

Remove the bolts (2), spring (3) and plain washers (4) securing the top bar of the handrail (1) to the lugs on the locomotive front panel.

Remove the bolts (2) and spring washers (3) securing the handrail (1) to the platform (5).

Remove the handrail (1) from the locomotive.

Side Step

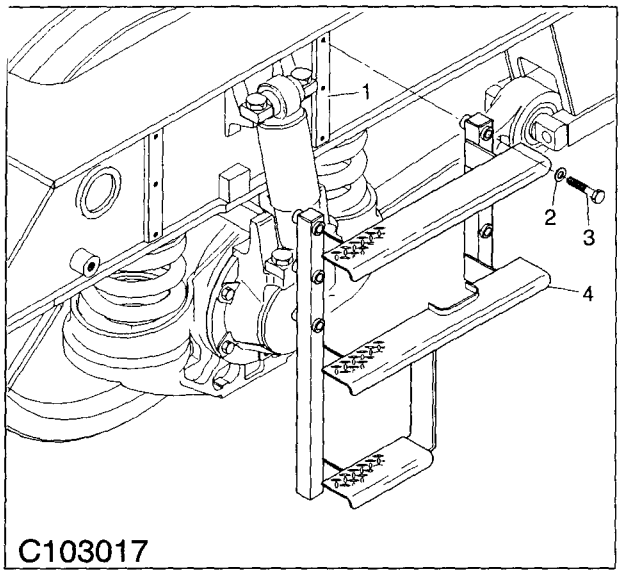


Support the side step (1) using a suitable stand.

Remove the bolts (2), spring (3) and plain washers (4) securing the side step (1) to the headstock.

Lift the side step (1) from the locomotive.

Bogie Step



Support the step (4) using a suitable stand.

Remove the bolts (3) and washers (2).

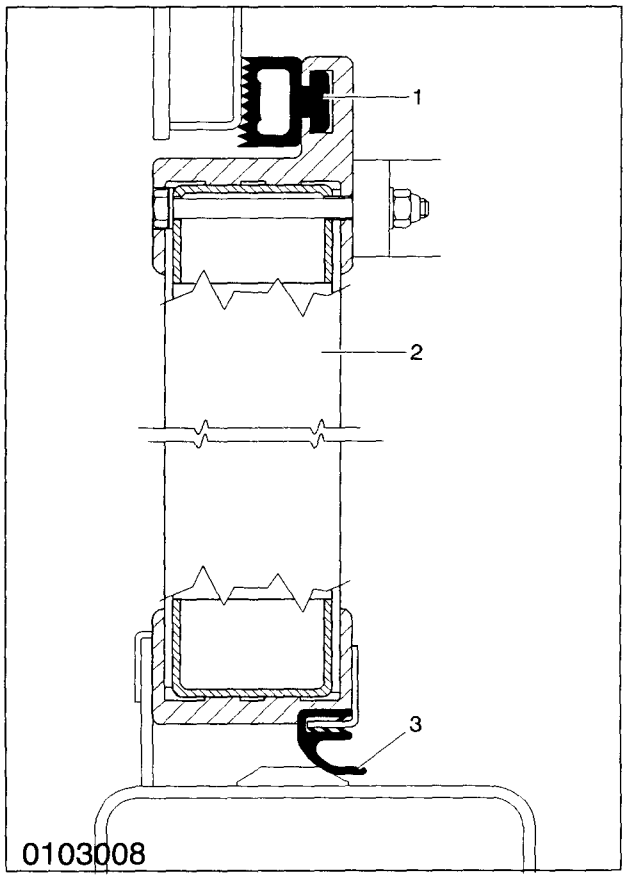
Remove step (4) from the bogie frame (1).

Disassembly

Disassembly procedures for the cab doors are described in the Southport Windows/Doors manual.

Inspection and Repair

Cab Door



Inspect the condition of the door seals (1, 3), replace if torn or damaged.

Remove the door seal (1) from the groove of the door (2).

Remove the door seal (3) at the bottom of the door.

Check the operation of the door handles and locks. Rectify any faults found.

Check the door hinges for excessive wear. Replace the hinges, if necessary.

Clear the door sill drainage channels of any obstructions.

Check the door sill for the formation of oxidation. Rectify any faults found.

Platform

Check the platform for cracks or damage to the support arms. Rectify any faults found.

Inspect the platform paint for chips or scratches. Repair any damaged paint to prevent corrosion.

Side Step

Check the side for cracks or damage to the support arms. Rectify any faults found.

Inspect the side step paint for chips or scratches. Repair any damaged paint to prevent corrosion.

Bogie Step

Check the bogie step for cracks or damage to the support arms. Rectify any faults found.

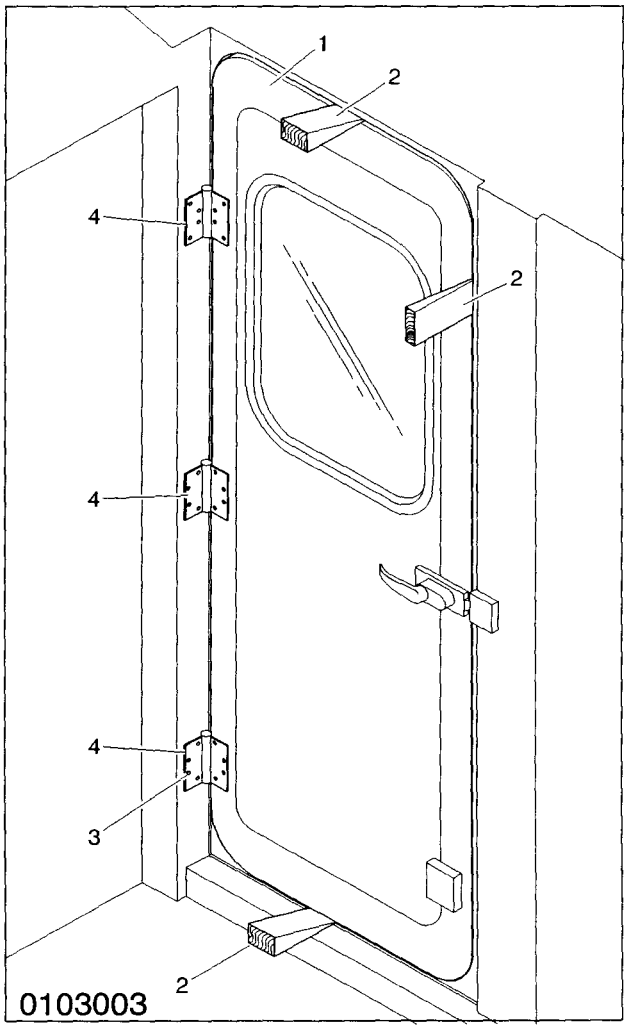
Inspect the bogie step paint for chips or scratches. Repair any damaged paint to prevent corrosion.

Assembly

Assembly procedures for the cab doors are described in the Southport Windows/Doors manual.

Installation

Cab Door



NOTE:

The door assembly is heavy, over 45 kg. Have an assistant help remove the door.

With the aid of an assistant, lift the door (1) through the opening into the cab.

Stand the door (1) upright with the window towards the top and the door hinges (4) facing inside the cab.

Lift the door (1) into the door opening. Position suitable wedges (2) at the top bottom and sides of the door to centralise it within the opening.

Install two screws (3) in the top and bottom hinges (4) then tighten the screws (3) to hold the door (1) in position.

Align the door so that the gap between the door and opening is even around the entire perimeter. The gap dimension is given in Section Technical Data.

Tighten the screws (3) in the hinges.

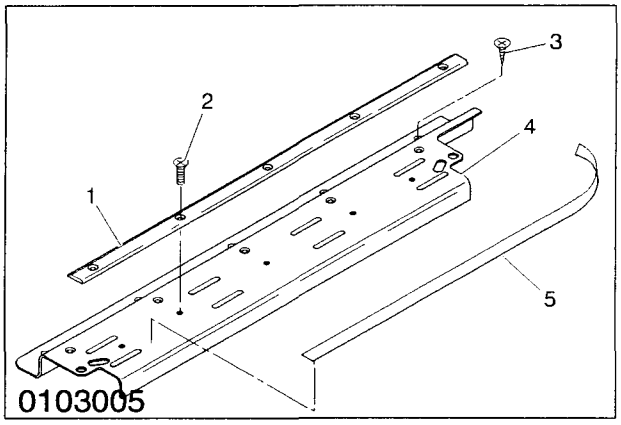
Install the remaining screws (3) and torque to specification.

Check the operation of the door. Ensure it latches securely.

Install the tread plates as described in Tread Plates.

Test the door for water leaks. Rectify any leaks found.

Tread Plates



Clean any remaining sealant from the door opening using a suitable scraper.

Wipe the area using a dry, clean, lint-free cloth.

Apply a 3 mm diameter bead of urethane sealant to the door sill underside edge of the tread plate (4).

Position the tread plate on the door sill.

Apply a small amount of urethane sealant under the head of the counter-sunk (3) and socket head (2) screws. Install the screws (2, 3) through the tread plate into the door sill and tighten to specification.

Wipe any excess sealant. Ensure the sealant does not obstruct the drain holes.

Apply a 3 mm diameter bead of urethane sealant approximately 5 mm from the door sill edge on the underside of the tread plate.

Position the tread plate on the door sill.

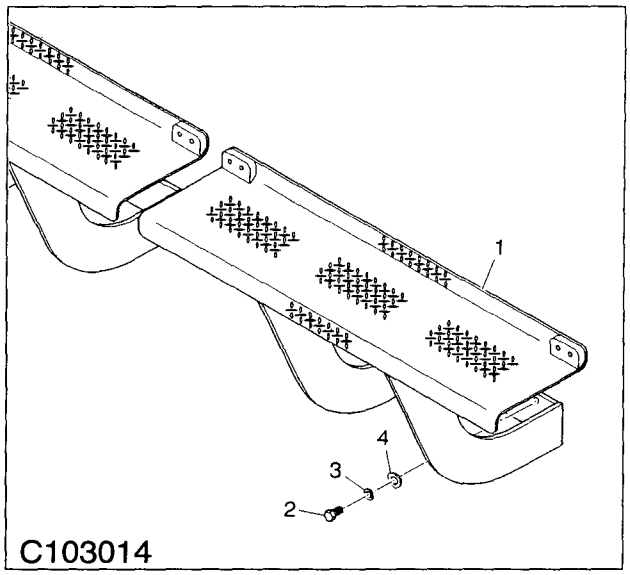
Apply a small amount of urethane sealant under the head of the counter-sunk screws.

Install the screws through the tread plate into the door sill and tighten to specification.

Install the self-tapping screws through the tread plate into the cab floor and tighten to specification.

Clean-up any excess sealant.

Platform



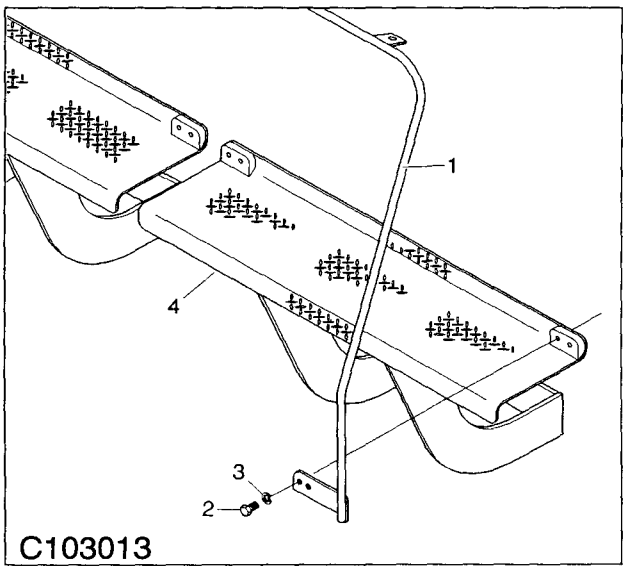
NOTE:

The platform assembly is heavy, over 32 kg. Use lifting equipment to handle the platform during maintenance procedures.

Position the platform (1) on the headstock and support using suitable stands.

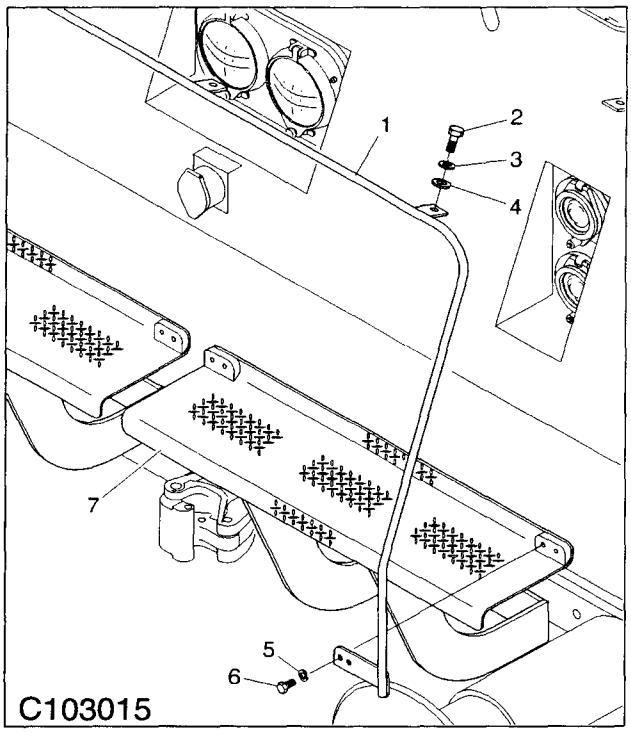
Align the bolt holes in the platform (1) and headstock.

Install the bolts (2), spring (3) and plain (4) washers to secure the platform (1) to the headstock.



Install the bolts (2) and washers (3) through the handrail (1) into the platform bracket (4), or, if necessary install the handrail (1) as described in Handrail.

Handrail



NOTE:

Have an assistant support the handrail during installation.

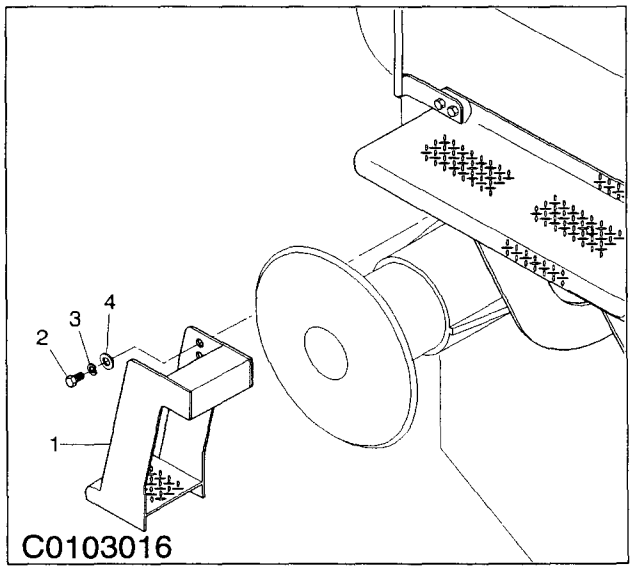
Position the handrail (1) on the locomotive front panel.

Install the bolts (2), spring (3) and plain washers (4) to secure the top bar of the handrail (1) to the lugs on the locomotive front panel.

Install the bolts (6) and washers (5) through the handrail (1) into the platform bracket (7).

Torque the bolts (6) to specification.

Side Step

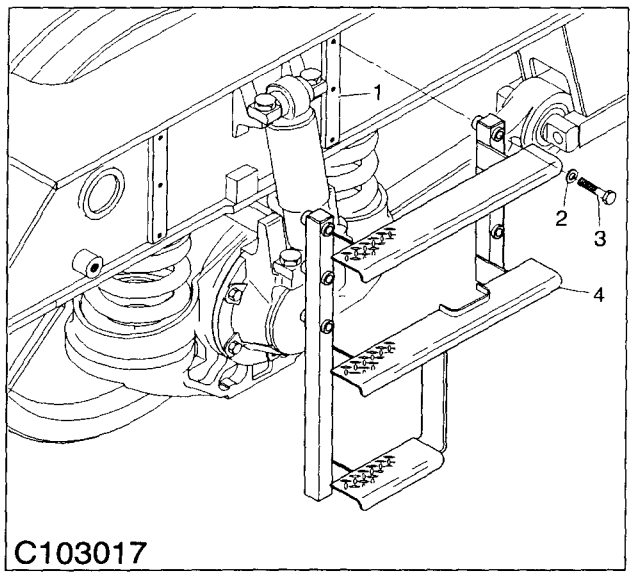


Position the side step (1) on the locomotive and support using a suitable stand.

Install the bolts (2), spring (3) and plain washers (4) through the side step (1) into the headstock.

Torque the bolts (2) to specification.

Bogie Step



Position the step (4) on the bogie frame (1) and support using a suitable stand.

Align the bolt holes in the bogie frame (1) and step.

Install the bolts (3) and washers (2) through the step into the bogie frame (1).

Torque the bolts (3) to specification.

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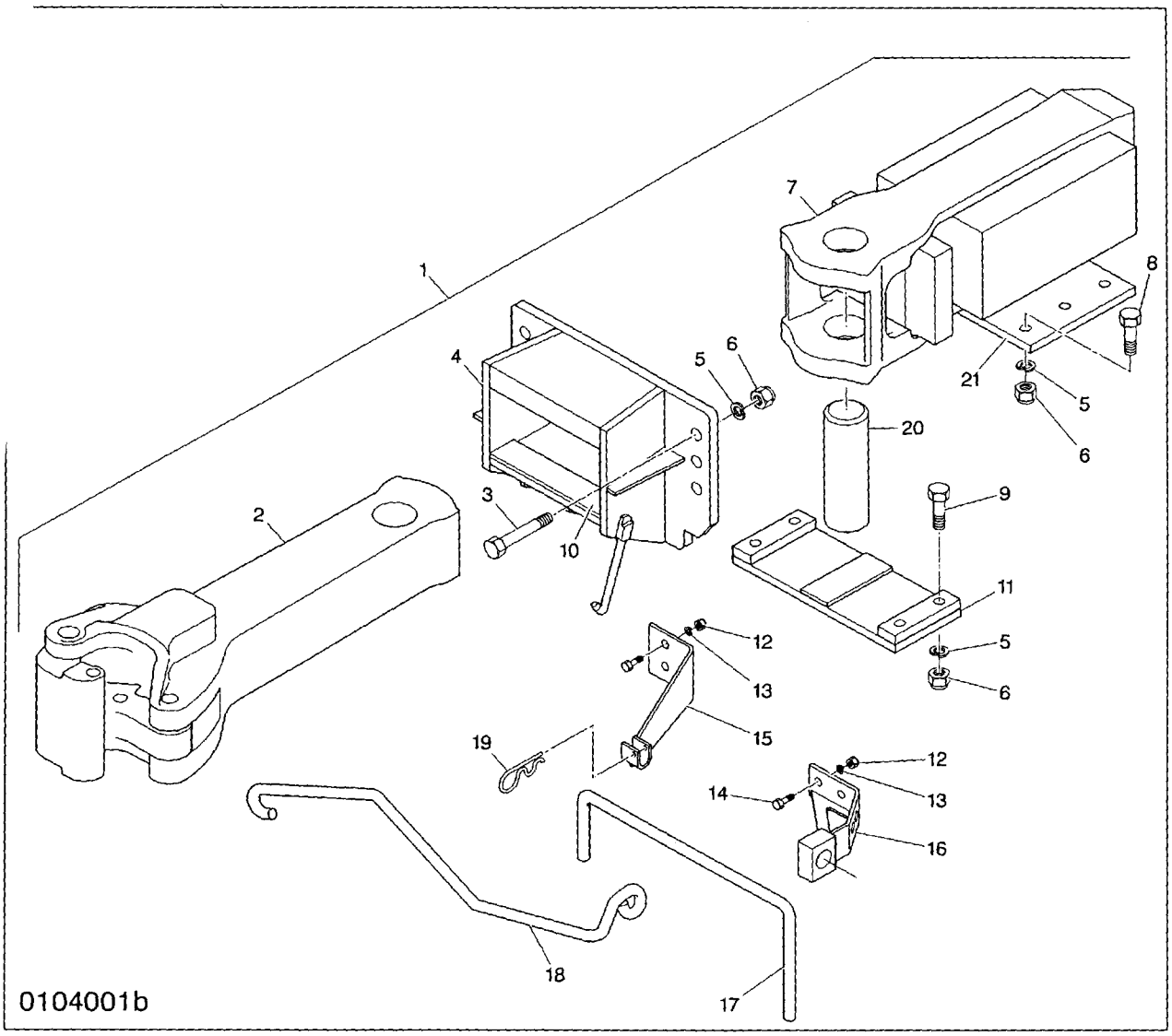
1.4 Draftgear and Couplers

Group Summary

@.1120

This chapter contains information regarding the draftgear which consist of; coupler, draftgear and uncoupler handles fitted to the headstocks at each end of the locomotive.



1	Draftgear and coupler	12	Hex nut Nyloc
2	Coupler	13	Spring washer
3	Hex bolt	14	Hex bolt
4	Striker block	15	Inner uncoupler bracket
5	Spring washer	16	Outer uncoupler bracket
6	Hex nut Nyloc	17	Short operating rod
7	Draftgear	18	Long operating rod
8	Hex bolt	19	R-clip
9	Hex bolt	20	Yoke pin
10	Striker block wear plate	21	Draftgear support plate
11	Yoke pin support plate		

Functional Description

@.1140

Also refer to BESCO's technical documentation.The draftgear and couplers are used to connect the locomotive to the trainset. The draftgear is secured to the headstock on the underframe and houses the knuckle coupler. The draftgear is installed compressed into a pocket in the underframe. Once in position, retaining pins are removed and the draftgear expands into the pocket for a secure fit. The draftgear absorbs buffing and shunting forces during operation of the locomotive.

The coupler pivots in the draftgear on a yoke pin which is held in position by a plate. A striker block prevents damage to the draftgear and locomotive by limiting the couplers range of movement. The striker block provides additional vertical support for the coupler.

Rods and levers act as uncoupler handles to release the coupler. The handles are designed to allow release of the couplers from the side of the locomotive.

Technical Data

@.1160

Draftgear and Coupler

- Manufacturer	BESCO, India
- Coupler type	Knuckle

Coupler

- Weight	178.2 kg

Yoke Pin

- Weight	15.5 kg
- Pin diameter	88.9 mm

aftgear

Weight	99.88 kg
Knuckle weight	36.97 kg

olerances and Wear Limits List

@.1170

Refer to BESCO's technical documentation.

Tools and Special Tools

@.1180

In addition to conventional railways workshop tools and equipment, lifting equipment and safety stands are required for the procedures described in this chapter.

Miscellaneous Materials

@.1200

The procedures described in this chapter require multi-purpose grease.

Before-Removal Operations

@.1220

Steam clean the draftgear, underframe in draftgear region, coupler, uncoupling handles, and surrounding area, remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

Damage to the components can result from improper application of the steam cleaning equipment. Do not direct the spray stream into the axle box drain holes or into the traction motor ventilation openings.

Removal

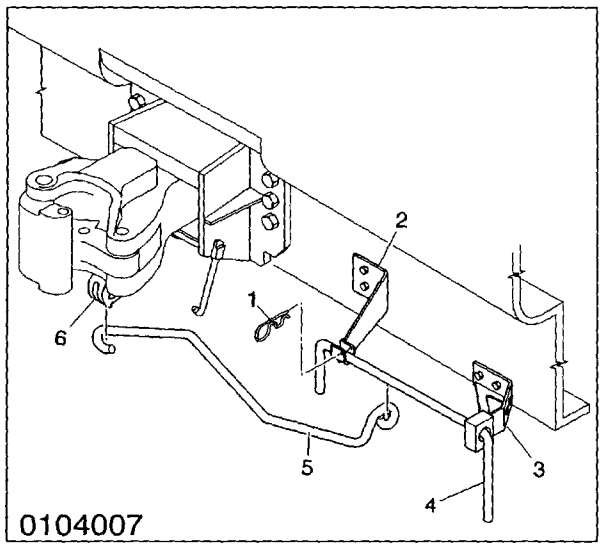
@.1230

WARNING:

The draftgear and couplers are heavy. Use suitable lifting equipment and handle with care to avoid personal injury or damage.

Uncoupler Handles

LONG OPERATING ROD



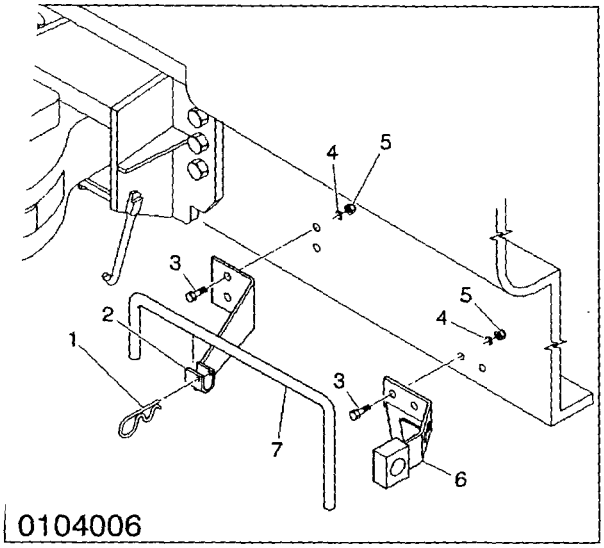
Remove the R-clip (1) from the inner uncoupler bracket (2).

Lift the short rod (4) out of the bracket (2).

Disconnect the long operating rod (5) from the coupler lock lift (6).

Manipulate the long operating rod (5) off the short operating rod (4).

IORT OPERATING ROD



Slide the short operating rod (7) from the outer uncoupler bracket (6).

Remove the bolts (3), washers (4), nuts (5) securing the outer uncoupler bracket (6) to the headstock.

Remove the outer uncoupler bracket (6) from the locomotive.

Remove the bolts (3) securing the inner uncoupler bracket (2) to the headstock, then remove the bracket (2).

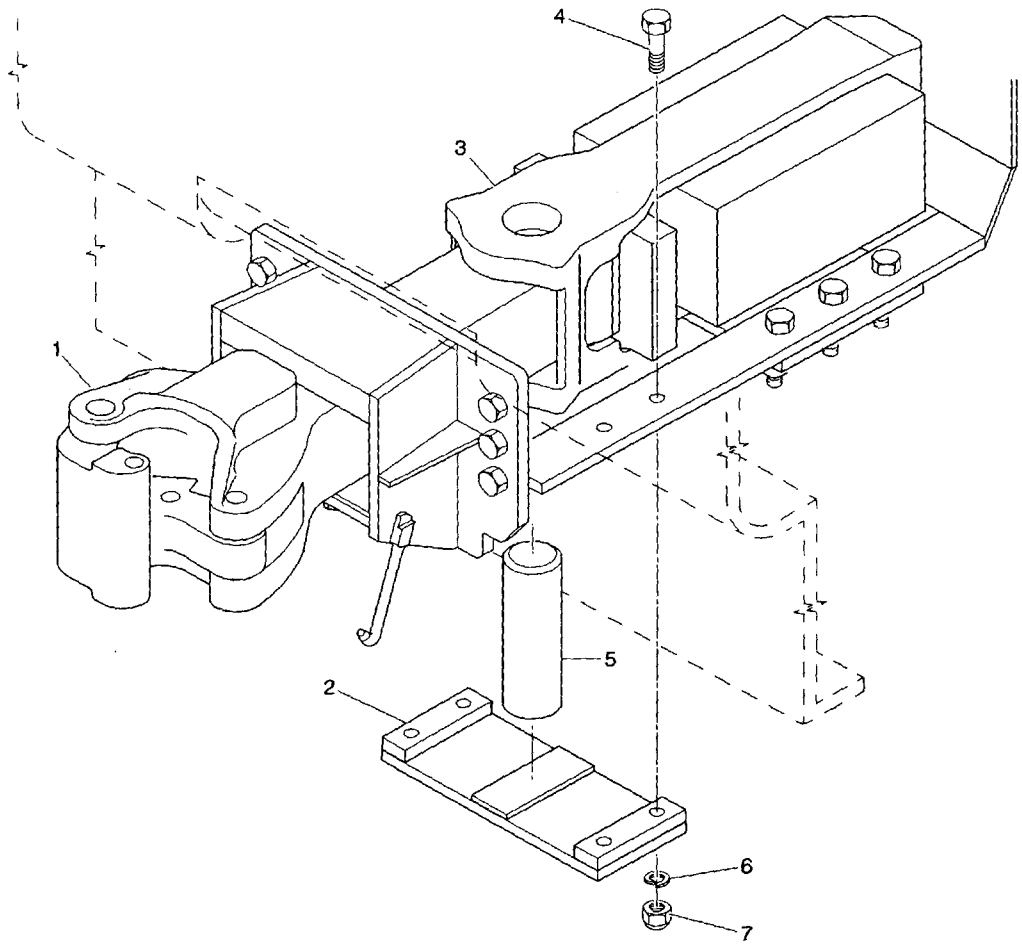
Coupler

Remove the uncoupler handles as previously described.

Disconnect the long operating rod from the coupler as described in Section Disassembly, Long Operating Rod.

Attach suitable lifting equipment to the coupler.

Raise the lifting equipment slightly to support the weight.



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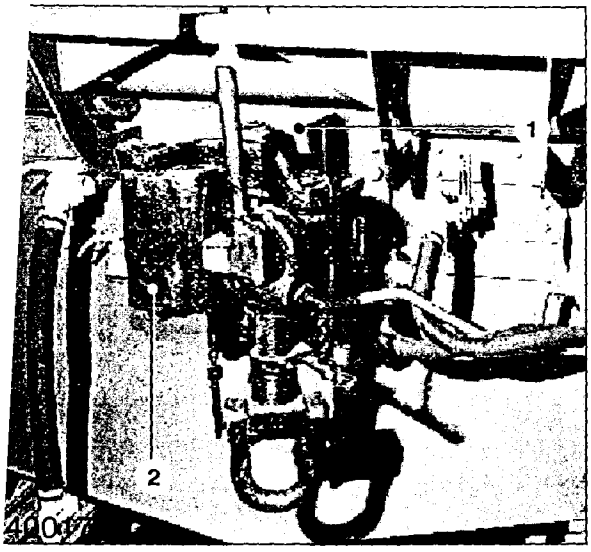
Position a stand below the yoke support plate (2) at the joint where the coupler pivots in the draftgear (3).

Remove the four lock nuts (7) and washers (6) securing the yoke pin support plate (2).

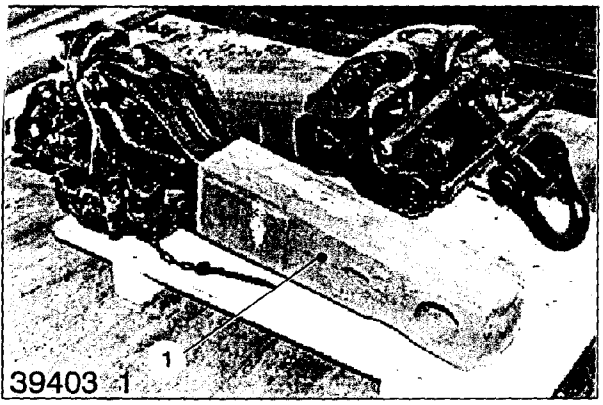
NOTE:

The coupler will move when the yoke pin is withdrawn. It is important to ensure the coupler is properly supported.

Remove the yoke support plate (2), then withdraw the yoke pin (5) from the draftgear (3).



Withdraw the coupler (2) from the draftgear until it is clear of the striker block (1).

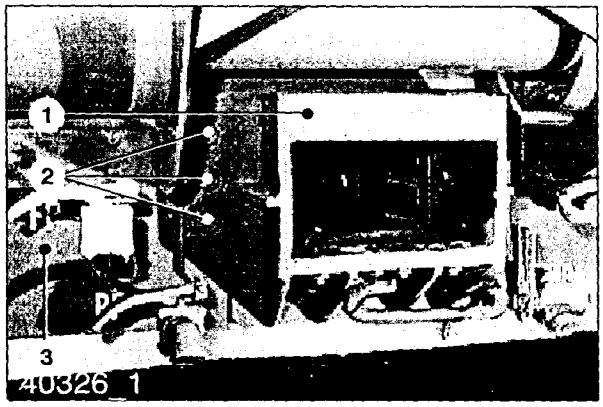


Move the coupler (1) to a suitable location.

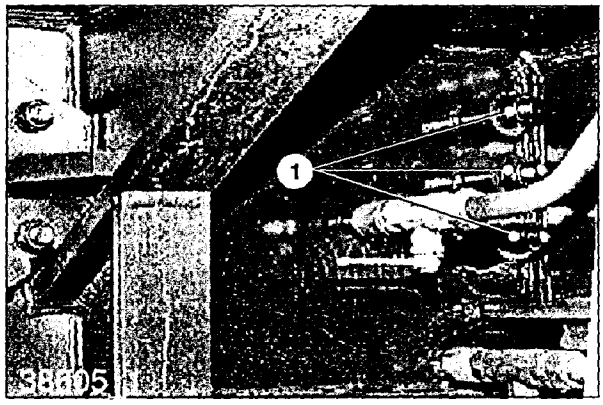
Inspect the condition of the coupler (1) as described in Section Inspection and Repair.

Striker Block

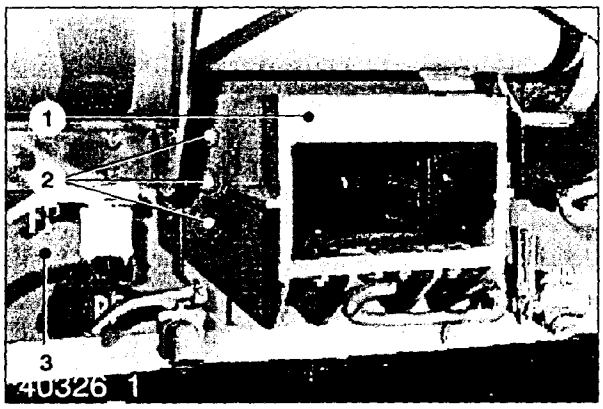
Remove the coupler as previously described.



Support the striker block (1) using a safety stand.



From behind the headstock, loosen the three lock nuts (1) on each side of the striker block. Remove locknuts and washers behind the headstock.



Ensure the striker block (1) is properly supported, then remove the bolts (2) securing the striker block (1) to the headstock (3).

NOTE:

Use care when removing the striker block to avoid damaging the adjacent pipe unions.

Remove the striker block (1) from the headstock (3).

ıftgear

ımove the coupler as previously described.

ıe draftgear is spring fit into the draftgear pocket on the locomotive underframe. The draft-
ar must be compressed and secured with locking plates during removal and installation.
efer to BESCO's technical documentation.

)isassembly

.1240

:oupler

Refer to BESCO's technical documentation.

Inspection and Repair

@.1250

Check the condition of the R-clip and replace if damaged or rusty.

Inspect the striker block wear plate. Remove and replace the wear plate, if necessary.

Refer to BESCO's technical documentation.

Waste Disposal

@.1260

Dispose of waste parts and materials according to the prevailing environmental standards or workplace practices.

Assembly

@.1270

Coupler

Refer to BESCO's technical documentation.

Installation

@.1280

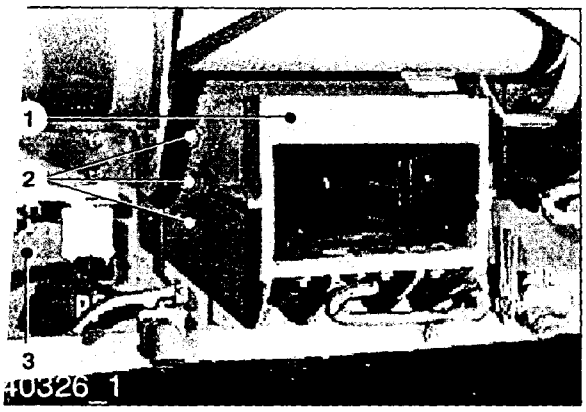
WARNING:

The draftgear and couplers are heavy. Use suitable lifting equipment and handle with care to avoid personal injury or damage.

Draftgear

The draftgear is spring fit into the draftgear pocket on the locomotive underframe. The draftgear must be compressed and secured with locking plates during removal and installation. Refer to BESCO's technical documentation.

ıiker Block



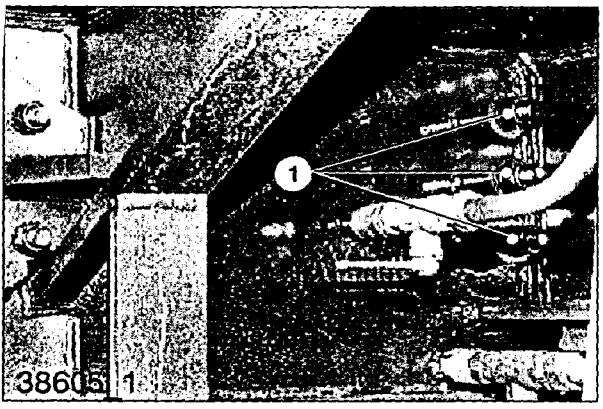
NOTE:

Use care not to damage the adjacent pipe unions when installing the striker block.

Position the striker block assembly (1) on the headstock (3). Support the block using safety stands.

Align the holes in the striker block (1) with those in the headstock (3).

Install the bolts (2) through the block (1) and headstock (3).

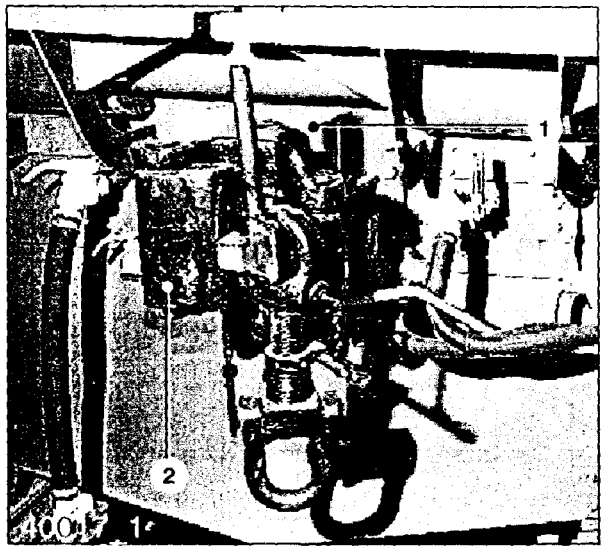


Apply a light film of grease to the threads.

Install the spring washers and nuts (1).

Check the striker block is installed square, then torque the nuts (1) to 576 Nm.

Coupler



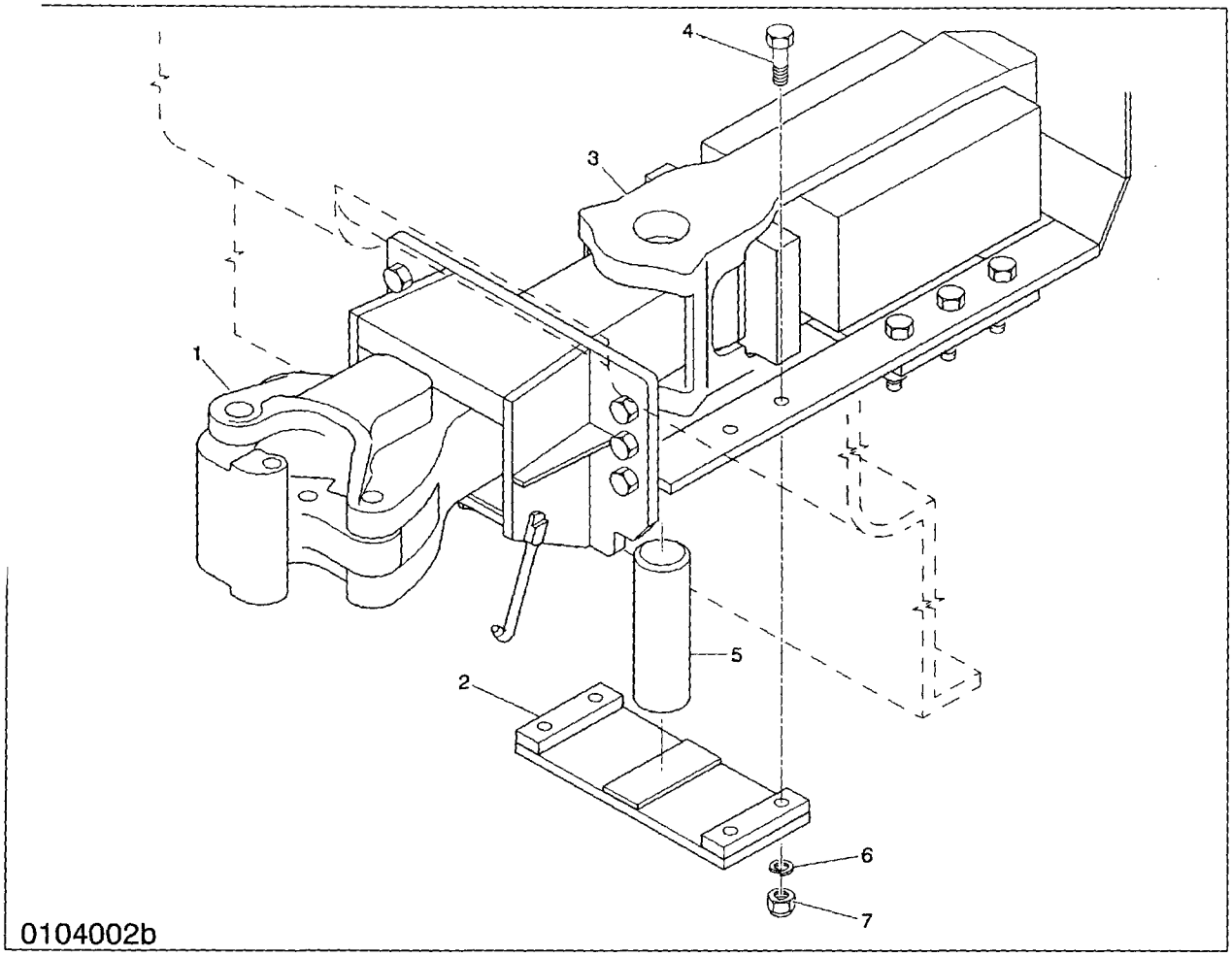
If necessary, install the draftgear as previously described.

If necessary, install the striker block as previously described.

The coupler (2) is installed with the knuckle pin on the assistant's side of the locomotive. Adjust the orientation of the coupler (2) as necessary, then attach suitable lifting equipment to the coupler (2).

Position the coupler (2) in front of the striker block (1).

Check the coupler (2) is oriented correctly, insert the coupler (2) through the aperture in the striker block (1) and into the draftgear yoke.



NOTE:

It may be necessary to have an assistant guide the coupler (1) into the yoke (3).

Align the yoke pin hole in the coupler (1) with the yoke in the draftgear (3). Position suitable supports to maintain the position of the two components.

Insert the yoke pin (5) through the yoke pin hole in the draftgear (3) and the coupler (1). Install the yoke pin support plate (2) on the headstock.

Position a stand below the yoke pin support plate (2).

Install the bolts (4) through the headstock and yoke pin support plate (2).

Apply a light film of grease to the bolt threads.

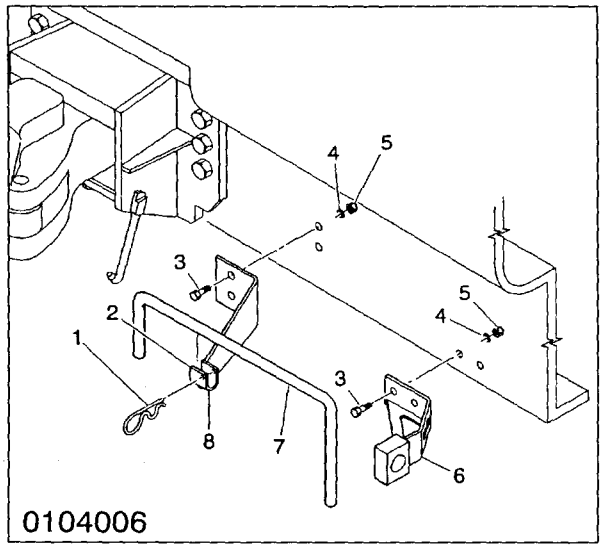
Install the washers (6) and lock nuts (7) and torque to 576 Nm.

Connect the long operating rod to the coupler (1), or install the handles, as required, as described in Uncoupler Handles in this Section.

Uncoupler Handles

Install the coupler, if necessary, as previously described.

SHORT OPERATING ROD



Position the inner uncoupler bracket (8) on the headstock with the rod seat outboard.

Align the holes and install the bolts (3) through the bracket (8) and headstock.

From behind the headstock, install the spring washers (4) and lock nuts (5) on the bolts (3). Tighten the nuts.

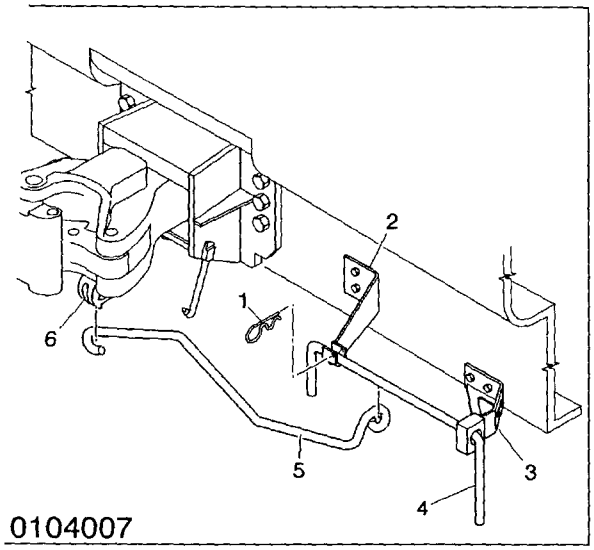
Slide the outer uncoupler bracket (6) onto the short operating rod (7) with the bush towards the long handle.

Position the outer uncoupler bracket (6) and rod assembly on the headstock.

Align the holes and install the bolts (3) through the bracket and headstock.

From behind the headstock, install the spring washers (4) and lock nuts (5) on the bolts (3). Tighten the nuts.

)NG OPERATING ROD



0104007

Lift the short operating rod (4) from the inner uncoupler bracket (2), if necessary.

Manipulate the long operating rod (5) into the short operating rod (4) with the hook of the long rod eye facing downwards.

Connect the long operating rod (5) to the coupler lock lift lever (6).

Place the short operating rod (4) into the inner uncoupler bracket (2).

Install the R-clip (1) into the inner uncoupler bracket (2).

Adjust the uncoupling clevis on the coupler and test the operation of the uncoupler.

After-Installation Operations

@.1290

Repair any chipped or damaged paint, refer to Chapter 1.2, Exterior Finish. Ensure all unpainted surfaces are coated with grease to prevent oxidation.

Adjustments

@.1310

Test the operation of the uncouplers, adjust the uncoupling clevis if necessary.

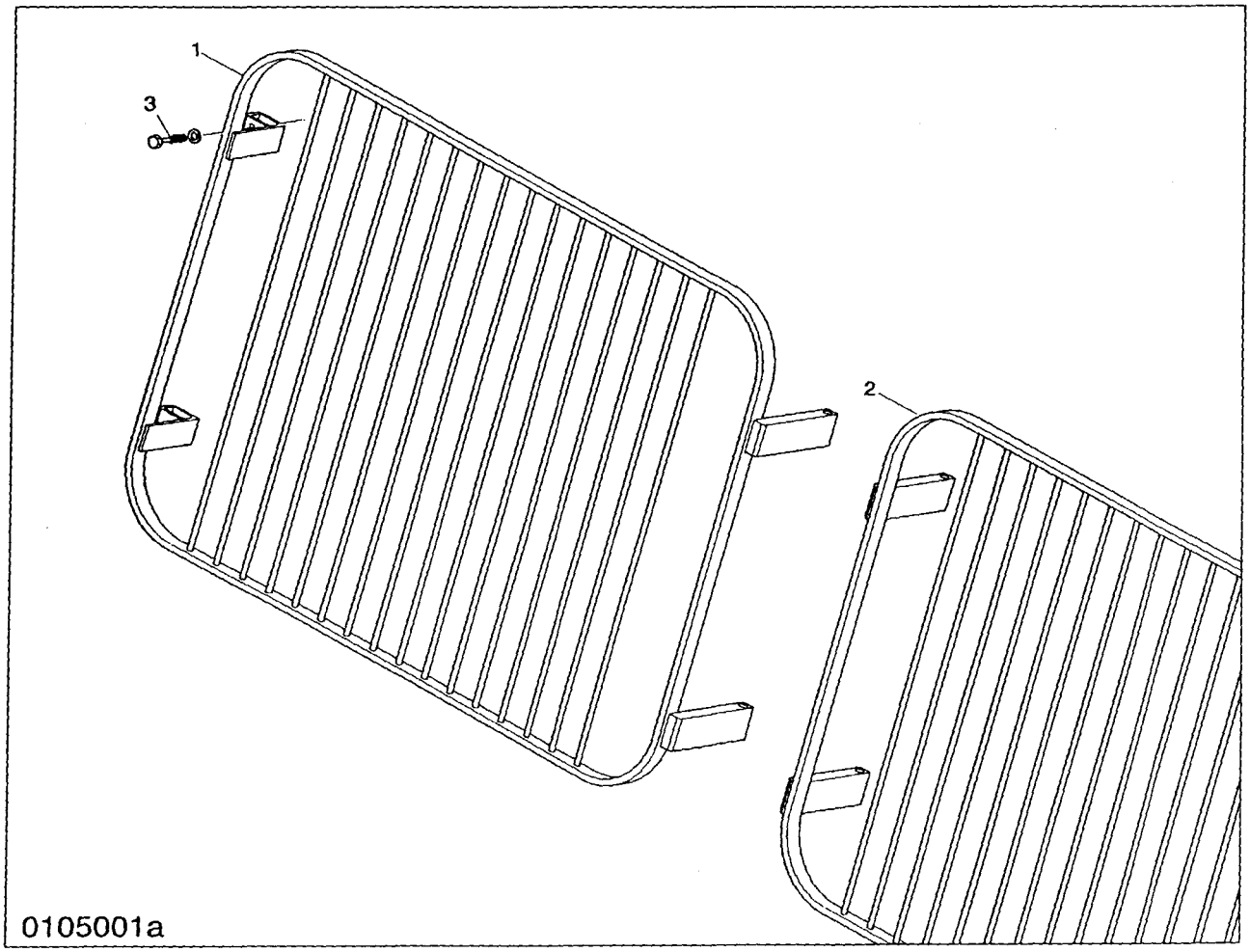
1.5 Windows

Group Summary

@.1120

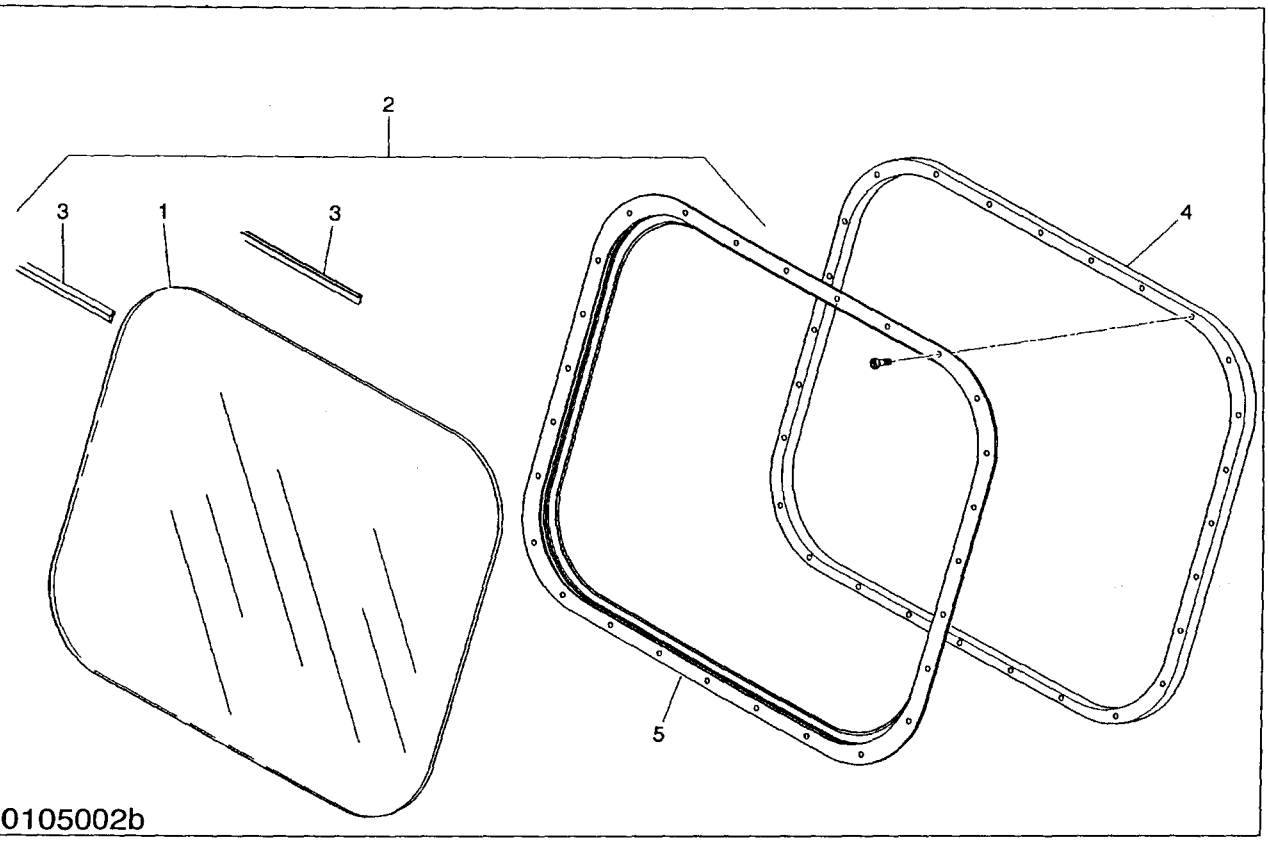
This chapter contains information on the cab windscreen and side window which consist of; front windscreens, windscreen guard grilles and side windows.

Windscreen Guard Grille



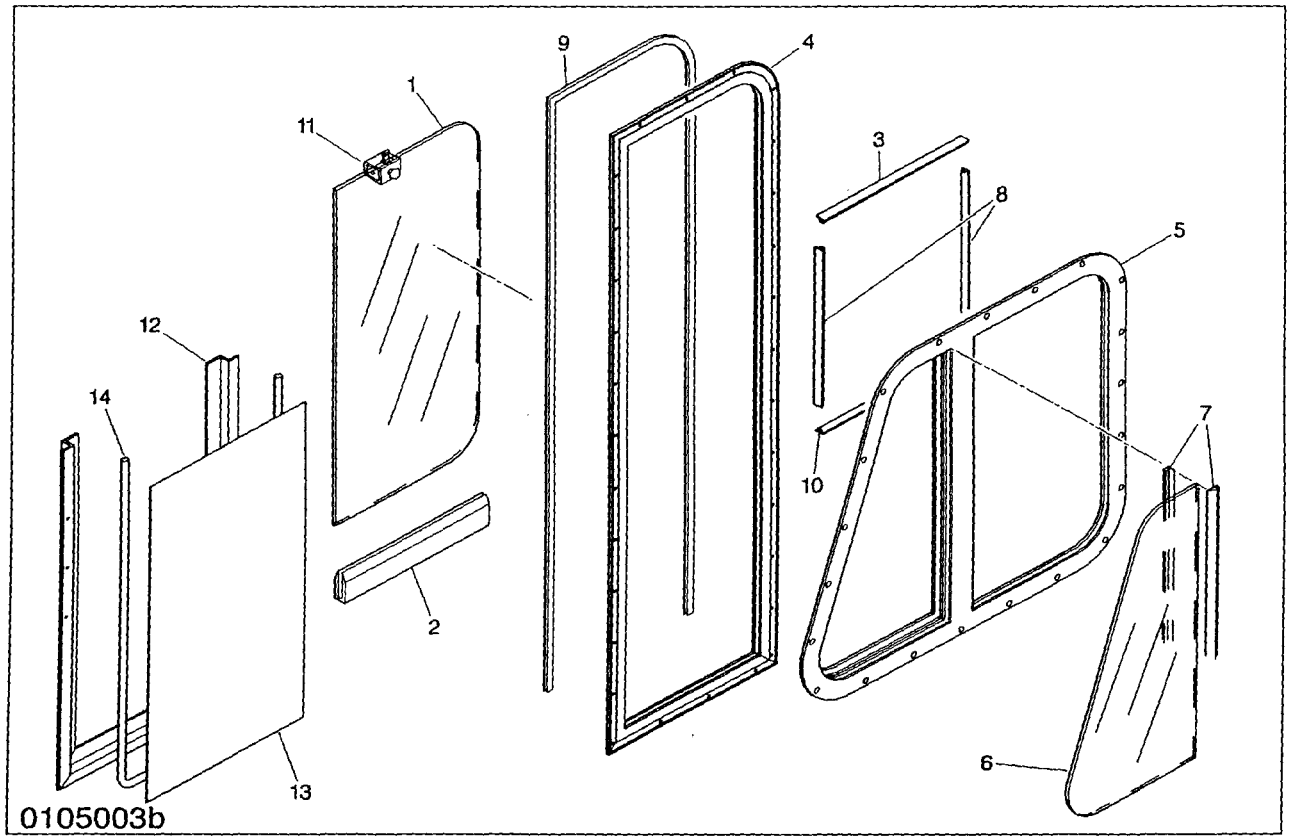
1	Windscreen guard grille right	3	Bolt
2	Windscreen guard grille left		

Windscreen



1	Windscreen	4	Mounting bar
2	Windscreen assembly	5	Windscreen frame
3	Windscreen seals		

Side Windows



NOTE:

This illustration shows the side window assembly of the driver's side.

1	Sliding window	8	Sliding window seals
2	Window dam	9	Sliding window channel seal
3	Sliding window water seal, upper	10	Sliding window water seal, lower
4	Sliding window frame	11	Sliding window catch
5	Side window frame	12	Splash shield retainer
6	Quarter window	13	Splash shield
7	Quarter window seals	14	Splash shield seal

Functional Description

2.1140

The locomotive is fitted with two rectangular windscreens in the end of each cab to provide protection for cab occupants from external conditions. Guard grilles are fitted ahead of the windscreens to prevent large objects from striking the windscreens.

Side windows are located on each cab side wall ahead of the doorway to provide peripheral vision from the locomotive. Each window has a fixed triangular portion, and a sliding rectangular window which may be opened to provide additional ventilation.

When closed, seals around the perimeter minimise the entry of water, dust and other debris. Excess water is caught by a gutter inside the cab, below the window. A channel ducts water from the gutter to a drain hole in the forward hand rail alcove. A rubber flap seals the drain hole.

Technical Data

2.1160

- Windscreen glass thickness	10.76 mm
- Windscreen glass type	laminated, clear to AS2080
- Side quarter window glass thickness	6.0 mm
- Side quarter window glass type	toughened, clear
- Side sliding window glass thickness	6.38 mm
- Side sliding window glass type	laminated, clear

Tolerances and Wear Limits List

1170

The windscreen and side windows must always be in good order. The glass should be replaced when cracked or damaged, or if chipping or pitting impedes visibility.

The sealing rubbers for the side sliding window should be replaced if worn or damaged.

Tools and Special Tools

@.1180

In addition to conventional workshop equipment, support props with suction pads are required for maintenance procedures described in this chapter.

Bead roller or hammer and chock are required for installation of glass panes as described in Chapter 3, Doors and Steps of Volume F1, Suppliers Documentation.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Masking tape
- Sikaflex 15LM sealant
- Loctite 222
- Suitable glass cleaning solution
- Clean dry lint free cloth.

Before-Removal Operations

@.1220

WARNING:

Wear suitable gloves when handling glass to prevent personal injury.

Before any maintenance procedures described in this chapter are carried out, ensure any broken or damaged glass is carefully removed and disposed of properly.

Windscreens

Remove the wiper arm assembly as described in Chapter 1.7, Washers/Wipers.

Side Windows

Remove the windscreen washer reservoir as described in Chapter 1.7, Washers/Wipers to allow removal of the assistant driver's side window.

To remove the driver's side window, first remove the cover panels from the desk, below the direct air brake handle. Plot the location of the screws using the assistant driver's side window

as a template, then cut suitable holes to access the screws using a hole saw. Take care not o damage the adjacent pneumatic piping.

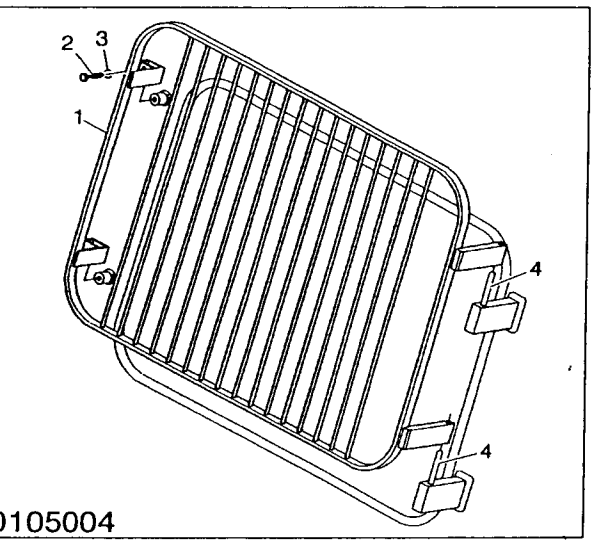
Removal

.1230

NOTE:

Replacement of the windscreen and side window glasses is described in Chapter 3, Doors and Steps of Volume F1, Suppliers Documentation

Windscreen Guard Grille

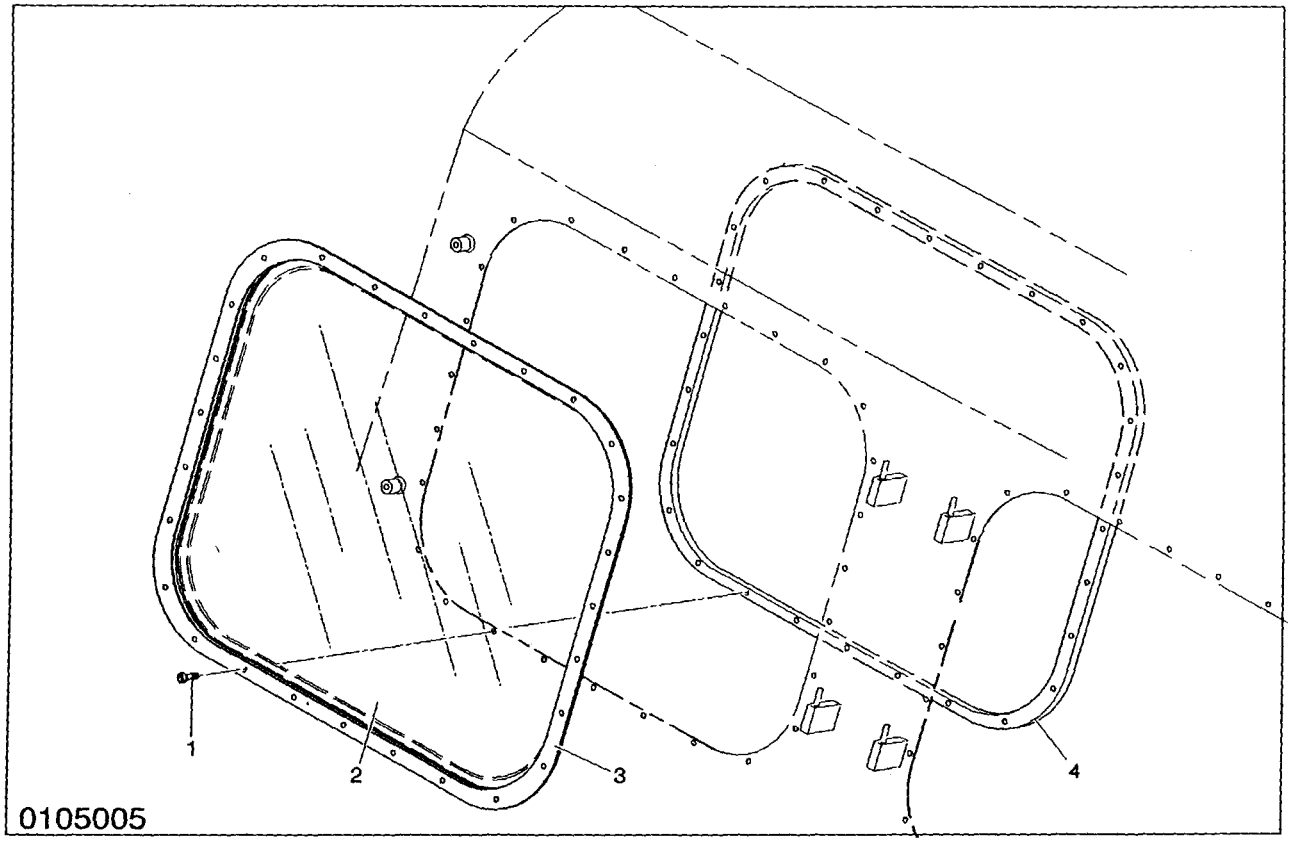


0105004

Open and remove the windscreen guard grille (1) as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

Inspect the grille (1) as described in Section Inspection and Repair.

Windscreen



Apply masking tape to hold the windscreen mounting bar (4) to the inside of the cab wall.

From outside the cab, unscrew the thirty screws (1) around the windscreen frame (3) in an alternating pattern, starting at the center bottom and working towards the center top.

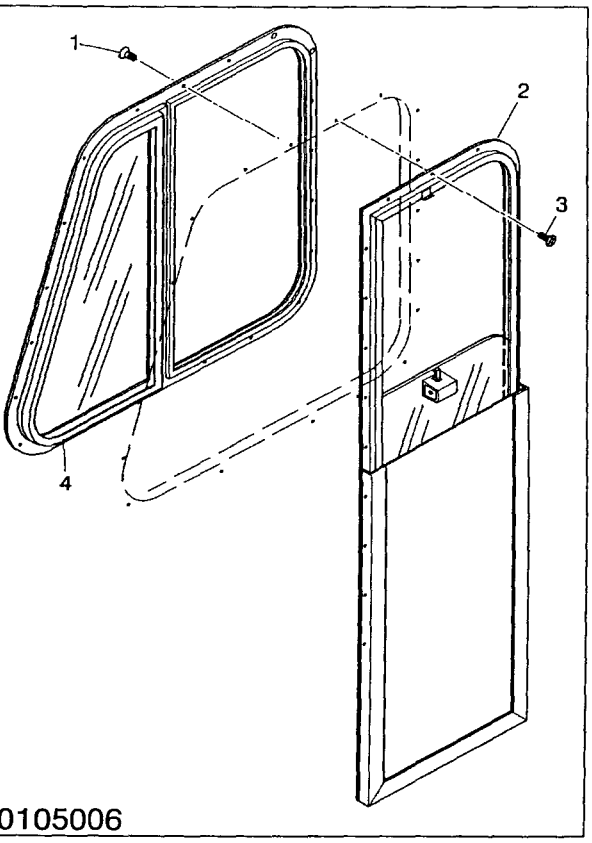
When all the screws (1) have been removed, have an assistant remove the windscreen mounting bar (4) from inside the cab.

While holding the windscreen assembly (2) to prevent it falling, have the assistant push the windscreen assembly (2) from inside the cab. The windscreen frame (3) is sealed to the cab front. Some effort may be required to break the seal.

Lift the windscreen assembly (2) from the locomotive.

Inspect the condition of the windscreen. Refer to Chapter 3, Doors and Steps of Volume F1, Suppliers Documentation.

Side Window



0105006

From inside the cab, remove the screws (3) around the sliding window frame (2) in an alternating pattern, starting at the center bottom and working towards the center top.

Separate the sliding window assembly (2) from the inside cab wall. The sliding window assembly (2) is sealed to the cab wall. It may be necessary to prise the sliding window assembly (2) from the wall to break the seal. Position support props with suction pads on the window to support its weight.

From outside the cab, unscrew the screws (1) around the side window frame (4).

While holding the side window assembly (4) to prevent it falling, have the assistant push the side window assembly (4) from inside the cab. The side window frame (4) is sealed to the cab wall. Some effort may be required to break the seal.

Inspect the condition of the side windows and windscreen. Refer to Chapter 3, Doors and Steps of Volume F1, Suppliers Documentation.

isassembly

240

sassembly of the windscreen and side windows is described in Chapter 3, Doors and Steps Volume F1, Suppliers Documentation.

Inspection and Repair

@.1250

Clean the catchment gutter and drain hole of the side window. Refer to Chapter 1.1, Structure. Remove all built-up dirt and debris from the gutter and ensure the drain hole is free of all obstructions.

Windscreen Guard Grille

Check the condition of the windscreen guard grilles. Rectify any faults found.

Check the windscreen guard grilles for chipped or damaged paint. Repair any damaged paint to prevent corrosion. Refer to Chapter 1.2, Exterior Finish.

Windows and Windscreen

Inspect the condition of the side windows and windscreen. Refer to Chapter 3, Doors and Steps of Volume F1, Suppliers Documentation.

Check the condition and operation of the sliding window latch. Replace the latch if worn or damaged.

Check the condition of the sliding window rubber seals. Replace if worn or damaged.

Waste Disposal

@.1260

Dispose of waste parts, materials and fluids according to the prevailing environmental standards or workplace practices.

Assembly

@.1270

Assembly of the windscreen and side windows is described in Chapter 3, Doors and Steps of Volume F1, Suppliers Documentation.

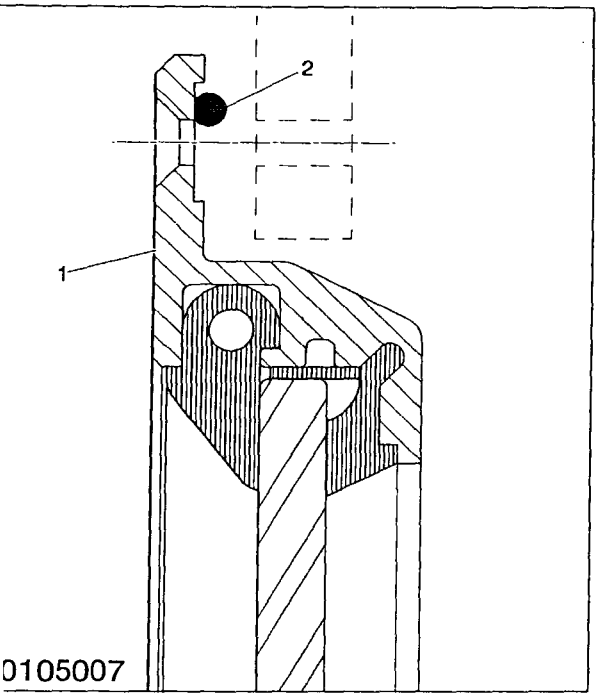
Installation

@.1280

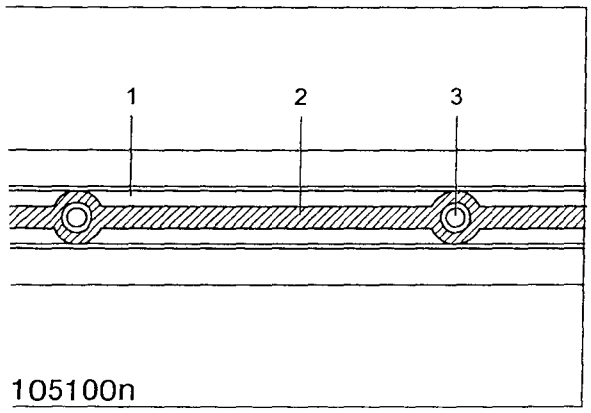
Windscreen Guard Grille

Install and close the windscreen guard grille as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

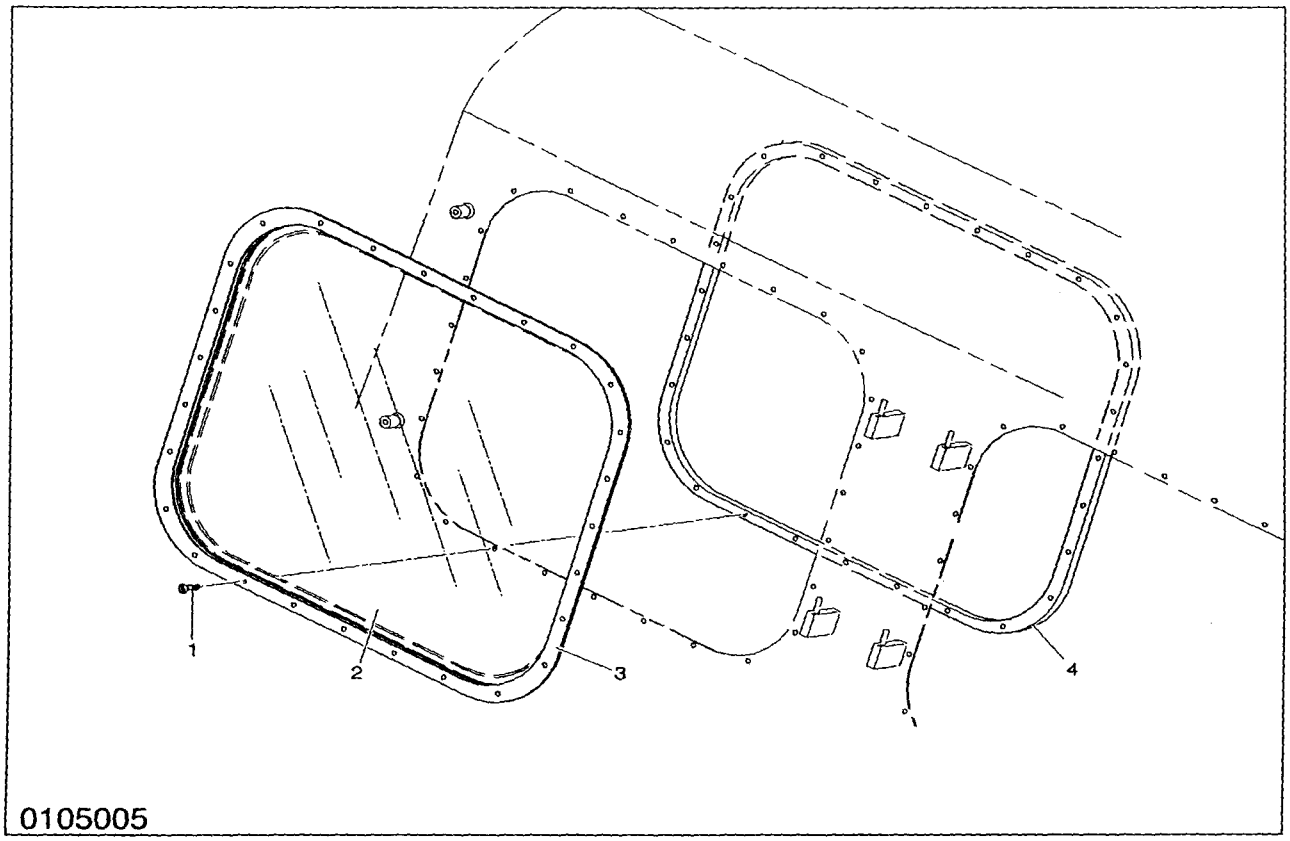
Windscreen



Ensure the windscreen frame (1) and the cab wall surfaces have been correctly prepared for the application of the Sikaflex sealant, as described in the Preface of this Volume.



Apply a continuous 4 mm diameter bead of Sikaflex 15LM (2) to the center of the windscreen frame recess (1). Ensure the bead (2) is continuous around the perimeter of the bolt holes (3).



Position the windscreen assembly (2) into the cab wall. Align the holes in the frame (3) with those in the cab wall.

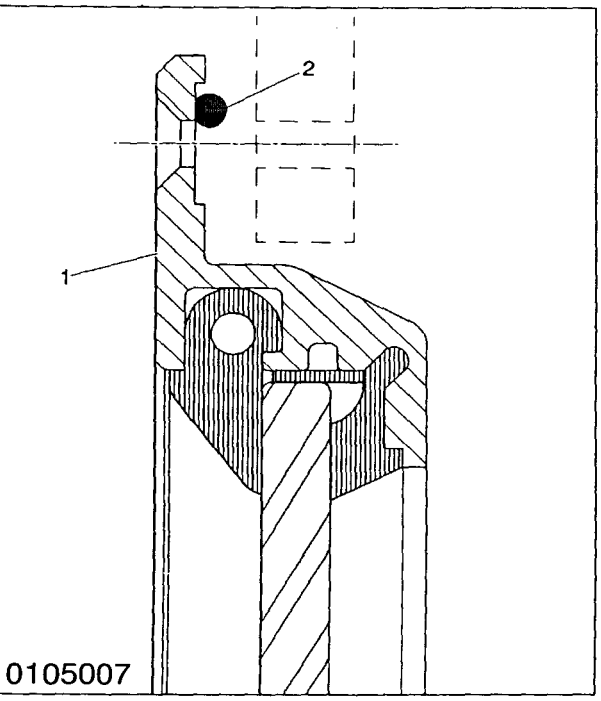
Have an assistant position the mounting bar (4) on the inside of the cab.

Apply Loctite 222 to the threads, then install a screw (1) at each corner through the frame (3) and cab wall into the mounting bar (4). Tighten the screws (1) sufficiently to hold the windscreen assembly (2).

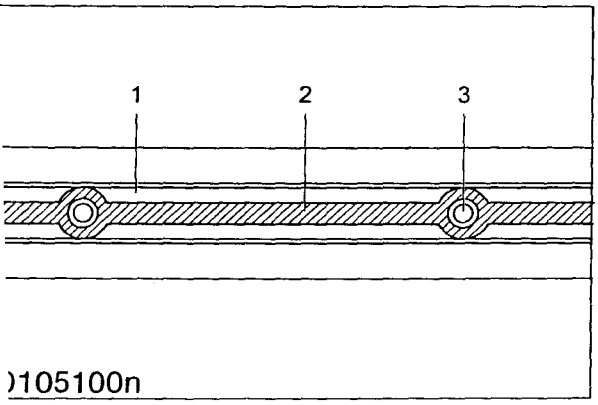
Apply Loctite 222 to the threads, then install the remaining screws (1). Once all the screws (1) are installed, tighten the screws (1) in an alternating cross pattern.

Clean up any remaining sealant extruded from the joint between the frames (3) and cab wall.

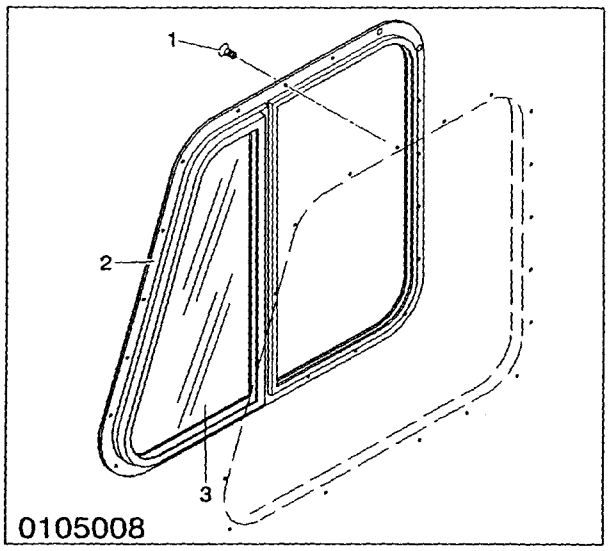
Side Window



Ensure the side window frame (1) and the cab wall surfaces have been correctly prepared for the application of the Sikaflex sealant, as described in the Preface of this Volume.



Apply a continuous 4 mm diameter bead of Sikaflex 15LM (2) to the center of the windscreen frame recess (1). Ensure the bead (2) is continuous around the perimeter of the bolt holes (3).

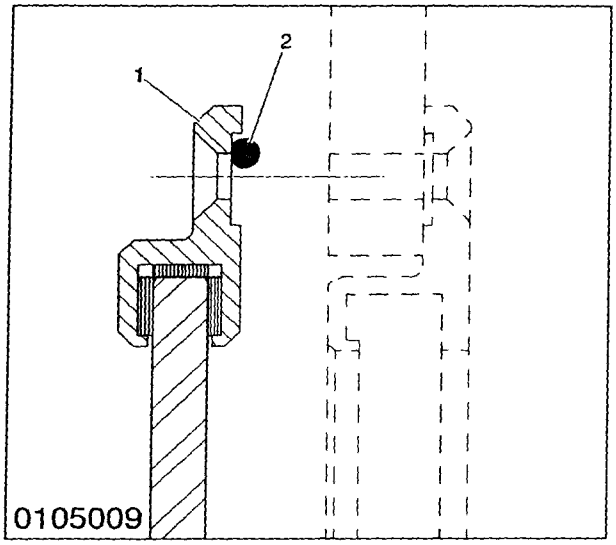


Position the side window assembly (3) into the cab wall. Align the holes in the frame (2) with those in the cab wall. Use suitable props to hold the side window assembly (3) in position.

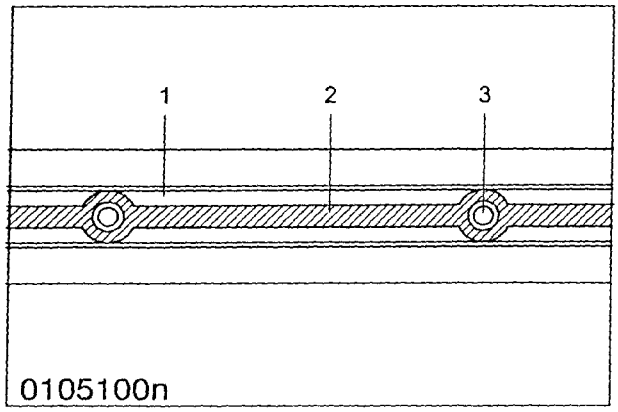
Apply Loctite 222 to the threads, then install a screw (1) at each corner to hold the side window assembly (3) in position. Tighten the screws (1) sufficiently to hold the side window assembly (3).

Apply Loctite 222 to the threads, then install the remaining screws (1). Once all the screws are installed, tighten the screws (1) in an alternating pattern.

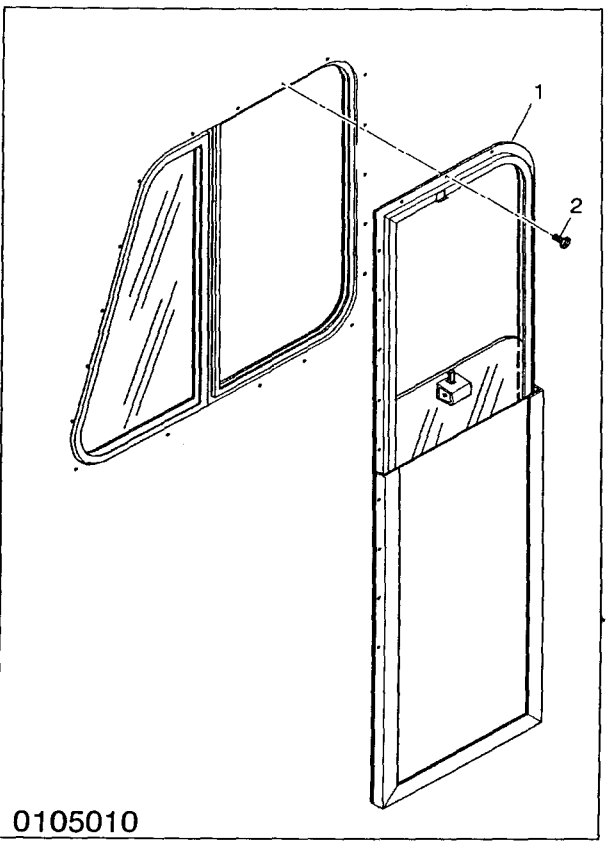
Sliding Window



Ensure the sliding window frame and the cab wall surfaces have been correctly prepared for the application of the Sikaflex sealant, as described in the Preface of this Volume.



Apply a continuous 4 mm diameter bead of Sikaflex 15LM (2) to the center of the sliding window frame recess (1). Ensure that the bead (2) is continuous around the perimeter of the bolt holes (3).



0105010

Position the sliding window assembly (1) into the cab wall. Align the holes in the frame (1) with those in the wall. Check that the edge of the sliding window frame (1) is flush with the side window frame and that the sliding window bottom seal is not caught between the two frames.

Apply Loctite 222 to the threads, then install a screw (2) at each corner to hold the sliding window assembly (1) in position. Tighten the screws (2) sufficiently to hold the sliding window assembly (1).

Apply Loctite 222 to the threads, then install the remaining screws (2). Once all the screws are installed, tighten the screws (2) in an alternating cross pattern.

Clean up any remaining sealant extruded from the joint between the frames and cab wall.

If necessary, install the washer reservoir from the assistant's side as described in Chapter 1.7, Wipers/Washers.

If necessary, install the access panel below the master brake controller.

After-Installations Operations

).1290

Test operation of sliding window. Ensure that it can be raised and lowered smoothly. Check ne operation of the window latch. Rectify any faults found.

Conduct a water test around the windows and check for leakage, refer to Water Test in the Preface of this Volume. Rectify any faults found.

Clean all glass surfaces thoroughly to remove all dirt and foreign material, using suitable glass leaning solution.

Adjustments

3310

There are no adjustments applicable to the windows.

1.6 Horns and Lights

General Notes on Hazards in the Work Area

@.1040

WARNING:

HIGH VOLTAGE! DANGER OF ELECTROCUTION. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVER-HEAD.

Disconnect the pantograph from the overhead and isolate the overhead as described in the Preface of this Volume.

DANGER OF PERSONAL INJURY

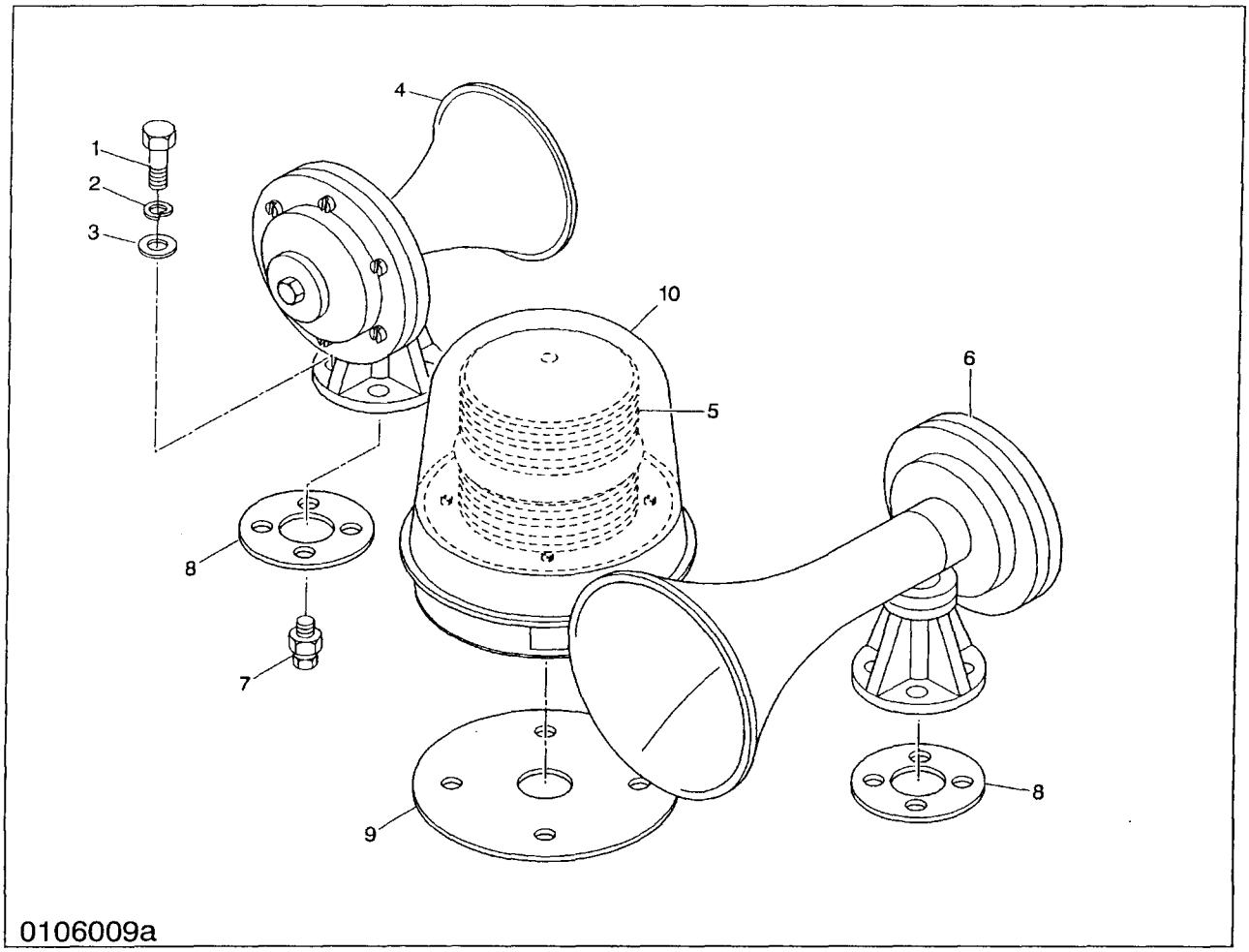
The warning horns are very loud, over 110 dB. Use hearing protection whenever testing, or sounding, the horns to prevent hearing damage.

Group Summary

@.1120

This chapter contains information on the signalling equipment, which consist of: marker lights, headlights, signal horns and strobe light.

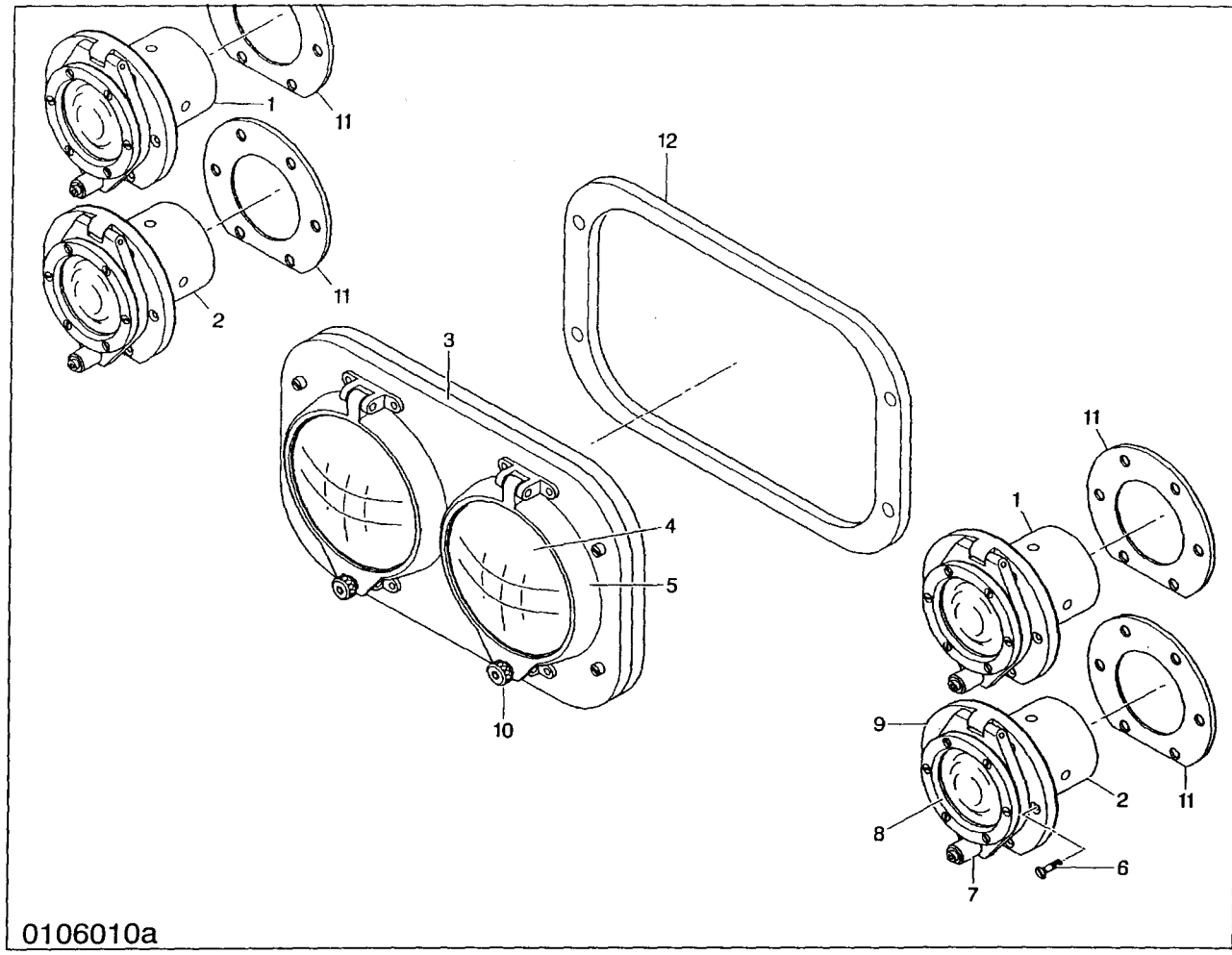
Warning Equipment



0106009a

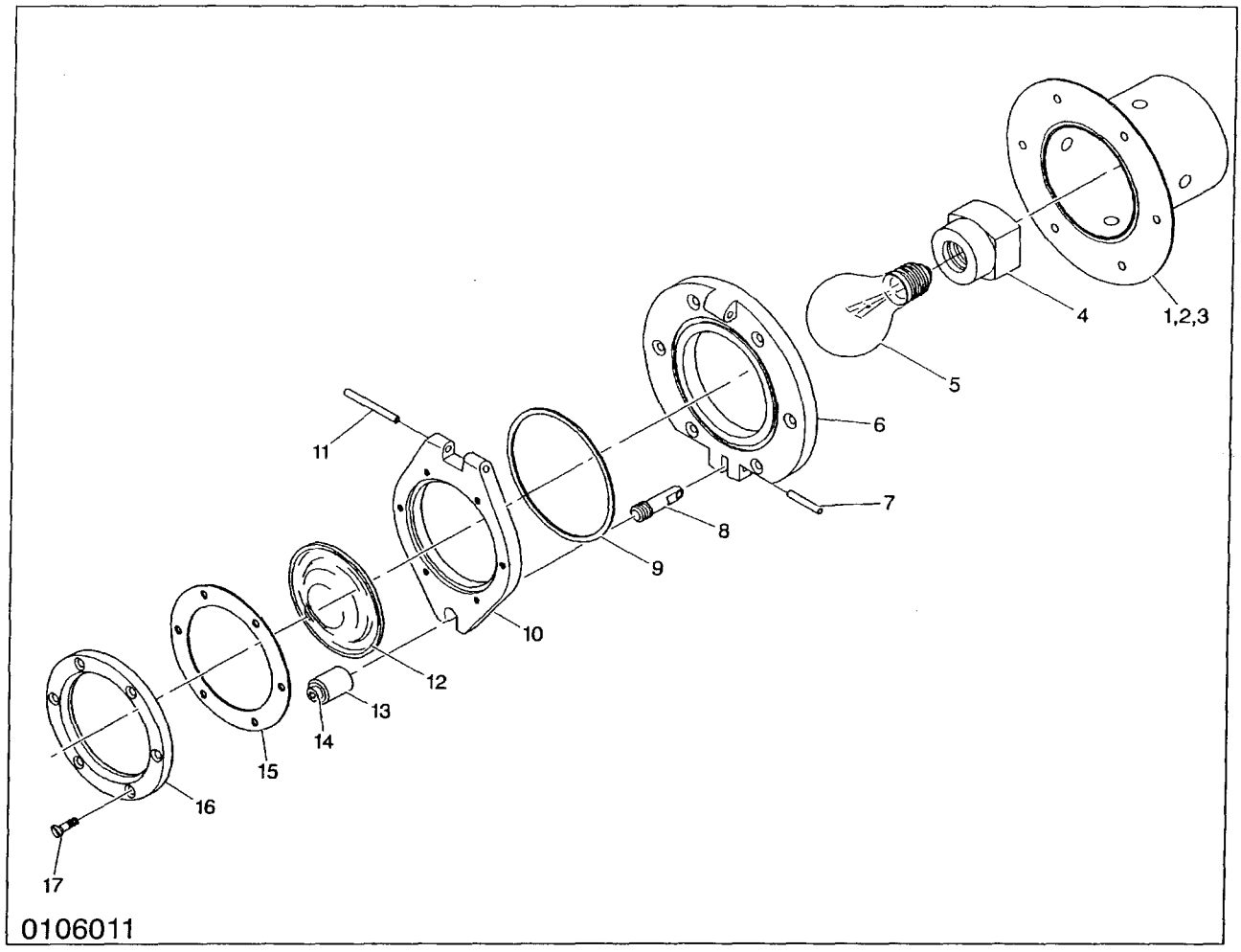
1	Hex head set screw	6	Pneumatic horn low tone
2	Spring washer	7	Male connector air supply
3	Flat washer	8	Gasket, horn
4	Pneumatic horn high tone	9	Gasket, strobe light
5	Strobe light unit	10	Dome, strobe light

Lights



1	Marker light white	7	Knurled knob with swing bolt
2	Marker light red	8	Lens housing
3	Headlight assembly	9	Housing flange
4	Sealed beam	10	Knurled knob w/ swing bolt
5	Headlight retaining ring	11	Gasket, marker light
6	Screw	12	Rubber gasket, headlight

Marker Light Assembly



1	Housing tube	10	Lens housing
2	Housing plate	11	Spring pin
3	Gasket	12	Lens (white or red)
4	Bulb socket	13	Knurled knob
5	Bulb	14	Socket set screw
6	Housing flange	15	Gasket
7	Spring pin	16	Lens retainer
8	Swing bolt	17	Screw
9	O-ring		

Functional Description

@.1140

The locomotive is fitted with headlights, marker lights, a strobe light and two warning horns. Dual sealed beam headlights are centrally fitted at each end of the locomotive. Both white and red marker lights are fitted to each side of each cab to provide clearance and directional indication of the locomotive.

An amber colour strobe light is fitted to the roof of each cab to act as a visual warning.

Two pneumatically operated warning horns are fitted to the roof of each cab. Each horn has a different tone to suit the required operating conditions.

Technical Data

@.1160

Horns

HIGH TONE WARNING HORN

- Frequency	622 Hz (E Flat)
- Loudness	108 dB at 30 m
- Operation	Pneumatic
- Weight	2.32 kg
- Overall length	210 mm
- Audibility in still air	1.6 - 2 km
- Air working pressure	1.4 - 13.8 bar

LOW TONE WARNING HORN

- Frequency	370 Hz (G Flat)
- Loudness	110 dB at 30 m
- Operation	Pneumatic
- Weight	3.12 kg
- Overall length	356 mm
- Audibility in still air	3.2 - 4 km
- Air working pressure	1.4 - 13.8 bar

Strobe light

- Type	Edwards 97 series
- Power requirement	125 Volt, 0.25 Amp
- Flash rate	65 per minute
- Lens colour	Amber

Headlight

- Type	PAR 56/MFL Sealed beam
- Nominal diameter	7 inch
- Voltage	120 Volt
- Wattage	200 Watt
- Vertical adjustment	± 2°
- Horizontal adjustment	± 1.5°

Marker Light

- Bulb type	GEC 13990
- Fitting type	Edison Screw
- Voltage	120 Volt
- Wattage	25 Watt

Tolerances and Wear Limits List

@.1170

Headlight sealed beams should be replaced if the reflectors are rusted, pitted or damaged. The sealed beam headlights should also be replaced if the lenses are cracked, damaged or chipped. Marker lamp lenses should be replaced if cracked, damaged or chipped.

Tools and Special Tools

@.1180

Conventional railway workshop tools are required for procedures described in this group.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Sikaflex 15LM sealant
- Sikalastomer 710 sealant
- Loctite 222
- Glass cleaning solution
- A cleaning solution suitable for use on acrylic materials
- Clean, dry, lint free cloths

Before-Removal Operations

@.1220

Horns

Open the cover marked "Wiper & Horn Isolation" on the driver's side of the cab console. Turn the horn isolation cock to the Off position.

Strobe Light

Set the "Lighting Front" circuit breaker (310.1) to the Off position. Circuit breaker 310.1/1 for the No. 1 End is situated in SB1 and circuit breaker 310.1/2 for the No. 2 End is situated in SB2. For more information on circuit breakers, refer Chapter 8.2, MR Control.

Headlights

Set the "Lighting Front" circuit breaker (310.1) to the Off position. Circuit breaker 310.1/1 for the No. 1 End is situated in SB1 and circuit breaker 310.1/2 for the No. 2 End is situated in SB2. For more information on circuit breakers, refer Chapter 8.2, MR Control.

Marker Lights

Set the "Marker Lights" circuit breaker (310.7) in cabinet SB2 to the Off position. For more information on circuit breakers, refer Chapter 8.2, MR Control.

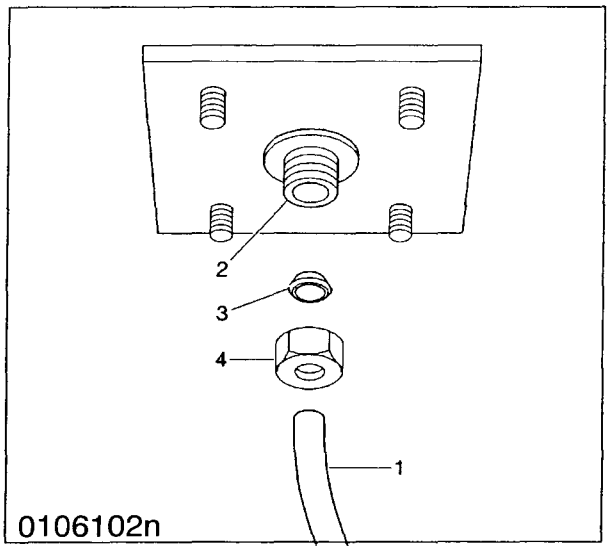
Removal

@.1230

WARNING:

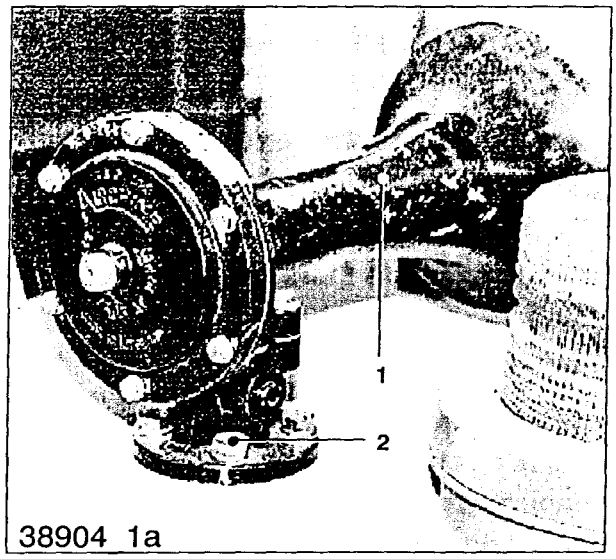
High Voltage! Danger of electrocution. Never work on the roof area while the locomotive is under a live overhead. Disconnect the pantograph from the overhead and isolate the overhead as described in the Preface of this Volume.

Horns



Remove the access panel in the driver's cab ceiling.

Tag and disconnect the pneumatic line (1) from the male connector on the base of the horn (2). The olive (3) will prevent the nut (4) from falling from the line (1).



From outside the cab, loosen the four bolts (2) securing the horns (1) to the cab roof.

Remove the bolts (2), spring washers and washers.

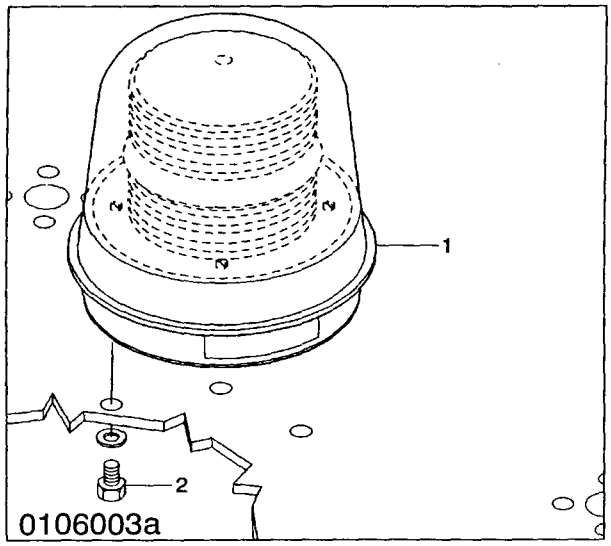
NOTE:

The horns (1) are sealed to the roof to prevent the ingress of moisture. Some effort may be required to separate the horn from the roof panel.

If necessary, use a sharp blade to cut the sealant between the horn base and roof. Take care not to scratch to roof. Repair any scratched or damaged paint to prevent oxidation, refer to Chapter 1.2, Exterior Finish.

Lift the horn assembly (1) from the roof.

Strobe Light



Remove the access panel in the drivers' cab ceiling.

Tag and disconnect the electrical cables from the strobe light terminals.

Cover any exposed wire with insulating material.

Have an assistant hold the strobe light on the cab roof. From inside the cab, remove the four screws (2) securing the light base (1) to the roof.

Once all screws (2) are removed, the assistant can separate the strobe light from the roof. Use care not to damage the rubber seal.

NOTE:

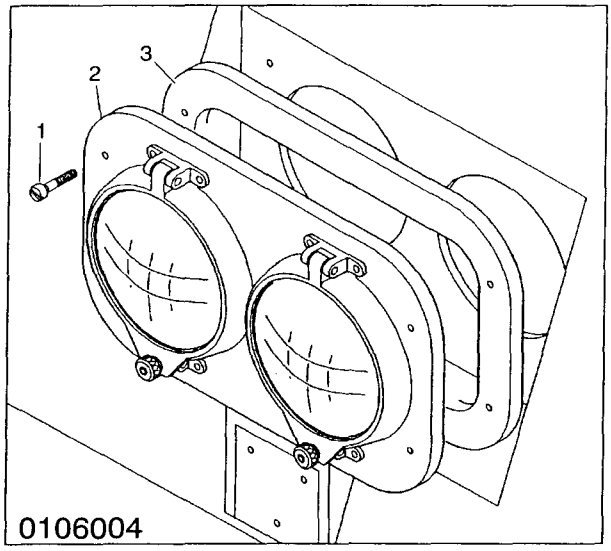
The strobe light is sealed to the cab roof. Some effort may be required to separate the light from the roof.

If necessary, use a sharp blade to cut the sealant between the light and roof. Take care not to scratch the roof. Repair any scratched or damaged paint to prevent oxidation, refer to Chapter 1.02, Exterior Finish.

Headlights

NOTE:

Headlight sealed beams may be removed from the headlight assembly with the headlight assembly mounted on the locomotive front. Refer to Section Disassembly.



From outside the cab, loosen and remove the four screws (1) securing the headlight housing assembly (2) to the front panel.

Separate the headlight housing assembly (2) from the front panel. Use care not to damage the rubber gasket (3) behind the headlight housing (2).

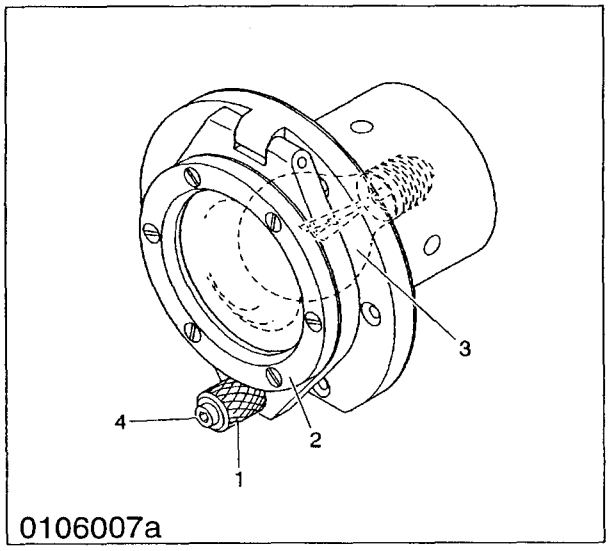
Tag and disconnect the electrical cables from both head light terminals.

Marker Light

NOTE:

Procedures for the marker lights are the same for both the red and white marker lights.

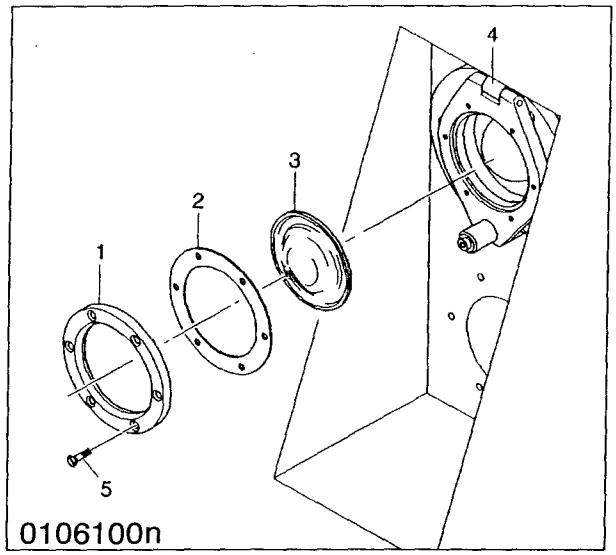
MARKER LIGHT BULB



Loosen the socket set screw (4) in the knurled knob, then loosen the knurled knob (1) and lower the swing bolt from the lens housing (2).

Lift the lens housing (2) and unscrew the bulb (3) from the socket.

MARKER LIGHT LENS

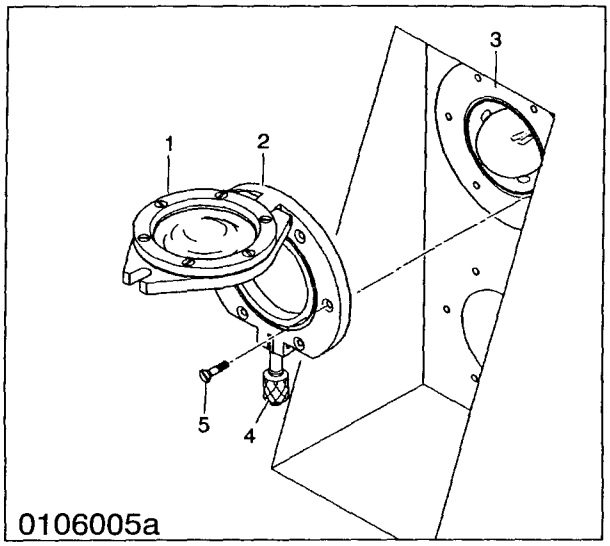


Remove screws (5) from marker light lens retainer (1).

Remove lens retainer (1), gasket (2) and lens (3) from the lens housing flange (4).

Inspect condition of gasket and discard if worn, cracked or damaged.

MARKER LIGHT ASSEMBLY



Loosen the socket set screw in the knurled knob, then loosen the knurled knob and lower the swing bolt (4) from the lens housing (1).

Raise the lens housing (1) as necessary to access the screws (5). Loosen and remove the six screws (5) securing the marker light housing flange (2) to the locomotive.

Disconnect the marker light housing flange (2) from the marker light housing (3).

Separate the marker light housing (3) from the front panel. Use care not to damage the rubber gasket.

Tag and disconnect the electrical cables from the marker light terminals.

Disassembly

@.1240

Horns

Additional information regarding the horns is described in Chapter 2, Miscellaneous Components of Volume F11, Suppliers Documentation.

Strobe Light

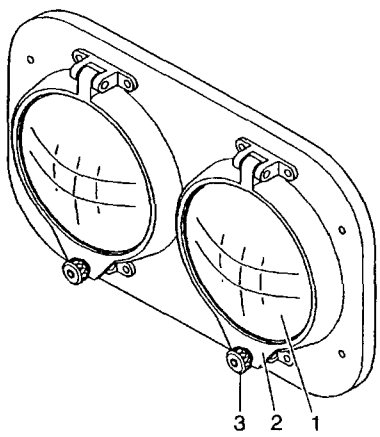
Remove the acrylic cover from the strobe light assembly. Inspect the cover as described in Section Inspection and Repair.

Additional information regarding the strobe light is described in Chapter 6, Horns/Lights of Volume F1, Suppliers Documentation.

Headlights

NOTE:

Headlight sealed beams may be installed to and removed from the headlight assembly with the headlight assembly mounted on the locomotive front.



0106006

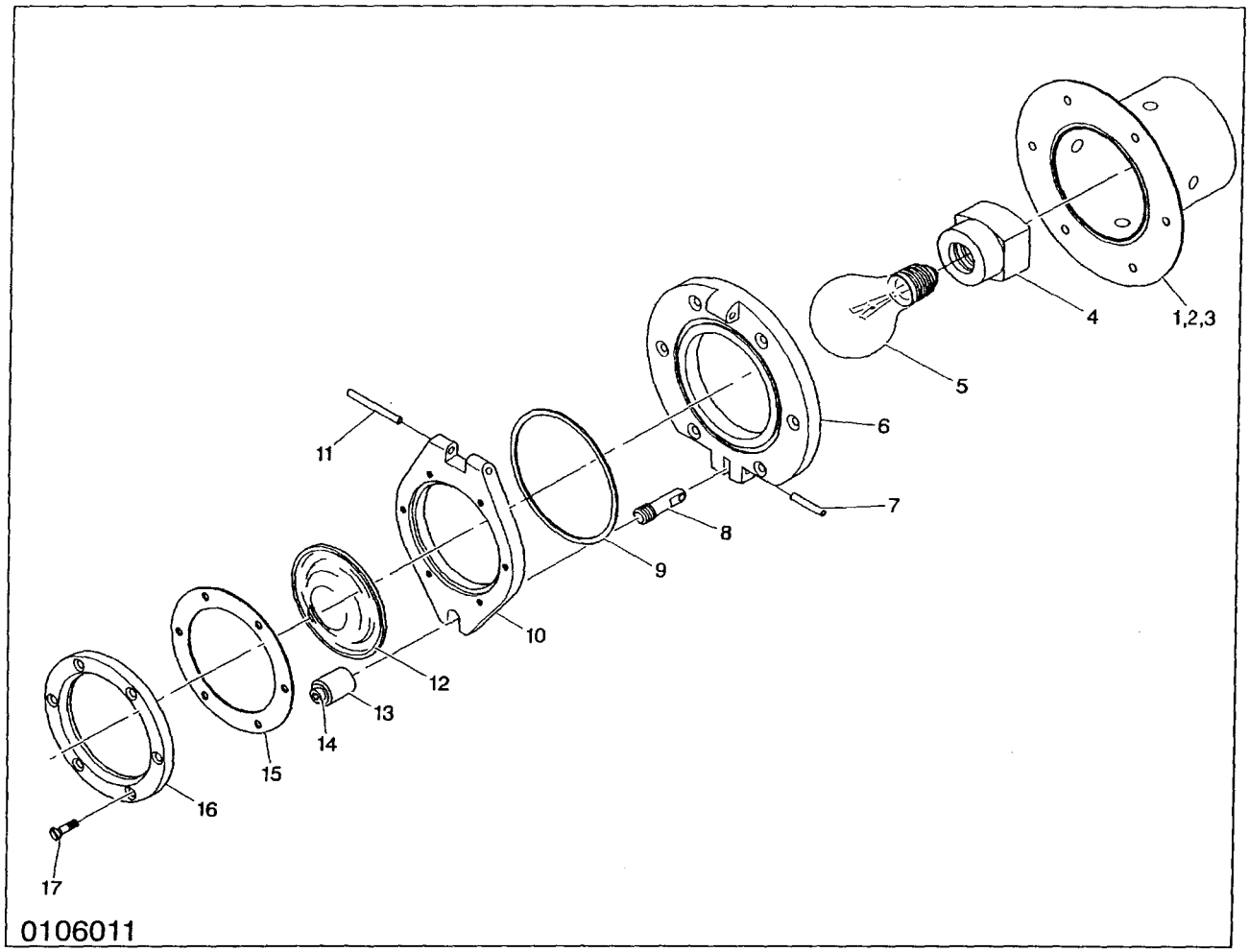
Unscrew the knurled knob (3) securing the headlight retaining ring (2).

Lift the headlight retaining ring (2) and pull the sealed beam (1) from the housing far enough to access the wiring terminals.

Tag and disconnect the electrical cables rom the terminals.

Withdraw the sealed beam (1) from the housing.

Marker Lights



Removal of the marker light assembly from the locomotive is described in Section Removal.

Removal of the lens and lens retaining assembly is described in Section Removal.

Swing bolt (8) can be removed from marker light housing flange (6) by driving out spring pin (7) using a suitable drift, as required.

The lens housing flange (10) can be removed from housing flange (6) by driving out spring pin (11) using a suitable drift, as required.

Bulb socket (4) may be removed from housing tube (1), as required.

Remove gasket (3) from housing plate (2). Inspect condition of gasket (2) as described in Section Inspection and Repair.

Inspection and Repair

@.1250

Horns

Inspect the condition of the horn gasket. Replace if worn, cracked or otherwise damaged.

Additional information regarding the horns is provided in Chapter 2, Miscellaneous Components of Volume F11, Suppliers Documentation.

Strobe Light

Inspect the condition of the strobe light cover. Replace if damaged or defective. Check the condition of the rubber gasket, replace if necessary. Clean serviceable covers using a cleaning solution suitable for acrylic materials.

Inspect the condition of the strobe light gasket. Replace if worn, cracked or otherwise damaged.

Clean the strobe light lens using a cleaning solution suitable for use on acrylic materials. Replace cover if cracked, chipped or otherwise damaged.

Additional information regarding the strobe light is provided in Chapter 6, Horns/Lights of Volume F1, Suppliers Documentation.

Headlights

Inspect the headlight lens for cracks or chips. Replace as necessary.

Check the reflector for signs of oxidation, peeling or other damage. Replace sealed beam unit if necessary.

Check the security of the headlight retaining ring. Tighten the knurled knob if necessary.

Marker Lights

Inspect the lenses for cracks or chips. Replace as necessary. Refer to Marker Light Lens in Section Removal.

Check the security of the retaining ring. If necessary, loosen the setscrew, then tighten the knurled knob. Tighten the setscrew to secure the knurled knob against vibration.

Waste Disposal

@.1260

Dispose of waste parts and materials according to the prevailing environmental standards or workplace practices.

Assembly

@.1270

Horns

Additional information regarding the horns is provided in Chapter 2, Miscellaneous Components of Volume F11, Suppliers Documentation.

Strobe Light

Place the acrylic cover over the strobe light.

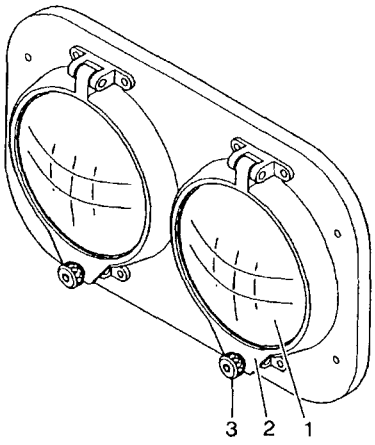
Apply Loctite 222 to the threads. Align the holes in the cover with those in the base and install then tighten the screws.

Additional information regarding the strobe light is described in Chapter 6, Horns/Lights of Volume F1, Suppliers Documentation.

Headlights

NOTE:

Headlight sealed beams may be installed to and removed from the headlight assembly with the headlight assembly mounted on the locomotive front.



0106006

Unscrew the knurled knob (3) securing the headlight retaining ring (2), then lower the swing bolt.

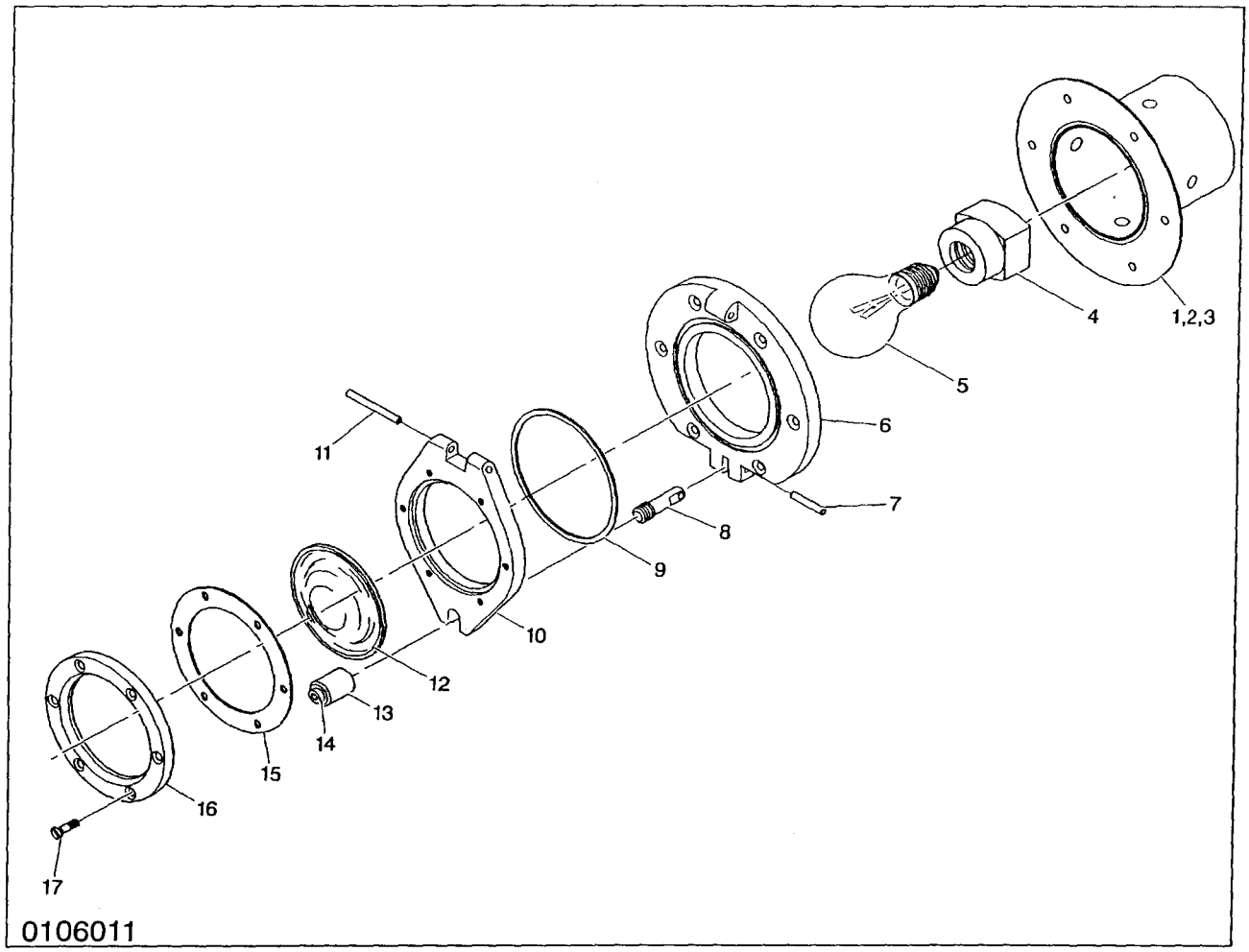
Lift the headlight retaining ring (2).

Re-connect the electrical cables to the terminals of the sealed beam as tagged during removal. Refer to Section 8, Sheet 07C, Head/Marker Lights of Volume G1, Cabling Documentation.

Install the sealed beam (1) into the housing.

Close headlight retaining ring (2). Raise the swing bolt, then tighten the knob (3) to secure retaining the ring (2).

Marker Lights



Install swing bolt (8) on marker light housing flange (6) by driving spring pin (7) through marker light housing flange (6) and swing bolt (8) using a suitable drift, as required.

Install lens housing flange (10) on marker light housing flange (6) by driving spring pin (11) through marker light housing flange (6) and lens housing flange (10) using a suitable drift, as required.

Install bulb socket (4) in housing tube (1), as required.

Installation of the lens and lens retaining assembly is described in Section Installation.

Installation of the marker light assembly to the locomotive is described in Section Installation.

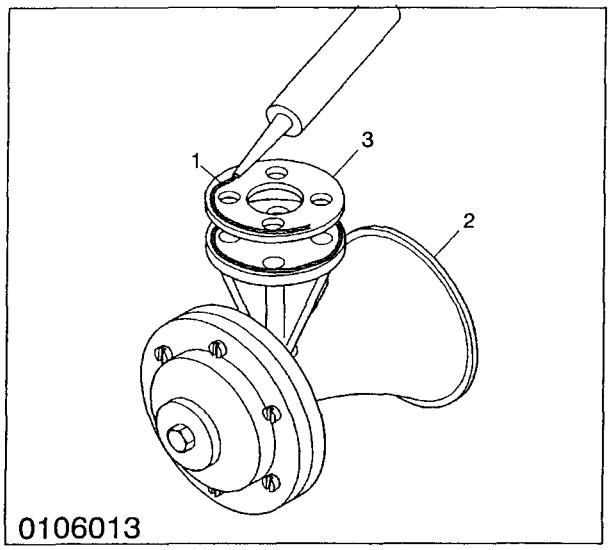
Installation

@.1280

WARNING:

HIGH VOLTAGE! DANGER OF ELECTROCUTION. Never work on the roof area while the locomotive is under live overhead. Disconnect the pantograph from the overhead and isolate the overhead as described in the Preface of this Volume.

Horns

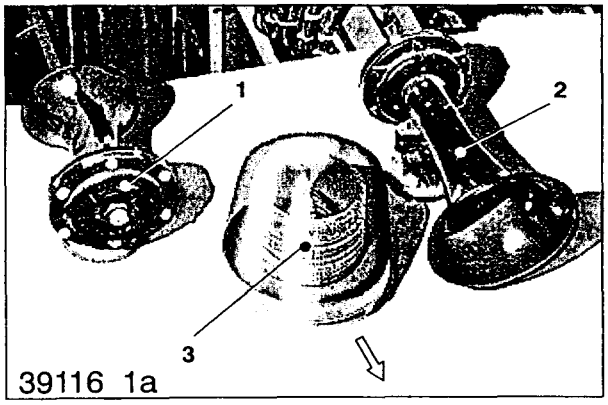


0106013

Apply a continuous 7 mm diameter bead of Sikaflex 15LM (1) to the base of the horn (2) about 3 mm in from the outside perimeter. Ensure all surfaces have been correctly prepared prior to application of the sealant, as described in the Preface of this Volume.

Position the gasket on the horn, aligning the holes for the bolts.

Apply a continuous 7 mm diameter bead of Sikaflex 15LM (1) to the gasket (3), approximately 3 mm in from the outside perimeter. Ensure all surfaces have been correctly prepared prior to application of the sealant, as described in the Preface of this Volume.

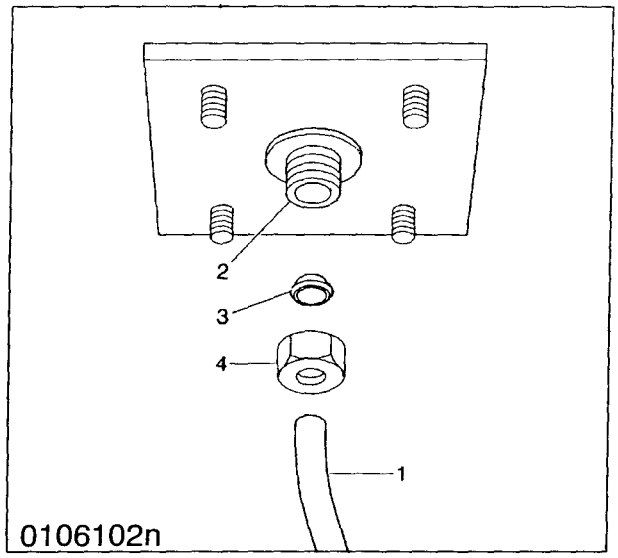


39116 1a

Position the horn on the roof. Check it is correctly oriented:- long horn (2) faces forward, short horn (1) towards the pantograph.

Apply loctite 222 to the threads. Install the bolts with spring washers and washers and tighten.

Ensure that sealant has been extruded from the joint between the roof and horn on both sides of the gasket around the entire perimeter of the base. Clean off any excess sealant.

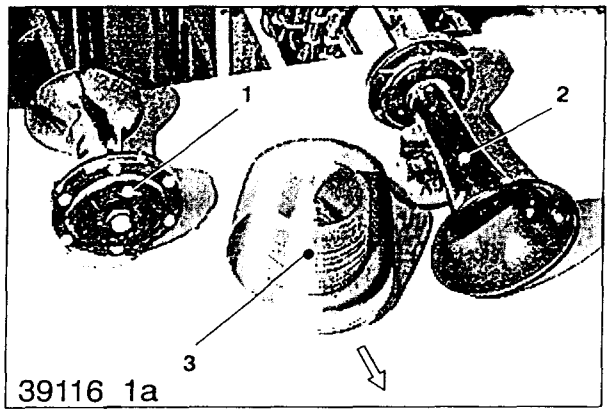


From inside the cab, connect the pneumatic line (1) to the male connector on the horn (2) and tighten the nut (4). If necessary, crop the pneumatic line (1) and use a new olive (3).

Install the cab ceiling access panel.

Move the locomotive to a suitable, approved test site, then check the operation of the horn as described in Section After-Installation operations.

Strobe Light



Ensure the strobe light (3) electrical circuit is isolated, as described in Section Before-Removal Operations.

Apply a continuous 7 mm diameter bead of Sikaflex 15LM to each side of the gasket, approximately 3 mm in from the outside perimeter. Ensure all surfaces have been correctly prepared prior to application of the sealant, as described in the Preface of this Volume.

Position the gasket on the base and align the holes.

Have an assistant hold the strobe light on the cab roof. The holes in the light base must be aligned with those in the roof panel. Ensure the gasket is correctly seated.

Apply Loctite 222 to the threads. From inside the cab, install the screws and washers into the strobe light, then tighten the screws.

Check to ensure that sealant has been extruded from the joint between the roof and strobe light from both sides of gasket around the entire perimeter. Clean off any excess sealant.

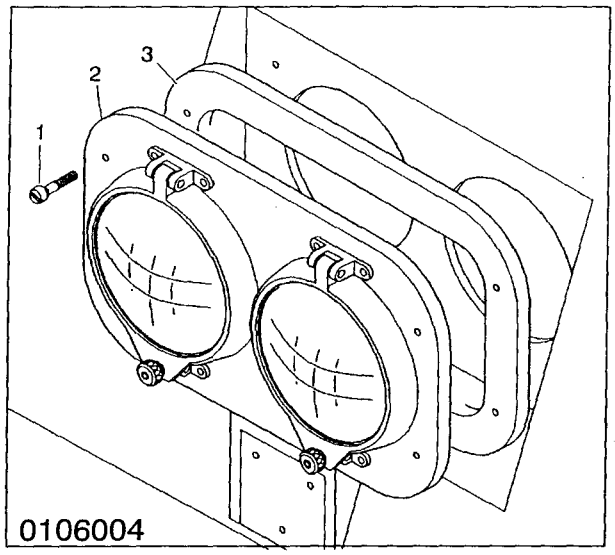
Re-connect the wires to the terminals on the strobe light terminals as tagged during removal. Refer to Section 8, Sheet 07D, Lighting Control-Emergency Flash Lights of Volume G1, Cabling Documentation.

Reinstall the access panel in the cab ceiling.

Headlights

NOTE:

Headlight sealed beams may be installed to the headlight assembly with the headlight assembly mounted on the locomotive front. Refer to Section Assembly.



Ensure the headlight electrical circuit is isolated, as described in Section Before-Removal Operations.

Apply a continuous 7 mm diameter bead of Sikalastomer 710 sealant to each side of the gasket (3), approximately 3 mm in from the outside perimeter. Ensure all surfaces have been correctly prepared prior to application of the sealant, as described in the Preface of this Volume.

Position the gasket (3) on the headlight housing assembly (2).

Position the headlight housing (2) into the recess with the hinges upwards. Ensure the gasket (3) is correctly seated.

NOTE:

The headlights are adjusted, both vertical and horizontal, by compressing the gasket with the retaining screws.

Install the four screws (1) and tighten the screws (1) until the headlight is secure without excessive compression of the gasket.

From inside the cab, remove any material protecting the ends of the wire.

Re-connect the wires as tagged during disassembly to the headlight terminals. Refer to Section 8, Sheet 07C, Head/Marker Lights of Volume G1, Cabling Documentation.

Check that sealant has been extruded from the joint around the entire perimeter. Clean off any excess sealant.

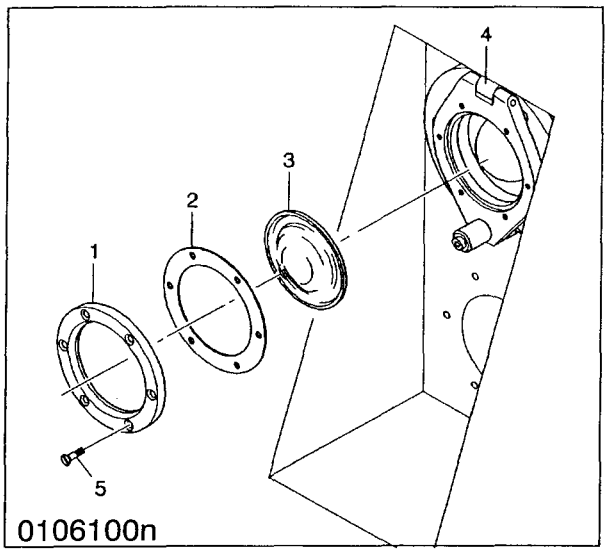
Reinstall the access panel to the centre of the console.

Marker Lights

NOTE:

Procedures for the marker lights are the same for both the red and white marker lights.

MARKER LIGHT LENSES

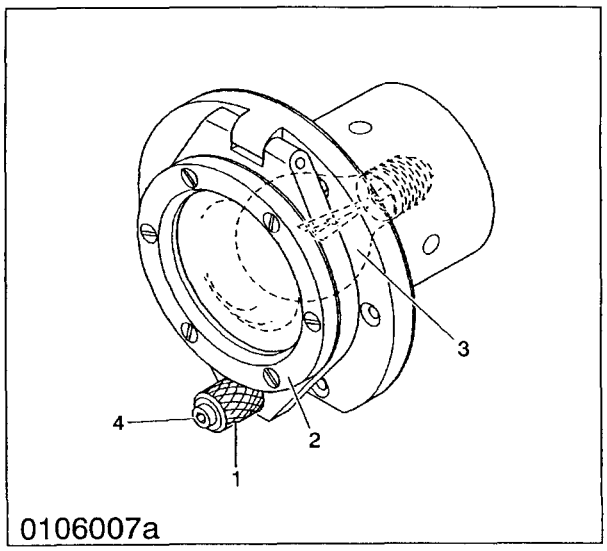


Install the lens (3) into the lens housing (4).

Place the gasket (2) on the lens retainer ring (1) and align the screw holes.

Position the lens retainer ring (1) and gasket (2) on the lens housing (4). Install and tighten screws (5) to secure the lens retainer ring (1) to the lens housing (4).

MARKER LIGHT BULBS



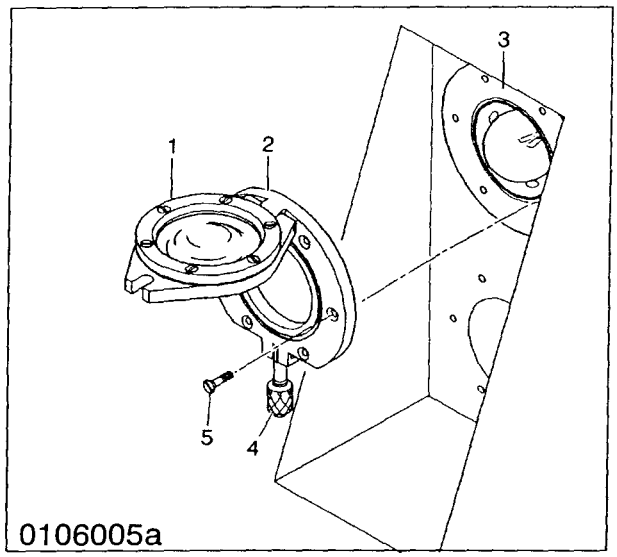
Loosen the locking screw (4) in the knurled knob (1). Loosen and lower the knurled knob (1).

Raise the lens housing (2) and install the globe (3), then close the lens housing (2).

Raise and tighten the knurled knob (1) to secure the lens housing (2).

Tighten the locking screw (4) in the knurled knob (1) to secure the knurled knob (1) against vibration.

MARKER LIGHT ASSEMBLIES



Ensure the marker light electrical circuit is isolated, as described in Section Before-Removal Operations.

Apply a continuous 7 mm diameter bead of Sikalastomer 710 sealant to each side of the gasket, approximately 3 mm in from the outside perimeter. Ensure all surfaces have been correctly prepared prior to application of the sealant, as described in the Preface of this Volume.

Position the gasket on the marker light housing (3) and align the screw holes.

Position the marker light (3) into the recess.

Position the housing flange (2) with the lens housing (1) pre-assembled onto the housing (3). Ensure the gasket is correctly seated.

Apply Loctite 222 to the threads. Install the six screws (5) securing the marker light housing (3) to the locomotive. Raise the lens housing (1) as necessary to install the screws (5).

Re-connect the wires as tagged during disassembly to the marker light terminals. Refer to Section 8, Sheet 07C, Head/Marker Lights of Volume G1, Cabling Documentation.

Check that sealant has been extruded from the joint from both sides of the seal around the entire perimeter. Clean off any excess sealant.

Reinstall the access panel into the console footwell.

After-Installations Operations

@.1290

Conduct a water test around the headlights, marker lights, strobe lights and warning horns and check for leakage, refer to Water Test in the Preface of this Volume. Rectify any faults found.

Close the circuit breakers, then test the operation of the headlights, marker lights and strobe light. Rectify any faults found.

Apply the pneumatic supply to the warning horns.

WARNING:

The warning horns are very loud, over 110 dB. Use hearing protection whenever testing, or sounding, the horns to prevent hearing damage.

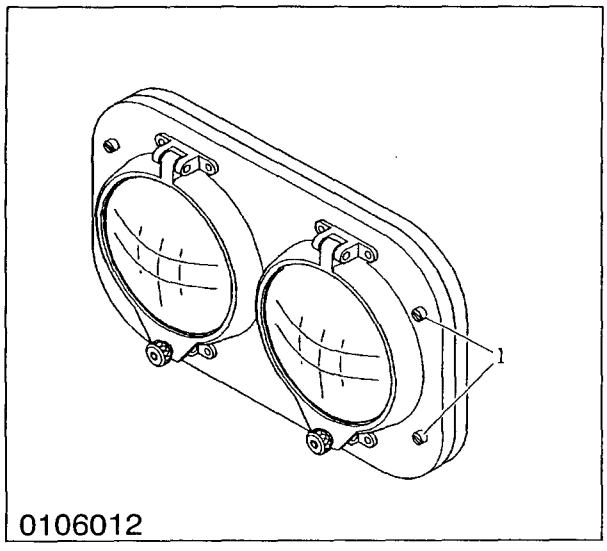
Move the locomotive to a suitable testing location. The horns are very loud. Wear hearing protection to avoid personal injury and ensure there are no bystanders within 50 meters.

Test the operation of the horns and rectify any faults found.

Adjustments

@.1310

Headlight Adjustment



0106012

Headlights should be aimed straight ahead, or as required by Indian Railways operational requirements.

The headlights are aligned by the screws (1). Both vertical and horizontal adjustments can be made within the range specified in Section Technical Data. Adjustment of the screws (1) compresses the headlight gasket. Ensure the gasket is not over compressed, as this may damage the gasket or break the sealing between the housing and the locomotive, possibly causing leakage.

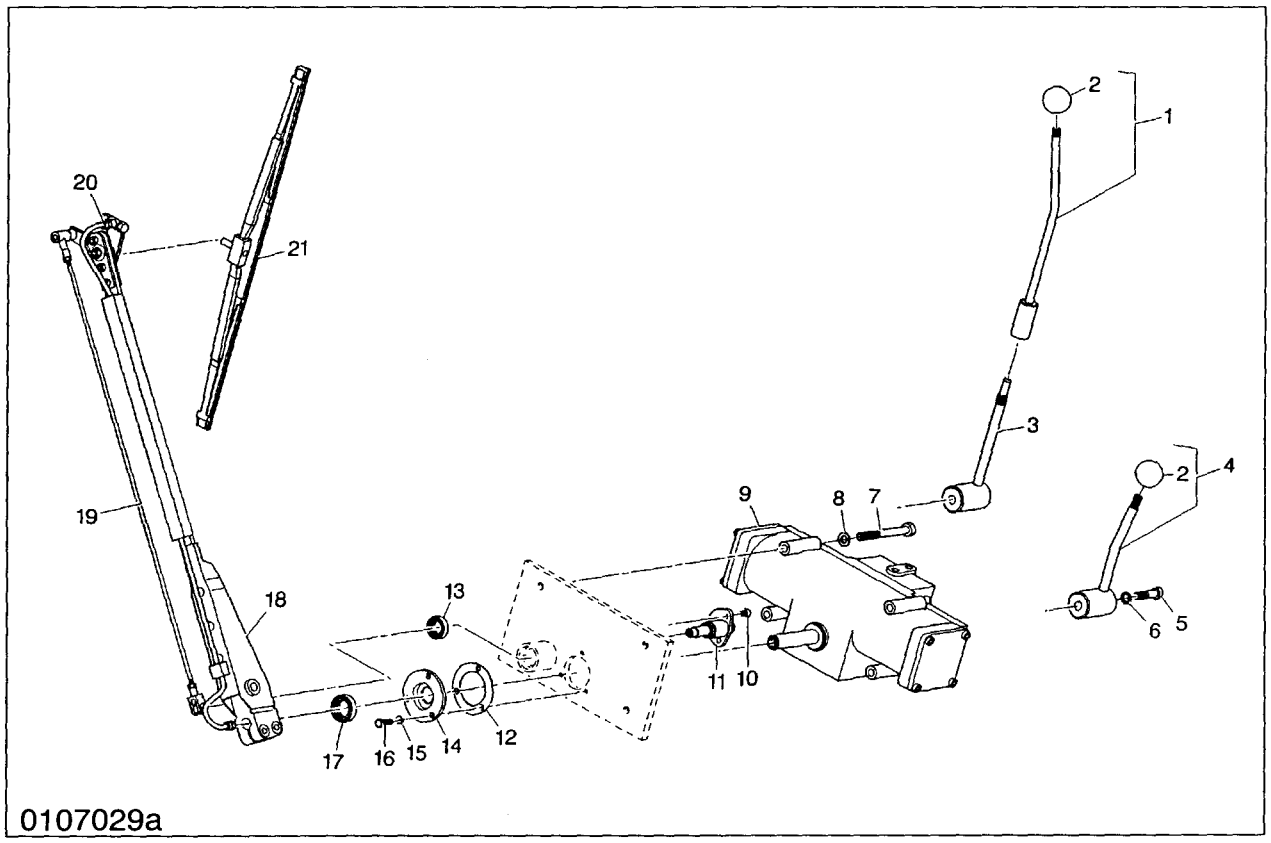
1.7 Wipers and Washers

Group Summary

@.1120

This chapter contains information on the windscreen wiper/washer system which consist of: a wiper motor, wiper arm and wiper blade assembly on each windscreen, and a washer reservoir and washer pump to service both windscreens, located inside the cab.

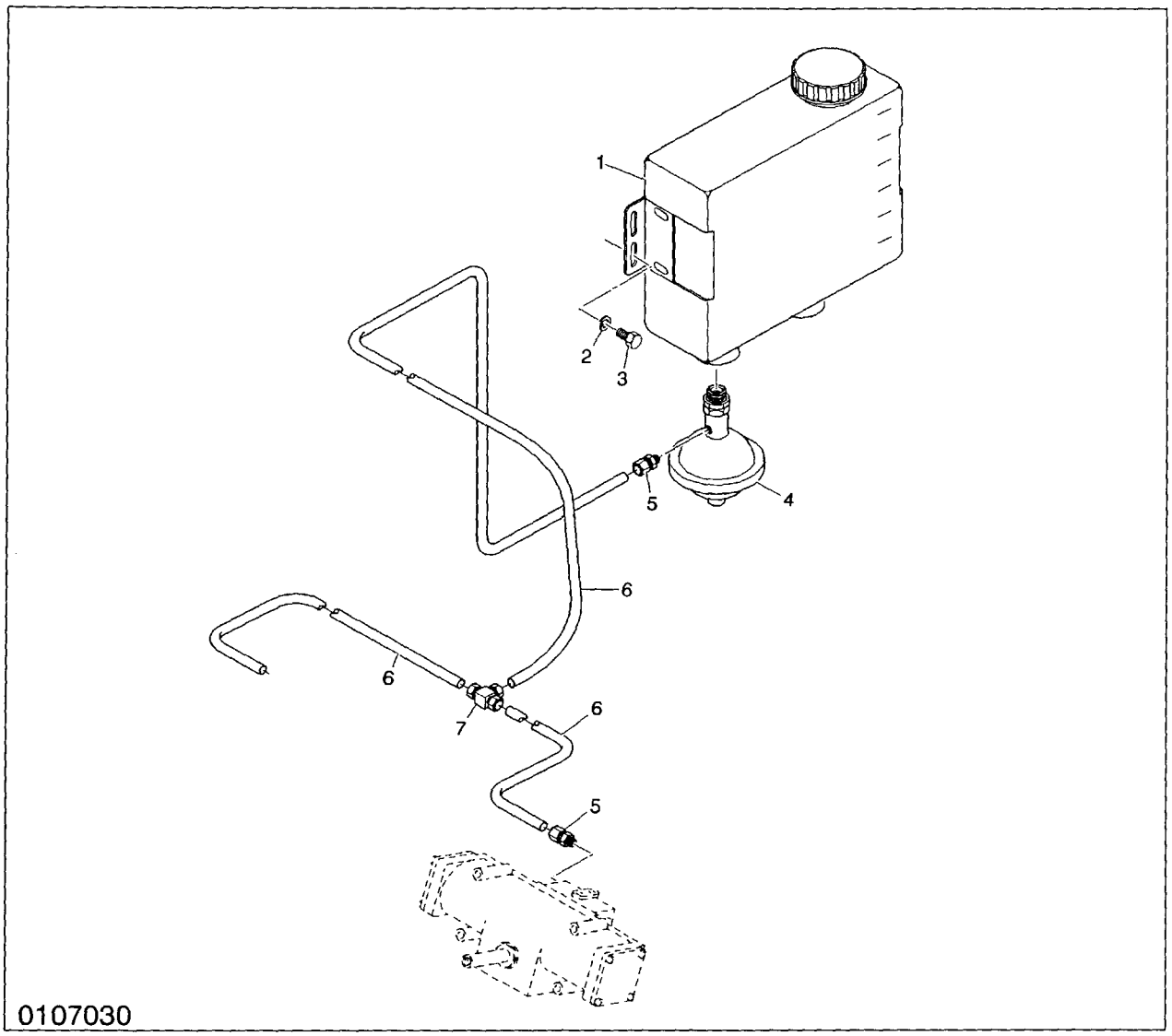
Wiper and Wiper Motor



0107029a

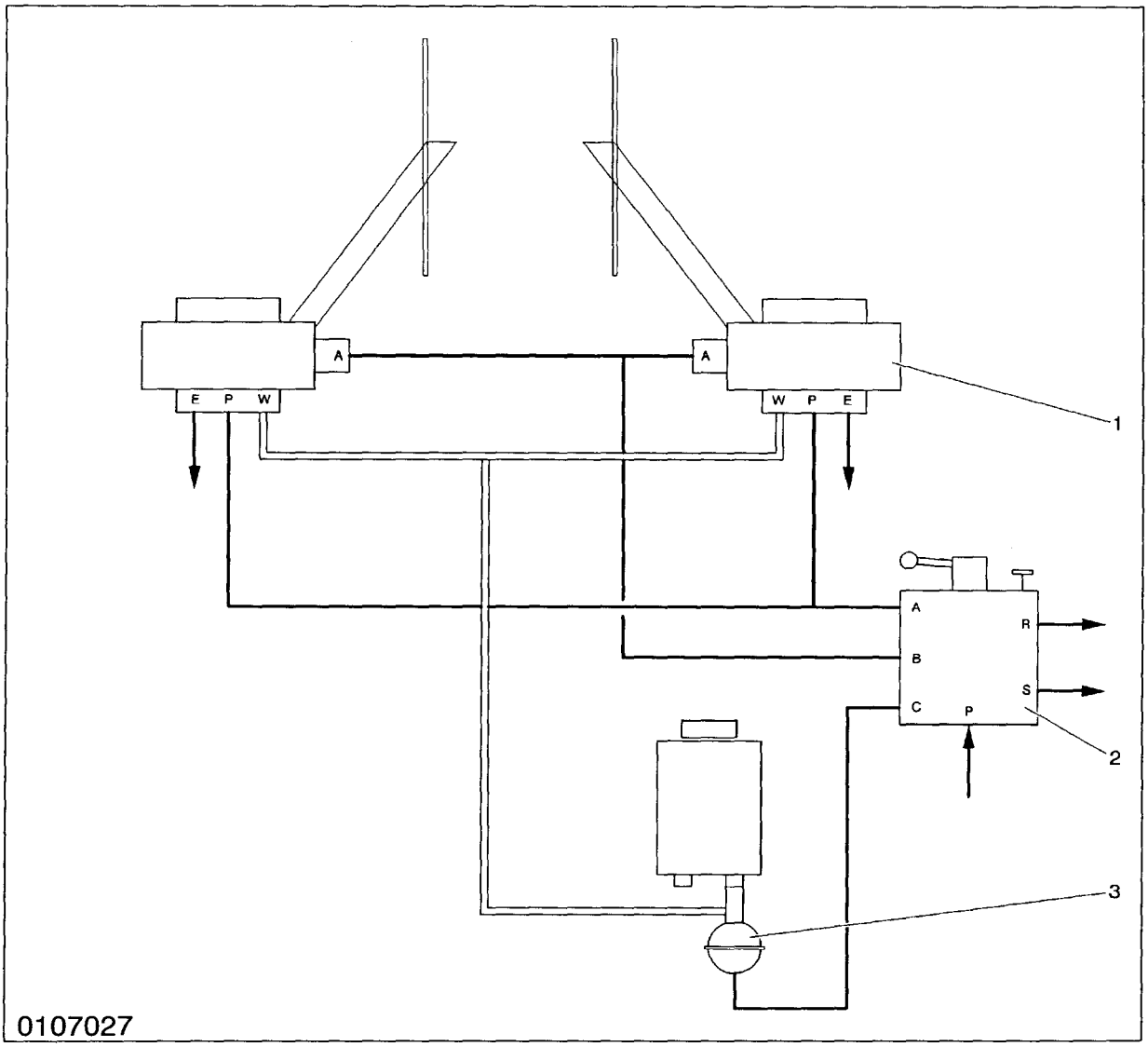
1	Lever extension (removable)	12	Gasket
2	Lever knob	13	Seal
3	Manual lever fixed, left	14	Seal flange
4	Manual lever fixed, right	15	Spring washer
5	Socket screw	16	Bolt
6	Flat washer	17	Seal
7	Bolt hex head	18	Wiper arm
8	Spring washer	19	Parallel arm
9	Wiper motor	20	Washer nozzle
10	Screw	21	Wiper blade
11	Idler shaft		

Washer



1	Reservoir	5	Male union
2	Spring washer	6	Nylon tube blue
3	Bolt	7	Tube union tee
4	Washer pump		

Schematic Wiper-/Washer Motor and Controls



1	Wiper motor	3	Washer pump
2	Wiper/washer control		

Functional Description

@.1140

The wipers and washers are used to enhance forward visibility in poor weather conditions by removing rain water and debris from the windscreens. There are two independent wiper motors, one for each windscreen, that operate the wiper arms. Water for the washer system is supplied from a single reservoir located on the assistant driver's side of the cabin. The wiper/washer system is pneumatically operated using the locomotive air supply. In the event of a system failure, the wipers can be actuated by hand using the manual levers attached to the wiper motor shafts.

Wiper/washer control is described in Chapter 7.5, Cab.

Troubleshooting for the wiper/washer system is given in Chapter 7, Wipers/Washers of volume F1, Suppliers Documentation.

Technical Data

@.1160

Windscreen Wiper

- Swept area	0.32 mm^2 (nominal)
- Operating range	65 ± 8°

Wiper Arm

Idler Shaft

- Shaft diameter (minimum)	11.957 - 12.000 mm
- Seal size	12 (ID) X 25 (OD) X 7 mm
- Parallel arm length (between eye centres)	550 mm

Wiper Blade

- Wiper blade length	508 mm
- Distance to screen edge (parked)	75-85 mm
- Distance to screen edge (operating)	140-150 mm
- Distance A (for assembly only)	145 mm

Wiper Motor

Motor Shaft

- Shaft diameter (minimum)	15.957 - 16.000 mm*

* measured at seal running surface

Flange Seal

- Seal size	16 (ID) X 30 (OD) X 7 mm

Washer Reservoir

- Capacity	8 litres
- Leak test pressure	60 kPa

Tolerances and Wear Limits List

@.1170

Wiper Arm

IDLER SHAFT

- Axial free play (maximum)	0.75 mm
- Vertical free play (maximum)	0.75 mm

Tools and Special Tools

@.1180

In addition to conventional railways workshop tools and equipment, the following items are also required for the procedures described in this chapter:

- A 17 mm diameter drift
- A steel tube, with a 32 mm inside dimension
- A blind M8 thread chaser
- A honing stone
- Receptacle, 8 litre capacity

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Loctite 262
- Light machine oil
- Suitable plastic plugs for sealing pipes and unions
- Diluted alkaline solution

WARNING:

Alkaline solution is corrosive. Work according to the prevailing workshop safety regulations. Any components washed in an alkaline solution must be thoroughly rinsed with clean, hot water.

Before-Removal Operations

@.1220

General

Open the cover marked "Wiper & Horn Isolation" on the driver's side of the cab console. Turn the wiper isolation cock to the Off position.

Steam clean the wiper arms, drive shafts, idler shafts and surrounding area. Remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume. Damage to the components can result from improper application of the steam cleaning equipment.

Wiper Arm

Open and remove the windscreen grille as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

WINDSCREEN WIPER BLADES

Open and remove the windscreen grille as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

Wiper Motor

Disconnect the pipes and hoses from the wiper motor as described in this chapter.

Remove the wiper arm as described in this chapter.

SEAL FLANGE

Remove the wiper arm as described in this chapter.

Idler Shaft

Remove the wiper arm as described in this chapter.

Manual Levers

There are no Before Removal Operations for the manual levers.

Washer Reservoir

Disconnect the pipes and hoses from the washer reservoir as described in this chapter.

WASHER MOTOR

Remove the washer reservoir as described in this chapter.

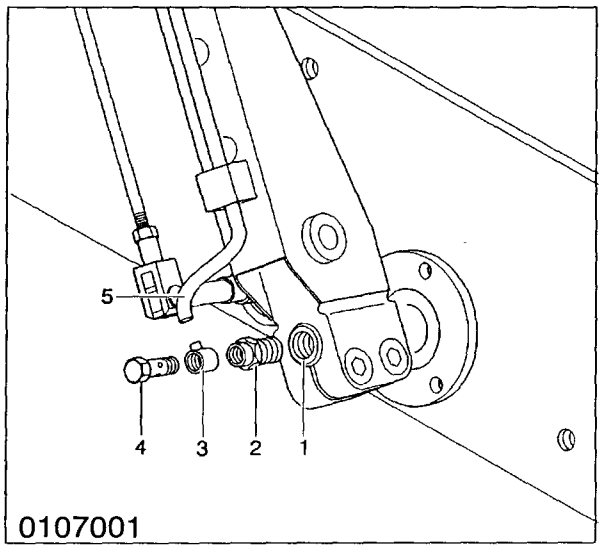
Pipes and Hoses

Isolate the pneumatic supply to the wipers and washers as described at the beginning of this Section.

Removal

@.1230

Wiper Arm

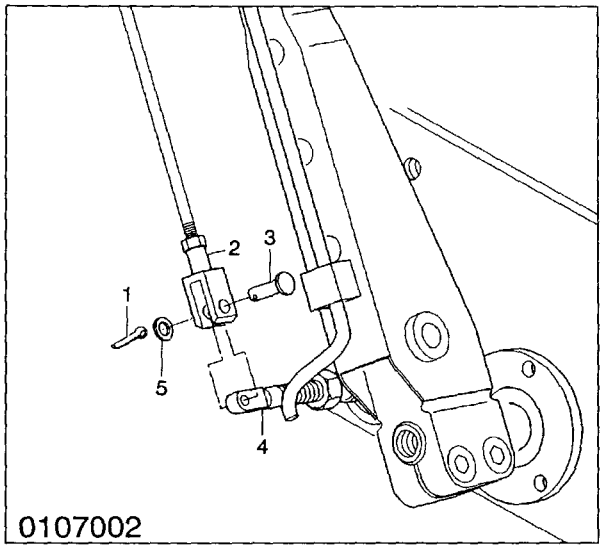


Disconnect the washer hose (5) from the banjo fitting (3).

Unscrew the bolt (4).

Remove the bolt (4) and banjo fitting (3). Unscrew the union (2) from the wiper arm drive shaft (1).

Lift the wiper arm from the windscreen.

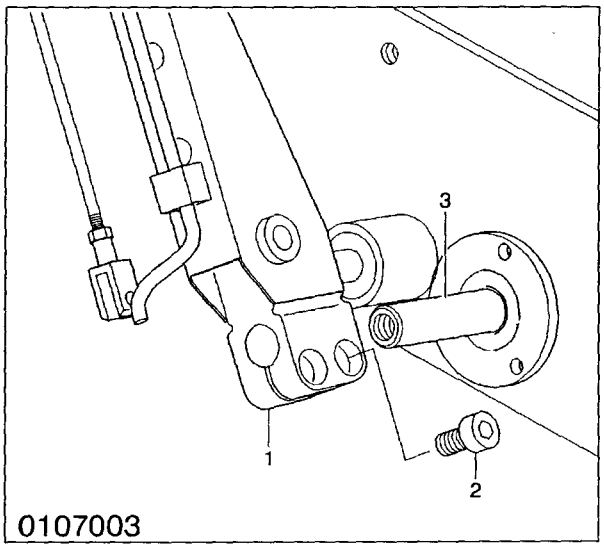


0107002

Remove the split pin (1) and the washer (5).

Withdraw the pivot pin (3).

Separate the parallel arm (2) from the clevis shaft (4).



0107003

Match mark the wiper arm (1) to the wiper arm drive shaft (3) to aid reinstallation.

Loosen the two socket head screws (2) that clamp the wiper arm (1) around the wiper arm drive shaft (3).

Pull the wiper arm assembly (1) from the shaft (3).

Remove the washer nozzle as described in Section Disassembly, if necessary.

Wiper Motor

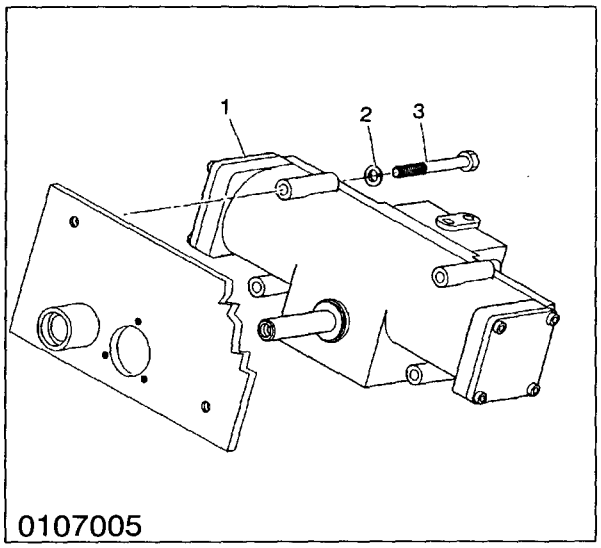
To aid in reinstallation tag the location of the pipes connected to the wiper motor.

Crack loose the pneumatic unions at the wiper motor. Allow any residual air to vent, then disconnect the pipes from the unions. Seal the pipes and unions on the motor to prevent the ingress of foreign material.

Position a suitable receptacle below the wiper motor.

Crack loose the water connections to the wiper motor. Allow any residual water to drain into the receptacle. Seal the pipes and unions to prevent further out-flow of liquid and the ingress of foreign material.

Remove the manual levers as described in Manual Levers in this Section.



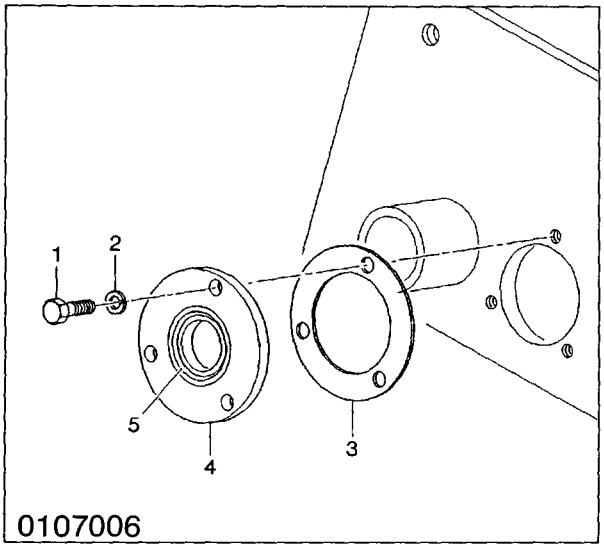
From outside the cab, remove the seal flange as described in Seal Flange in this Section.

Remove the four bolts (3) and washers (2) securing the wiper motor (1) to the front panel.

SEAL FLANGE

NOTE:

To protect the seal from damage, remove any burrs from the end of the wiper arm drive shaft using a honing stone before withdrawing the seal flange.



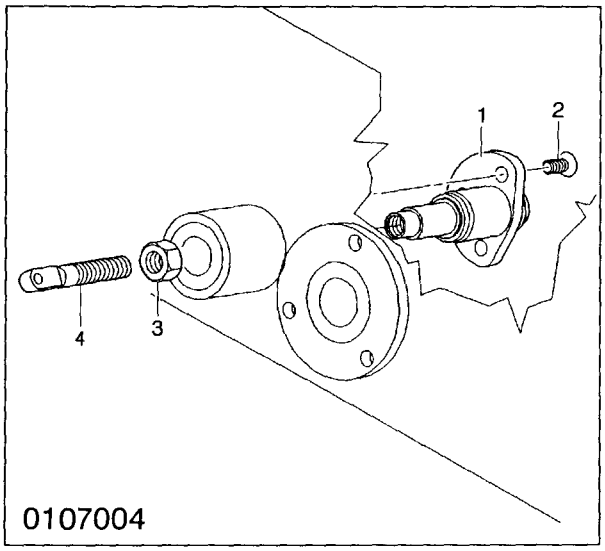
0107006

Remove the three bolts (1) and spring washers (2) securing the seal flange (4) to the front panel.

Slide the seal flange (4) and gasket (3) from the shaft.

Remove the seal (5) from the flange as described in Section Disassembly, if necessary.

Idler Shaft



0107004

Remove the wiper arm as previously described.

Slacken the lock nut (3) on the clevis shaft (4), then unscrew the clevis shaft (4).

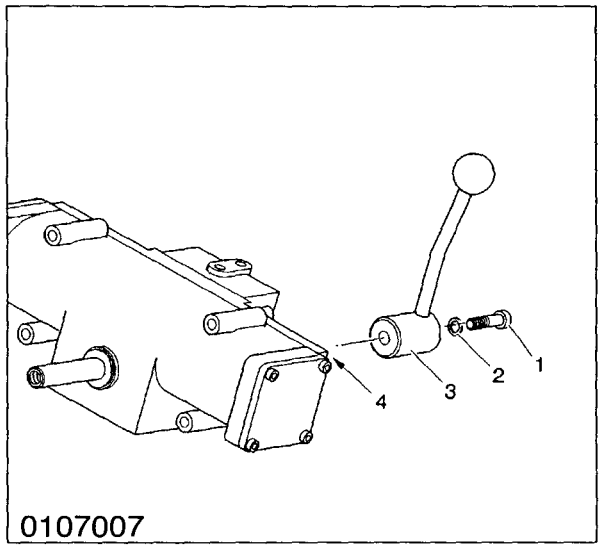
Remove the windscreen wiper motor as described in Wiper Motor in this Section, if necessary.

From inside the cab, remove the three screws (2) securing the idler shaft (1) to the front panel.

Withdraw the idler shaft assembly (1) from the panel.

Remove the seal from the front panel boss as described in Section Disassembly.

Manual Levers

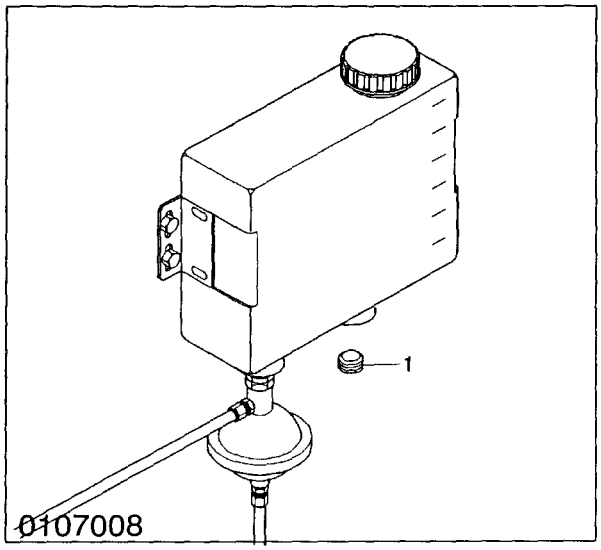


Separate the extension from the driver's lever, if necessary.

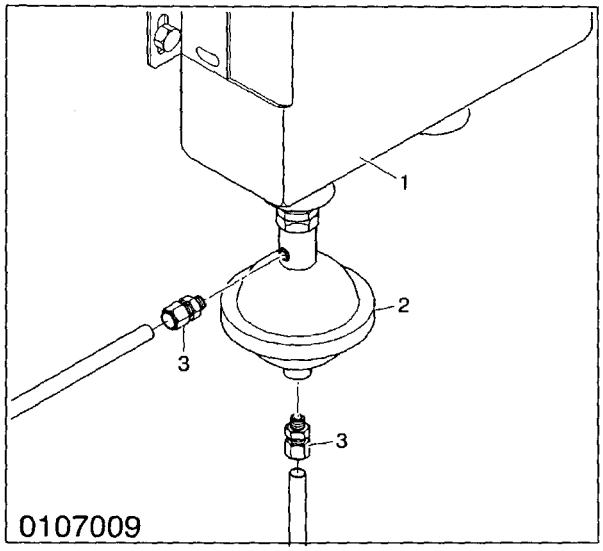
Remove the 6 mm socket head screw (1) and the washer (2) from the wiper motor shaft (4) using an Allen key.

Remove the manual lever (3) from the wiper motor shaft (4).

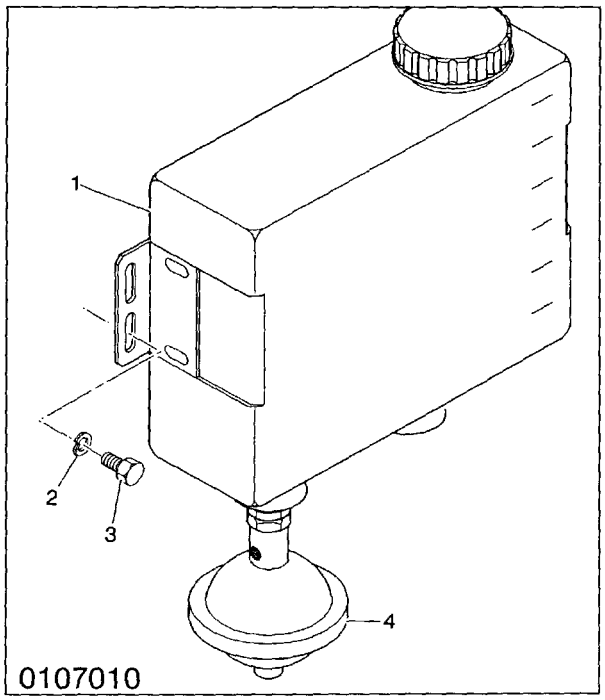
Washer Reservoir



Place a suitable receptacle below the reservoir drain plug (1). If necessary, remove the plug and drain the reservoir.



Crack loose the unions (3) at the washer pump (2). Drain any residual liquid into the receptacle. Unless damaged, the diaphragm in the washer motor (2) will seal the reservoir (1).



Seal the pipes to prevent out-flow of water and the ingress of foreign material.

Support the reservoir (1), then remove the bolts (3) and washers (2) securing the brackets to the cab side wall.

Remove the reservoir (1) from the cab and inspect for damage as described in Section Inspection and Repair.

Disconnect the washer pump (4) from the reservoir as described in Section Disassembly, if necessary.

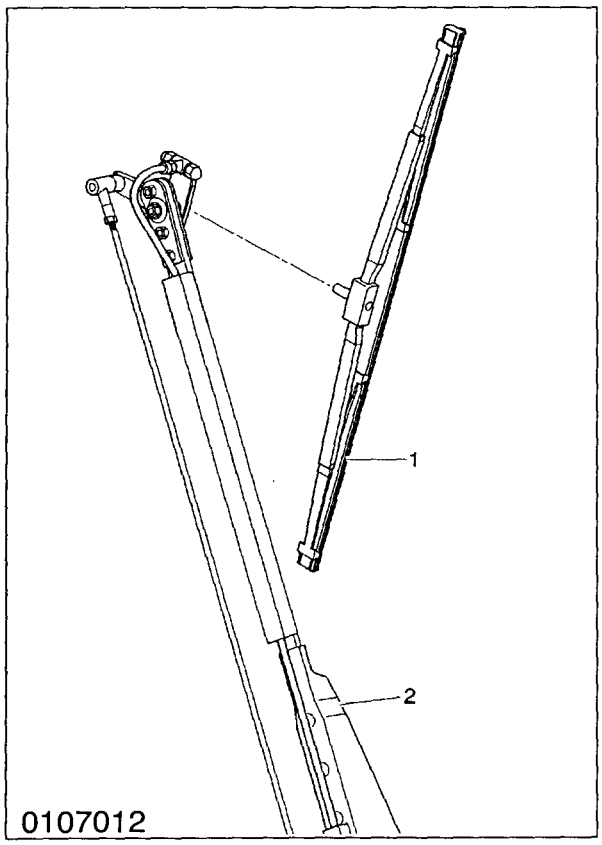
Disassembly

@.1240

Wiper Arm

For more information regarding the wiper arm, refer to Chapter 7, Wiper/Washer of Volume F1, Suppliers Documentation.

WIPER BLADE

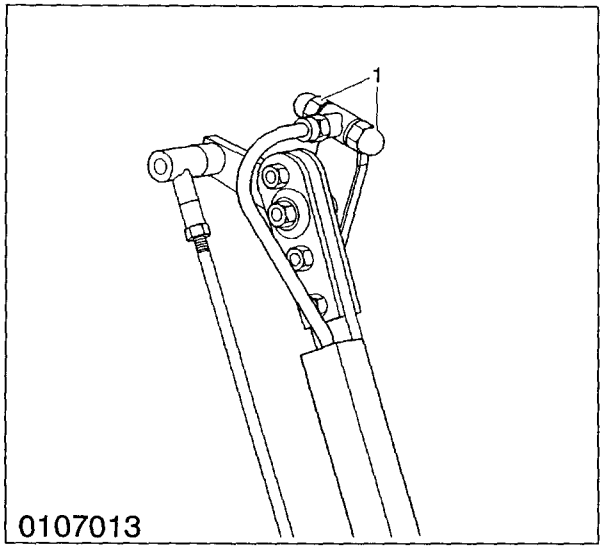


Lift the wiper arm (2) from the windscreen.

Depress the tang that holds the wiper blade assembly (1) to the wiper arm (2) using a flat blade screwdriver.

Withdraw the blade assembly (1) while holding the tang depressed.

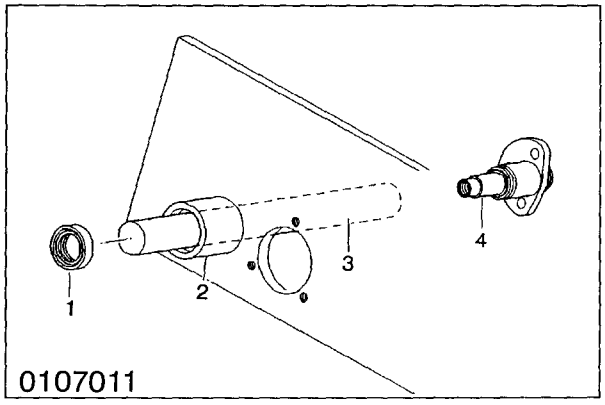
WASHER NOZZLE



Unscrew the washer nozzle (1) from the connection at the end of the wiper arm.

Idler Shaft

SEAL



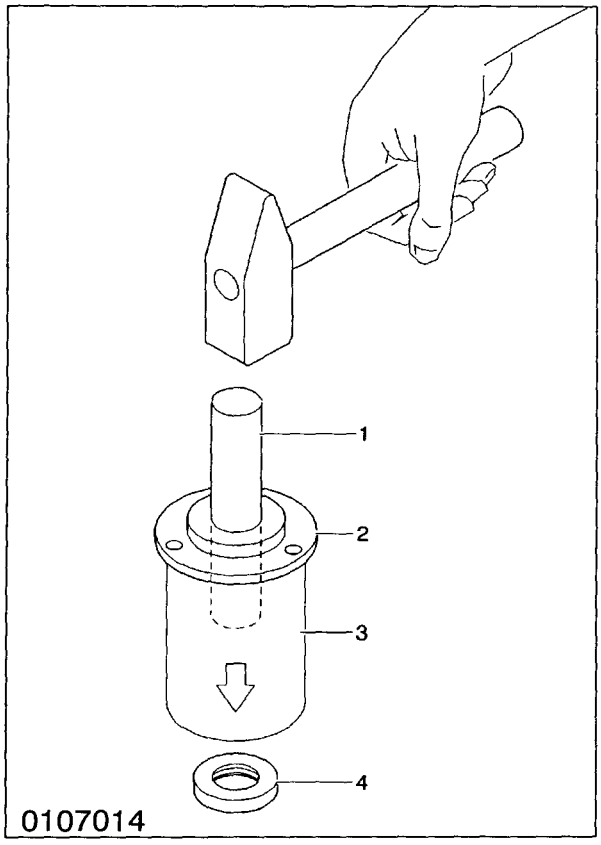
Remove the idler shaft assembly (4) as described in Section Removal.

From inside the cab, drive the seal (1) from the boss (2) using a 17 mm diameter drift (3).

Wiper Motor

For more information regarding the wiper motor, refer to Chapter 1.7, Wiper/Washer of Volume F1, Suppliers Documentation.

SEAL FLANGE

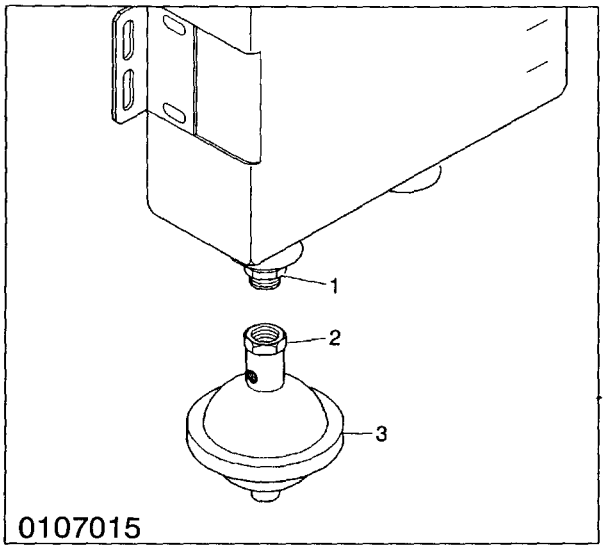


Position the flange (2) on a suitable steel tube (3) with the seal (4) facing downwards. Ensure the steel tube (3) will not interfere with the seal (4) during removal.

Drive the seal (4) from the back of the flange (2) using a 17 mm diameter drift (1).

Washer Reservoir

WASHER PUMP



Hold the union (1) on the reservoir using a spanner.

Loosen the fitting (2) using a spanner, then unscrew the pump (3) from the union (1). Do not allow the union (1) to rotate in the reservoir.

Inspection and Repair

@.1250

Wiper Arm

Inspect the wiper arm for wear or damage.

Check all the moving joints of the wiper and parallel arm for wear. Replace the arm assembly if the joints have excessive movement.

Repair any chipped or worn paint as described in Chapter 1.2 Exterior Finish.

Measure the distance between the centre of the clevis' at each end of the parallel arm. If necessary, adjust parallel arm length to the specification given in Section Technical Data.

WIPER BLADE

Inspect the condition of the windscreen wiper blades. Replace if worn or the rubber is deteriorated.

WASHER NOZZLE

WARNING:

Alkaline solution is corrosive. Work according to the prevailing workshop safety regulations.

Immerse the nozzle in an alkaline solution to remove any built-up deposits. Rinse thoroughly with clean, hot water, then dry nozzle using compressed air.

NOTE:

Do not enlarge the jet diameter.

Check the jets for blockage. If necessary, clean the jet using a piece of thin wire.

Test the nozzle and ensure the jets are clear.

Wiper Motor

Inspect the condition of the seal running surface on the shaft. Check for circumferential grooves. Replace the shaft assembly if the depth of the grooves exceeds the minimum diameter of the shaft. Refer to Section Technical Data.

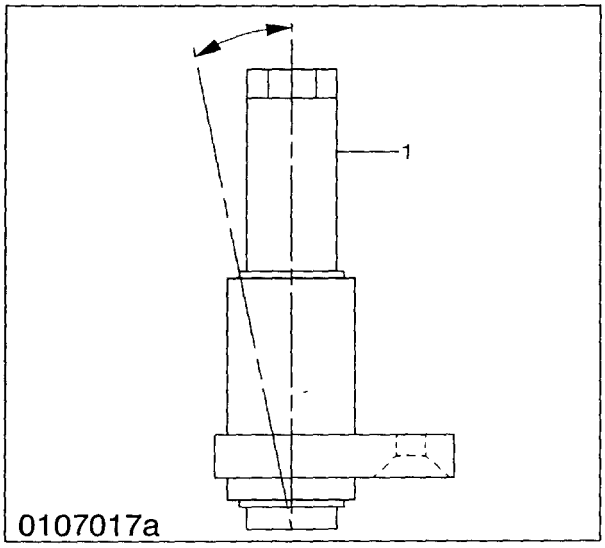
Measure the diameter of the shaft at the seal running surface. Replace the shaft if the diameter is below the specification in Section Technical Data.

Inspect the wiper motor as described in Chapter 7, Wiper/Washer of Volume F1, Suppliers Documentation. Rectify any faults found.

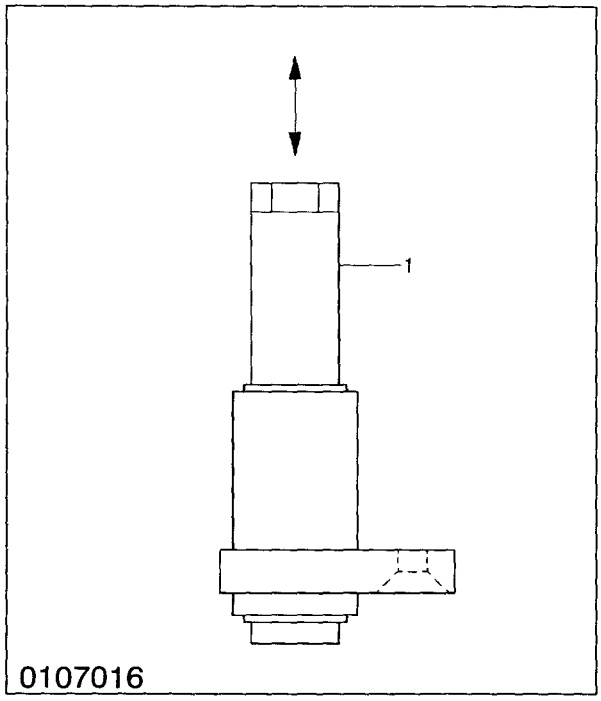
SEAL FLANGE

Inspect the condition of the seal. Replace if worn or damaged.

Idler Shaft



Check the idler shaft (1) for excessive movement. Replace the idler shaft assembly if the axial movement exceeds the specification in Section Tolerances and Wear Limits List.



Check the idler shaft (1) for excessive vertical movement. Replace the idler shaft if the vertical movement exceeds the specification in Section Tolerances and Wear Limits List.

Check the condition of the internal thread. Repair the thread if necessary using a blind M8 thread chaser.

Remove any sharp edges or burrs from the end of the shaft using a honing stone.

Apply a few drops of machine oil to the shaft, then check that the shaft rotates freely, without restriction. Replace the idler shaft assembly if it binds after lubrication.

Inspect the condition of the seal running surface on the shaft. Check for circumferential grooves. Replace the shaft assembly if the depth of the grooves exceeds the minimum diameter of the shaft. Refer Section Technical Data.

Measure the diameter of the shaft at the seal running surface. Replace the idler shaft assembly if the diameter is below the specification in Section Technical Data.

SEAL

Inspect the condition of the seal. Replace if worn or damaged.

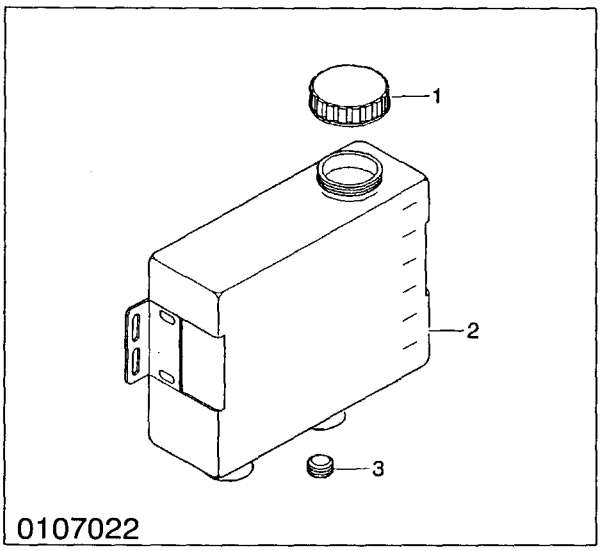
Manual Levers

Check the condition of the lever knobs, unscrew and replace if necessary.

Check the spindle for excessive wear. Replace the lever assembly if worn.

Check the fit between the lever and extension arm of the drivers' position lever. Replace the lever if there is excessive movement.

Washer Reservoir



Remove the filler cap (1) and inspect the cap (1) and seal for damage. Replace the cap assembly if required.

Remove the drain plug (3) from the bottom of the reservoir.

Check the washer reservoir (2) for cracks or holes. Replace the reservoir if damaged.

WARNING:

Alkaline solution is corrosive. Work according to the prevailing workshop safety regulations.

Remove the washer pump as described in Section Disassembly, then soak the reservoir (2) in a diluted alkaline solution for sufficient time to remove all built-up deposits. It may be necessary to use a scraping tool, with a long handle, to loosen the deposits.

Remove the reservoir (2) from the solution and rinse thoroughly with clean hot water.

Reinstall the drain plug (3).

Install a suitable fitting in the washer pump union and attach a compressed air supply.

Fill the reservoir (2) with liquid and reinstall the cap (1).

Pressurise the reservoir (2) to specification given in Section Technical Data and check for leaks. Replace the reservoir if leaking.

Remove the fitting and drain the reservoir contents into a suitable receptacle.

WASHER PUMP

Test and inspect the washer pump as described in Chapter 7, Wiper/Washer of Volume F1, Suppliers Documentation.

Waste Disposal

@.1260

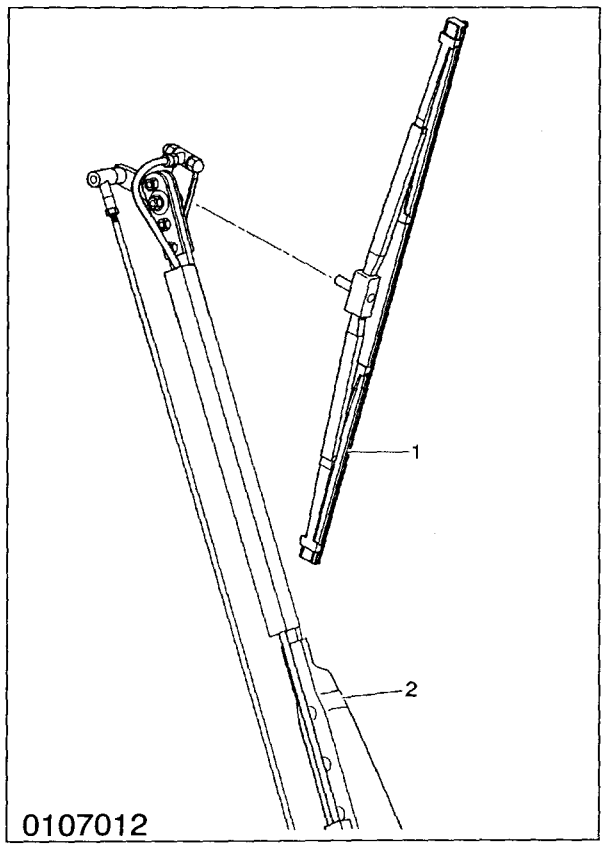
Dispose of waste parts and materials according to the prevailing environmental standards or railway company's regulations.

Assembly

@.1270

Wiper Arm

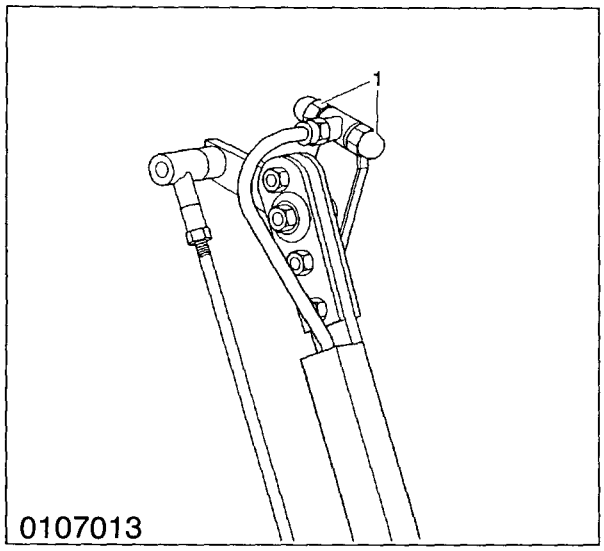
WIPER BLADE



Clip the tang on the wiper blade assembly (1) over the peg in the wiper arm (2). Ensure the wiper blade is secure and seated properly.

Lower the wiper arm (2) onto the wind-screen.

WASHER NOZZLE



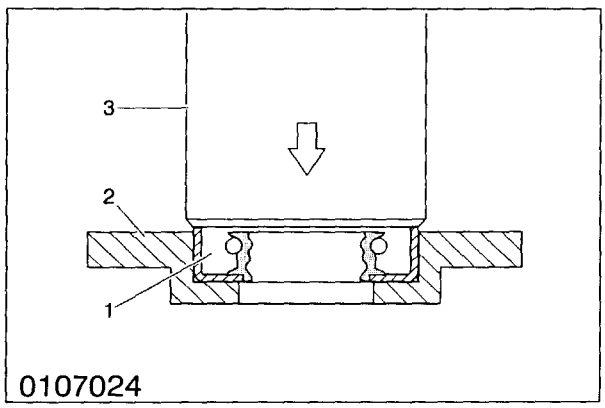
Install the washer nozzle (1) onto the wiper arm connection.

Wiper Motor

SEAL FLANGE

NOTE:

If installing the seal with the wiper motor in place, apply a few drops of oil to the shaft before installation of the seal.



Position the seal in the flange with the sealing lip facing outward.

Ensure the seal (1) is square in the flange (2).

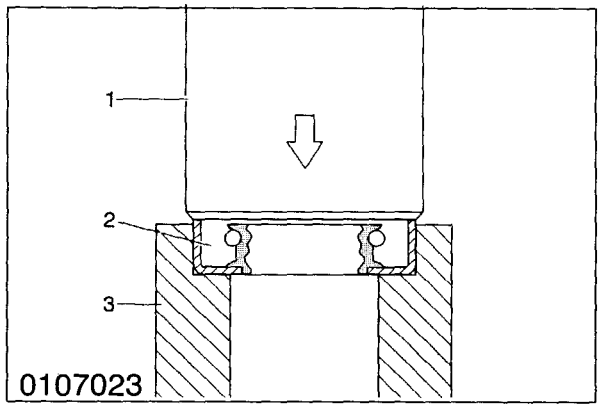
Drive the seal (1) into the flange using a suitable drift (3) or tube until the seal (1) contacts the stop.

Install the seal flange onto the locomotive front panel as described in Section Installation.

Install the wiper arm as described in Section Installation.

Idler Shaft

SEAL



NOTE:

If installing the seal with the idler shaft in place, apply a few drops of oil to the shaft before installation of the seal.

Position the seal (2) with the sealing lip facing outward into the idler shaft boss (3) on the front panel.

Ensure the seal (2) is square in the boss (3).

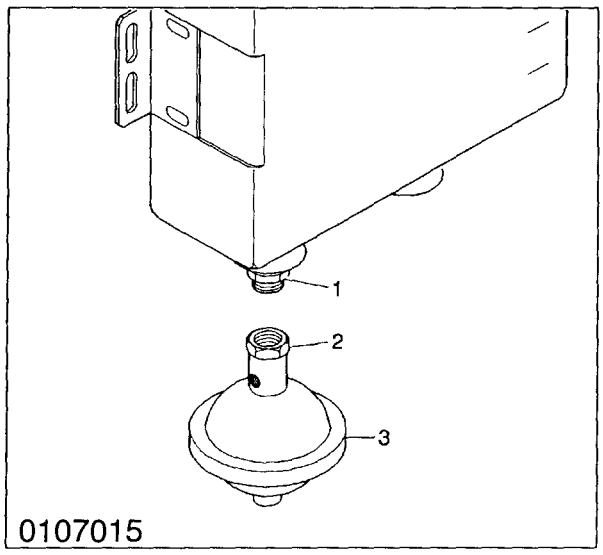
Drive the seal (2) into the boss using a suitable drift (1), or tube until the seal contacts the stop.

Install the idler shaft assembly as described in Section Installation, if necessary.

Install the wiper arm as described in Section Installation, if necessary.

Washer Reservoir

WASHER MOTOR



Screw the washer pump (3) into the fitting (1) on the bottom of the reservoir.

Hold the fitting (1) with one spanner, then tighten the pump (3) into the fitting (1) using another spanner. Do not allow the fitting (1) in the reservoir to rotate.

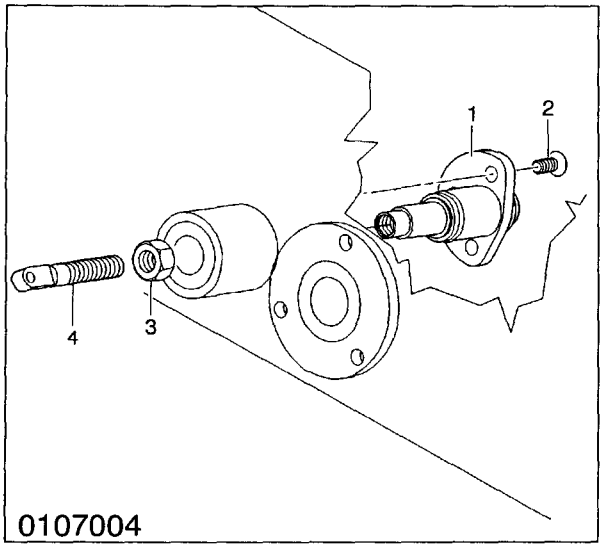
Install the reservoir into the cab as described in Section Installation, if necessary.

Installation

@.1280

Idler Shaft

Apply a thin film of oil to the shaft. The lubricant is applied to avoid damaging the seal. Do not apply too much oil.



From inside the cab, position the idler shaft assembly (1) through the front panel.

Align the three holes securing the idler shaft to the front panel.

Apply Loctite 262 to the threads, then install the screws (2).

Place the lock nut (3) on the parallel arm clevis shaft (4).

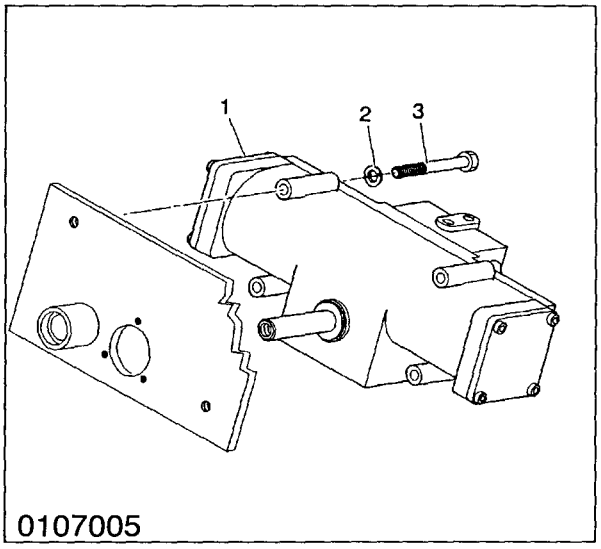
Screw the clevis shaft (4) into the idler shaft (1). Adjust the clevis shaft so the end is approximately 68 mm from the front panel. Align the groove with the wiper arm pivot and tighten the lock nut (3).

Wiper Motor

From outside the cab, install the seal flange as described in Seal Flange.

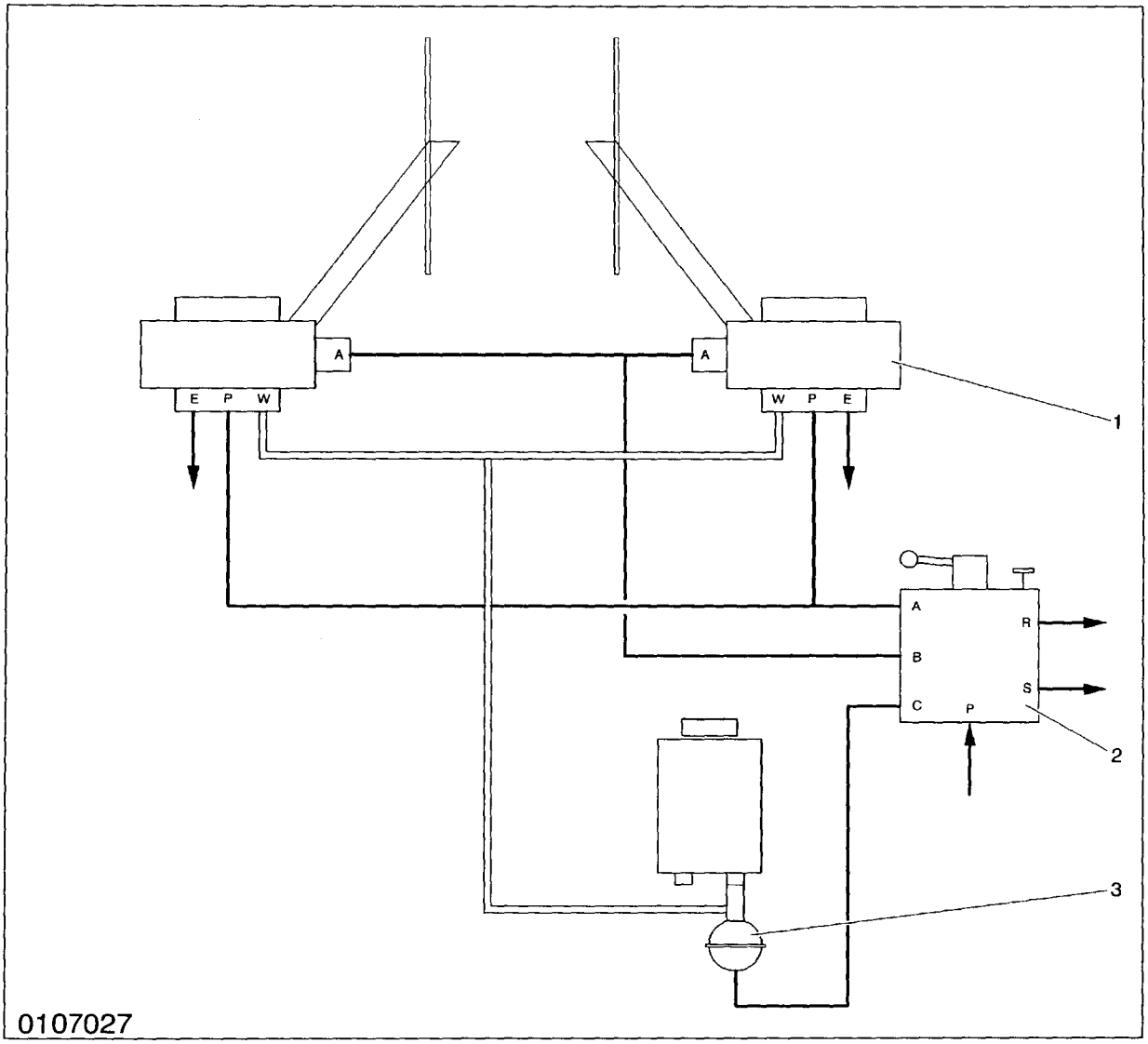
To protect the seal from damage, remove any burrs from the end of the wiper arm drive shaft using a honing stone.

Apply a thin film of oil to the motor shaft. The lubricant is applied to avoid damaging the seal. Do not apply too much oil.



From inside the cab, position the wiper motor (1) on the front panel boss.

Align the holes and install the four bolts (3) with spring washers (2) through the wiper motor (1) into the front panel.



1	Wiper motor	2.B	Working line (to park position)
1.A	Air supply port for parking position	2.C	Working line (to washer)
1.E	Breather port	2.P	Air supply port
1.P	Air supply port	2.R	Vent
1.W	Water supply	2.S	Vent
2	Wiper/washer control	3	Washer motor
2.A	Working line (to wiper drive)		

Remove the seals from the pipes and unions.

Connect the pipes from the wiper motor (1) and the pneumatic supply (2) to the washer motor (3) as tagged during disassembly. The figure shows the location of the lines.

nstall the manual handle as described in Manual Handles in this Section.

Open the air supply to the windscreen wipers.

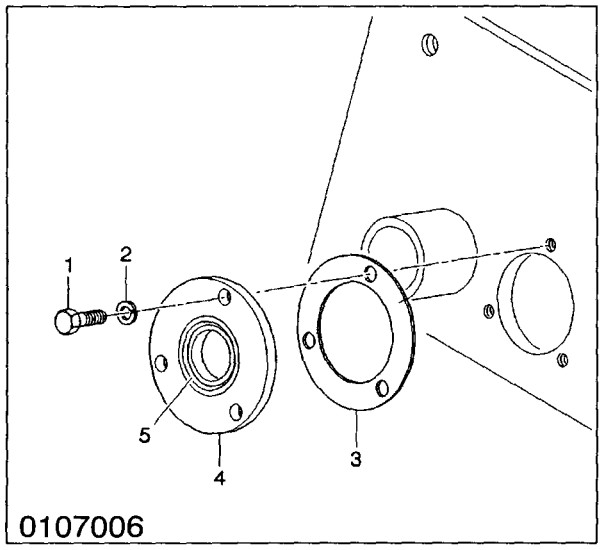
Test the operation of the wipers. Rectify any faults found.

Adjust the position of the wiper arm as described in Section Adjustments.

SEAL FLANGE

Inspect the seal as described in Section Inspection and Repair.

Install the seal into the flange as described in Section Assembly.



Check the condition of the gasket (3). Replace if damaged or torn.

Position the gasket (3) on the back of the seal flange (4). Ensure it is seated on the step.

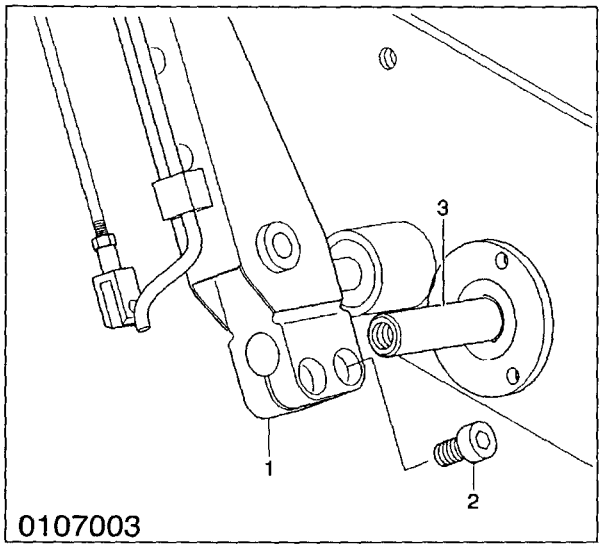
Position the seal flange (4) on the front panel. Ensure the step is seated in the aperture.

Align the holes in the flange with those in the front panel.

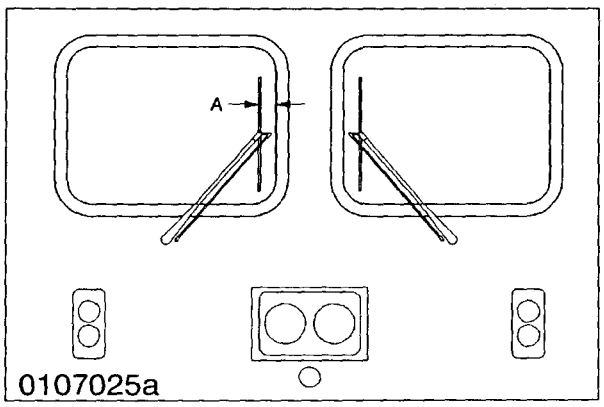
Apply Loctite 262 to the bolt threads, then install the bolts (1) and spring washers (2). Tighten the bolts.

Install the wiper arm as described in Section Installation.

Wiper Arm



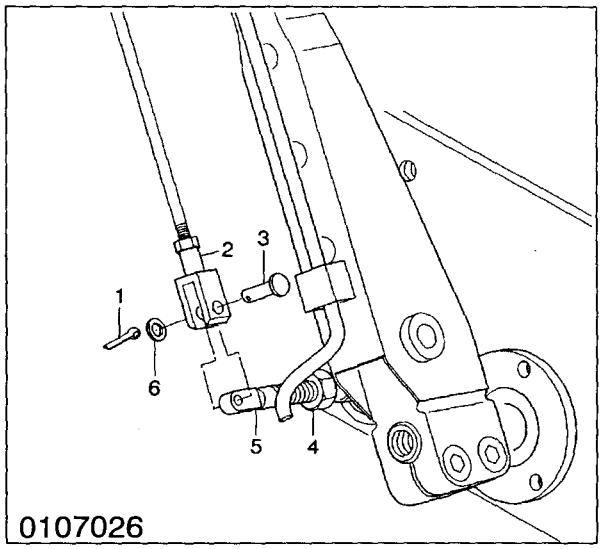
Position the wiper arm assembly (1) onto the drive shaft (3). Install socket head bolts (2), but do not tighten bolts at this stage.



Lower the wiper arm assembly onto the windscreen.

Align the match mark made during disassembly, or position the wiper blade parallel with the edge of the windscreen. Distance A is given in Section Technical Data.

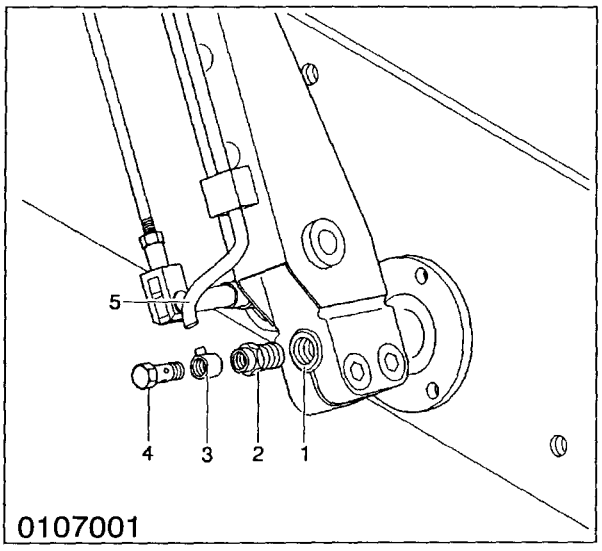
Tighten the two socket head bolts on the wiper arm assembly.



Install the parallel arm (2) onto the clevis shaft (5). If necessary, slacken the lock nut (4) and rotate the clevis shaft (5) to obtain the correct alignment, then tighten the lock nut (4).

Install the pivot pin (3) through the parallel arm (2) and clevis shaft (5).

Place the washer (6) over the end of the pivot pin (3) and install the split pin (1).



Screw the union (2) into the wiper arm (1).

Position the banjo fitting (3) onto the union (2).

Screw the bolt (4) through the banjo fitting (3) into the union (2).

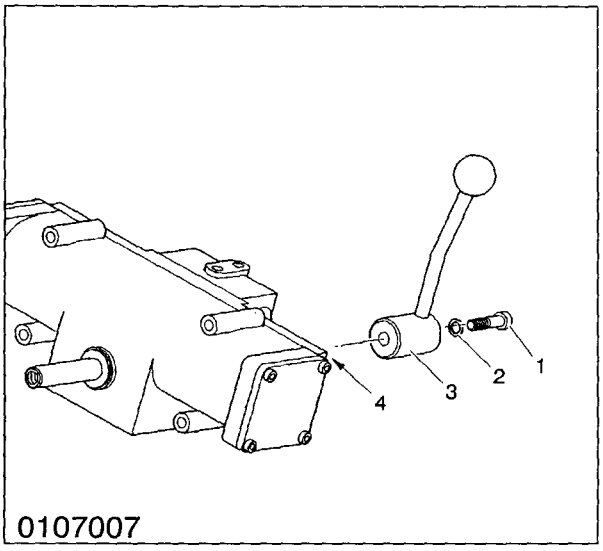
Connect the washer hose (5) to the banjo fitting (3).

Install the washer nozzle as described in Section Assembly, if necessary.

Adjust the position of the wiper arm as described in Section Adjustments.

Manual Handles

Inspect the levers as described in Section Inspection and Repair.



0107007

Position the lever (3) on the end of the wiper motor shaft (4).

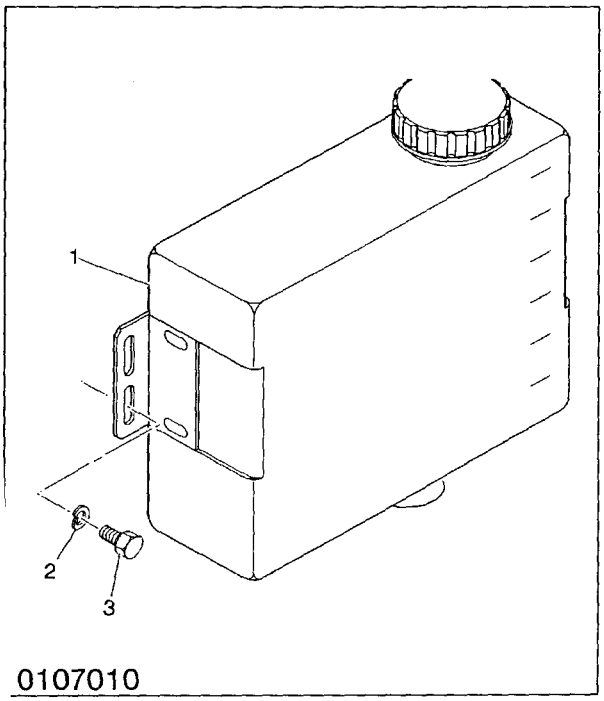
Apply Loctite 262 to the thread of the socket head screw (1).

Install the screw (1) with spring washer (2) through the lever spindle into the wiper motor shaft (4).

Tighten the screw (1).

Attach the extension lever to the driver's side lever, if necessary.

Washer Reservoir



0107010

Install the washer pump to the reservoir as described in Section Assembly, if necessary.

Position the reservoir (1) in the cab and align the holes in the brackets with those in the cab wall.

Support the reservoir (1), then install the bolts (3) and washers (2) securing the brackets to the cab side wall.

Remove the seals from the pipes and unions.

Connect the pipes to the washer motor as tagged during disassembly. Refer Wiper Motor in this Section.

Fill the reservoir with clean, fresh water, then replace the cap.

Test the operation of the windscreen washers.

Rectify any faults found.

After-Installations Operations

@.1290

Install and close the windscreen guard grille as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

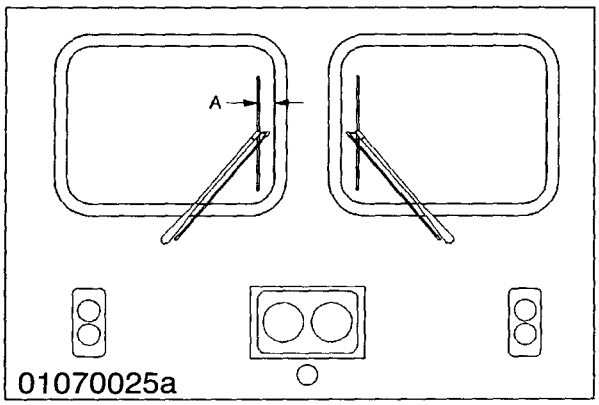
Check the operation of the wiper/washer pneumatic system as described in Chapter 13, Static Test of Volume F14, Suppliers Documentation. Rectify any faults found.

Adjustments

@.1310

Test the operation of the windscreen washers. Rectify any faults found.

Wiper Arm



Open the windscreen guard grille as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

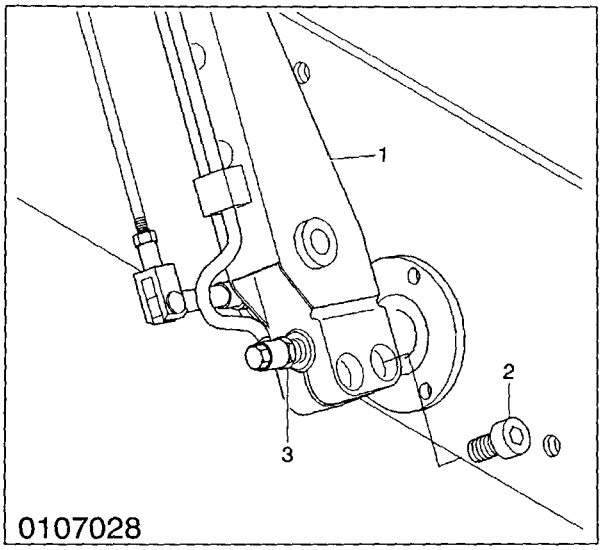
Clean the windscreen to prevent the blade scratching the glass during adjustment.

Open the air supply to the windscreen wipers.

To avoid unnecessary scratches to the windscreen and to allow the wiper blades to move with the least friction, wet the windscreen with water.

From inside the cab, test the operation of the wipers using the console control.

Move the control to the OFF position, then measure the distance (A) between the wiper blade and the inside edge of the windscreen. Adjust the position of the wiper arm as described below if the distance from the wiper blade to edge of windscreen is not within the specification in Section Technical Data.



Raise the wiper arm (1) from the windscreen.

Loosen the two socket head screws (2) that clamp the wiper arm around the shaft.

Loosen the washer union (3) in the end of the wiper arm drive shaft.

Adjust the position of the wiper arm (1) as required.

Tighten the two socket head bolts (2) and recheck the wiper operation.

Tighten the washer union (3).

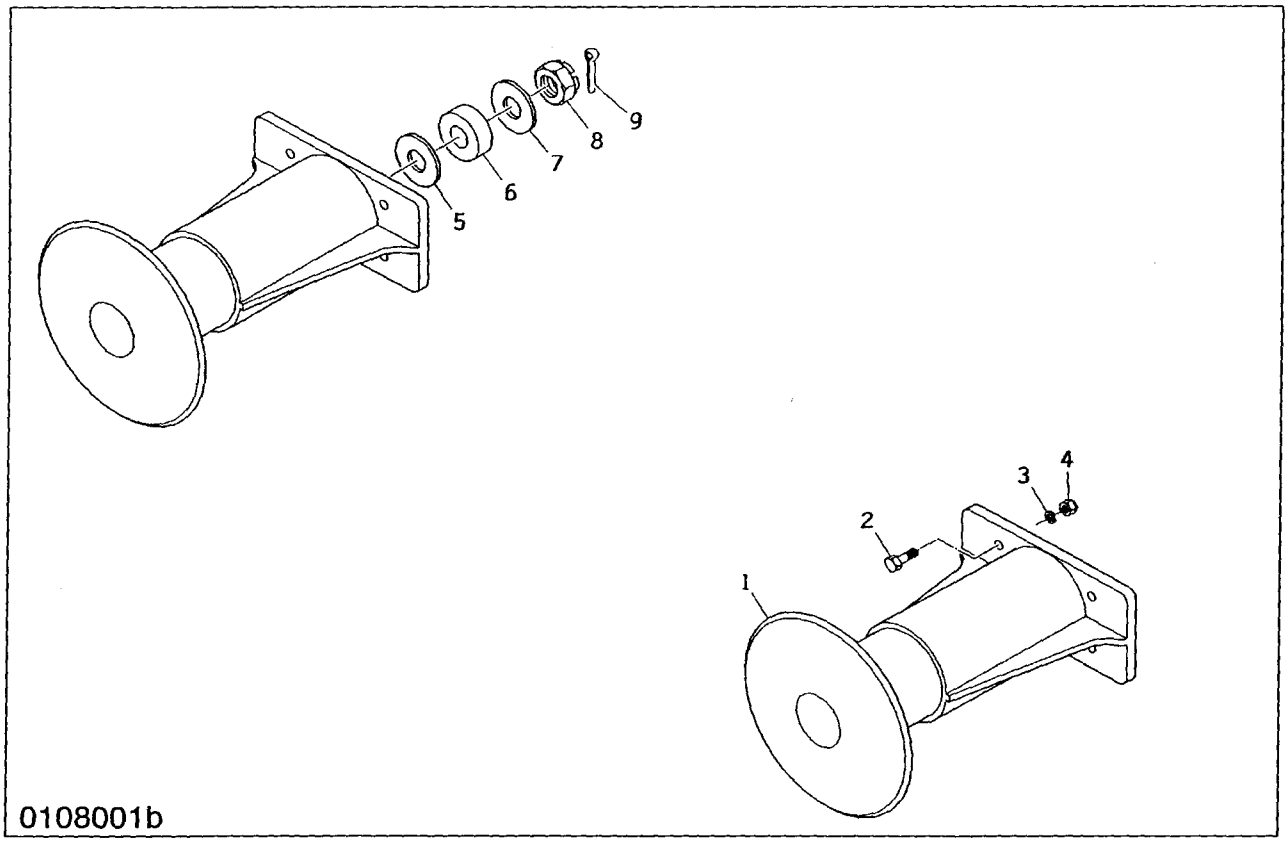
Close the windscreen guard grille as described in Chapter 4, Vehicle Operation of Volume A, Driver's Manual.

1.8 Buffers

Group Summary

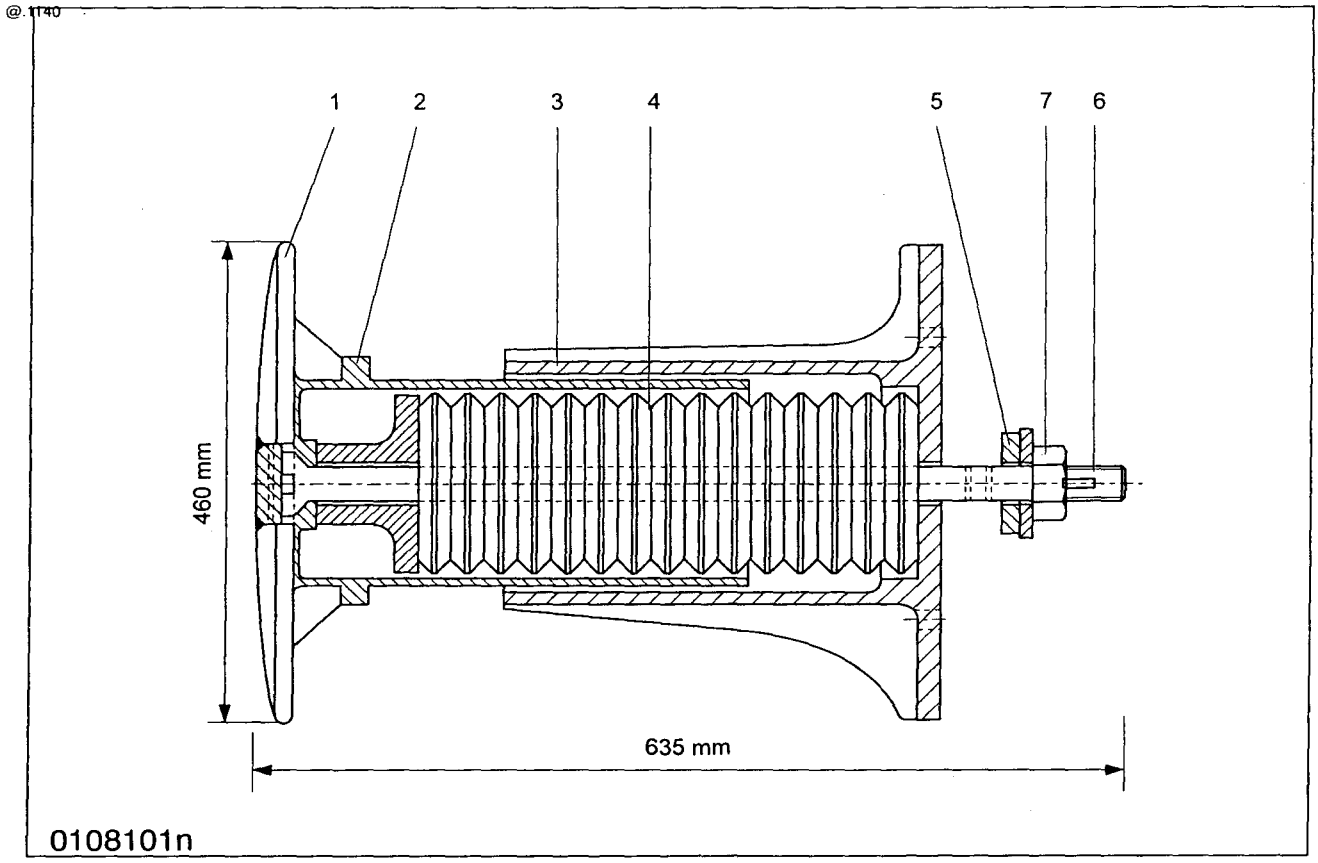
@.1120

This chapter contains information regarding the buffers fitted to each end of the locomotive.



1	Buffer	6	Recoil block
2	Bolt	7	Washer
3	Washer	8	Nut
4	Lock nut	9	Split pin
5	Packing plate		

Functional Description



1	Buffing pad	5	Recoil block
2	Buffer plunger	6	Adjusting rod
3	Buffer casing	7	Adjusting nut
4	Rubber buffing elements		

Buffers are located at either end of the locomotive.

Shocks generated during buffing and shunting are absorbed by the buffing elements. Once compressed, the buffer plunger rests on stops located on the buffer casing, transmitting shocks directly to the headstock. Recoil blocks absorb energy released as the buffer plunger returns to its unloaded position.

An additional packing plate is added to the adjusting rod to obtain the correct installed length. Refer to Section Assembly.

For further information on the buffers, refer to BESCO's Technical Documentation.

Technical Data

@.1160

Buffer

- Manufacturer	BESCO, India
- Model	WA/BD-211
- Weight	127 kg
- Stroke	127 mm
- Diameter	460 mm
- Capacity	1,030 kgm
- Installed length (X)	645 mm

Tolerances and Wear Limits List

@.1170

For further information on the buffers, refer to BESCO's Technical Documentation.

Tools and Special Tools

@.1180

In addition to conventional railway workshop tools, heavy lifting equipment and safety stands are also required for procedures described in this group.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- General purpose grease
- Light oil

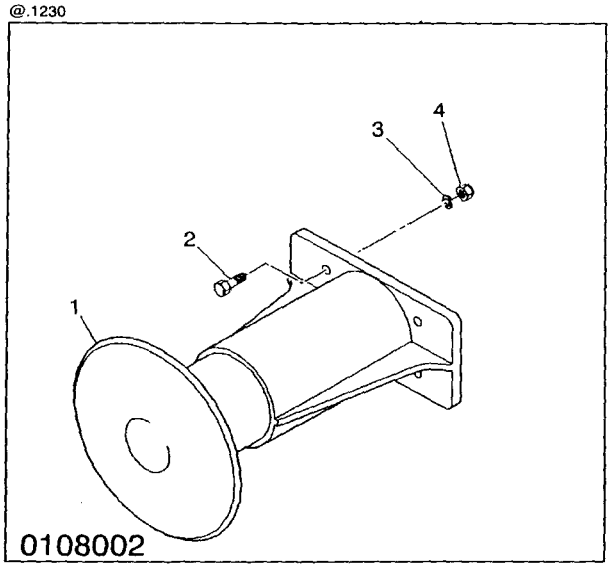
Before-Removal Operations

@.1220

Steam clean the buffers and surrounding area, remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume. Damage to the components can result from improper application of the steam cleaning equipment.

Removal

@.1230



WARNING:

Heavy component, handle with care to avoid personal injury or damage. Use suitable lifting equipment.

Attach suitable lifting equipment to the buffer (1).

Raise the equipment slightly to take the weight.

Loosen the four lock nuts (4).

Remove the lock nuts (4) and washers (3) from the bolts (2). Discard the washers (3) and lock nuts (4).

Move the buffer clear of the locomotive using the lifting equipment.

Lower the buffer to a suitable support stand.

Disassembly

@.1240

For further information on the buffers, refer to BESCO's Technical Documentation.

Inspection and Repair

@.1250

Inspect the surface finish of the buffers. Remove any rust and repair any paint chips or scratches as described in Chapter 1.2, Exterior Finishes. For further information on the buffers, refer to BESCO's Technical Documentation.

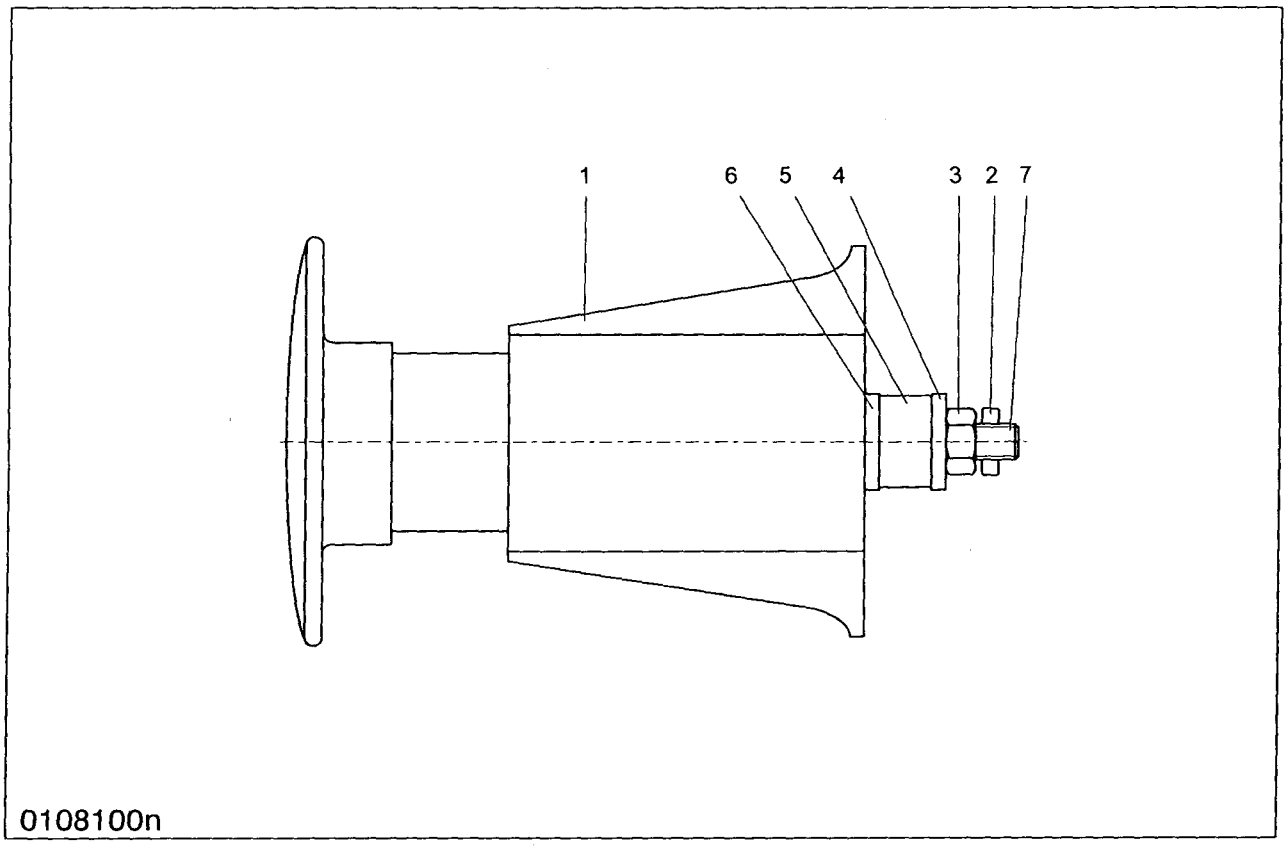
Waste Disposal

@.1260

Dispose of waste parts and materials according to the prevailing environmental standards or workplace practices.

Assembly

@.1270



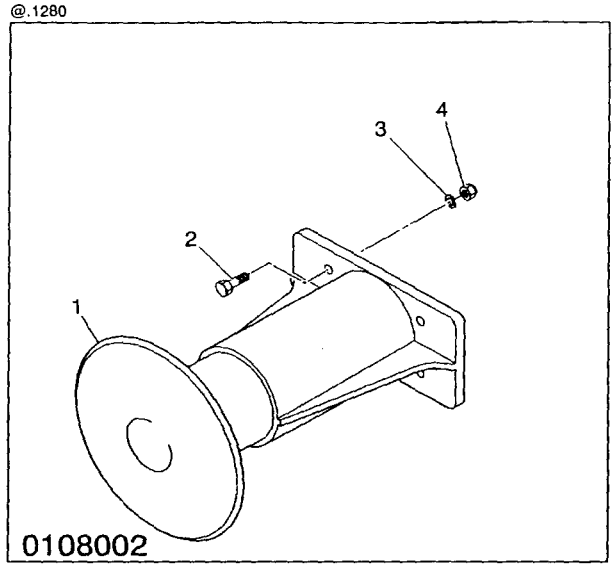
0108100n

To add the packing plate (6) to a new buffer assembly, compress the buffer (1) in a suitable press. Remove the split pin (2), nut (3), washer (4) and recoil block (5) from adjusting rod (7). Add the packing plate (6), then reinstall recoil block (5), washer (4), nut (3) and split pin (2).

For further information on the buffers, refer to BESCO's Technical Documentation.

Installation

@.1280



WARNING:

Heavy component, handle with care to avoid personal injury or damage. Use suitable lifting equipment.

Attach suitable lifting equipment to the buffer (1) and position it on the locomotive headstock.

Align the bolt holes in the buffer (1) and headstock, then support the buffer (1) using a suitable safety stand.

Install the four bolts (2) through the buffer (1) and headstock.

Apply a film of light oil to the threads, then place the new spring washers (3) and new lock nuts (4) on the bolts (2).

Check the buffer (1) is square on the headstock. Torque the nuts to 335 Nm.

After-Installations Operations

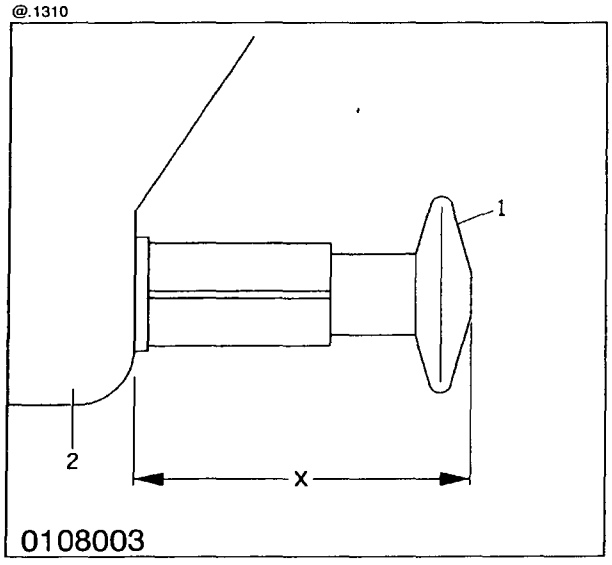
@.1290

Check and adjust, if necessary, the installed length (X) of the buffer as described in Section Adjustments.

Cover the exposed areas of the buffer face and shaft with a light coat of grease to prevent corrosion.

Adjustments

@.1310



Measure the installed length (X) from the face of the buffer (1) to the face of the headstock (2).

Adjust the buffer using the following procedure if the installed length (X) is not within the specification given in Section Technical Data.

From behind the headstock, remove and discard the split-pin from the buffer adjusting nut.

Adjust the nut to obtain the required installed length (X) as described in Section Technical Data.

Install new split-pin on the buffer adjusting nut.

Cover exposed threads, buffer face and buffer shaft with grease to prevent corrosion.

1.9 Cable Duct

For complementary information see Suppliers Documentation Volume G:

ABB Three Phase Electric Drive Locomotive WAG-9
Cable Schematics

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BOMBARDIER TRANSPORTATION

IR WAG9

Volume D1

Bogies & Running Gear

2.00	Bogies & Running Gear	1
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2.02	Wheelset	3
2.03	Primary Suspension	4
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2.05	Traction Link	6
2.06	Transmission	7
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2.08	Wheel Flange Lubrication	9
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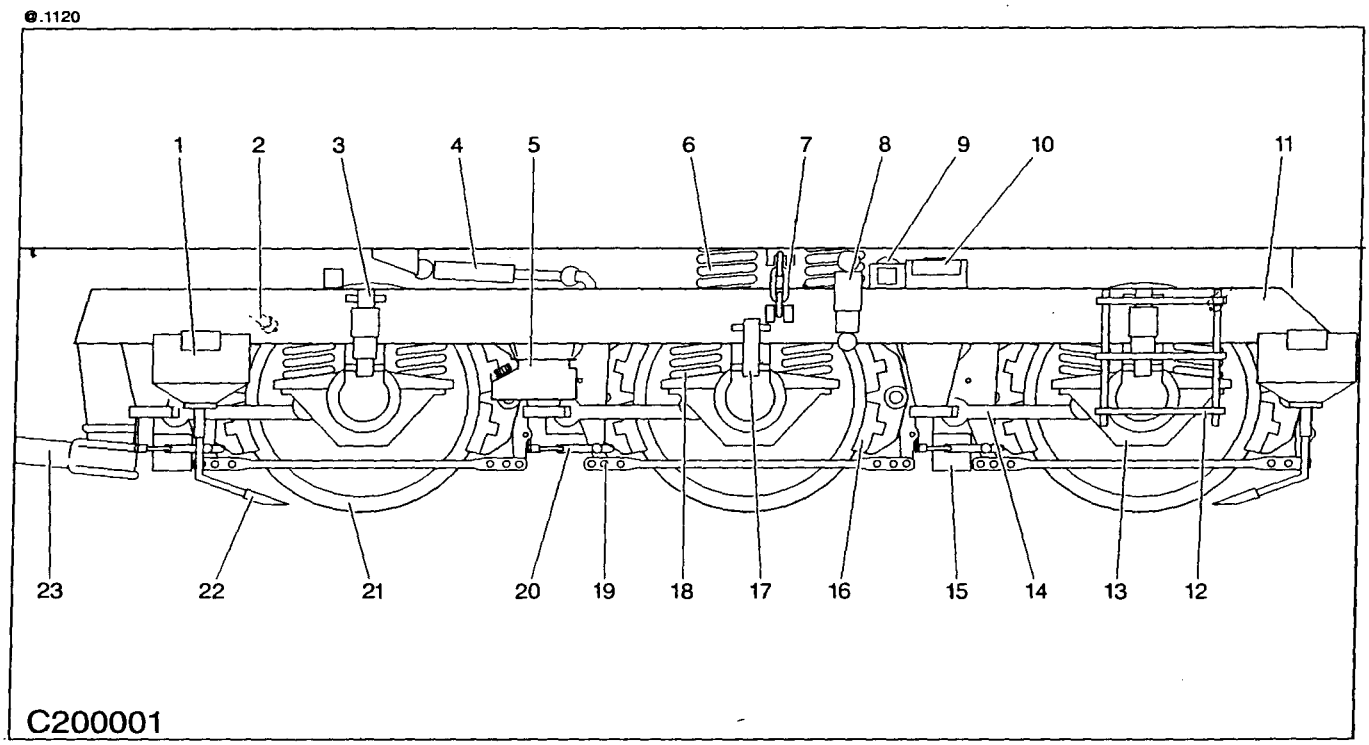
		11
		12

2 Bogies and Running Gear

General Precaution

Care should be taken to keep the spheriblocks, vulkollan rings (traction link bush), dampers and bump stops free from oil, grease or other rubber solvents.

Overview



1	Sand box	12	Step
2	Wheel flange lubrication nozzle	13	Axle journal box
3	Primary suspension vertical damper	14	Guide rod
4	Yaw damper	15	Brake cylinder
5	Wheel flange lubrication reservoir	16	Brake pad
6	Secondary suspension spring	17	Middle axle link
7	Safety chain	18	Primary suspension springs
8	Secondary suspension vertical damper	19	Brake rigging
		20	Brake slack adjuster
9	Secondary suspension horizontal damper	21	Wheel
		22	Sanding nozzle
10	Bump stop	23	Traction rod
11	Bogie frame		

Functional Description

@.1140

The three axle, three motor Co–Co bogie assembly, is one of the major parts of the locomotive. Two bogie assemblies support the entire weight of the locomotive and provide a means for transmission of the tractive effort to the rails.

The bogies are designed to withstand the stresses and vibrations resulting from normal rolling stock applications. An important function of the bogie is to absorb and isolate shock caused by variations in the track. The suspension systems minimise the transmission of these shocks to the locomotive underframe.

The traction motors are suspended in the bogie frame and on the individual axles. The motors transmit their torque to the driving axles through a gear mounted on the driving axle. The force from the driving axles is transmitted to the contact point between the wheel tread and the rail. Traction force is, in turn, transmitted through the axle journal boxes and guide rods to the bogie frame.

The push–pull link rod, connected between the bogie transom and car underframe, transmits the tractive forces to the car body.

Slowing or stopping the locomotive is achieved by use of electrically regenerative braking or pneumatically operated drum brakes. The brake cylinders and rigging are positioned to enable the brake shoes to clamp against the wheel tread surface. As with the tractive effort, braking effort is transmitted to the bogie frame by the axle journal boxes and guide rods and from the bogie frame to the locomotive by the traction rods.

Isolation and absorption of shock loads and vibration is performed by the primary and secondary suspension. Movement between the car body and bogie is smoothly controlled by the primary and secondary suspension. Although the springs permit free movement in any direction, ateral buffers and dampers limit the amount and rate of lateral movement. Vertical dampers imit the amount and rate of the vertical bounce of the locomotive car body. Yaw (longitudinal) dampers control the car body pitch rate. Guide rods control the fore and aft movement beween the axles and the bogie frame, while the link rod controls the fore and aft movement etween the bogies and the locomotive car body.

The primary suspension, located between the axles and the bogie frame, is provided by twin oil springs on the axle journal box fore and aft of the axle line. Vertical hydraulic dampers n the end axles are used to dampen the rebound rate of the springs. This "Flexicoil" arrangement permits lateral movement of the axle. Longitudinal control of the axle, and the transmission of tractive and braking effort to the bogie frame, is provided by guide rods connected etween the axle journal boxes and bogie frame. Spheribloc rubber bushes in the guide rods llow the axle lateral movement without undue restriction.

Secondary suspension, is also provided by coil springs and vertical hydraulic dampers, located between the bogie frame and the locomotive underframe on each side of the bogie. The weight of the locomotive car body is carried by the secondary suspension springs. The "Flexi-Float" arrangement of the secondary suspension allows the locomotive car body to move both laterally and vertically within certain limits relative to the bogies.

The Co–Co bogie is fitted with wheel flange lubrication equipment to minimise wheel wear and sanding equipment is installed to provide additional traction between the wheels and rail when required.

Technical Data

@.1160

– Wheel Arrangement	Co–Co
– Weight	22,504.4 kg
– Maximum Axle Load (without ballast)	20,500 kg
– Wheelbases	1,850 mm
– Overall Length	6,209 mm
– Overall Width	2,962 mm
– Overall Height	1,240 mm
– Max. Transverse Motion*	± 30 mm, between bogie frame and car body
– Max. Vertical Motion*	± 30 mm, between bogie frame and car body
– *Limited by bumps stops	

Tolerances and Wear Limits List

@.1170

[Not required for bogie assembly. Wear limits apply to individual equipment]

Tools

@.1180

This maintenance procedure requires conventional workshop equipment and those special tools described in Section Special Tools.

Special Tools

@.1190

The bogies can be removed from the locomotive using either overhead lifting crane or jacks to raise the car body, or a drop table. Cranes or lifting equipment must have capacity to lift a total weight of 125 tons to allow bogie removal.

An overhead crane or portable lifting device is required to remove and install some equipment on the bogie.

IMPORTANT:

Raise all four corners of the car body equally. Support the locomotive using safety stands.

Miscellaneous Materials

@.1200

Plastic plugs, or alike suitable to seal pneumatic pipes.

Plastic tape, or alike, 200 mm wide to seal the traction motor cooling inlet against the ingress of dirt, dust and foreign material.

Before–Removal Operations

@.1220

Clean the traction motor bellows and the surrounding area.

WARNING:

Danger of High Voltage Electric Shock. To avoid personal injury, disconnect the loco from the overhead power supply.

Use the Key Interlocking System to keep the electrical system earthed.

High Pressure Pneumatic Systems. Ensure the bogie pneumatic system is de-pressurised before commencing maintenance work.

Lifting Bogie Assemblies

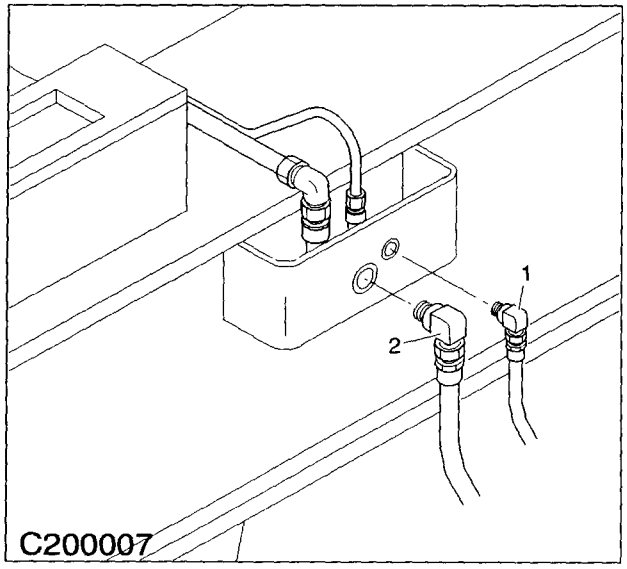
When lifting the bogie assemblies, it is not necessary to secure the axles to the bogie frame. The axles will be lifted by the primary suspension dampers and guide rods when the frame is raised.

Removal

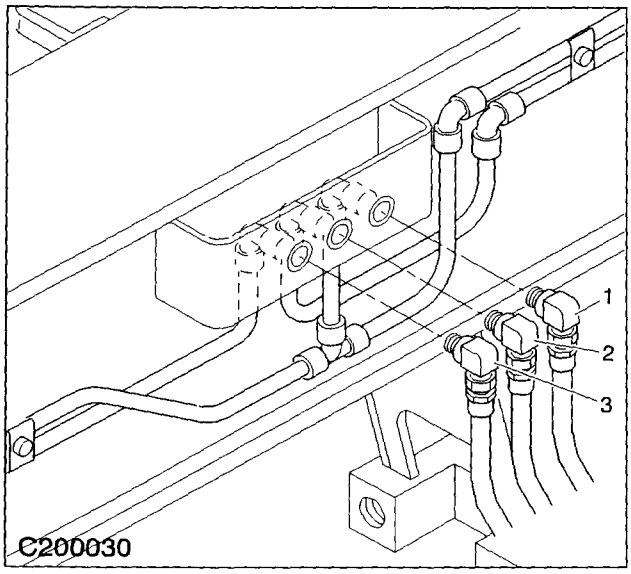
@.1230

Chock the wheels to prevent movement of the locomotive. With the parking brakes released, cage the parking brake spring at the brake cylinders. Refer Section Brake Actuators, Assembly/Disassembly.

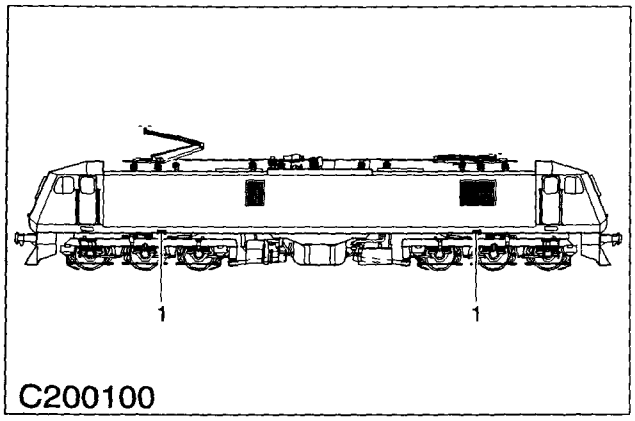
Close the bogie isolation cocks.



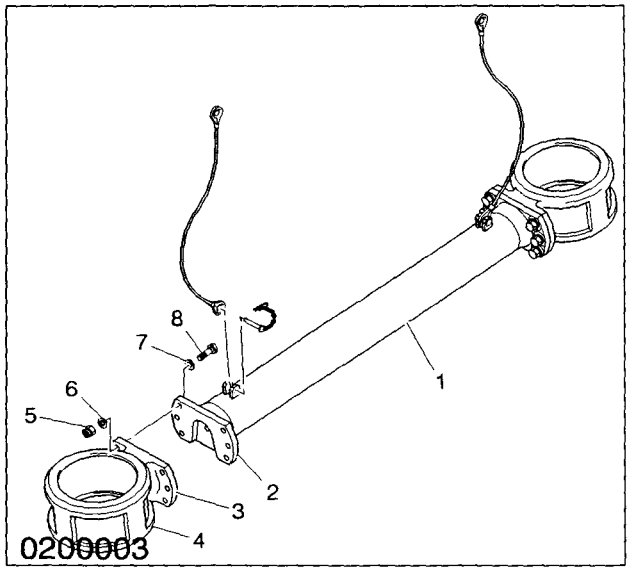
Crack loose the brake pneumatic connections (1,2) between the locomotive and bogie at the bogie unions. Allow any residual pressure to vent, then disconnect the air lines from the unions at the bogie. Seal the air line with suitable plugs to prevent the ingress of foreign material.



Crack loose the sanding equipment (2, 3) and flange lubrication (1) connections between the locomotive and bogie at the bogie unions. Allow any residual pressure to rent, then disconnect the air lines from unions. Seal the pines and unions with suitable plugs to prevent the ingress of foreign material.

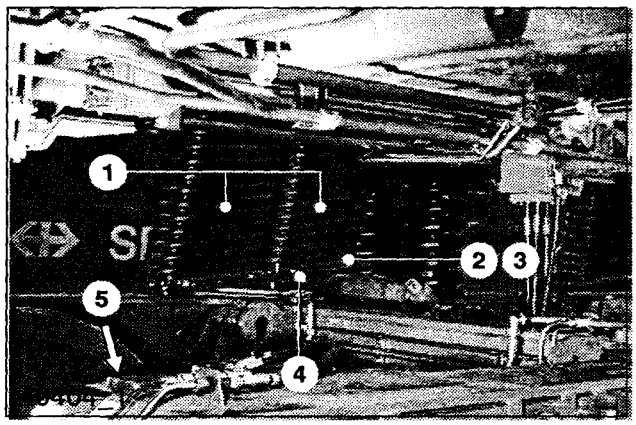


Position the lifting equipment under the locomotive. Jacking pads (1) are located on the underframe just behind the secondary suspension spring recess cavity. Raise the jacks to take up the weight. Each of the four jacking pads (1) on the locomotive is rated for raising 75 tons.



From beneath the locomotive, support the link rod (1), then remove the bolts (8), nuts (5) and washers (6,7) securing the link rod (1) tube to the bogie pivot head (4). Take care to not damage the flanges (2,3) during removal. Cover the flanges to prevent damage. Refer to Chapter 2.05 Traction Link.

Tag and disconnect the electrical cables from both traction motors; refer to Chapter 4.04 Traction Motor, Section Removal.



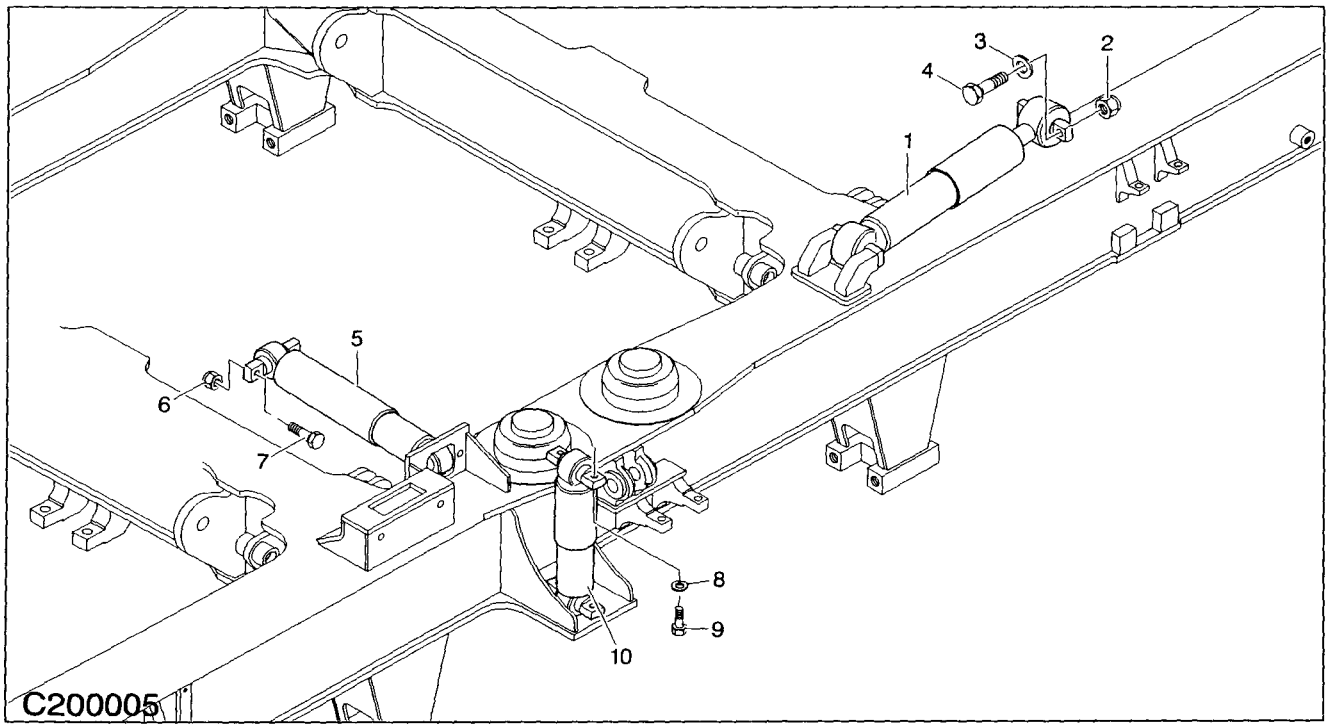
Remove the bolts and washers (2,3) securing the traction motor cooling bellows (1) to the ventilation duct inlet flange. Carefully disconnect the bellows (1) from the flange to avoid damage to the gasket (4). Discard the gasket (4) if damaged and replace with a new part. Cover the traction motor inlets (5) to prevent the ingress of foreign material. Each of the traction motors on a bogie has two bellows (1).

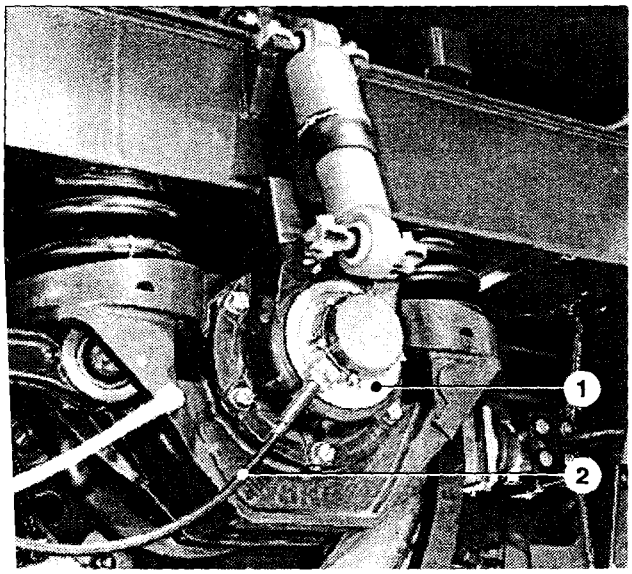
Ensure that no bolt, washer or tool is falling inside the traction motor ventilation duct!

Remove the bolts (4), nuts (2) and washers (3) securing the yaw (1) (longitudinal) dampers to the locomotive underframe.

Remove the bolts (9) and washers (8) securing the secondary suspension vertical dampers (10) to the underframe.

Remove the bolts (7) and nuts (6) securing the lateral dampers (5) to the underframe.



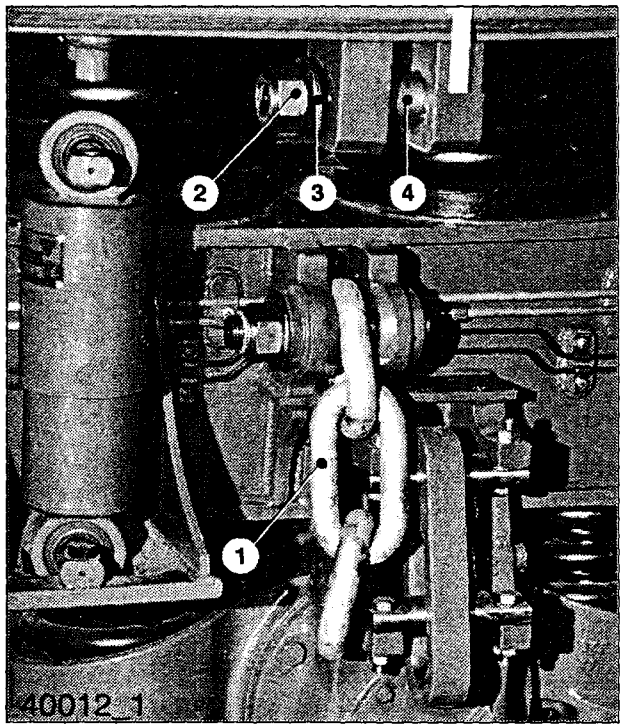


Disconnect the speed sensor cable (2) from the underframe junction box.

Secure the cable to prevent entanglement during bogie removal.

Disconnect the cables of the axle box (earth brushes) at the underframe junction box. Secure the cables to prevent entanglement during bogie removal.

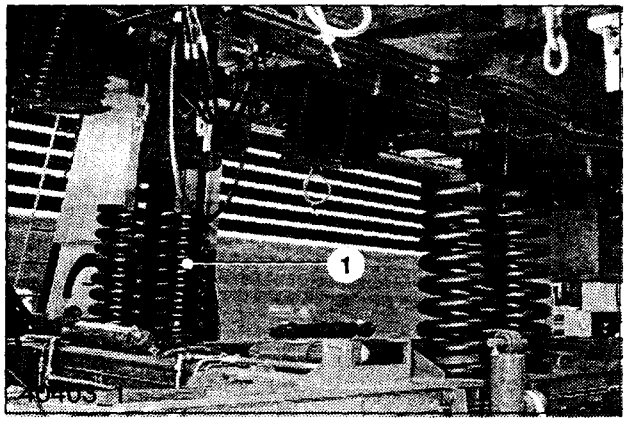
Disconnect the earthing cables between the body and bogie. Secure the cables to prevent entanglement during bogie removal.



Remove the nut (2) and washer (3) from the bogie safety chain (1), then withdraw the bolt (4) from the eye.

Mark the positions of the secondary suspension spring, seats and shims.

Raise the locomotive slightly and ensure that no equipment is entangled or any physical connection between bogie and locomotive underbody. When all equipment is clear, raise the locomotive sufficiently to remove the bogie from beneath the vehicle.



Remove the secondary suspension springs (1). Tag the location of each set of secondary springs, compensating plates and insulating bases.

Disassembly

9.1240

NOTE:

Once the traction motors and wheel sets are removed it may be more efficient to work with the bogie frame inverted.

Drain the lubricant from the flange lubrication reservoir and remove the remaining equipment as described in Section Wheel Flange Lubrication, Removal.

Drain the lubricant from the gear box, refer Section Transmission, Before – Removal Operations.

Remove the sanding equipment nozzles as described in Section Sanding Equipment, Removal

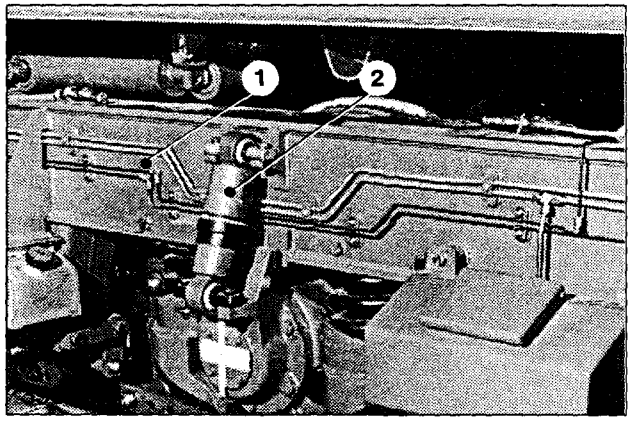
Remove the brake cylinders and brake rigging as described in Section Brake Actuators.

Remove the secondary suspension dampers as described in Section Secondary Suspension, Removal.

Remove the traction motor and motor suspension as described in Section Traction Motor, Removal.

WARNING:

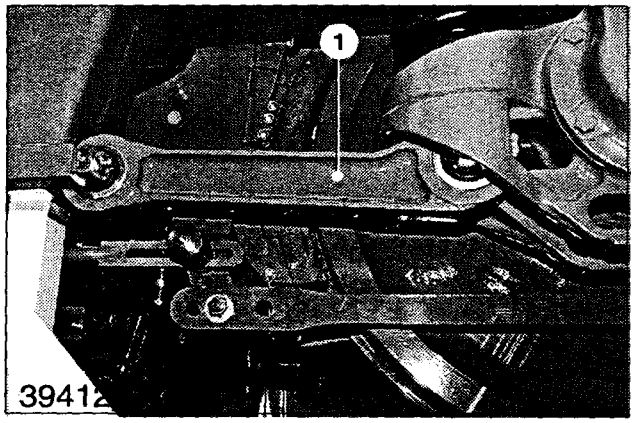
The wheel sets are heavy and may roll once disconnected from the frame. Chock the wheels securely to prevent movement during disassembly.



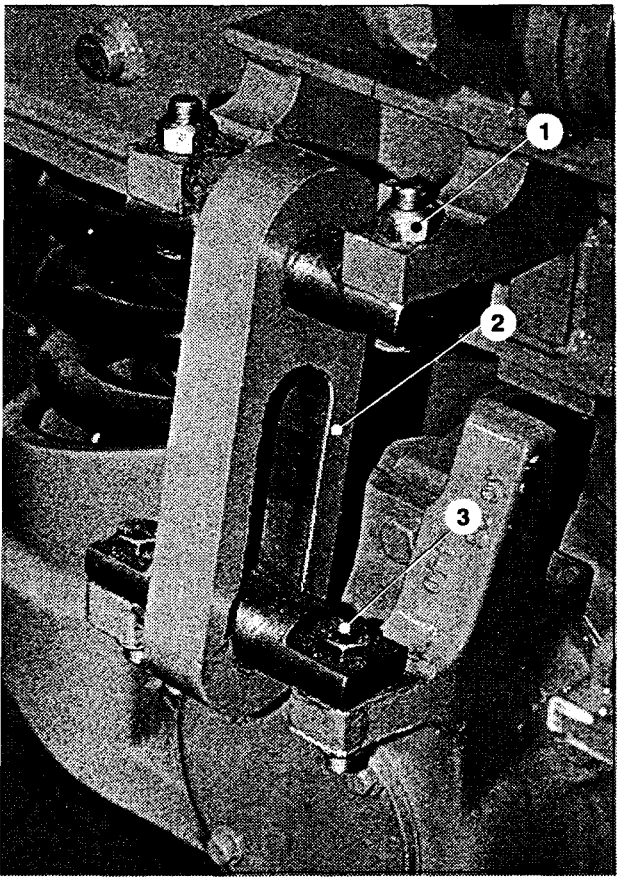
Support the frame (1) using safety stands and overhead, or portable lifting equipment.

Raise the frame (1) to so that the lifting equipment takes the weight of the frame (1).

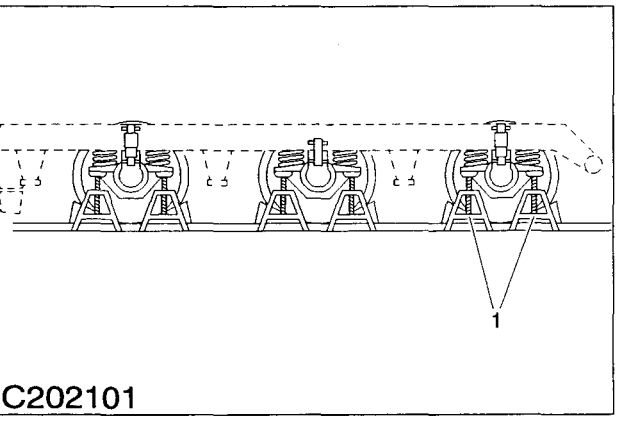
Disconnect and remove the primary suspension dampers (2), refer Chapter 2.03 Primary Suspension, – Removal.



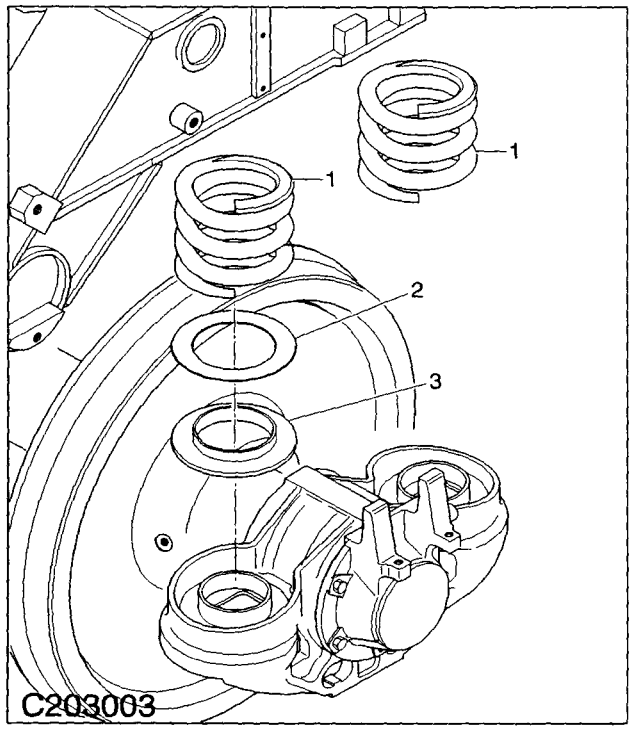
Disconnect the axle journal box guide rods (1).



Remove the bolts (3) and nuts (1) securing the axle holder (2).



Support the axle journal boxes with safety stands (1).



Remove the wheel set assemblies as described in Section Wheelset, Removal. The best practice is to lift the bogie frame clear of the wheel sets.

Secure the frame on suitable safety stands.

Mark the location of the primary suspension springs (1), then remove the springs (1), compensating plates (2) and insulating bases (3). Mark their location for later reinstallation in the same position.

Remove the link rod pivot head as described in Section Traction Link, Removal. Cover the pivot spigot to prevent damage.

Inspection and Repair

@.1250

Make a thorough inspection of the bogie and other bogie equipment. Repair or replace any damaged or worn parts.

Conduct a thorough inspection to ensure all parts are in working condition.

Clean the bogie frame, refer Section Bogie Frame, Sanitation Parts/Operating Material.

Check the bogie frame thoroughly for wear, cracks or damage. Refer to Section Bogie Frame, Inspection and Repair. Inspect areas that may not normally be subjected to wear. Loose parts can cause damage to adjacent areas.

Inspect all locating holes of rotating parts and pins, such as brake rigging and clevis pin holes, for cracks, wear or damage.

Replace any bent or broken bolts, studs or pins.

Check the condition of the bogie safety chain, pin and nut. Replace if worn or damaged.

Clean all threaded holes and check the threads for wear that may result from loose components. Remove the build–up of oil from the bottom of blind threaded holes.

Inspect all rubber bushing for wear or damage. Press–out and replace bushes as required. Inspect bushing holes and the adjacent area for wear, damage or cracks. In most cases, damage or out–of–round can be corrected by ring welding the hole, then reaming to the correct size.

Check primary suspension coil springs, refer Section Wheelset.

Check all hydraulic dampers, refer Section Primary Suspension and Secondary Suspension.

Inspect axle bearing journals, bearings and axle boxes, refer Section Wheelset.

Inspect link rod and vulkolland rings (link rod bushes), refer Section Traction Link.

Inspect brake pads, rigging and piping, refer Section Air Supply & Pneu, Brakes. Rectify any faults found.

Inspect the tread cleaning devices and check the thickness of the pad. Refer Section Brake Actuators.

Check the wheel flange lubrication device, refer Chapter 2.08 Wheel Flange Lubrication.

Assembly

@.1270

NOTE:

Do not use pipes that have been stored unsealed. Unsealed pipes may be contaminated with scale, oxidation or foreign material that will have an adverse effect on the braking systems performance and operation.

Secure the bogie frame in a suitable jig, or support using safety stands.

Install the link rod pivot head as described in Section Traction Link, Removal.

If necessary, install the pneumatic piping to the bogie frame. After installation pressure check the pipes and fittings for leakage. Pressure drop may not exceed 20 kPa in 10 minutes.

WARNING:

The wheel sets are heavy and can roll. Chock the wheels securely to prevent movement.

Install the wheel sets, axle journal boxes and primary suspension springs. Refer Sections Wheelset and Primary Suspension.

Install the primary suspension dampers, refer Section Primary Suspension .

Install the traction motor and motor suspension as described in Section Traction Motor, Installation.

Install the brake cylinders and brake rigging, refer Section Brake Actuators.

Install the secondary suspension dampers as described in Section Secondary Suspension, Removal.

Install the lateral and vertical bump stops.

Install the sanding equipment nozzles as described in Section Sanding Equipment, Installation.

Install the flange lubrication equipment and reservoir as described in Section Wheel Flange Lubrication, Installation.

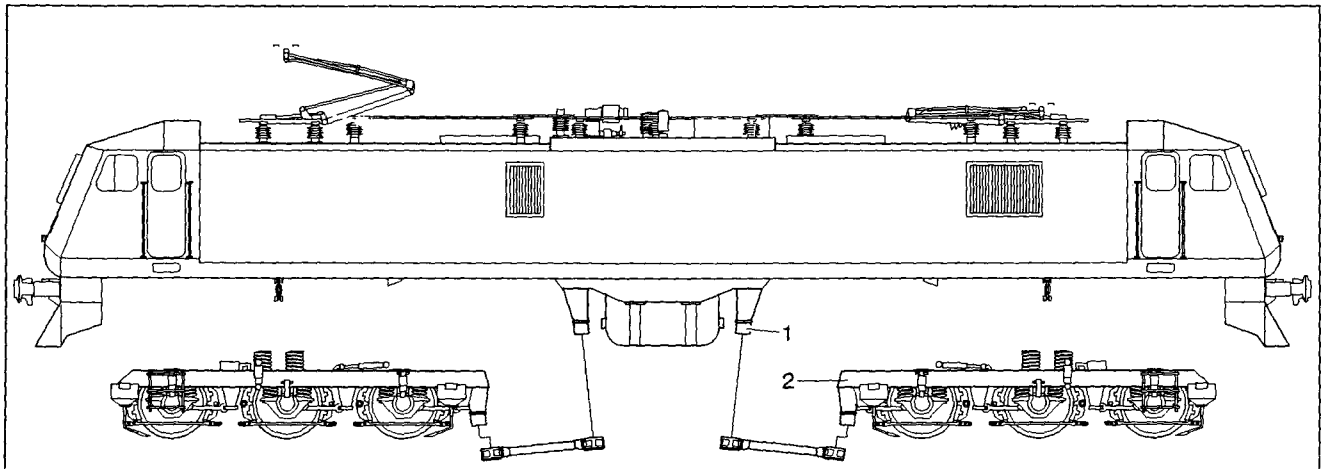
Install any other ancillary equipment on the bogie frame as required.

Installation

@.1280

WARNING:

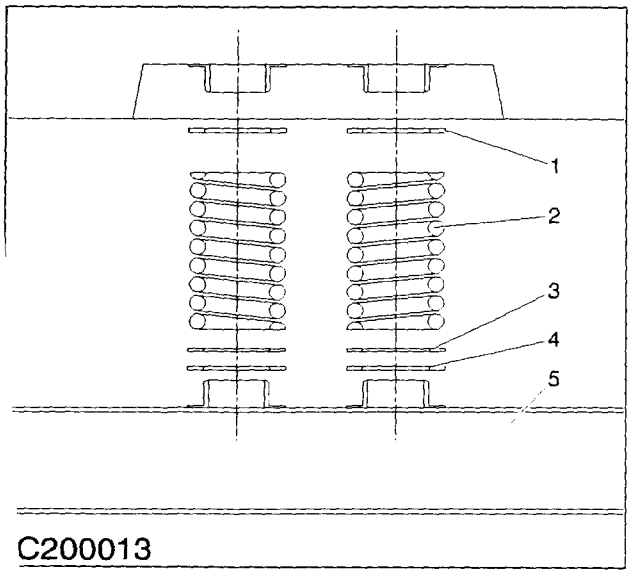
The car body should be supported by safety stands during installation of the bogies.



C200012

Position the bogie assembles beneath the car body. Ensure the bogies (2) are correctly orientated with the link rod pivots (1) towards the centre of the locomotive.

Check that no equipment or cables will be fouled during installation. Secure any items as necessary to prevent entanglement.



C200013

Position the secondary springs (2) on the bogie frame (5) as described in Chapter 2.04. Ensure the top (1) and bottom spring seats (4) are correctly installed. The original location of each spring was marked during the disassembly procedure. Reinstall the springs (2), seats (1,4) and compensating plates (3) in their original location as tagged during disassembly.

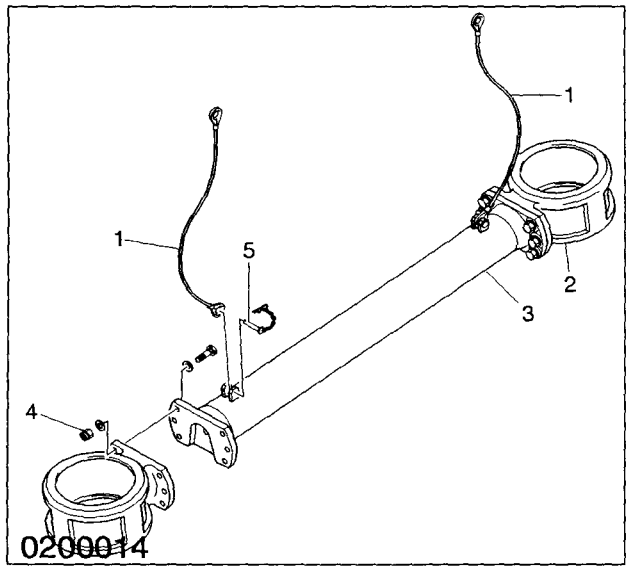
Manoeuvre the bogies into the exact location below the car body, then chock the wheels.

IMPORTANT:

Lower all four corners of the car body equally.

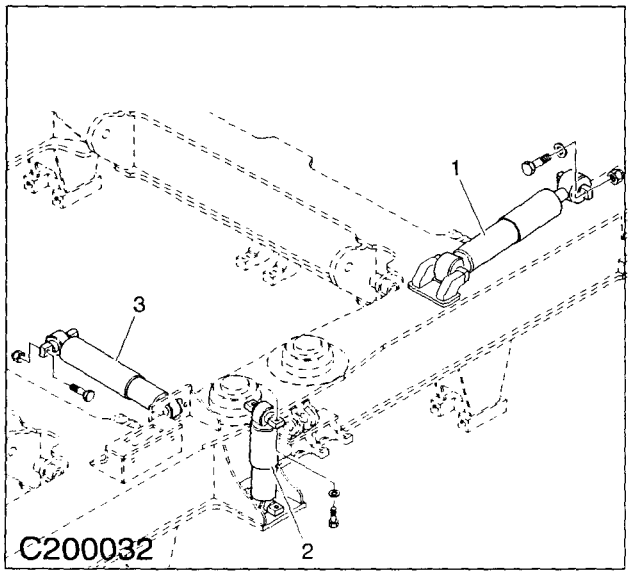
Progressively lower the locomotive on to the bogies. The locomotive must be lowered evenly at all four corners. Ensure the secondary suspension springs seat correctly in the car body.

Once the car body is in position and its full weight on the suspension springs, support the car body using suitable safety stands.



Connect, or install the link rod (3) to the pivot heads (2), refer Section Traction Link, Installation.

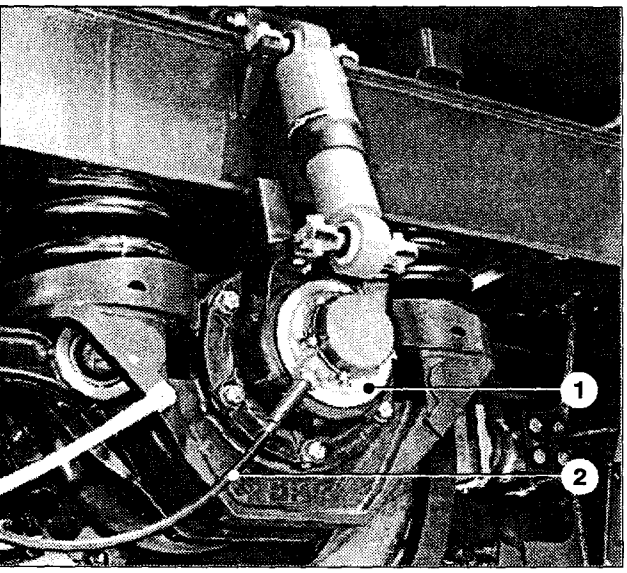
Install the fixing cable (1) and pins (5). Torque the nuts (4) pivot head to link rod to 193 Nm.



Connect the vertical dampers (2) between the bogie frame and car underbody, refer Section Secondary Suspension.

Connect the lateral dampers (3) between the bogie frame and car underbody, refer Section Secondary Suspension

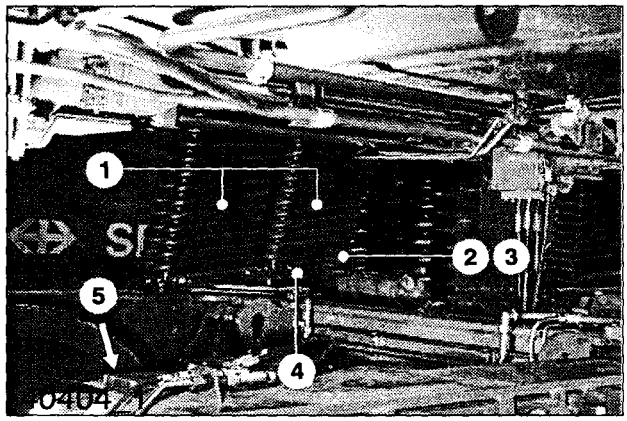
Connect the yaw dampers (1) to the underframe.



Connect the speed sensor cable (2) to the underframe junction box.

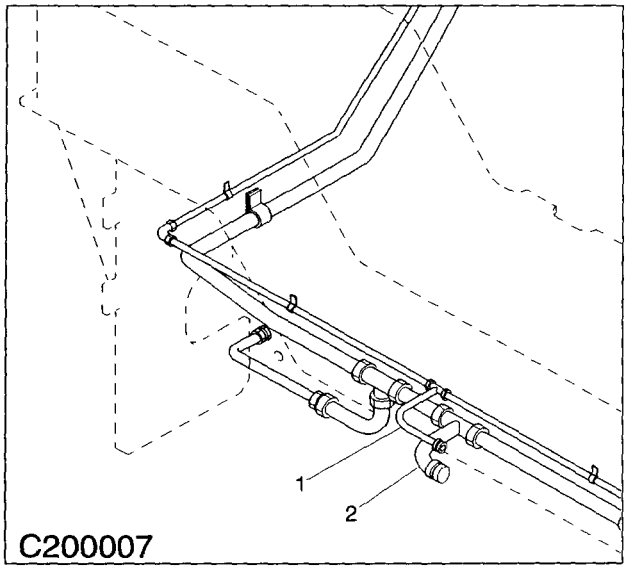
Connect the Earth Brush (1) (Axle End) cables to the underframe junction boxes.

Connect all safety earthing cables between the body and bogie.

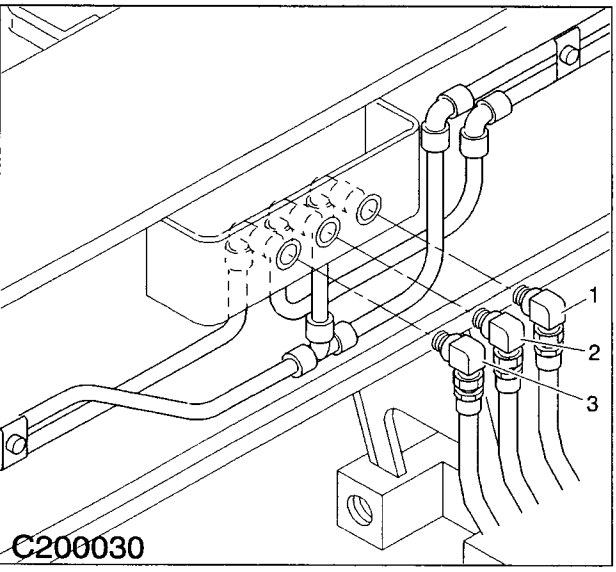


Install the traction motor cooling bellows (1) with the bolts and washers (2,3) to the ventilation duct inlet flange (5). Check the condition of the gaskets (4) , replace if damaged. Each of the traction motors on a bogie has two bellows.

Connect the electrical cables to both traction motors.



Make the brake pneumatic connections (1,2) between the locomotive and bogie.



Make the sanding (2, 3) and flange lubrication (1) pneumatic connects between the locomotive and the bogie.

After–Installations Operations

@.1290

Adjust the position of the tread cleaning devices as described in Section Brake Activators.

Adjustments

@.1310

Wheel and Axle Load Adjustment

IMPORTANT:

Improper wheel or axle load adjustment will result in poor bogie performance.

Record all adjustments in the bogie and locomotive logbooks for future reference.

All springs vary slightly from batch to batch due to the manufacturing process. The springs used on WAG–9 locomotives are marked with one or two aluminium bands to identify their tolerance range. The number of bands also corresponds to the number of 2 mm thick compensating plates below the spring. Before adjusting the wheel or axle loadings, check to ensure that all the primary and all the secondary suspension springs on the bogie are of the same tolerance range. Do not mix springs of different tolerance ranges.

Adjustment of the wheel and axle loads is performed in the following sequence.

Adjust individual wheel loads

Adjust axle loads

Check vertical bump stop clearance

Wheel Load Adjustment

Adjustment of individual wheel loads is performed by adding compensating plates between the axle boxes and primary suspension springs. The adjustment compensates for twist within the bogie frame or variations in spring lengths or stiffness.

Wheel loads for a bogie are measured on a weighbridge. The bogie must be separated from the locomotive. A load equal to half the mass of the locomotive is applied to the bogie frame secondary suspension spring seats. The load is evenly distributed over the two seats.

Generally, compensating plates are added to the lightest wheel on the bogie. The load on the wheel were the compensating plate thickness is added will increase, while the load on the diagonally opposite wheel will reduce by the same amount.

The compensating plates must be positioned between the spring and axle box. The thickness of compensating plates between each of the two springs on one axle box must be equal. An unequal thickness of compensating plates on the same axle box will result in poor bogie performance. Removal of plates from the heaviest wheel is not recommend if it will reduce the number of 2 mm thick plates to less than the number of aluminium bands on the spring. A reduction in clearance between the axles and bogie frame may result.

Wheel load adjustment is performed on an assembled bogie. The traction motors and link rod pivot head must be installed. A mass of 67 kg, half the weight of the link rod, must be added to the frame at the centre of the link rod end transom.

Disconnect the primary suspension dampers from the bogie frame lugs. Place packing between the axle box and the damper to ensure the damper will not foul on the frame during the procedure.

Remove the secondary suspension springs, lateral, vertical and yaw dampers from the bogie frame.

Half the weight of the yaw dampers is applied to the bogie frame. Masses of 19.1 kg, half the weight of a yaw damper, must be added to each bogie frame yaw damper mounting point.

NOTE:

Masses of the other dampers and secondary springs are included in the applied body mass.

Position the bogie assembly on a suitable weighbridge with each wheel centrally positioned over a load cell.

Using hydraulic rams, apply a load of 130 $\pm$2 kN to each side of the bogie at the secondary suspension spring seats. DO NOT apply a combined load to the centre of the bogie frame.

NOTE:

The applied body load is equal to the maximum allowable locomotive weight for a nominal axle load of 20.5 tonnes.

Measure and record the individual wheel loads.

The difference between wheel loads on any axle, and the between axles must not exceed 400 kg.

If necessary, adjust the wheel loads by adding compensating plates between the axle box and primary suspension spring. Use the following procedure to determine the number and thickness of plates required.

Place shim(s) between the lightest wheel and the rail until the wheel load is (are) within specification. Compensating plate are available in 0.4, 1.0 and 2.0 mm thicknesses. Shims of the same thickness should be used.

NOTE:

One millimetre of packing increase the wheel load by 150 kg and will decrease the load on the diagonally opposite wheel by the same amount.

Check the other wheels and adjust as necessary to obtain the specified wheel loads for all wheels on the bogie.

Disconnect the guide rods at the axle box as described in Chapter 2.02 Section Disassembly.

Disconnect the gear box support arm as described in Chapter 2.06 Section Disassembly.

Disconnect the drive coupling between the traction motor and gear box as described in Chapter 2.06 Section Disassembly.

Install the compensating plates between the axle boxes and primary suspension springs.

NOTE:

Compensating plates equal to the thickness of the shims are installed under each primary suspension spring of an axle box. DO NOT divide the shim thickness between the two springs.

DO NOT place the compensating plates above the springs or weld the plates to the axle box or bogie frame.

Reassemble the bogie:

Connect the guide rods at the axle box as described in Chapter 2.02 Section Installation.

- Install the gear box support arm as described in Chapter 2.06 Section Installation.
- Install the drive coupling between the traction motor and gear box as described in Section 0206.1280.

Remove the shims between the wheels and rail, then recheck the axle loads. If necessary, readjust the thickness of the compensating plates to obtain axle loadings within specification.

Measure the distance between the axle and bogie frame. The distance must be within the range of 27 – 35 mm.

NOTE:

If the clearance is less than 27 mm, all the primary suspension springs on the bogie must be packed with a thickness of compensating plates equal to the difference between the minimum specification and the actual clearance.

Axle Load Adjustment

Adjustment of individual axle loads is performed by adding compensating plates between the bogie frame and the secondary suspension springs. The adjustment compensates for variations in the bogie frame, locomotive underframe and spring lengths or stiffness.

Wheel loads are measured on a weighbridge with both bogies and the locomotive assembled.

Generally, axle loads are adjusted by adding compensating plates under the two secondary suspension springs closest to the lightest axle on the bogie; either the two inboard or the two outboard springs. Adding compensating plates will increase the axle load on the closest axle by approximately 12 kg per 1 mm of plate thickness. The load on the other axle of the same bogie will reduce by the same amount.

Wheel loads on one side of the bogie can be adjusted by adding compensating plates under the secondary springs on one side of the bogie only; either both right hand or both left hand side springs. Adding compensating plates below secondary suspension springs on one side of one bogie only will increase the axle load on the adjacent wheels by approximately 70 kg per 1 mm of plate thickness. The load on the diagonally opposite wheels of the other bogie will reduce by the same amount. Individual wheel loadings can only be adjusted by packing the primary suspension springs as described in WHEEL LOAD ADJUSTMENT.

The compensating plates are always positioned between the bogie frame and secondary suspension springs. Removal of plates from the heaviest axle is not recommended if it will reduce the number of 2 mm thick plates to less than the number of aluminium bands on the spring. A reduction in clearance between the vertical bump stops may result.

Axle load adjustment is performed with both fully assembled bogies attached to the locomotive. The link rod must be installed between the bogie and locomotive underframe.

Disconnect the secondary suspension dampers from the bogie frame.

Position the locomotive on a suitable weighbridge with each wheel centrally positioned over a load cell.

Measure and record the axle loads.

NOTE:

The nominal axle load is 20.5 tonnes. Axle loads must be within ± 2% of the nominal axle load; 19.306 – 20.094 tonnes.

Wheel loads must be within 4% of the measured axle load.

Disconnect the safety chains between the bogies and locomotive underframe.

If necessary, adjust the axle loadings by adding compensating plates between the bogie frame and secondary suspension springs.

NOTE:

Compensating plates are available in 2.0, 3.0 and 5.0 mm thicknesses.

DO NOT place the compensating plates above the springs or weld the plates to the locomotive underframe or bogie frame.

Recheck the axle loads and readjust if necessary to obtain the specified axle loadings.

Measure the distance between the vertical bump stops as described in VERTICAL BUMP STOP CLEARANCE.

Reconnect the secondary suspension dampers to the bogie frame.

Reconnect the safety chains between the bogies and locomotive underframe.

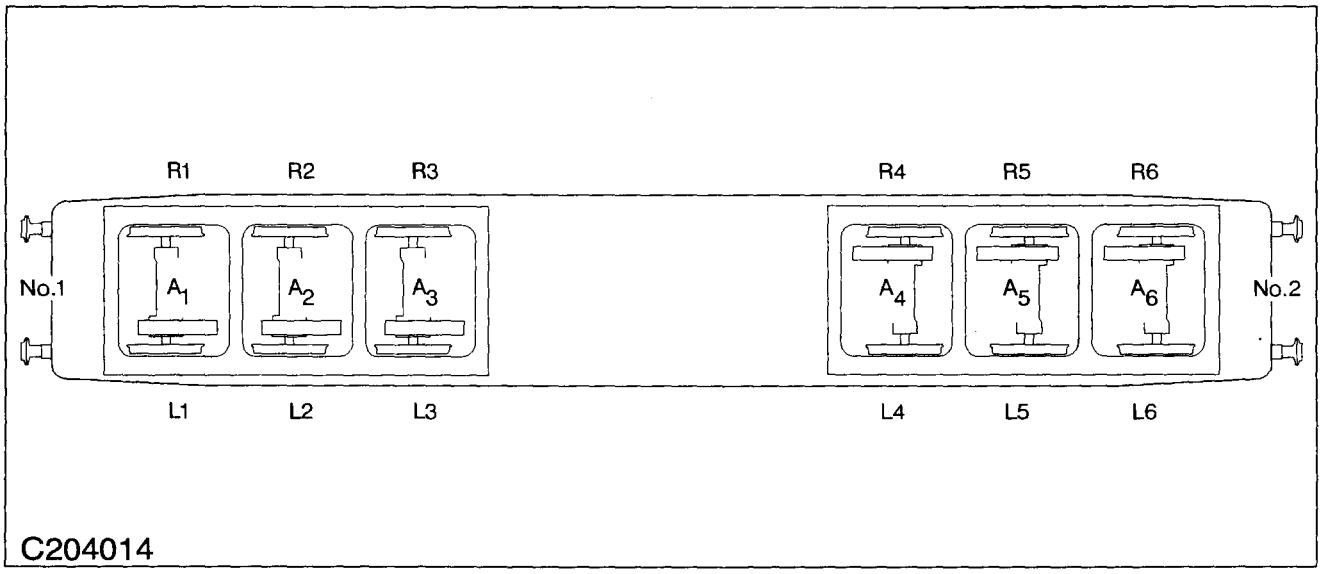
Vertical Bump Stop Clearance

Measure the clearance between vertical bump stops and locomotive underframe. The specified clearance is 32 – 60 mm.

- If the clearance is less than 32 mm, all the secondary suspension springs must be packed with a thickness of compensating plates equal to the difference between the minimum specification and the actual clearance.
- If the clearance is greater than 60 mm, compensating plates equal to the difference between the clearance and the maximum specification must be removed from below each secondary suspension spring.
- Recheck the axle loads after any adjustments to the bump stop clearance is made.

Data Sheet

Locomotive No.



C204014

	Wheel load [kg]	Axle load [A_i kg]	Diff. in Wheel Load [Δ kg]	Percentage of Axle Load $((\Delta/A_i)*100)\%$
R1 L1				
R2 L2				
R3 L3				
R4 L4				

Allowable Axle Load 19'306 kg (min.) to 20'094 kg (max.)

Allowable difference in wheel load as a percentage of axle load 4%

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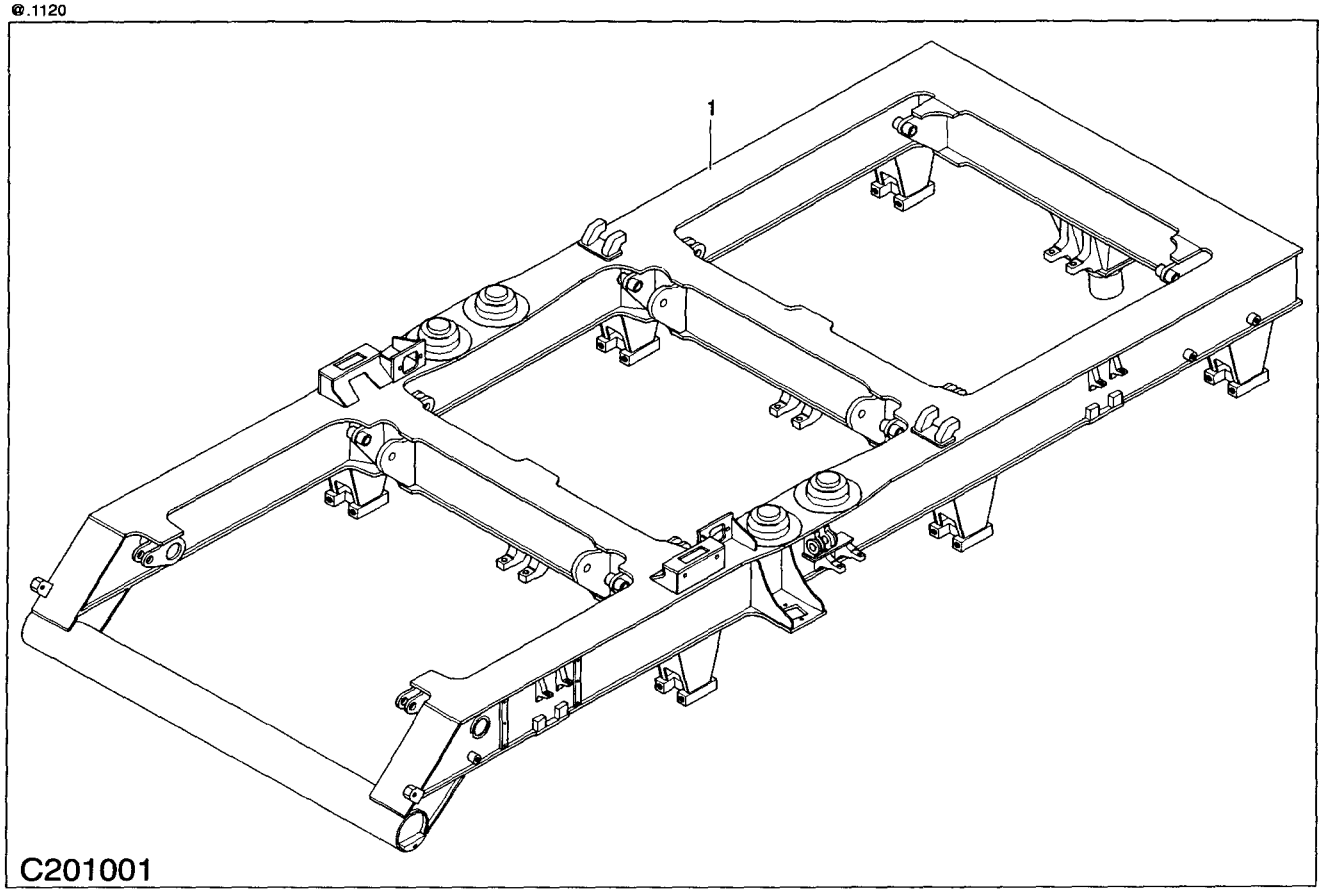
2.1 Bogie Frame

Overview

@.1120



1 Bogie frame

Functional Description

@.1140

Bogie Frame

The bogie frame consists of two longitudinal sections, which form the side members, and three lateral transoms, which form the cross members. The cross members are welded to the side members forming a rectangular frame.

The side and cross members are fabricated from 350L–15 high strength low–alloy steel. The link rod pivot assembly is welded to the centre of the end cross member. All structural welds on the bogie are ultrasonically tested during manufacture for penetration.

The axle guide rod support brackets are of cast steel and are welded to the bottom flange of the side members. The axle spring guides and primary suspension spring pads are welded to the bottom flange of the side members as are the mounting brackets for the sanding equipment and wheel flange lubrication. Secondary suspension spring guides, longitudinal (yaw) damper brackets and vertical bump stops are all welded to the top flange of the side members. Brackets for the vertical dampers and pivot brackets for the rebound limiting chains are welded to the outer webs of the side members. Brackets for pneumatic piping and wheel flange lubrication pipes are welded to the webs of the side and cross members. Lateral damper and bump stop brackets are welded to the top flange of the side members. Brackets for mounting the traction motors and transmission are welded to the cross members. Anchorage points for the brake rigging are located on the inside web of the cross members.

To ensure full protection against corrosion all box sections are sealed against the entry of moisture and the frame is coated with a two–pack polyurethane paint over an epoxy primer.

Technical Data

@.1160

Surface Coatings

Technical Data Wattyl Poly–U 400 Paint

– Manufacturer	Wattyl–Sigma, Australia
– Finish Type	Two part isocyanate–cured, Polyurethane finish
– Solids by volume	49%
– Coverage	20 m^2/litre @ 250 micron coat
– Drying time	2–3 Hours @ 15 °C
– Finish type	High Gloss
– Heat resistance	80 °C
– Application temperature	> 10 °C
– Spraying pressure	275 – 415 kPa
– Spray nozzle orifice	0.33 mm
– Thinning, spray painting	Wattyl L707 Thinner, 20–25%
– Shelf life	12 months
– Touch dry	2–3 hours
– Recoat	after 16 hours
– Fully cured	7 days
– Coat thickness	60 microns (dry)
– Primer material	Sigmacover CM primer
– Other	Contains 0.37% monomeric disocyanate

Technical Data Wattyl Sigmacover CM primer

– Manufacturer	Wattyl–Sigma, Australia
– Finish Type	Two–Pack Epoxy Primer, contains zinc phosphate
– Solids content	61%
– Coverage	18 m^2/litre @ 150 micron coat
– Spraying pressure	300–400 kPa
– Spray nozzle orifice	1.6 – 3.175 mm
– Thinning, spray painting	Wattyl Thinner 91–92, 10–15%
– Shelf life	12 months
– Coat thickness	150 microns (dry)
– Pot life	6.0 hours @ 20 °C
– Other	free from lead and chromates containing pigments

Tolerances and Wear Limits List

@.1170

Tools and Special Tools

@.1180

This maintenance procedure requires conventional workshop equipment and the equipment described below.

Non–Destructive Testing Equipment

Non–destructive testing equipment, such as x–ray or ultrasonic, is required to inspect welds on the bogie frame. Operate the equipment in accordance with the manufacturer's directions.

Additionally, special tools for examining welded areas are required.

Welding Equipment

ES4S Welding Wire Mechanical Properties

– Type	ES4S, Copper Coated
– C (carbon)	0.75%
– Si (silicon)	49%
– P (phosphorous)	0.015%
– Mn (magnesium)	1.3%
– S (sulphur)	0.015%
– Yield Strength	390 MPa
– Tensile Strength	500 MPa
– Elongation	32%

Argoshield 51 Welding Gas Properties

– CO^2 (carbon dioxide)	16% ± 0.2%
– H (hydrogen)	2.5% ± 0.2%
– Ar (argon)	81.5% approximately, remainder

Cleaning Equipment

Blast Cleaning Equipment

Blast cleaning equipment is required to remove corrosion and scale from the bogie frame. Cleaning should be performed in a suitable enclosure and safety practices must be observed.

Alkaline Immersion

A large tank suitable to immerse the bogie frame, and alkaline solution for cleaning. Alkaline solution is corrosive and can cause injury. Refer to the WARNING in Section Bogie Frame, Sanitation Parts/Operating Material.

A quantity of hot water sufficient to thoroughly rinse the alkaline solution from the bogie frame after cleaning.

Miscellaneous Materials

@.1200

Plastic plugs, or other material suitable for plugging threaded holes to prevent the ingress of paint and foreign material.

Plastic plugs, or alike, suitable to seal pneumatic pipes.

Clean, dry lint free cloth will be required during paint preparation.

Before–Removal Operations

@.1220

All parts and equipment should be removed from the bogie frame to facilitate cleaning and inspection.

For immersion in alkaline solution, remove the pneumatic piping from the bogie frame. Moisture in the pneumatic pipes can lead to corrosion and reduced brake performance. Otherwise, seal pneumatic pipes with suitable plastic plugs to prevent the ingress of dirt, moisture and foreign material.

Remove the link rod pivot head, refer Section Traction Link, Removal. Cover the spigot to prevent damage.

Remove the lateral and vertical bumps stops from the bump stop webbing on the centre cross member.

Remove all rubber hoses and other rubber components.

Removal

@.1230

[Intentionally left blank]

Disassembly

@.1240

[Not applicable for bogie frame]

Inspection and Repair

@.1250

Inspection

Clean the bogie frame by immersion in a tank of alkaline solution. Refer Section Sanitation Parts/Operating Material.

If necessary, blast clean the frame, remove all rust and build–up of debris, refer Section Sanitation Parts/Operating Material.

Clean all threaded holes and check the threads for wear that may result from loose components. Remove the build–up of oil from the bottom of blind threaded holes.

Welding on the bogie frame must be performed by a qualified welding technician. Welding in critical areas must be tested for penetration using a non–destructive technique. Do not weld in areas designated non–weldable.

Any welding to the bogie frame is performed using Gas Metal Arc (GMA) welding equipment with constant–voltage characteristics and capacity suitable for welding plate up to 25 mm thick. The electrical connection is made with the electrode positive. ES4S copper coated welding wire is used with Argoshield 51 inert gas.

Inspect the bogie frame for wear, fatigue, damage or cracking. In most cases, wear or damage in non–critical areas can be corrected by welding. In some instances it may be necessary to add reinforcement plates to the area, or drill relief holes to prevent the spread of cracks. Out–of–round holes can be ring welded, then reaming to the correct size.

Inspect all bushing holes and the adjacent area for wear, damage or cracks.

Check the bogie frame thoroughly for wear, cracks or damage. Inspect areas that may not normally be subjected to wear. Loose parts can cause damage to adjacent areas.

Carefully inspect the brake caliper mounting arms and the welds to the side member for wear, fatigue, cracks or damage.

Check all the damper, traction motor, gear box and guide rod mounting lugs and the adjacent members for wear, fatigue, cracks or damage.

Inspect the spring seat areas for signs of excessive wear.

Inspect the lateral and vertical bumps stop webbing on the centre cross member for excessive wear or cracking.

Inspect the safety pin eye at the side member for wear or cracks. Ring weld the hole, then ream to the correct diameter if required.

Check the bogie frame for cracks or fatigue using a non–destructive testing procedure, such as x–ray or ultrasonic testing. Particular attention must be paid to the areas described under the heading critical areas. Operate the equipment according to the manufacturer's instructions. Rectify any faults found.

Refinish any exposed metal as described in Section Assembly.

Sanitation Parts/Operating Material

@.1260

WARNING:

Alkaline Solution Is Corrosive. Work According To The Prevailing Workshop Safety Regulations.

NOTE:

Remove all rubber parts from the bogie frame before immersion in alkaline solution.

If necessary, loosen any built–up debris and foreign material using appropriate tools.

NOTE:

Remove the pneumatic piping before immersing the bogie frame in alkaline solution.

Immerse the bogie frame in a cleaning tank containing an alkaline solution.

After sufficient time to ensure removal of all foreign material, remove the frame from the tank and rinse thoroughly with hot water.

Scrape any loose or flaking paint using a wire brush.

If necessary, blast clean the bogie frame. Otherwise inspect the frame as described in Section Inspection and Repair.

Refinish any exposed metal as described in Section Assembly.

Blast Cleaning

Cover the link rod pivot spigot to prevent abrasion of its surface. Blast cleaning will pit the surface and result in reduced operating life of the Aclathan rings (link rod bushes).

To prevent damage to the threads and a build up of abrasive material, plug all threaded holes using suitable plastic plugs.

Cover all exposed threads to prevent damage.

Blast the surface clean to Class 2 $^{1}/_{2}$ standard, Near White Metal Blast Cleaning. Remove all mill scale, oxidation and foreign particles from the surface. The finished surface should be pitted to 125 microns deep, but need not have a consistent colour.

Clean the surface, remove debris, grit and foreign material.

Remove the plugs and other protective measures.

Inspect the frame as described in Section Inspection and Repair, then recoat the frame as described in Section Assembly.

Assembly

0.1270

Surface Finishes

The bogie frame is coated with a two–pack polyurethane paint over an epoxy primer. This combination of surface finishes ensures full protection against corrosion.

A top coat of Wattyl Poly–U 400 is applied over two coats of Wattyl Sigmacover CM primer to protect the bogie frame against corrosion. The bogie frame must be refinished to the same specification to maintain corrosion resistance.

Always observe the warnings when handling or applying surface finishes.

WARNING:

Uncured epoxy and polyurethane paints, and their solvents can be harmful if handled incorrectly. Products of these types are flammable. Wear protective clothing; including a particle respirator and impervious gloves. Always follow the precautions and directions of the manufacturer.

Preparation

Prepare the surface to be painted:

Repair any damage or corrosion to the bogie frame. If necessary, apply a corrosion inhibitor to prevent the spread of corrosion.

Plug or cover all threaded holes and exposed threads to prevent the contamination with debris or paint.

Remove all sharp edges, corners and burrs from the material.

Remove all weld slag and spatter.

If necessary, blast the surface clean using abrasive blast cleaning technique as described in Section Sanitation Parts/Operating Material, then thoroughly clean the surface, remove debris, grit and foreign material.

Where the surface is not being blast cleaned, remove all loose or flaking paint. Roughen secure paint using 400 grit emery paper.

Mask any areas not being painted.

Remove all foreign material, dirt, grease or other debris, then wipe the surface with solvent and a clean, lint–free cloth. Dry the surface with another clean, dry, lint free cloth.

Remove all surface contaminates; grease, grime and oil processing soil using white spirit, trichloroethane or other suitable solvent.

Priming

Prime the surface with Wattyl Sigmacover CM primer, or equivalent.

Mix, in a clean container, sufficient quantity of primer for the application Mix the proportions according to the manufacturer's recommendations.

Thin the mixture according to the application and manufacturer's recommendations.

NOTE:

Epoxy primers are not suited to application in temperatures below 4º C.

Apply the first coat of primer, approximately 250 microns thick when wet, and allow to dry according to the manufacturer's directions.

Apply a second coat of primer, approximately 250 microns thick when wet, and allow to dry.

Top Coat

Coat the surface with Wattyl Poly U–400 paint, or equivalent.

Mix, in a clean container, sufficient quantity of paint for the application Mix the proportions according to the manufacturer's recommendations.

Stir thoroughly using a flat stirrer until a uniform consistency is achieved, then allow the mixture to stand as specified by the manufacturer.

Thin the mixture according to the application and the manufacturer's recommendations.

NOTE:

Premature setting may occur if freshly catalysed Polyurethane paint is added to paint that has been mixed for longer than 20 minutes.

Apply a coat of finish, 65 microns thick (wet), to the entire surface, according to the manufacturer's recommendations.

Allow the first coat to dry according to the manufacturer's specification, then apply the second coat in the same manner.

Final Assembly

Install parts and equipment removed from the bogie frame.

NOTE:

Do not use pipes that have not been sealed while stored. Unsealed pipes may be contaminated with scale, oxidation or foreign material that will have an adverse effect on the braking systems performance and operation.

Install the pneumatic piping.

Remove the protective covering and install the link rod pivot head, refer Section Traction Link, Assembly.

Install the lateral and vertical bump stops to the webbing on the centre cross member. Check the bump stops before installation, replace if less than 2 mm of rubber protrudes above the backing plate.

Installation

@.1280

[Not required]

After–Installations Operations

@.1290

Installation of the Transmission onto the Wheelset as described in Section 2.06, if required.

Installation of the Wheelset as described in Section 2.02.

Installation of the Primary Suspension as described in Section 2.03.

Installation of the Sanding Equipment as described in Section 2.07.

Installation of the Wheel Flange Lubrication as described in Section 2.08.

Installation of the Traction Motor as described in Section 4.04.

Installation of the Secondary Suspension as described in Section 2.04.

Installation of the Bogie as described in Section 2.00.

Installation of the Traction Link as described in Section 2.05.

After installation pressure check the pneumatic piping and fittings for leakage. Pressure drop may not exceed 20 kPa in 10 minutes.

2.2 Wheelset

General Notes on Hazards in the Work Area

@.1040

WARNING:

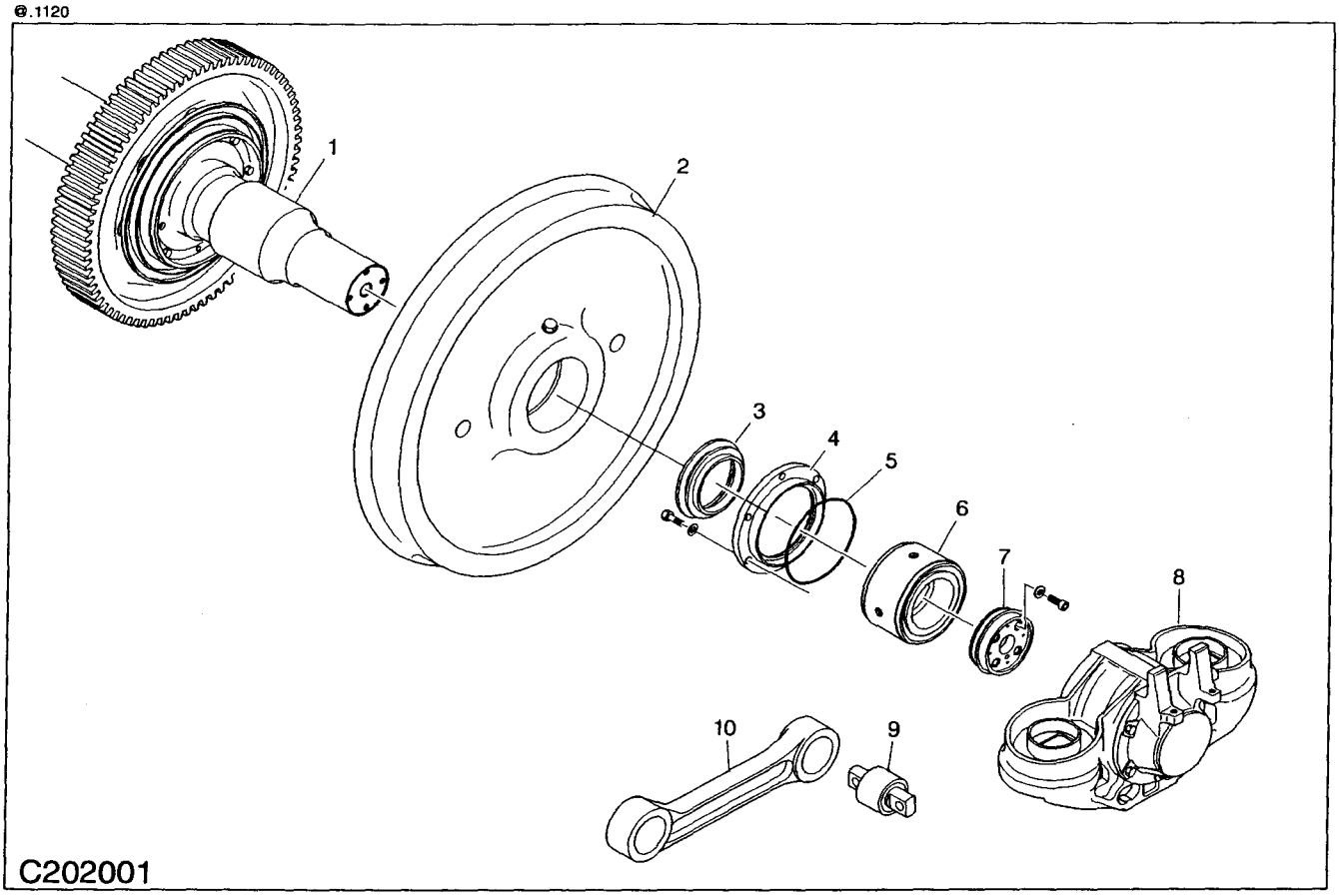
Most components on the bogie are heavy. Use lifting equipment to raise or lower heavy parts and ensure they are supported by safety stands.

Some procedures require components to be heated. Personal injury can result from improper handling. Always wear protective clothing whenever handling hot parts.

The wheelsets are heavy and may roll once disconnected from the frame. Chock the wheels securely to prevent movement during assembly or disassembly.

The primary and secondary suspension springs are held in position by the weight of the locomotive and bogie frame, respectively. The springs are under tension and are heavy. Whenever removing the springs use care to ensure the springs do not jump from their seats and cause injury or damage.

Overview



1	Wheelset axle	6	Tapered roller bearing
2	Wheel	7	End plate
3	Backing ring	8	Axle box
4	Split cover	9	Spheribloc
5	O–ring	10	Axle guide

A Co–Co locomotive is fitted with two bogies each containing three wheelsets. Each wheelset comprises an axle shaft, a drive gear, two Monobloc wheels, two axle boxes and guide rods, and two tapered roller bearings.

All information, procedures and specifications regarding the axle bearing are located in the SKF roller bearing manual, see Supplier's Documentation Volume F2. Bearings should be returned to the manufacturer for overhaul.

Information relating to the drive gear is in Chapter Transmission. Details of the axle shaft drive gear journal are included in this Chapter.

Functional Description

@.1140

Wheelset

Wheelsets; axle and wheels are matched sets. Care should be taken to keep the set together. In the event one of the wheels requires replacement, the new wheel must be machined down within tolerance of the other wheel on the axle.

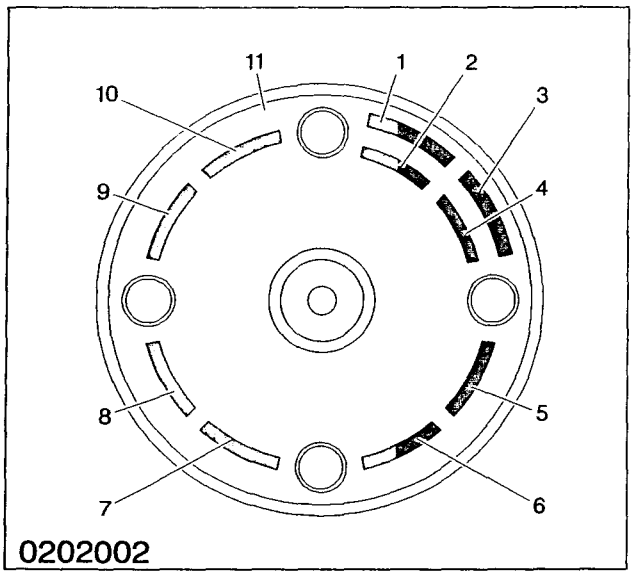
Wheel

One piece Monobloc wheels are machined from a single casting. Wheel hub, tread profile and brake mounting blocks are machined to precision tolerances. The axle bore surface is ground to a 6.3 micron finish. The wheels are manufactured and tested to comply with India Railways standard IRS R 34–81. After machining, each wheel is balanced to UIC 812–3 standards and the value of the residual imbalance is stamped on the wheel hub.

A groove on the inner wheel face provides a reference line for the minimum tread diameter. The wheel tread, not the flange, may wear or be machined down to the level of this groove. The tread and wheel flange are heat treaded for improved service life.

An oil gallery is located within the wheel hub for "floating off" the wheels from the axle using hydraulic pressure. The hole is sealed with a screw plug and copper washer to prevent the ingress of dirt during service.

Axle



The axle shaft is forged from 25 CrMo4 (chromium molybdenum steel). Journals, transition points and radii are machined to precision tolerances. Journals are ground to a 6.3 micron surface finish. The axle is manufactured and tested to comply with India Railways standard IRS R 43. After machining, each axle shaft is ultrasonically tested for flaws.

Markings, in letters 6 mm high, on the axle hub display manufacturing information about the axle and wheelset.

1	Drawing number
2	Manufactured for "IR" Indian Railways
3	Material mark
4	Order number
5	Wheelset acceptance
6	Wheelset shaft acceptance
7	Manufacturer code
8	Wheelset number
9	Material Supplier code
10	Batch number
11	Axle shaft

Axle Box

The axle box is cast aluminium alloy and machined to precision tolerances. After machining, each axle box is x–ray tested for flaws.

Six different types of front covers are fitted to the axle boxes depending on the application and location on the locomotive. Lugs, cast as part of the front cover, provide mounting points for the primary suspension vertical dampers.

Guide Rod

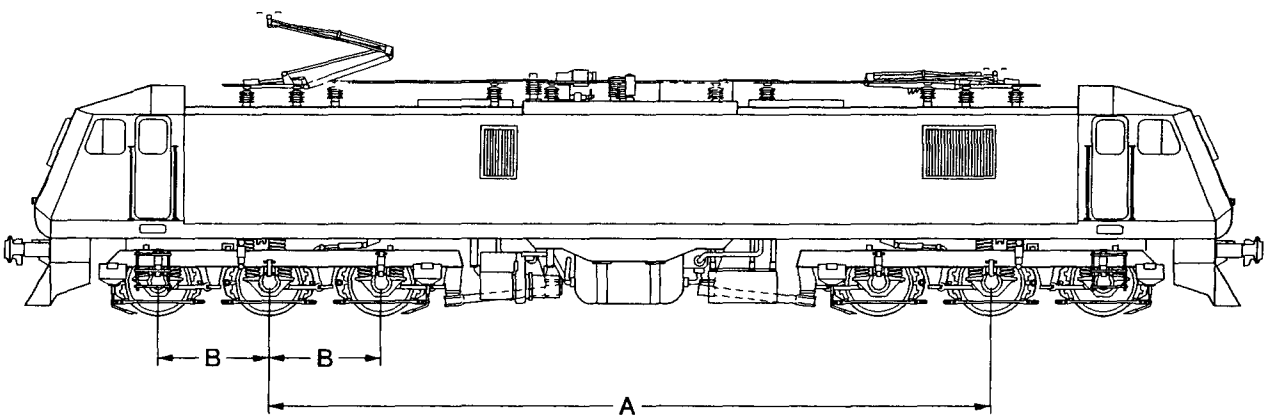
The guide rod, which is bolted to the axle box housing and to the bogie frame, provides a longitudinal guide for the axle box housing. The guide rod is fitted with spherical rubber joints (Spheriblocs) at each end, which provide positive longitudinal guidance while allowing negligible resistance to lateral movement.

The guide rods contact the bottom of the axle box and provide positive lift for the wheelset whenever the bogie is raised.

Each axle box has one guide rod. There are six guide rods on the Co–Co bogie.

Technical Data

@.1160



C202004

Wheelset

– Weight	1,697 kg
– Gauge	1,676 mm
– Wheel base B	1,850 mm
– Bogie centres A	12,200 mm
– Lateral wheel displacement	± 15 mm
– Contact force	854 – 1,068 kN
– Nominal axle load	20.5 tonne

Wheel

– Weight	554 kg
– Diameter, new	1,092 mm
– Diameter, worn (min)	1,016 mm
– Permissible wear	76 mm
– Residual imbalance (max)	125 gr
– Imbalance specification	UIC 812–3, (value stamped on hub)
– Axle hub bore	217.670 – 217.720 mm
– Press–on force	779 – 1,026 kN
– Interference fit	0.251 – 0.330 mm
– Shrink on temp. (max)	250 ° C. (120 – 140 minutes)
– Wheel flange to axle hub dimension	260 ± 0.5 mm

Axle

– Axle weight	589 kg

Bearing Journal

– Diameter	150.043 – 150.068 mm

Wheel Journal

– Diameter	217.971 – 218.00 mm
– Length	180 ± 0.5 mm

Labyrinth Ring Journal

– Diameter	170.146 – 170.186 mm
– Length	9.6 mm

Drive Gear Journal

– Diameter	219.360 – 219.390 mm
– Length	176.0 ± 177.5 mm

Axle Box

– Axle box weight	100 kg

Bearing bore

– Diameter	250.000 – 250.052 mm

Bearing

– Type & model	CRU 150/SKF, BC2–0067A
– Nominal inside diameter	150 mm
– Nominal outside diameter	250 mm
– Nominal length	160 mm
– Lubricant	EXXON ARAPEN RB 320 (or equivalent)

Guide Rod

– Length (nominal)	762 mm
– Weight	32 kg
– Eye inside diameter	110.096 – 110.120 mm

Labyrinth Ring

– Seat diameter	170.000 – 170.063 mm

Tolerances and Wear Limits List

@.1170

Wheelset

Wheel

[Wheel Wear Limits And Tread Profile Here]

Wheelset Dimensional Variations

DIAMETERS OF WHEELS ON

– Same axle	1.0 mm
– Same bogie	4.0 mm
– Same locomotive	20.0 mm

Axle

– Bend (max)	TBA
– Twist (max)	TBA

Journals

– Out–of–round	Less than 0.01 mm
– Taper	Less than 0.01 mm
– Valleys (waviness)	Less than one third of journal length. Lowest point must be greater than the minimum journal diameter.

Axle Box

Earth Brush

– Brush length	22 mm
– Spring length (min)	TBA

Guide Rod

– Twist (max)	TBA

Spheribloc

– Axial wear	Less than 0.6 mm. Section Inspection and Repair

Tools and Special Tools

@.1180

Cranes for lifting, hydraulic presses, electric and induction heating equipment will be required for the installation of the drive gear, and wheels.

NOTE:

Special tools or kit specifications and contents may vary according to the availability from the supplier. Consult the supplier for the latest specifications.

Pressing Off Wheels And Gears

Thyssen Henschel provides a special oil injection tool kit for "floating off" Monobloc wheels and gears. The kit form comprises; an oil injector with oil feeder, high pressure pipe with 3/4 and 1/4 inch connections, injector attachment with 2 x 3/4 and 1 x 1/2 inch connectors, oil pressure gauge (0 – 250 N/mm^2) and 1/2 inch connecting unions.

– Supplier	THYSSEN HENSCHEL
– Suppliers Special Tool No.	729101 B
– Lubricant	Shell Hypoid GX
– Lubricant Specification	Pure mineral oil, 40 mm^2 /s at 50 ° C

SKF Roller Bearings

Special tools for removal, installation and disassembly of the bearings are required.

[Details to follow]

Miscellaneous Materials

@.1200

Clean, dry lint free cloths

Heat indicating crayons for mounting of wheels, drive gear and labyrinth ring

Before–Removal Operations

@.1220

The axle bearings are precision parts that require careful handling. Some procedures in this Chapter will expose the wheel bearings. It is important to prevent the ingress of dirt, dust or other foreign materials to the bearings or lubricant. Contamination will severely reduce the service life of the bearings and can cause damage to the journals. Dusty or exposed conditions are not suitable for handling bearings. All operations on the wheelsets, axle boxes and bearings must be carried–out indoors. Ensure the workshop area is clean.

Steam clean the bogies before undertaking any procedure that will expose the bearings or journals. Particular attention must be paid to ensure the axle boxes are thoroughly clean to prevent particles of foreign material entering the bearings during disassembly.

New bearings are coated in rust preventative and packaged in protective cardboard cylinders. Do not unpack bearings until immediately before installation. Always check the condition and measure the journals and bores before installing bearings.

Removal

@.1230

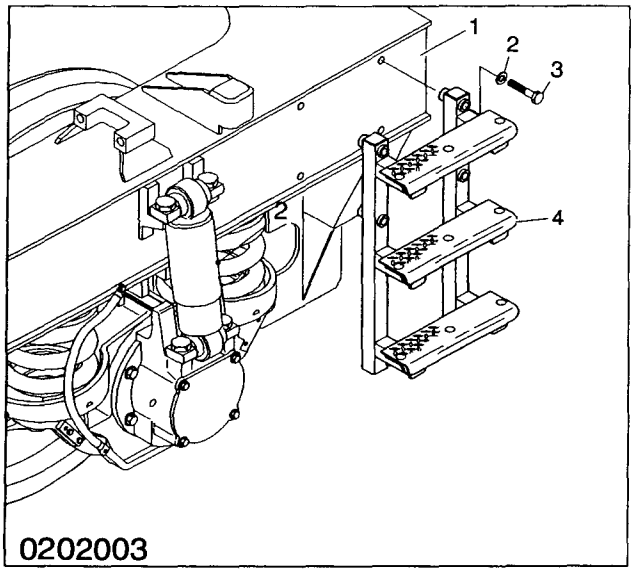
Wheelset

This procedure describes the removal of the wheelsets from a bogie detached from the locomotive. The wheelsets can, if required, be removed while a bogie is under the locomotive. Ensure the weight is supported on the locomotive jacking pads and safety stands are positioned under the bogie frame.

Each bogie has three wheelset assemblies. This procedure describes removal of one wheelset. Repeat the steps for the other wheel sets.

NOTE:

During the removal procedure, seal any exposed pneumatic piping with suitable plastic plugs to prevent the ingress of foreign matter. Dirt or moisture in the pneumatic piping may have an adverse effect on the operation and performance of the braking system.



0202003

Remove bogie from locomotive, if required.

Chock the wheels, then cage the parking brake.

Undo the bolts (3), washers (2) and remove the step assemblies (4) from the bogie frame (1).

Remove the plug and drain the lubricant from the gear box, refer Chapter 2.06 Section Before–Removal Operation. Replace the plug once the lubricant has drained. The lubricant should be analysed for contaminates.

Match mark the flange lubrication nozzle bracket to the bogie frame, then remove the nuts, bolts and washers from the bracket. Secure the nozzle in a position clear of the wheel. Remove the nozzle, if necessary. Refer Chapter 2.08 Section Removal.

Match mark the sanding equipment pipe to the bogie frame, then remove the nuts, bolts and washers from the bracket. Secure the pipe in a position clear of the wheel. Remove the pipe assembly if necessary.

Remove the bolts and washers securing the wheel tread cleaners to the bogie frame. Secure the tread cleaner in a position clear of the wheel. If necessary, disconnect the pipe and remove the tread cleaner. Refer Chapter 2.07 Section Removal.

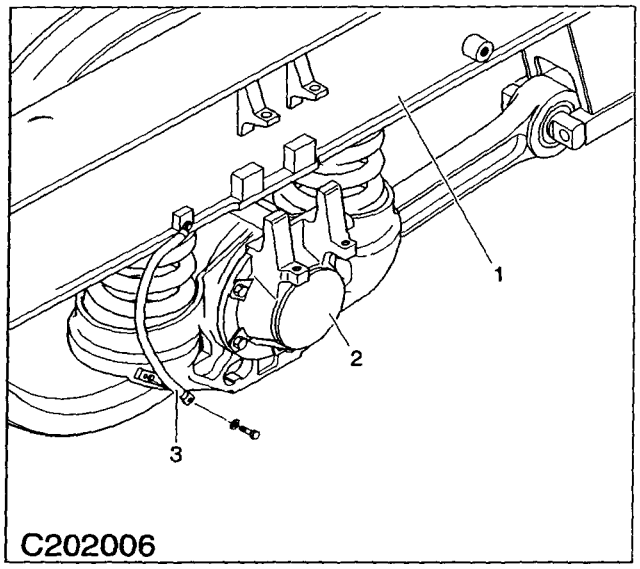
Axle Box

Bearing removal is described in the SKF roller bearing manual, see Volume F2. Two opposed recesses are provided in the labyrinth ring for use with a bearing extractor.

Steam clean the axle box and adjacent area. Particular attention must be paid to the area between the axle box and wheel.

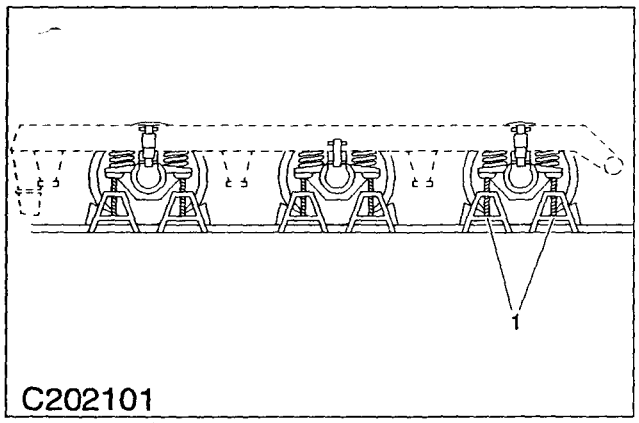
Support the bogie frame using suitable safety stands and chock the wheels to prevent the axles rolling.

Remove the steps from the bogie frame.



C202006

Disconnect the earth cable (3) from the axle box (2). Secure the cable (3) to the bogie frame (1), or remove, to prevent entanglement during removal.



C202101

To prevent the axle box rotating, position suitable safety stands (1) between the webbing and the floor on each side of the axle.

Remove the primary suspension vertical dampers as described in Chapter 2.03 Section Removal.

Mark each guide rod to identify their position. Support the rod, then remove the nuts, bolts and washers securing the guide rod to the bogie frame and the axle box. Remove the rod. Inspect the rods and Spheriblocs as described in Section Assembly.

Remove the brake blocks, then remove the brake actuators as described in Chapter 6.07 Section Removal.

Remove the traction motor as described in Chapter 4.04 Section Removal

NOTE:

Keep the bearings and journal boxes completely free of dust, dirt and other contaminants. Immediately cover the bearings to protect from contamination or damage.

Attach appropriate lifting equipment to the bogie frame. Raise the frame approximately 5 – 10 mm to take the weight of the frame.

Remove the primary suspension vertical dampers and the centre axle safety link as described in Chapter 2.03 Section Removal.

Remove the axle boxes as described in Section Removal.

Ensure the wheels are securely chocked, then carefully raise the bogie away from the wheelsets. Lower the bogie frame onto suitable fixture.

Check and inspect the bearings. Refer to the SKF roller bearing manual, see Volume 2.

Labyrinth Ring

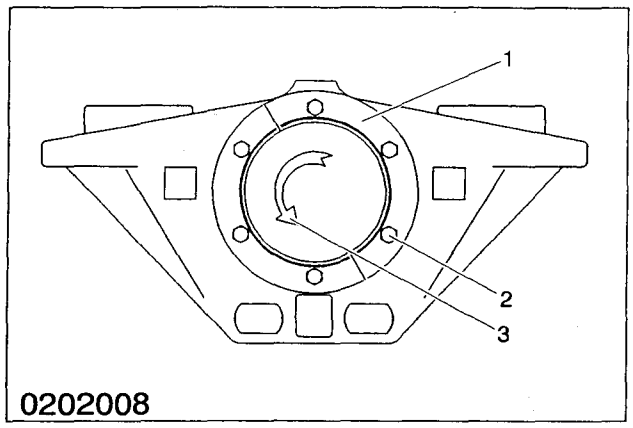
NOTE:

Do not use flame to remove the labyrinth ring.

Remove the axle box and wheel bearing as previously described.

The labyrinth ring is an interference fit on the axle. Use a bearing extractor or induction heating equipment to remove the ring. Take care not to damage the ring or journals during removal.

Check the labyrinth ring for damage or cracks and measure the dimensions. Refer Section Inspection and Repair.



0202008

The split rings (1) are precision matched parts. Match mark the two halves of the split ring (1) to aid reinstallation and identification during inspection. Slacken the bolts (2) securing the split ring (1) to the wheel side of the axle box in a counter–clockwise (3) pattern. Remove the bolts (2) after all the bolts are loosened.

Separate the split ring from the axle box.

Remove the axle boxes and discard the o–rings. Refer Section Disassembly.

NOTE:

It is important that the bearings and journals be kept absolutely clean and protected from damage. Foreign material will damage the bearing and/or journal.

Remove the socket head bolts securing the end cap to the axle, then remove the end cap.

CAUTION:

Each axle box assembly weighs more than 100 kg. Support the axle box to prevent it falling during removal.

Support the axle box using suitable overhead lifting equipment.

Carefully slide the axle box straight off the bearing. The fit between the axle box and bearing will cause some resistance. The axle box may jam in position if not pulled completely straight. Discard the o–ring from the rear of the axle box.

Cover the axle boxes, axle and bearing to prevent damage or contamination with foreign material.

Measure the bore and inspect the axle box as described in Section Inspection and Repair.

Remove the labyrinth ring as described in the following procedure.

Disassembly

@.1240

Wheel Dismounting

Dismounting of the wheel is achieved by "floating off" using hydraulic pressure. The procedure uses pressurised fluid to separate the interference fits between the cylindrical surfaces of the wheel hub and axle journal.

Once the hydraulic pressure exceeds the pressure created by the interference fit an oil film builds up between the contact areas. The film reduces friction between the surface. The parts can easily be displaced without scoring the mating surfaces.

The work area, joint surfaces and oil gallery must be completely clean; free of all swarf, dirt and other contaminates.

Dismounting of the drive gear is described in Chapter 2.06 Section Removal.

NOTE:

Do not remove the plug in the oil injection gallery until just before the wheel is ready to be removed.

Remove the wheel bearing as described in the SKF roller bearing manual, see Volume F2.

Remove the labyrinth ring. Refer Section Removal.

Clean the wheelset thoroughly. The area around plug must be completely clean. Entry of foreign material to the gallery will damage the axle journal or wheel hub.

Mount the axle set in a wheel press.

Secure the oil injector device to the wheel press.

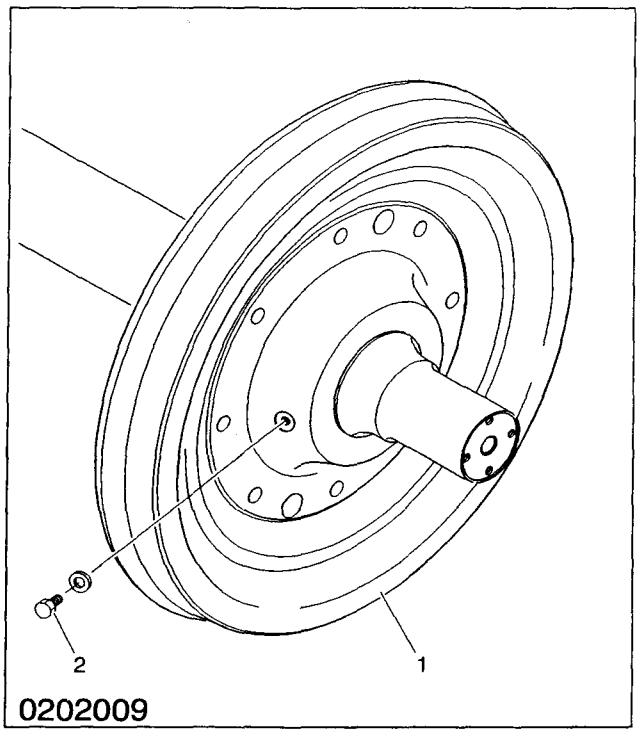
Assemble the high pressure pipe, oil injector and pressure gauge to the injector attachment.

Dip the injector nozzle into pure mineral oil, Shell Hypoid GX or equivalent.

Fill the oil feeder with lubricant. Hold the nozzle upwards and depress the valve slightly to bleed the air while filling.

Attach the feeder to the oil injector, then open the valve.

Operate the pump handle until clean lubricant, free from air, is expelled from the high pressure pipe. Close the valve.



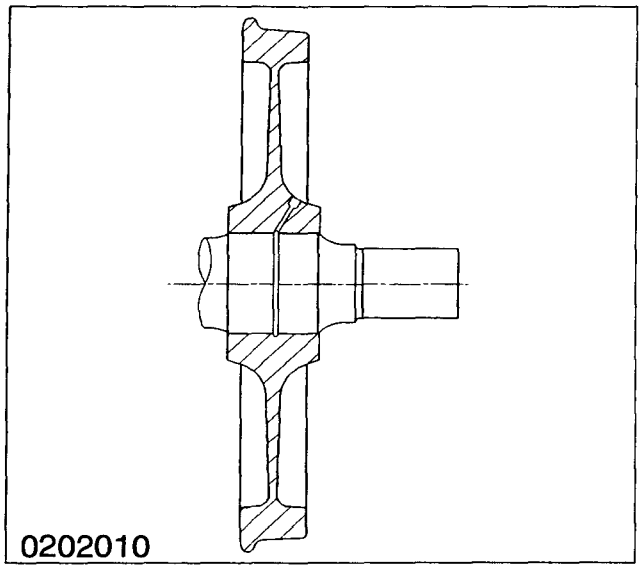
0202009

Clean around the screw plug (2) using compressed air. Ensure that no dirt or debris is located near, or around the plug (2). When the area around the plug is completely clean, remove the plug (2) from the wheel hub (1) .

Connect the high pressure hose to the wheel hub.

NOTE:

Do not interrupt the pressing–off of the wheel once the oil groove becomes visible. Stopping or pausing will cause the oil film to leak away from the contact surfaces. The wheel hub will seize on the axle.


0202010

Slowly pump the injector until oil exudes at the front fitting joint at the front of the wheel hub. Do not allow the oil pressure to exceed [CRITICAL] kPa.

The oil needs some time to fill the gallery and seat. Keep the pressure up for approximately 10 minutes. Trying to press the wheel off too soon will damage the wheel hub or axle journal.

Slowly press the axle from the wheel using the wheel press. Keep the oil pressure constant until the oil groove is visible.

Sufficient oil is trapped in the second half of the seat to complete wheel removal.

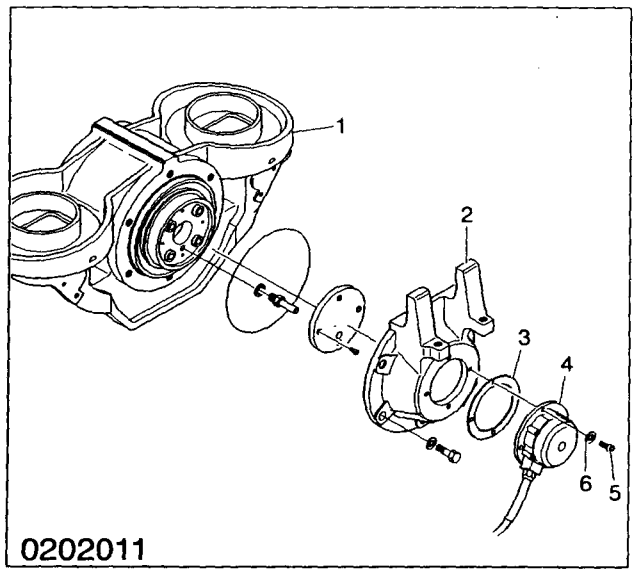
Cover the journal and wheel hub to prevent damage or contamination.

Inspect and measure the wheel hub and axle journal. Refer Section Inspection and repair.

Axle Box

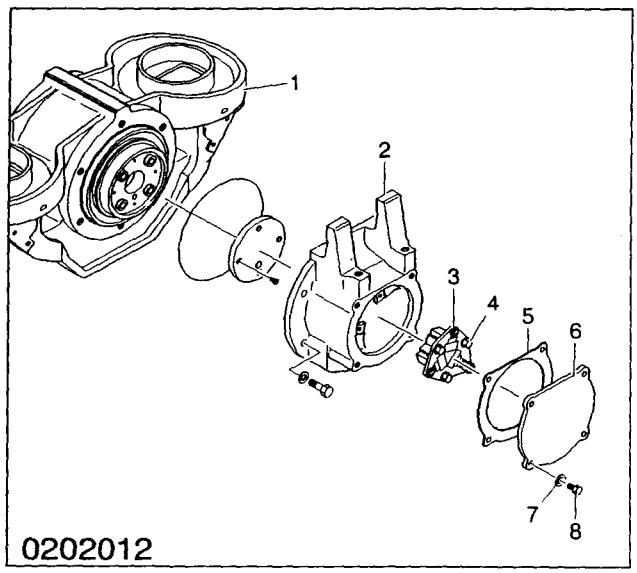
NOTE:

Before loosening the cover screws ensure that the housing surfaces and the adjacent areas are completely clean to prevent contamination of the bearings.



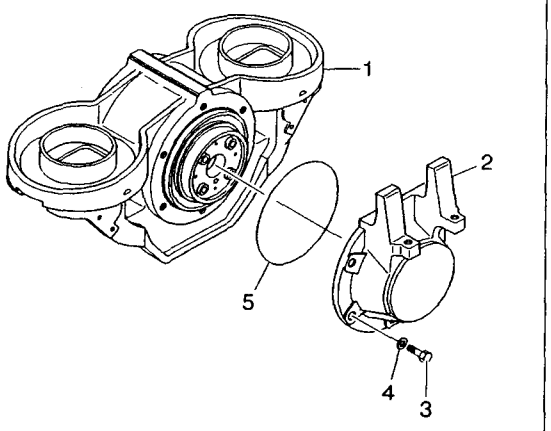
0202011

On axle boxes (1) fitted with the Hasler transmitter (4), remove the bolts (5) and washers (6) securing the transmitter (4) to the front cover (2). Remove and discard the gasket (3).



0202012

For axle boxes (1) fitted with the earthing brush, remove the bolts (8) and washers (7) securing the cover (6). Discard the gasket (5). Apply pressure and hold the brush holder (3), then remove the bolts (4) securing the holder (3) to the front cover (2). The brush holder (3) will spring off if not held securely.



0202013

It is not necessary to remove the cover plate (2) on axle boxes (1) that are not fitted with either the transmitter or earthing brush.

Remove the bolts (3) and washers (4) securing the front cover (2).

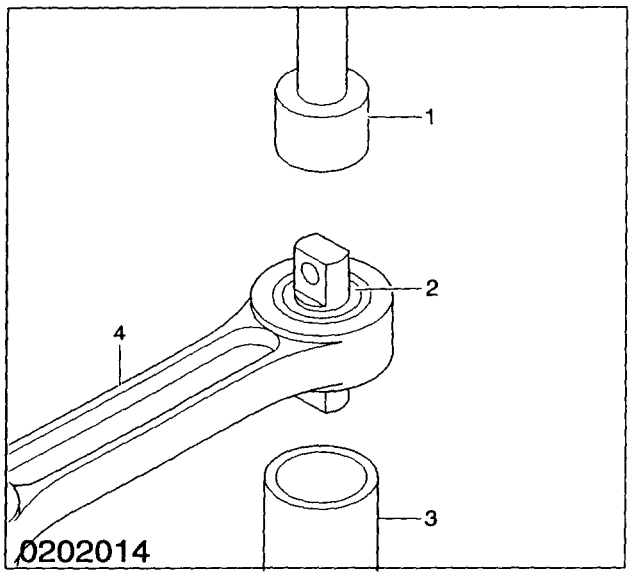
Remove the front cover (2) and discard the o–ring (5).

On axle boxes fitted with the Hasler transmitter, unscrew the drive pin from the axle end cap.

For axle boxes fitted with the earthing brush, remove the contact plate from the axle end cap.

Guide Rod

Spheribloc Removal



Mark each guide rod (4) to identify its position on the locomotive or bogie. Support the rod, then remove the nuts, bolts and washers securing the guide rod to the bogie frame and the axle box, then remove the rod.

Mark the location of the Spheribloc (2) to aid in diagnosis during inspection.

Test and inspect the Spheriblocs (2) as described in Section Inspection and repair.

Position the guide rod horizontally in a press.

Support the guide rod eye using a suitable steel tube (3). Ensure the tube (3) will not interfere with the Spheribloc (2) during removal.

Position a suitable mandrel (1), slightly smaller than the outer diameter of the collar, over the Spheribloc (2). Check that the mandrel (1) is square with the yoke on the press and contacts around the entire perimeter of the collar.

Press the Spheribloc (2) assembly from the guide rod (4).

Repeat the procedure for the Spheribloc (2) at the other end of the guide rod (4).

Inspection and Repair

@.1250

Wheelset

@.1250A

Profile Correction

Wheel tread profiles can be corrected using either wheelset turning equipment or an underfloor wheel turning machine. Tie down lugs are provided on the axle box for the purpose of securing the wheelset during machining.

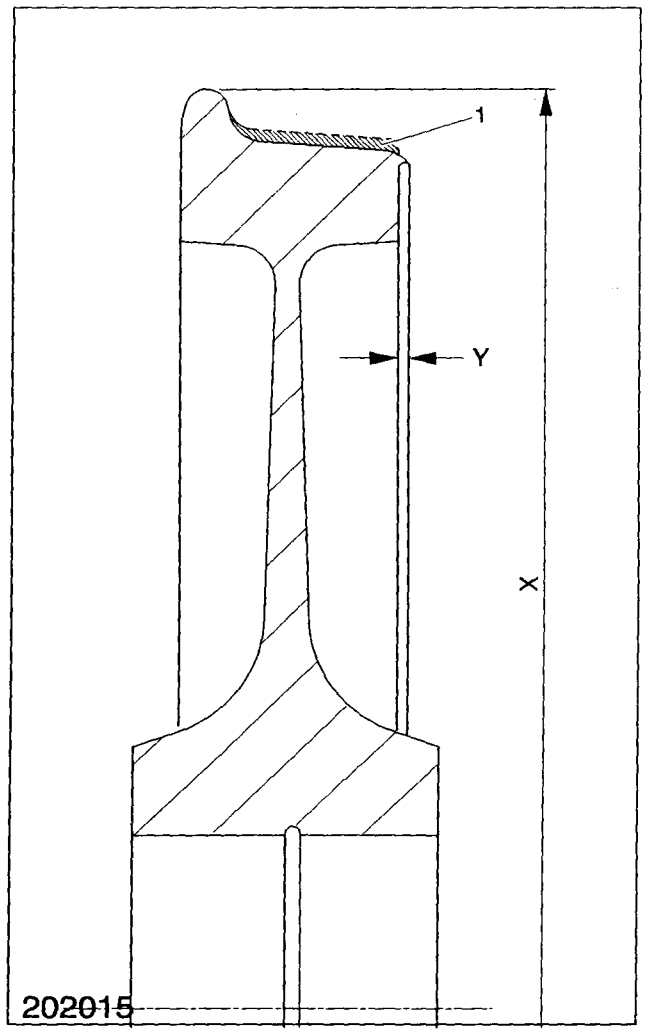
Best accuracy is obtained by using wheelset turning equipment; which requires removal of the wheelsets from the bogie frame.

The locomotive, or bogie, is positioned above underfloor wheel turning equipment and the wheels are machined in situ. Flange irregularities and out–of–round are transferred to the new contour because the wheel is centred on the worn flange. To minimise flange out–of–round the wheelset should be machined using a wheelset turning equipment after two corrections using under floor equipment.

There are two types of profile rectification; full and partial correction. Full correction removes all worn material to restore the original tread and flange profile. Partial correction is used to preserve the areas consolidated during operation, while minimising the removal of material.

Partial correction is recommended for most re–profiling work. Full correction removes a large amount of material from the wheel, subsequently reducing the service life of the wheel. Full correction should only be carried out when absolutely necessary.

Individual wheel profiles should be corrected when:



All wheels on the bogie should be corrected when:

Tread and flange wear, on the most badly worn wheel on the bogie, differs by more than 7 mm from the last machining profile.

The projected throat thickness is less than [6.5] mm.

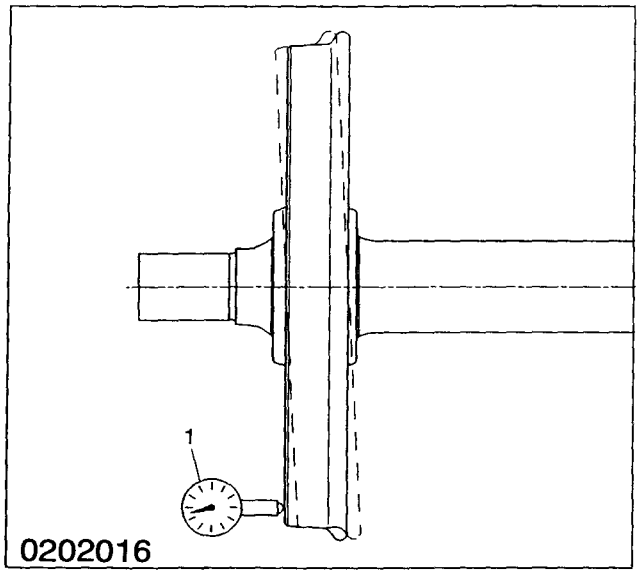
The tread burr (Y) is greater than 5 mm.

Diameters X between the two wheels of a wheelset differ by more than 0.5 mm.

Diameters X between wheelsets on a bogie differ by more than 4 mm.

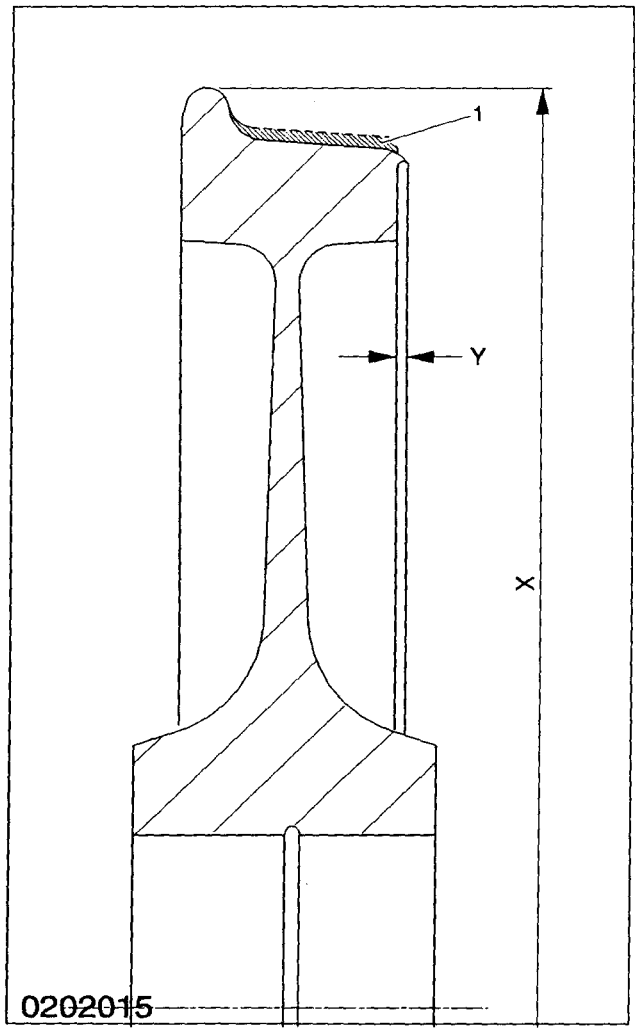
Diameters X between wheels of the two bogies on a locomotive differ by more than 20 mm.

Wheel



Visually inspect the wheel for cracks, damage or defects in the tread profile.

Check the axial runout of the wheels using a dial indicator (1).



Test the wheels ultrasonically for flaws and examine the axle to ensure no movement has occurred between the wheel and axle.

Measure the diameter of all the wheels on the bogie and record the results.

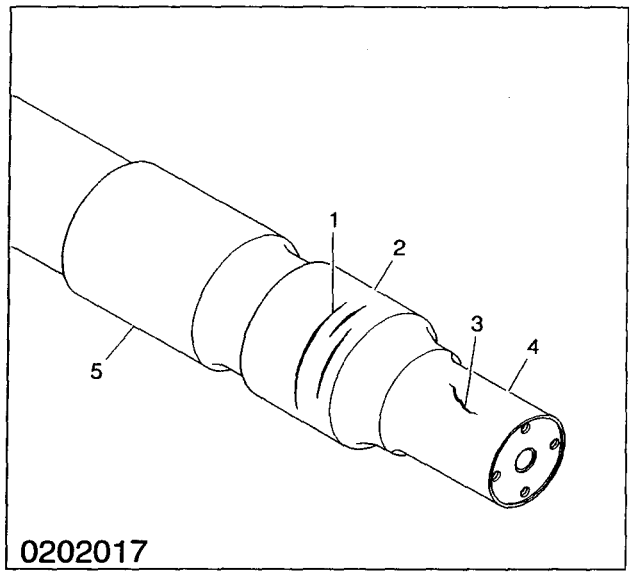
Measure the throat thickness.

Measure the wheel diameter at the tread line (1).

Check the tread for burr (Y) formation.

Check the tread profile.

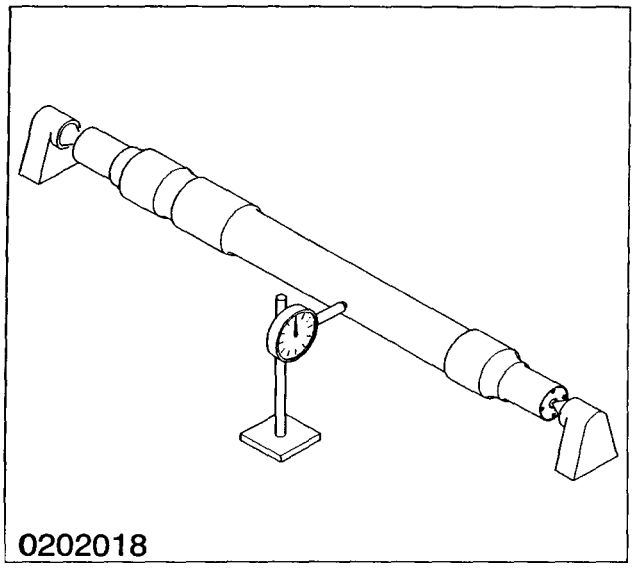
Axle Shaft



0202017

The axle shaft should be returned to the manufacturer for reconditioning if out of specification.

Visually inspect the bearing (4), drive gear (5), wheel (2) and labyrinth ring journals for scratches or damage. Small scratches (3) may be blended out using fine emery paper. Circumfrancial grooves (1) indicate slippage due to improper tolerances.

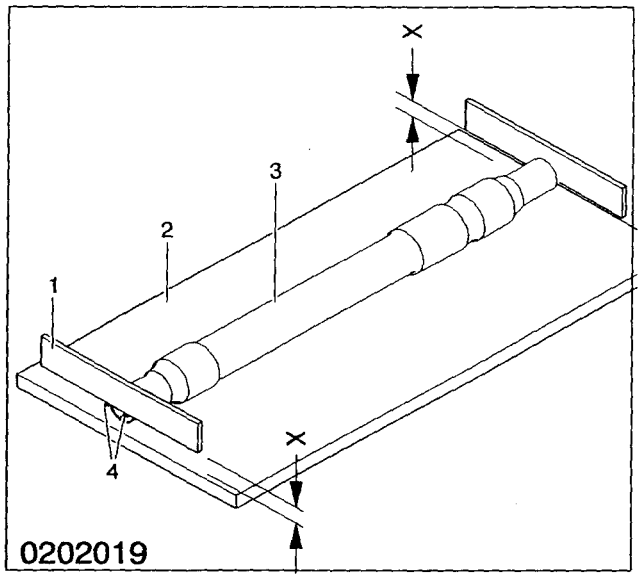

0202018

Remove any sharp edges or burrs using a honing stone.

Visually inspect the axle shaft for cracks or damage.

Check the bearing journal for evidence of overheating.

Check the axle shaft alignment in a suitable fixture. A 60 ° taper is provided in the ends of the shaft. Bend in the axle shaft must not exceed the specification given in Section Tolerances and Wear Limits List.



Check the shaft for twist:

Position the axle (3) on a suitable flat bed bench (2).

Install dowels (4) into the threaded M16 holes in the axles end.

Position a straight edge (1) across the dowels.

Measure the distances (X) between the straight edge (1) and the bench (2) with dial indicators. Rotate the shaft (3) until the straight edge (1) is completely level. Secure the shaft (3) to prevent further movement.

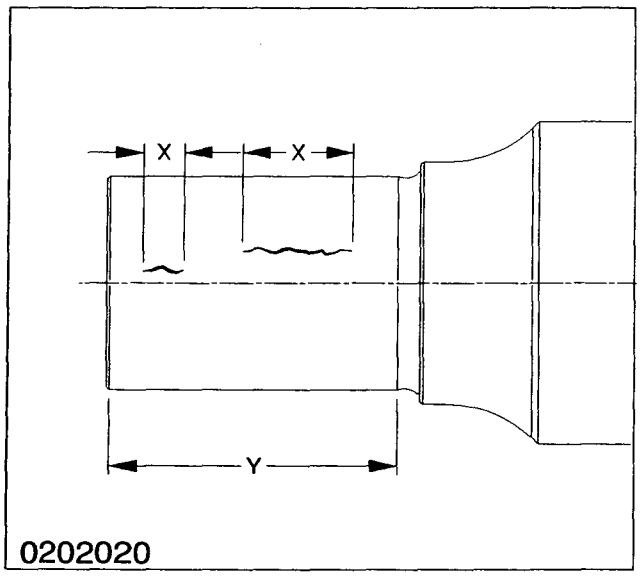
Place dowels and a straight edge (1) on the opposite end of the axle shaft.

Measure the distance between the bed (4) and straight edge (1) using dial indicators.

Replace the shaft (3) if the twist is greater than the specification described in Section Tolerances and Wear Limits List.

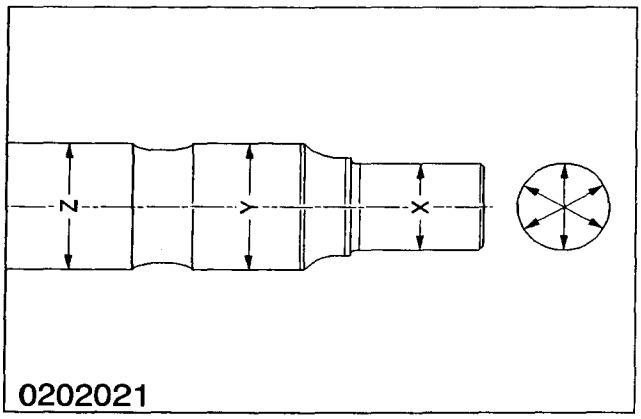
NOTE:

Before measuring the journals, thoroughly clean the seats, fillets, journals and shoulders. Where necessary, remove small scratches with a honing stone or 180 to 200 grit emery cloth.



0202020

Check the drive gear, wheel, labyrinth ring and bearing journals for valleys using a high–precision surface plate smeared with marking paste. Move the surface plate back and forth along the journal in two planes 90 ° apart. The combined width (X) of any valleys must be less than one–third the length (Y) of the journal. If the combined width of the valleys exceeds one–third the length of the journal, the journal must be ground to within the specified tolerance limits. If machining will reduce the journal diameter to below the minimum dimension specified in Section Technical Data, recondition the axle shaft.

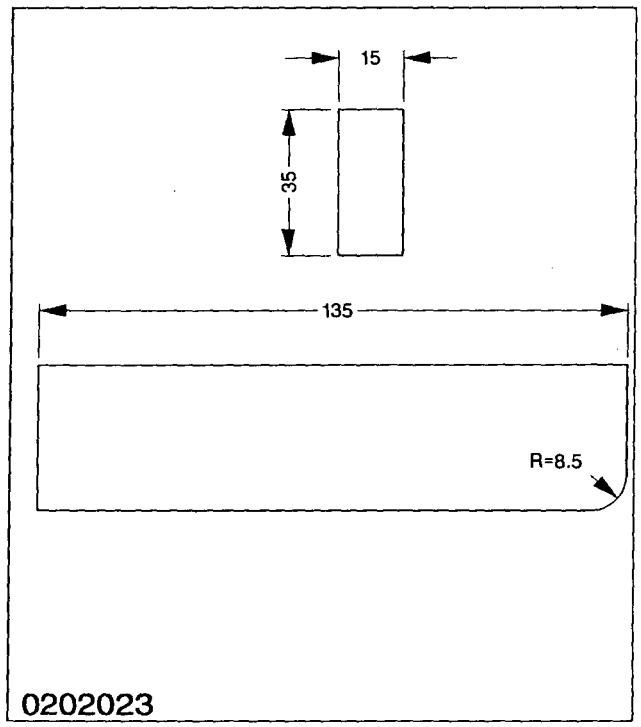


0202021

Measure the diameter of the drive gear (Z), wheel (Y), labyrinth ring and bearing journals (X) in three planes and in three different positions (approximately 60 ° apart) on each of the three planes. If the diameter of any journal is less than specified in Section Technical Data, recondition the axle shaft.

Check the drive gear, wheel and bearing journals for taper. Measure the diameter at each end of the journal. If the minimum diameter of any journal is less than specified in Section Technical Data, recondition the axle shaft.

Check the condition of all transition points and bevels. Small imperfections can be removed using fine emery paper. Do not repair imperfections that cover the entire circumference. Circumferential damage must be repaired by machining to specification. If machining will reduce the journal diameter to below the minimum dimension specified in Section Technical Data, recondition the axle shaft.



Fabricate a template using the dimensions in the figure. Check the fillet between the bearing journal and the journal shoulder using the template. The template should not make contact with any part of the fillet radius.

Inspect the abutting faces of the axle shoulder and the labyrinth ring. Shoulders must be exactly square with the axis of the journal. Out–of–square shoulders may result in bearing seizure.

Inspect the threaded holes in the ends of the axle shaft for damage. Repair the threads using a M16 thread chaser if necessary.

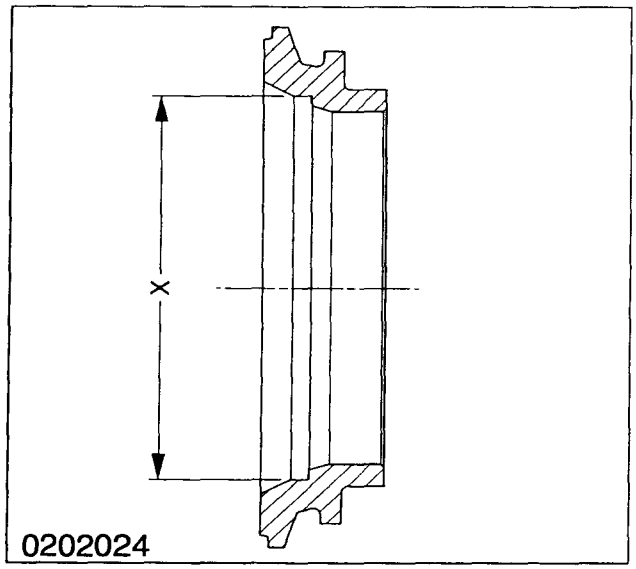
Test the axle shaft for sub–surface cracks using ultrasonic or magnetic testing equipment. Discard any cracked or damaged shafts. Demagnetise the axle shaft before installing the bearings, if necessary.

Labyrinth Ring

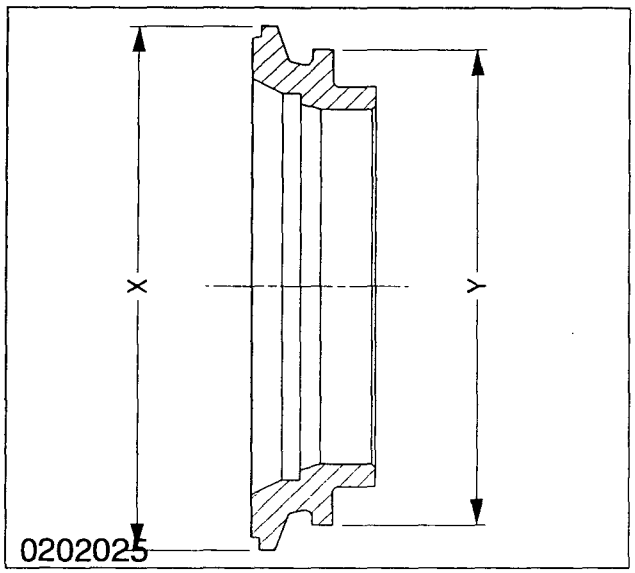
Visually inspect the labyrinth ring bore for scratches or damage. Small scratches may be blended out using fine emery paper.

Inspect the oil seal seat for excessive wear. If serviceable, remove any sharp edges or burrs using a honing stone.

Visually inspect the labyrinth ring for cracks or damage.



Measure the inside diameter (X) of the labyrinth ring shoulder in three different planes 60 ° apart. If the diameter is greater than specified in Section Technical Data, replace the ring.



Measure the diameters (X) and (Y) of the labyrinth ring at the split ring shoulders, in three different planes 60 ° apart. If the diameter is less than specified in Section Technical Data, replace the ring.

Check the condition of all transition points and bevels. Small imperfections can be removed using fine emery paper. Do not repair imperfections that cover the entire circumference. Circumferential damage must be repaired by machining to specification. Replace the shaft if out of specification. Refer Section Technical Data.

Inspect the abutting faces of the axle shoulder and the labyrinth ring. Shoulders must be exactly square with the axis of the journal. Out–of–square shoulders may result in bearing seizure.

Check the labyrinth ring for twist on a flat bed bench. Replace the ring if not perfectly flat.

Test the labyrinth ring for sub–surface cracks using ultrasonic or magnetic testing equipment. Discard any cracked or damaged rings. Ensure that the ring is not magnetised. Demagnetise the labyrinth ring before installing the bearings, if necessary.

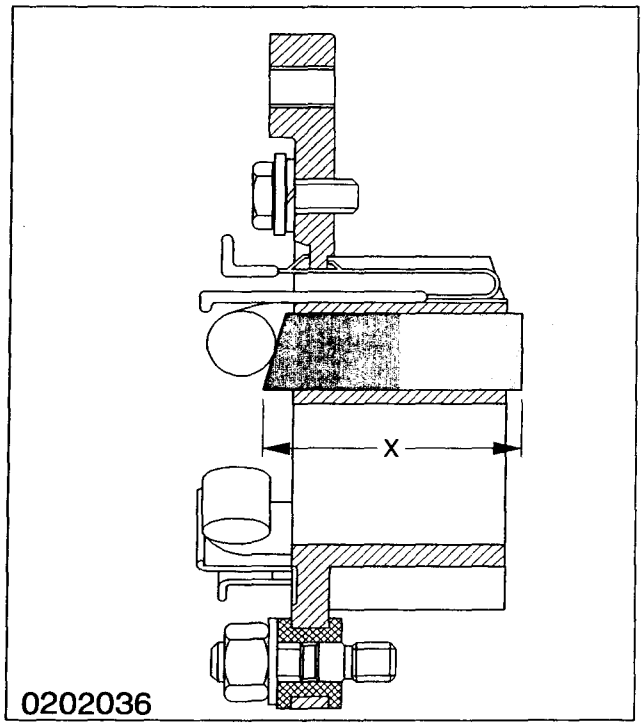
Drive Gear

Inspect the drive gear and bearings as described in Chapter 0206 Section Inspection and Repair.

Axle Box

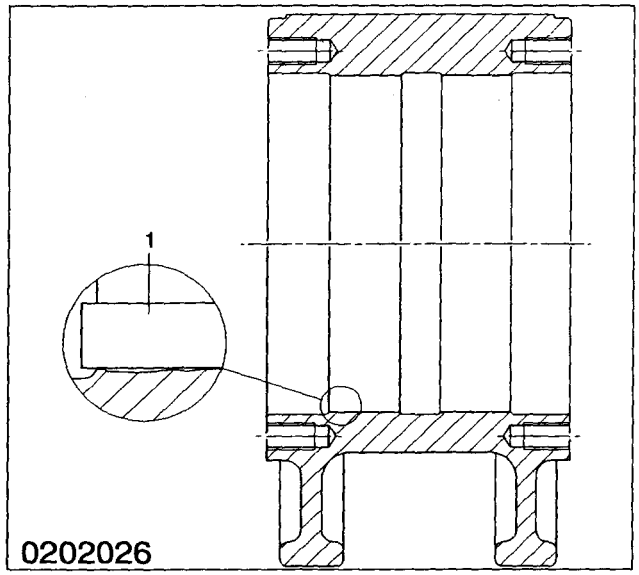
Disassemble and clean all axle box components. Remove all traces of dirt, debris and build–up of grease.

Remove and discard the front cover and spilt ring o–rings.

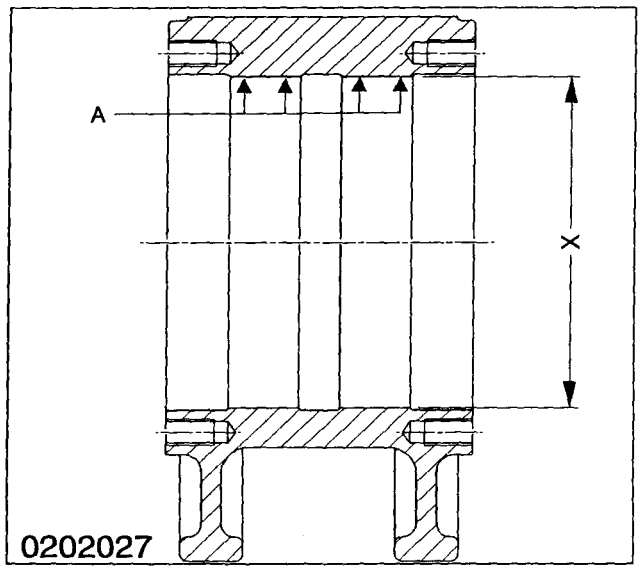


Check the length of earth brushes. Replace if below the specification in Section, Tolerances and Wear Limits List.

Inspect the condition of the axle box bearing bore. Surfaces must be in perfect condition and within the tolerances described in Section Technical Data Small scratches may be blended out using fine emery paper.



Check the axle box bore for valleys using a high–precision surface plate (1) smeared with marking paste. Move the plate back and forth along the bore in two planes 90 ° apart. The combined width of any valleys must be less than one–third the length of the journal. If the combined width of the valleys exceeds one–third the length of the journal, the journal must be re–ground to specification. If machining will enlarge the diameter to above the maximum dimension specified in Section Technical Data, replace the axle box.



Measure the inside diameter (X) of the axle box bore in three planes, approximately 60 ° apart, and in four different positions (A) on each of the three planes. If the diameter is less than specified in Section Technical Data, replace the axle box.

Visually inspect the areas around the spring seats for signs of excessive wear or damage. Repair by welding and machining if necessary.

Visually inspect the guide rod mountings for signs of wear or damage. Repair by welding and machining if required.

Visually inspect the vertical damper mounting lugs on the axle box front cover for signs of wear or damage. Repair by welding and machining if required. A loose damper can cause wear to the mounting pad.

Check all the threaded holes and Helicoils in the axle box. Remove and replace any damaged Helicoils. Repair any damaged threads using an appropriately sized chaser.

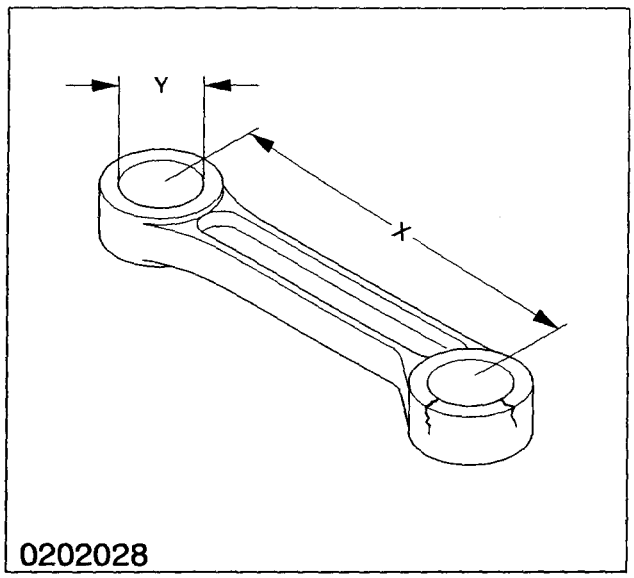
Check the face surface flatness.

Bearing

Inspect the wheel bearings as described in the SKF roller bearing manual, see Volume F2.

Wheel bearing inspection to follow.

Guide Rod



Visually inspect the guide rod for cracks or damage. Pay particular attention to the eye.

Measure the distance (X) between the eye centres. Replace the rod if not to the specification described in Section Technical Data.

Measure the inside diameter (Y) of the eye bores.

Position the guide rod in a suitable fixture and check for twist. Replace the rod if the twist is greater than the specification described in Section Tolerances and Wear Limits List.

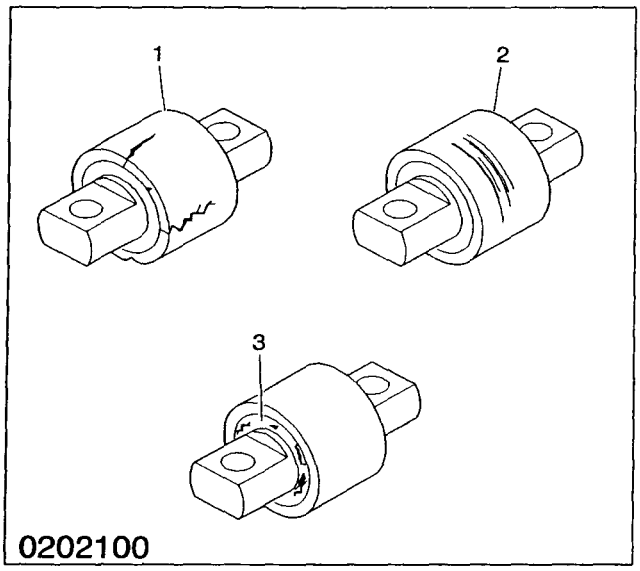
Use a penetrate dye or ultrasonic equipment to test for cracks around the eye and length of the rod.

Spheriblocs

NOTE:

The Spheriblocs in the axle guide rods are critical to maintaining wheel alignment. No damage or wear is permissible on either the metal or rubber parts. Discard damaged or suspect components and replace with new parts. Where one Spheribloc on a bogie is deemed unfit for service it is good engineering practice to thoroughly inspect all Spheriblocs on the bogie.

Press the Spheriblocs from the guide rod. Refer Section Disassembly.



Check the Spheribloc collar (1) for the formation of cracks, pitting or damage and replace if necessary.

Scratches or gouge marks around the circumference (2) of the collar may indicate rotation of the Spheribloc. Discard any Spheriblocs that show signs of rotation and carefully inspect the guide rod for damage.

Inspect the rubber areas (3) for tears, cracks or evidence of disintegration. Replace if worn or the rubber is becoming detached from the collar or is loose and ragged. No damage is permissible to the rubber or collar of the Spheribloc.

Spheribloc Axial Wear Test

The test for axial wear in the Spheribloc can be carried out on the Spheribloc even if mounted in the guide rod.

Before measuring the Spheribloc for axial wear, remove the guide rod from the bogie and store for 48 hours.

Position the Spheribloc in a press and support the collar on a piece steel tube. Ensure there is sufficient space within the tube to allow clearance of the rubber part of the Spheribloc. The collar of the Spheribloc must be supported around its entire perimeter while conducting the test.

Apply an axial load of 50 kg to the Spheribloc cross–pin, then position the plunger of a dial indicator on the shoulder of the cross–pin and zero the dial indicator.

Increase the load on the cross–pin to 1500 kg, one time only, then decrease the load to 50 kg and maintain for one minute.

Check the reading on the dial indicator. If the reading is below 0.6 mm, turn over the Spheribloc and repeat the procedure on the other side. If the reading still remains below 0.6 mm the Spheribloc is serviceable. If either reading was greater than 0.6 mm, replace the Spheribloc.

Sanitation Parts/Operating Material

@.1260

[Not required]

Assembly

@.1270

Wheel Mounting

Either of two methods are recommended for the installation of Monobloc wheels to the axle shaft; shrink fitting or cold press–on.

Although the wheels are cold pressed onto the axle in production, shrink fitting recommended for maintenance procedures. Shrink fitting involves no risk of damage to either the wheel hub or axle journal and provides the best fit between wheel and axle. The oil film builds up evenly when floating off shrunk–on wheels facilitating easy wheel dismounting. Shrink fitting is normally carried out without the aid of lubricants.

Shrink Fit Method

Measure and inspect the wheel hub and axle journal as described in Section Inspection and Repair.

If the wheel was pressed off, it is necessary to ensure that it has an adequate interference fit to enable it to be cold–pressed onto the original axle shaft and achieve the minimum contact force.

Before the wheel is placed in a furnace for heating, check the hub bore for damage. Blend out any small scratches, and ensure the oil injection gallery is clean.

The furnace temperature and heating time must be modulated to ensure the wheel temperature never exceeds 250 °C. Heat indicating crayons can be used to show the wheel temperature while heating. Heat the wheel to 250 °C. for 120 – 140 minutes.

Remove the wheel from the heat and position it on the axle. Before the wheel cools and shrinks check, and adjust if necessary, the distance between the outer wheel flange and the axle hub flange. Ensure the wheel is square and seated correctly on the axle journal. Specifications are provided in Section Technical Data.

Wait 48 hours after installation then conduct a Wheel Contact Test. Specifications are given in Section Technical Data.

Cold–Press Method

Cold press–on of wheels is not recommended in service, however can be carried out if the circumstances dictate.

Check the contact surfaces for damage scratches or burrs. Small scratches can be blended out using emery cloth. Burrs can be removed with a honing stone.

Carefully align the axle, wheel hub and wheel press using a sprit level and a hair protractor. The wheel must fit perfectly against the mandrel (yoke spar) of the press to ensure that an even pressure is applied around the wheel hub.

Apply sufficient Molykote Paste 6 lubricant, or equivalent, to prevent scoring either the wheel hub or axle journal during installation.

Set the press for a contact force of 779 – 1,026 kN. Ensure the pressure recorder is operating.

Press the wheel onto the axle until the outer wheel flange is correct distance from the outer edge of the axle hub flange. The dimension is described in Section Technical Data.

Inspect the plotted diagram. Remove the wheel using the oil injection method described in Chapter 2.02 then repeat the press–on procedure if;

- the maximum permissible press–on force was exceeded
- a score mark is indicated by the diagram curve
- the wheel jumped during the installation procedure
- If the minimum press–on force was not achieved, where the press–on force falls short of the minimum by less than 5%, conduct a contact test after 48 hours. The wheelset is serviceable if the results exceed the minimum contact force by 15%.

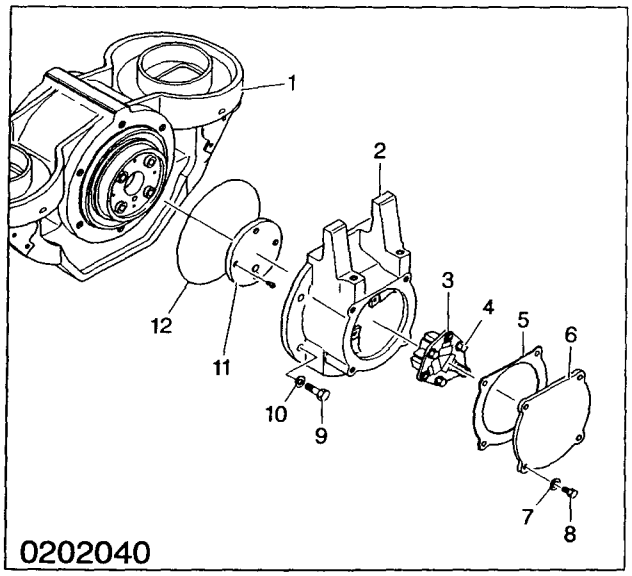
Conduct a contact test 48 hours after successful installation of the wheel. Specifications are given in Section, Technical Data

File the plot diagrams in the wheelset or locomotive logbook.

Drive Gear

Installation of the drive gear is described in Chapter 2.06 Section Installation.

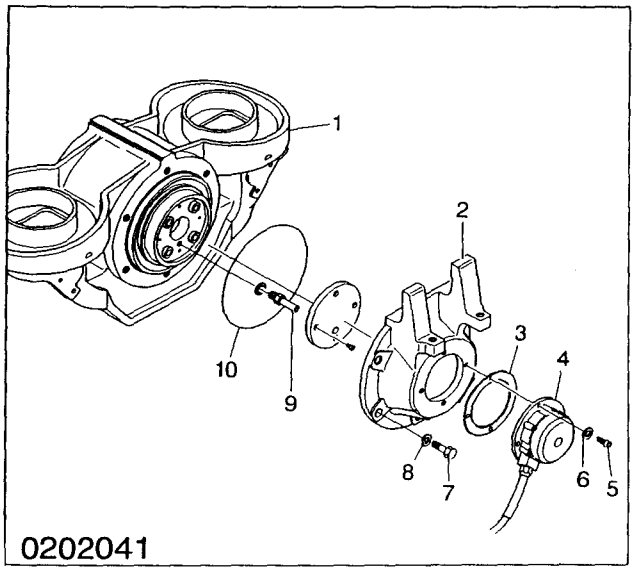
Axle Box



Install the contact plate (11) onto the axle end cap.

Check the o–ring (12) is correctly seated on the axle box (1). Install the front cover (2) with the bolts (9) and washers (10) to the axle box (1). Torque the bolts (9) to specification (M_A = 100 Nm). Install the axle box (1), noting the orientation described in Section Installation.

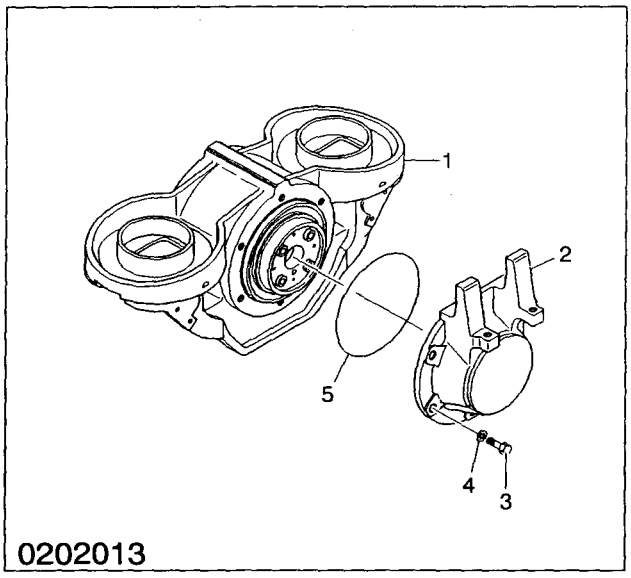
For axle boxes (1) fitted with the earthing brush, check the length of the brushes in the holder (3), then install the holder (3) into the front cover (2) with the bolts (4). The brush holder (3) will spring off if not held securely. Install a new gasket (5) on the cover plate (6), then secure the plate (6) to the front cover (2) using the bolts (8) and washers (7). Torque the bolts (9) to specification (M_A = 47 Nm).



Install the contact plate onto the axle end cap.

Check the o–ring (10) is correctly seated on the axle box (1). Install the front cover (2) with the bolts (7) and washers (8) to the axle box (1). Torque the bolts (7) to specification (M_A = 100 Nm). Install the axle box (1), noting the orientation described in Section Installation.

On axle boxes (1) fitted with the Hasler transmitter (4), install a new gasket (3), then position the transmitter (4) ensuring the drive pin (9) is correctly engaged. Install the bolts (5) and washers (6) securing the transmitter (4) to the front cover (2). Torque the bolts (5) to specification (M_A = 47 Nm).



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Apply a film of bearing grease to the o–ring (5), then install the o–ring (5) into the axle box recess.

Install the axle box (1), noting the orientation described in Section wheelset Installation. Check the o–ring (5) is correctly seated, then install the front cover (2) with the bolts (3) and washers (4). Torque the bolts (3) to specification. M_A = 100 Nm.

Bearing

Assembly of the bearing is described in the SKF roller bearing manual, see Volume F2.

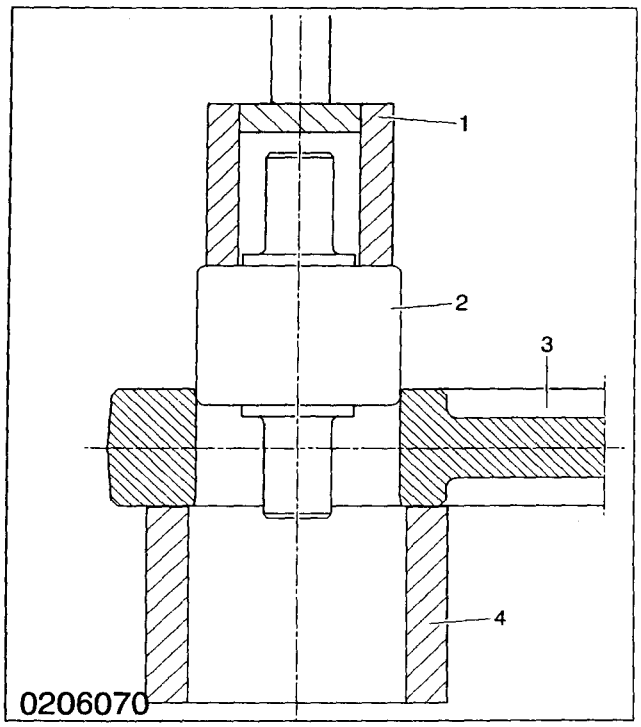
Guide Rod

Spheribloc Installation

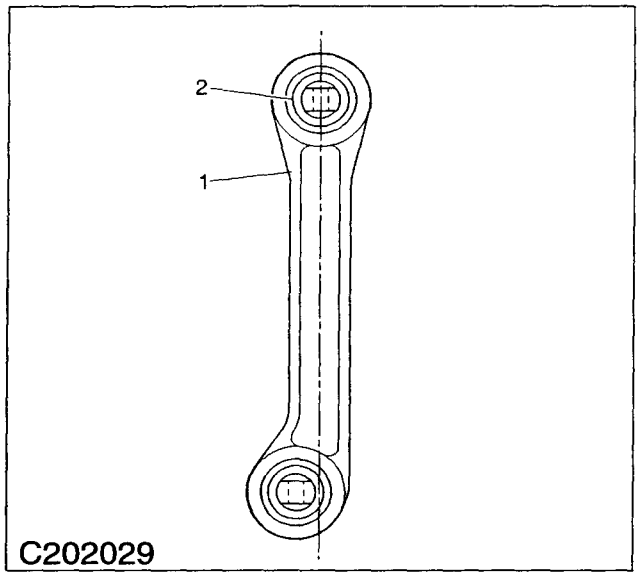
Inspect the Spheribloc and guide rod as described in Section Inspection and Repair.

Remove any burrs or scratches from the Spheribloc collar and the eyes of the guide rod as necessary.

Apply a thin film of machine oil, or other suitable lubricant, to the Spheribloc collar.



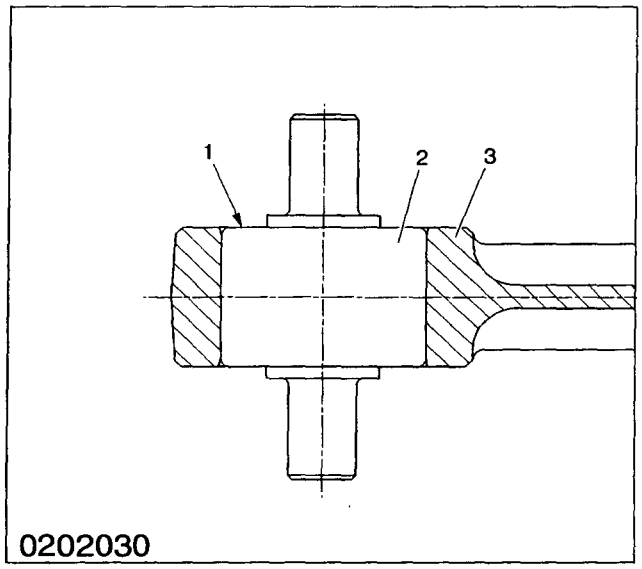
Position the guide rod horizontally in a suitable press. Support the guide rod beneath the eye with a piece of suitable steel tube. Ensure that the tube will not interfere with the cross–pin.



Position the Spheribloc (2) on the guide rod (1), align the centre line of the cross–pin bolt holes to run parallel with the longitudinal centre line of the guide rod.

Position a suitable bush above the Spheribloc, ensuring contact around the entire perimeter of the Spheribloc collar.

Ensure the Spheribloc is square with the guide rod.



Press the Spheribloc (2) into the guide rod (3) until the collar (1) is flush with the guide rod (3). Repeat the procedure for the other Spheribloc.

Installation

@.1280

Wheelset

This procedure describes the installation of the wheelsets to a bogie removed from the locomotive. The wheelsets may be installed whilst the bogie is beneath the locomotive. When removing the wheelsets from beneath the locomotive it is important to support the weight on the locomotive jacking pads and safety stands are positioned under the bogie frame.

Each bogie has two drive axle assemblies. The procedures described here must be performed on all three drive axles on the bogie.

If necessary, install the drive gear. Refer Chapter 2.06 Section Installation.

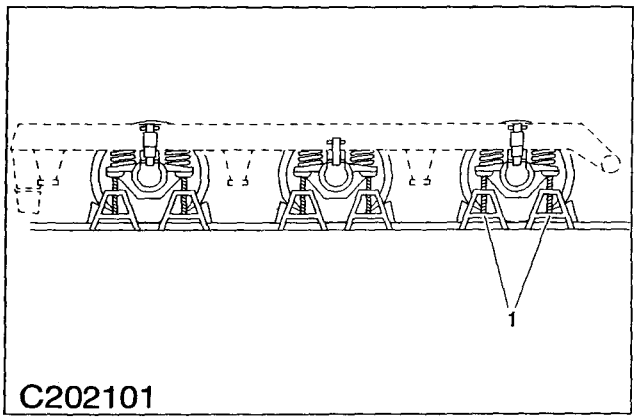
If necessary, install the wheels. Refer Section Assembly.

Install the labyrinth ring as described in Section Assembly.

NOTE:

It is important that the bearings and axle boxes are kept completely free of dust, dirt and other contaminants.

Install the gear box as described in Chapter 2.06 Section Installation.



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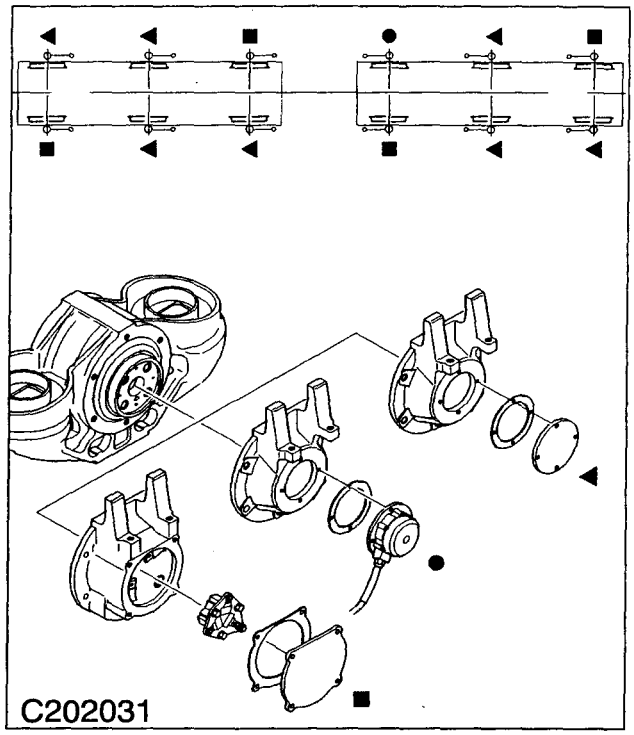
Position the wheels with the axle centres 1,850 mm apart in a suitable safety stand (1). Chock the wheels to prevent movement of the axle.

Inspect the condition of the bearings and journals, then install serviceable bearings as described in the SKF roller bearing manual, see Volume F2.

NOTE:

All axle boxes must be installed with the grease nipple plug facing towards the link rod cross member.



Inspect the axle box condition. Install the axle boxes as described in Section Installation axle box.

Chock the axle boxes in an upright position, then install the primary suspension springs, seats and shims onto the axle boxes. If reusing serviceable springs, etc., reinstall them into the same position from where they were removed.

Carefully position the bogie frame above the wheelsets. Ensure the springs and seats are correctly located, then lower the frame onto the wheelsets.

Install the primary suspension vertical dampers between the axle boxes and bogie frame and the center axle safety link. Refer Chapter 2.03 Section Installation.

Install the traction motor as described in Chapter 4.04 Traction Motor, Section Installation.

Refill the gear box with lubricant, refer Chapter 2.06 Section After–Installations Operations.

NOTE:

Do not use pipes that have been stored unsealed. Unsealed pipes may be contaminated with scale, oxidation or foreign material that will have an adverse effect on the braking system performance and operation.

Install the brake actuators as described in Chapter 6.07 Section Installation. Connect the pneumatic piping.

Install the sanding equipment nozzles as described in Chapter 2.07 Section Removal.

Install the flange lubrication nozzle as described in Chapter 2.08 Section Removal.

Reinstall the bogie to the locomotive, refer Chapter 2.00 Section Installation.

Axle Box

NOTE:

It is important that the bearings and journals be kept absolutely clean, and protected from damage. Foreign material will damage the bearing and/or journal.

DO NOT USE HAMMERS when installing the axle box.

All axle boxes must be installed with the grease nipple plug facing towards the link rod cross member. Axle boxes are dimensionaly symmetrical and their positions can be interchanged. However, it is recommended that axle boxes be reinstalled in their original position. On one side of the bogie the SKF logo will be visible on all axle boxes. The tie down lugs will be visible on the opposite side.

Remove the protective coverings from the axle journal. Check the axle shaft and remove any burrs using a honing stone.

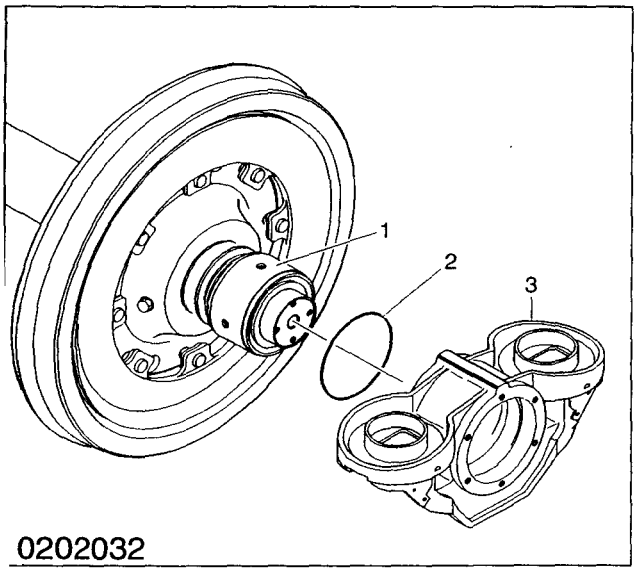
Install the labyrinth ring as described under LABYRINTH RING.

NOTE:

Do not over fill the axle box with lubricant. Excessive lubricant will cause the bearings to overheat.

Lubricate and install the bearing as described in the SKF roller bearing manual.

Apply a thin film of lubricant to the outside of the bearing case.

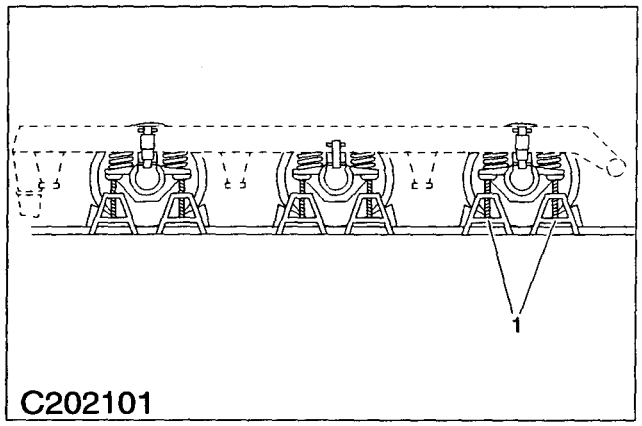


0202032

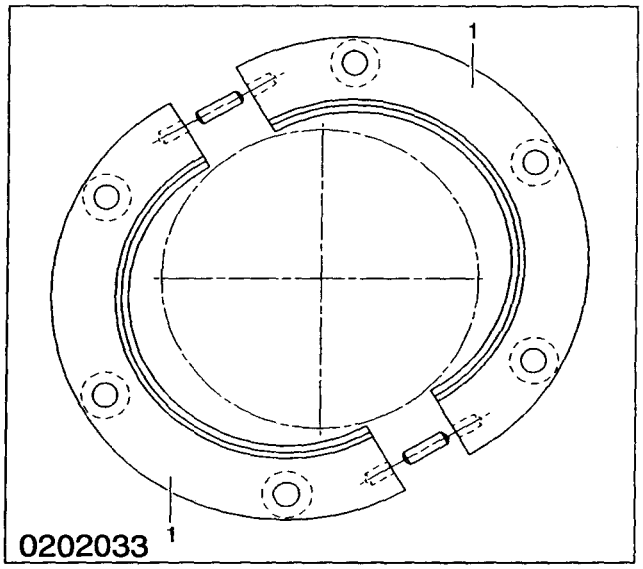
Lubricate the split ring o–ring (2) with bearing grease. Install the o–ring (2) over the bearing (1).

Attach suitable lifting equipment to the axle box (3), then raise it into position.

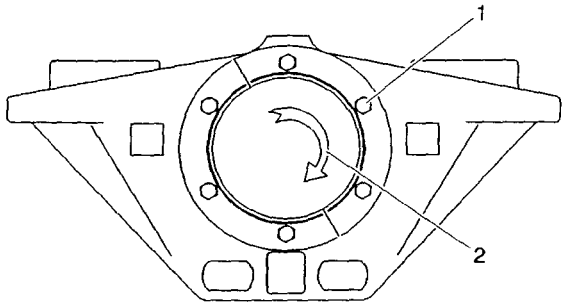
Carefully slide the axle box over the bearing. The fit between the axle box, bearing and the seals will cause some resistance. The axle box may jam if not installed perfectly in–line with the axle.



To prevent the axle box rotating, position suitable safety stands (1) between the webbing and the floor on each side of the axle.



Install the split rings (1) into the same positions as marked during removal. Align the holes, then install the bolts around the split ring into the axle box. Tighten the bolts finger tight.



0202034

Torque the split ring bolts (1) in a clock–wise direction (2) to 100 Nm.

Install the end cap. Ensure the end cap seats correctly in the oil seal. Improper alignment will cause damage to the seal. Torque the socket head bolts to specification. M_A = 670 Nm

Install the primary suspension springs as described in Chapter 2.03 Section Installation.

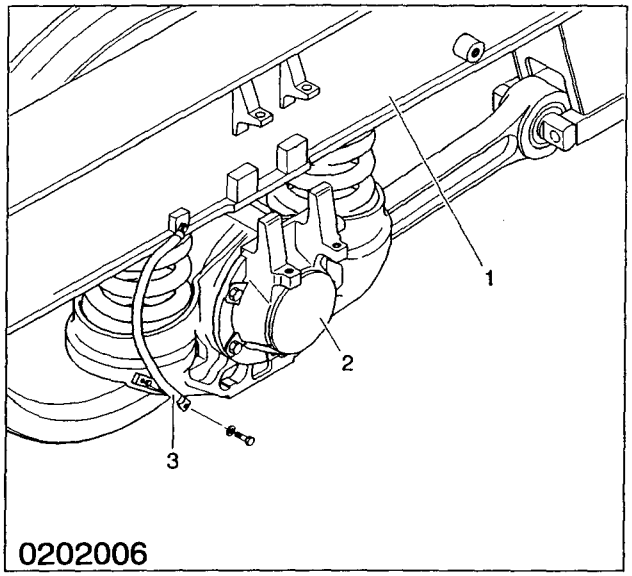
Check the guide rod as described in Section Installation. Repair or recondition as required. Replace if unserviceable.

Raise the guide rod into position and support using safety stands. Align the mounting holes. Insert the bolts with the heads towards the pivot end bogie cross-member. Install the nuts and torque to specification. M_A = 670 Nm

There are different types of axle box front covers depending on their application. Install the covers as described in Section Assembly. Lubricate the o–rings with bearing grease before installation into the axle box housing groove.

Install the primary suspension vertical dampers and centre axle safety link between the axle boxes and bogie frame with the bolts and washers. Refer Chapter 2.03 Section Installation.

Install the primary suspension vertical dampers and centre axle safety link between the axle boxes and bogie frame with the bolts and washers. Refer Chapter 2.03 Section Installation.



Connect the earthing cable (3) between the axle box connector (2) and the bogie frame (1).

Labyrinth Ring

The labyrinth ring is an interference fit on the axle shaft and must be heated to facilitate fitment. Measure the inside diameter of the labyrinth ring and the outside diameter of the axle shaft journal. Ensure the dimensions are within the limits specified in Section Technical Data.

Clean the journal and labyrinth ring using clean, dry, lint free cloth.

Heat the ring to 130 – 150 °C. using a heating cabinet, induction heating equipment, a hot oil bath, or similar.

WARNING:

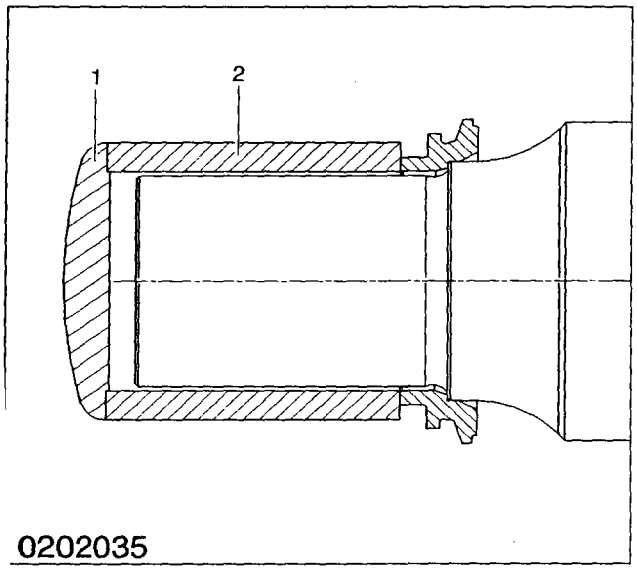
The labyrinth ring is heated to 130 – 150 °C. Personal injury can result from improper handling. Wear protective clothing whenever handling hot parts.

NOTE:

The installation operation must be performed rapidly. The ring will not fit if it becomes cool.

Once the ring is at the specified temperature, remove it from the heat. Carefully clean the labyrinth ring and axle journal using a clean, dry lint free cloth.

Install the ring on to the axle shaft with a slight twisting motion until the ring is squarely positioned against the shoulder.



0202035

Use a mounting sleeve (2), striking pad (1) and hammer to drive the ring against the shoulder while the ring cools. The ring must be squarely and snugly fitted against the shoulder.

Allow the labyrinth ring to cool, then repeat the procedure on the other end of the axle shaft.

Cover the axle shaft to prevent contamination with dirt or dust.

After–Installations Operations

@.1290

Test run

@.1300

Whenever new bearings or drive gears are installed the assembly should be tested actively before installation to a locomotive.

Using a suitable jig, run the wheels at approximately 90 km/h for 20 minutes in each direction. The direction of rotation should be changed periodically during the test.

CAUTION:

During this test the axles and wheels are rotating. Use extreme care to ensure that no part of clothing, rags or hair will be caught in the rotating equipment.

Check the bearings for noise or overheat conditions that may indicate faulty parts or improper installation.

Listen to the gear box for unusual sounds that indicates incorrect meshing of the drive gears.

Adjustments

Wheelset

@.1310

Balance the bogie as described in Chapter 2.00 Section Adjustments. The axle load must be within 400 kg on each pair of wheels and 410 kg between each wheelset on the bogie.

Trouble Shooting

Axle Box

Notes on Bearings and Lubrication

Inspect and maintain the bearings.

[Details to follow]

Always clean around the grease nipple screw plug before removal. Discard the copper gasket.

The bearings must be dismounted and cleaned according to the directions.

[Details to follow]

Never mix different grease types in the bearings.

Always use a metering device whenever adding lubricant. Over lubricating will cause damage to the bearing as quickly as under lubrication does.

In normal use the grease will become softer and darker with usage. Particles of steel from deteriorating bearings causes the grease to become a grey colour.

Grease Quick Test

Place a small amount of grease between two glass plates. Compress the plates together using finger pressure. Slide the plates back and forth. Contaminated grease will cause the glass plates to slide roughly. Clean, uncontaminated grease will allow the plates to slide smoothly over one another.

2.3 Primary Suspension

Group Summary

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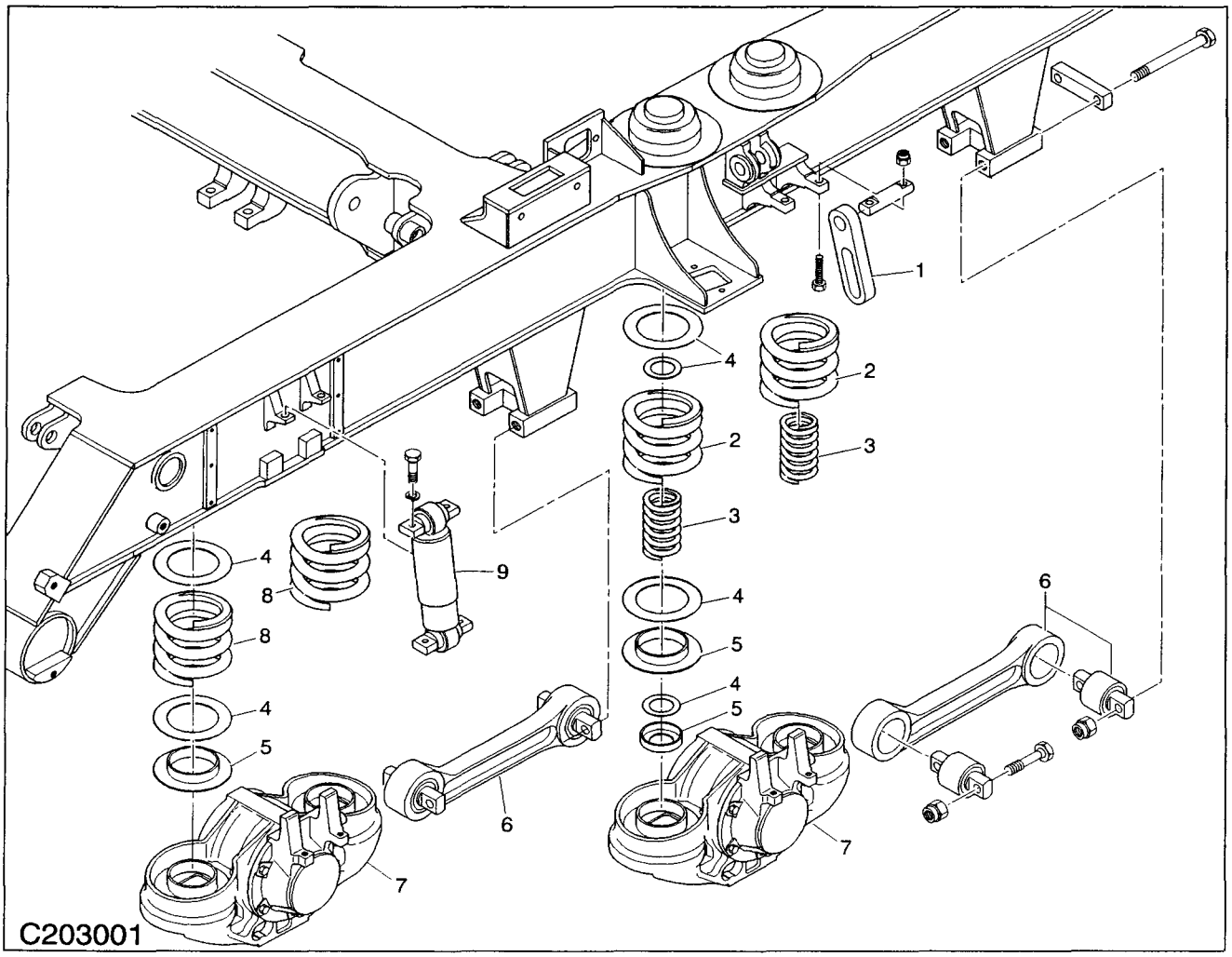
This group contains information on the bogie primary suspension system.



1	Middle Axle Safety Link	6	Guide Rod
2	Middle Axle Outer Coil Spring	7	Axle Box
3	Middle Axle Inner Coil Spring	8	End Axle Coil Spring
4	Compensating Plate	9	Vertical Damper
5	Insulating Base		

Functional Description

@.1140

Isolation and absorption of shock loads and vibration between the bogie frame and wheelsets is performed by the primary suspension. The primary suspension, located between the axles and the bogie frame, comprises coil springs on the axle box and vertical hydraulic dampers.

The middle axle has a safety link between the axle box and underframe. The link lifts the axle with the bogie frame when bogie is raised by lifting equipment.

The vertical dampers are mounted on the end axles between the axle box front cover and lugs on the bogie frame and are used to dampen the rebound rate of the springs. End axles have a single coil spring situated on the axle box fore and aft of the axle centre line. Each end axle (wheelset) has four coil springs. The middle axle has an inner and an outer coil spring situated on the axle box fore and aft of the axle centre line. Each middle axle (wheelset) has eight coil springs.

The springs are situated in seats of each axle box at each end of the wheelset. An insulating base and compensating plates are installed between each spring and the axle box to establish the correct wheel load rate.

Longitudinal control of the axle, and the transmission of tractive and braking effort to the bogie frame, is provided by guide rods connected between the axle boxes and bogie frame. The "Flexicoil" arrangement of the primary suspension permits lateral movement of the axle. Spheribloc rubber bushes in the guide rods allow the axle lateral movement without undue restriction.

Technical Data

@.1160

Primary Suspension Spring

	End Axle Spring	Middle Axle Springs	
		Outer	Inner
– Material	50CrV4	50CrV4	50CrV4
– Bar Diameter	36	31.5	16.5 mm
– Active Coils	3.0	3.5	7.5
– Total Coils	4.5	5.0	9.0
– Winding Direction	Clockwise	Clockwise	Clockwise
– Winding Ratio	5.14:1	5.73:1	5.30:1
– Weight	18.6	19.53	TBA kg
– Mean Spring Diameter	185.0	180.5	87.5 mm
– Free Height (maximum, group 1)	238.8	258.6	252.4 mm
– Free Height (maximum, group 2)	TBA	TBA	TBA mm
– Nominal Loaded Height	192.0	192.0	188.0 mm
– Spring Rate (Linear)	868	473	144 N/m
– Lateral Stiffness (static)	TBA	TBA	TBA N/mm
– Lateral Stiffness (stop)	TBA	TBA	TBA N/mm

Compensation Plates

– THICKNESSES	2 and 3 mm (used as required)

Insulating Base

– SPRING PAD THICKNESS	18 mm (unladen)
– SPRING PAD THICKNESS	16 mm (laden)

Tolerances and Wear Limits List

.1170

Hydraulic Axle Dampers

– MAXIMUM LENGTH	384 – 391 mm
– MINIMUM LENGTH	291 – 298 mm
– INSTALLED LENGTH	338 mm
– STROKE	90 mm
– DAMPING FORCE, AT 0.1 m/s *	5,000 N
– DAMPING FORCE, AT 0.3 m/s *	9,000 N
* (damping force test stroke = 50 mm)	

Middle Axle Safety Link

– Weight	4.76 kg
– Overall lenght	295 mm
– Thickness	40 mm
– Slot lenght	150 – 165 mm
– Slot width	45 – 47 mm
– Pin hole diameter	44 – 45 mm

Springs

Spring heights at given loadings are described in Section Inspection and Repair.

Tools and Special Tools

1180

Normal heavy repair work shop equipment is required for the procedures in this Section. A conventional fixture for measuring springs at load is required.

Before – Removal Operations

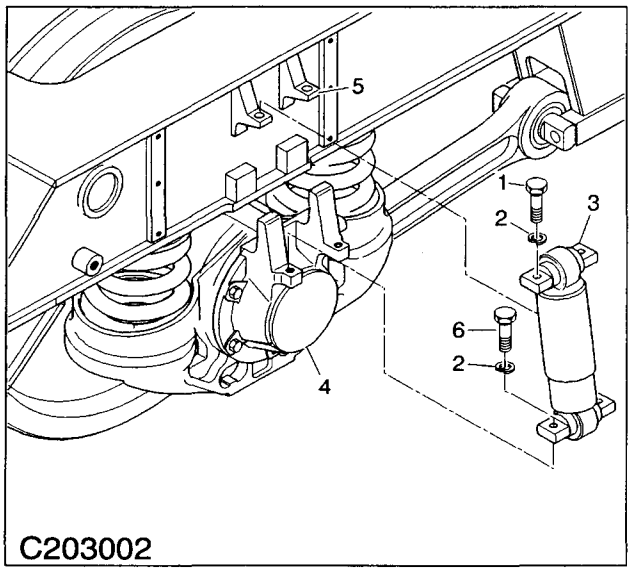
1220

Remove the bogie from the locomotive, if required. Refer Chapter 2.00 Section Removal.

Removal

@.1230

Vertical Damper



Position suitable safety stands below the bogie frame and chock the wheels.

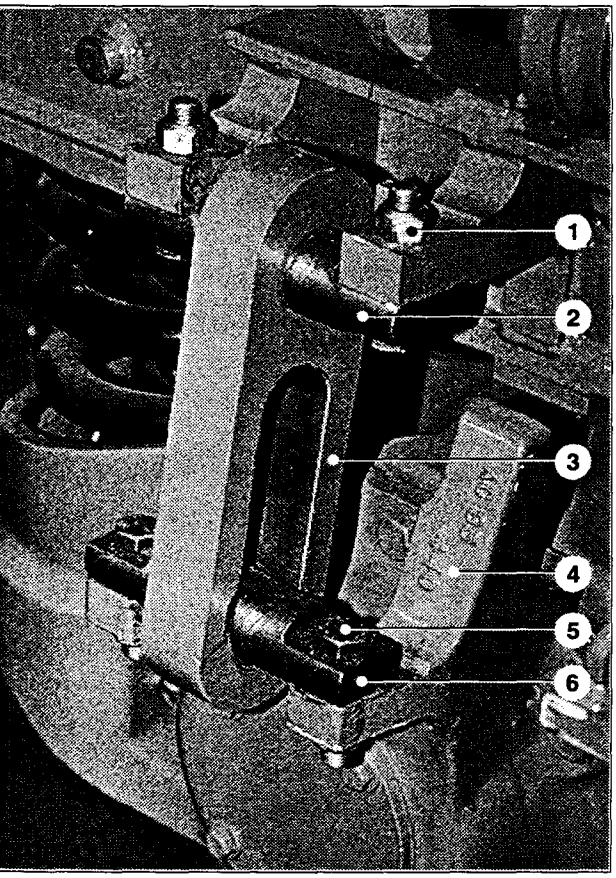
Loosen and remove the bolts (6) and washers (2) securing the damper (3) to the axle box (4).

Loosen and remove the bolts (1) and washers (2) securing the damper (3) to bogie frame (5), then remove the damper (3).

Repeat the procedure for the other vertical dampers on the bogie, if necessary.

Inspect the dampers as described in Section Inspection and Repair.

Axle holder

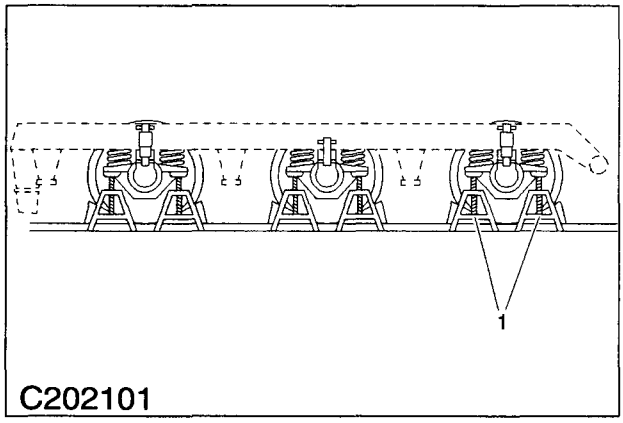


Remove the bolts (3) and nuts securing the axle holder lower pin (6) to the axle box (4).

Withdraw the pin (6) and inspect as described in Section Inspection and Repair.

If necessary, remove the bolts and nuts (1) securing the upper pin (2) to the bogie frame and remove the axle holder (3).

Suspension Springs



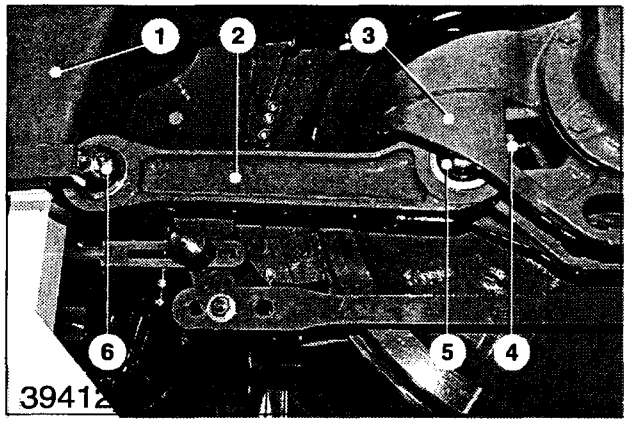
Chock the wheels to prevent movement.

Position suitable lifting equipment under the bogie frame, then raise the equipment slightly to support the weight.

Position suitable supports between the webbing and the floor on each side of the axle to prevent the axle box rotating.

Disconnect the vertical dampers and axle holder from the axle box, as previously described.

Drain the lubricant from the gear box and separate the traction motor from the gear housing as described in Chapter 2.6.



Mark the position of each guide rod (2). Support the rod (2), then remove the bolts (5), nuts (4, 6) and plate securing the guide rod (2) to the bogie frame (1) and the axle box (3). Remove the guide rod (2), then inspect the rods and Spheriblocs as described in Chapter 2.00 Section Inspection and Repair.

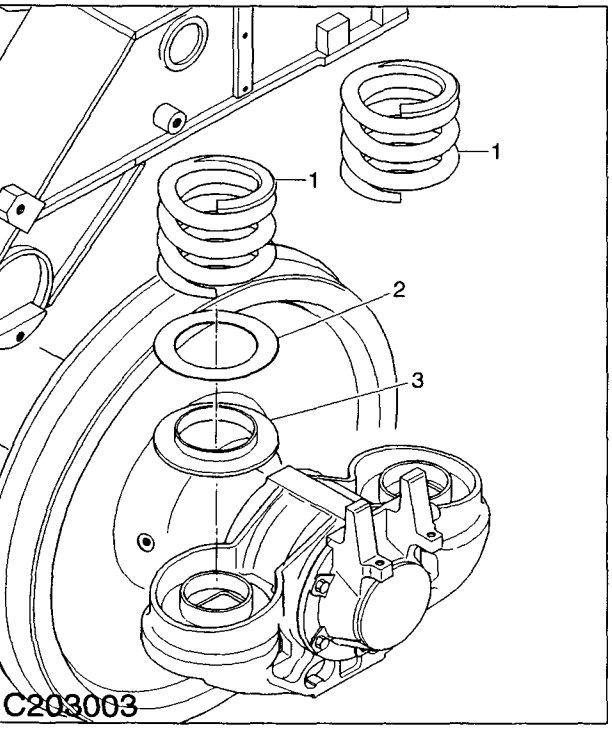
Position suitable lifting equipment under each side of the bogie frame.

WARNING:

The primary suspension springs are held in position by the weight of the locomotive and/or bogie frame. The springs are under compression and are heavy. Whenever removing the springs use care to ensure the springs do not jump from their seats and cause injury or damage.

Evenly raise the bogie frame until there is sufficient clearance to remove the springs.

Position safety stands under the bogie frame.



NOTE:

The middle axle outer springs are different to the end axle springs, and have an additional inner spring.

Tag the location of each set of springs (1), compensating plates (2) and insulating bases (3) to aid reinstallation and inspection. Remove the springs (1), bases (3) and compensating plates (2).

Inspect the springs as described in Section Inspection and Repair.

Disassembly

@.1240

Worn or damaged hydraulic dampers should be returned to the manufacturer for repair or overhaul.

Inspection and Repair

@.1250

Vertical Dampers

Check the dampers for leakage or damage. Replace if damaged or leaking.

Test the damping force as described in the Maintenance and Repair Handbook for KONI Adjustable Railway Dampers, see Volume F2. Replace any dampers not within the specifications described in Section Technical Data.

Suspension Springs

	End Axle Spring			Mid. Axle Outer Spring			Mid. Axle Inner Spring		
	Deflection	Spring height	Load kN	Deflection	Spring height	Load kN	Deflection	Spring height	Load kN
Unloaded	0.0	238.8	0.0	0.0	258.6	0.0	0.0	252.4	0.0
Static Load	46.8	192.0	40.6	66.6	192.0	31.5	64.4	188.0	9.3
Load at Stop	76.8	162.0	66.6	96.6	162.0	45.7	94.4	158.0	13.7
Load at Solid	91.2	147.6	79.1	113.7	144.9	53.8	110.5	141.9	16.0

Inspect the springs for broken ends. Replace if damaged.

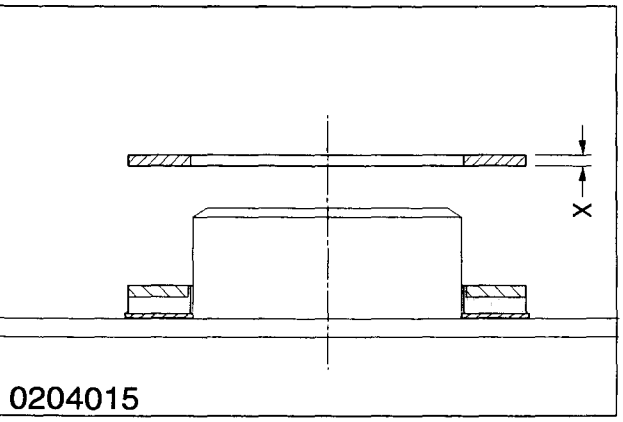
Inspect the springs for cracks or wear. Replace if damaged.

Check the surface of the springs for chipped paint and oxidation. Remove any oxidation and touch–up any paint chips.

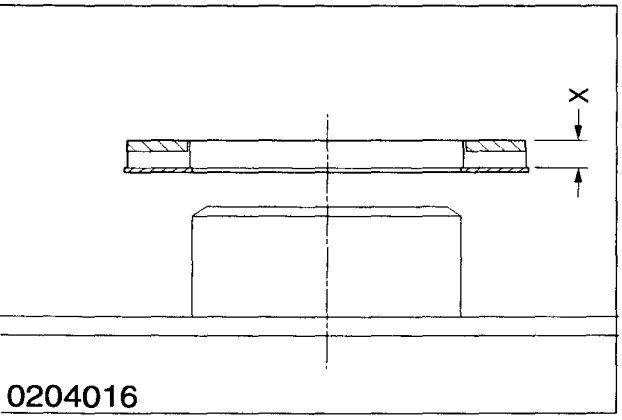
Measure the free height (X) of the spring. Replace if below the specification described in Section Technical Data.

Position the spring in a testing fixture. Apply the loads in the table and measure the spring height at each given load. Replace any springs not within specification.

Compensating Plates & Insulating Pads



Check the compensation plates for wear, cracks or damage. Measure the plate thickness in four places 90° apart. Replace if worn, damaged or cracked.



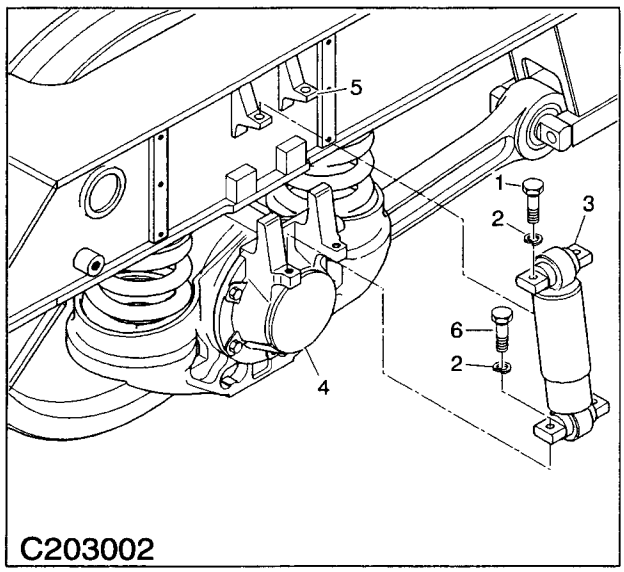
Inspect the insulating bases for wear, cracks or damage. Measure the thickness of the base in four places 90° apart. Replace the insulating base if worn, damaged or cracked.

Inspect the spring seats on the bogie frame and locomotive underframe. Check for cracks, damage or wear. Rectify any faults found.

Installation

@.1280

Vertical Damper



Position the primary suspension vertical damper (3) between the bogie frame (5) and axle box (4).

NOTE:

The damper upper cross–pin seats above the bogie frame lug.

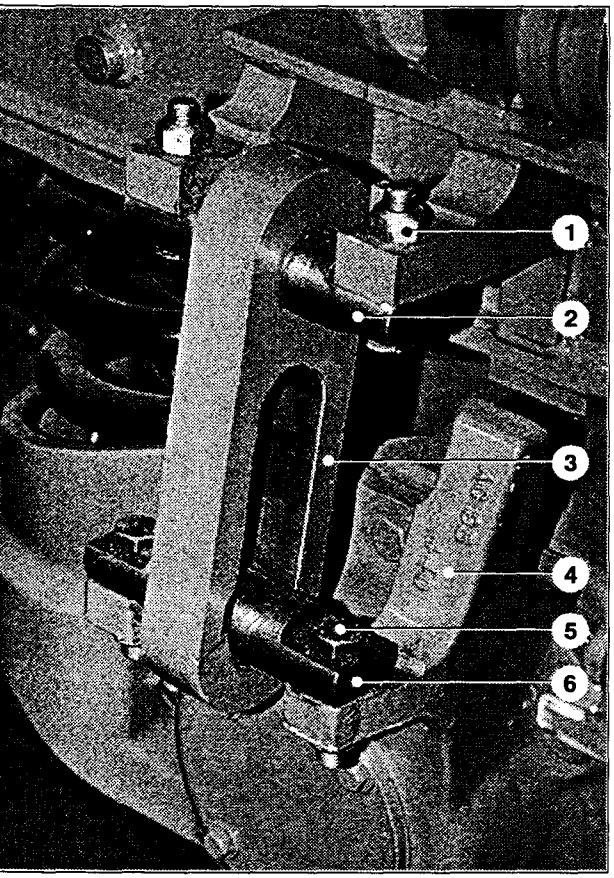
Check the damper (3) is correctly orientated with the smaller cylinder pointing towards the rail, then align the holes in the cross–pins with the holes in the bogie frame lug (5) and axle box (4).

Install the washers (2) on the upper bolts (1), then install the bolts (1) through the cross–pin into the lug (5).

Install the bolts (6) through the lower cross–pin into the axle box. Install the nuts, then torque to 192 Nm.

Repeat the procedure for the other vertical dampers on the bogie as necessary.

Axle holder



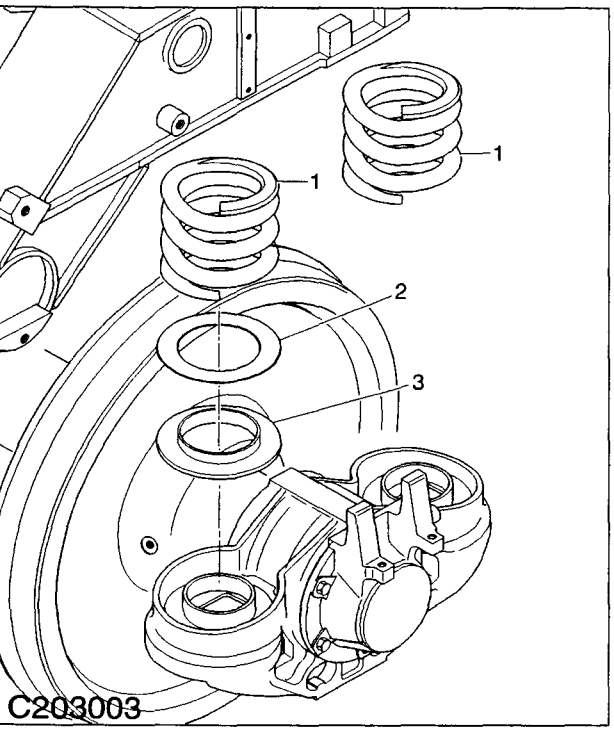
Apply a thin film of a suitable grease to the pins (2, 6) and the slot of the axle holder (3). Ensure the pin (6) slides freely in the slot.

Insert the pins (2, 6) through the hole and slot in the axle holder (3).

Position the link (3), with the slot downwards, between the bogie frame and axle box mounting lugs. The upper pin (2) is positioned below the bogie frame lugs and the lower pin (6) is situated on top of the axle box mounting lugs.

Install the bolts (5) through the lugs and pins (2, 6), then install the nuts (1) and torque to 192 Nm.

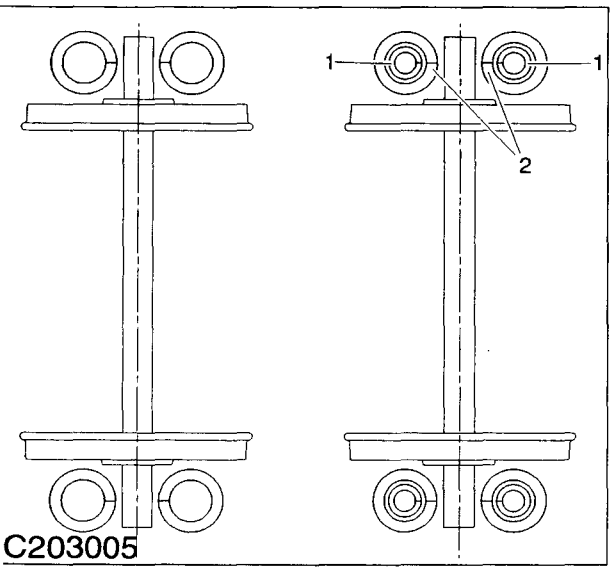
Repeat the procedure for the other axle holder if necessary.



NOTE:

The middle axle outer springs are different to the end axle springs. The dimensions of the springs are given in Section Inspection and Repair.

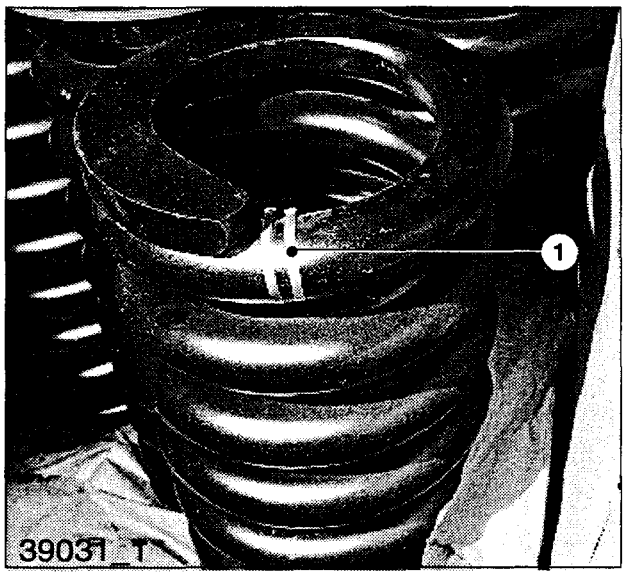
Install the end axle springs (1), bases (3) and compensating plates (2) as tagged during disassembly.



NOTE:

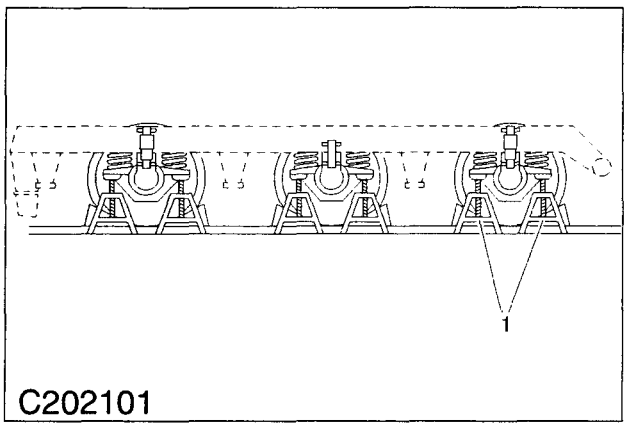
The thickness of the compensating plates must be equal for the inner (1) and outer springs (2). All springs are installed with the ends facing one another at the axle centre line.

Primary Suspension Spring



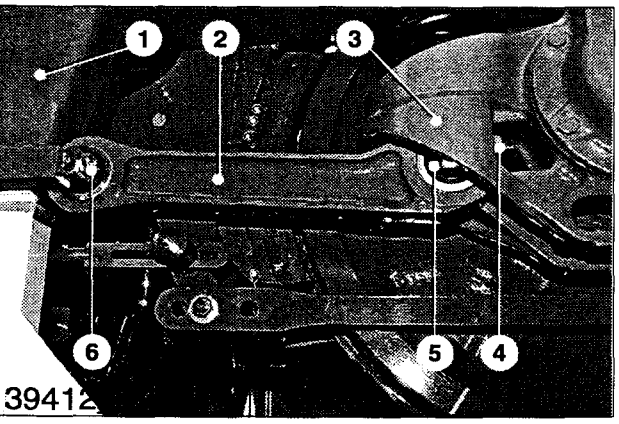
All springs vary slightly due to the manufacturing process. In smaller springs this difference is generally negligible, but on larger springs, such as used on the WAG–9 primary suspension, small variations can have a marked impact on performance. WAG–9 locomotive springs are manufactured to exacting standards, but variations between different batches do occur. Springs are marked with one or two aluminium bands (1) during manufacture to identify the spring's tolerance range. All springs on the bogie must be within the same tolerance range. Do not mix springs with different numbers of aluminium bands on a bogie.

During the removal procedure the springs, insulating bases and compensation plates were tagged to identify their location, reinstall the suspension components into the same position from which they were removed. Whenever replacing a spring, always use a new spring with the same tolerance range as the other springs on the bogie.



Chock the wheels to prevent movement and ensure the bogie frame is supported by suitable lifting equipment and, if necessary, safety stands.

Position suitable supports between the webbing and the floor on each side of the axle to prevent the axle boxes rotating.



Carefully lower the bogie frame. Ensure the springs are correctly seated on the bogie frame spigots and axle box seats.

Raise the guide rod (2) into position and support using safety stands. Align the mounting holes. Install the bolts (5), nuts (4,6) and plate (4).

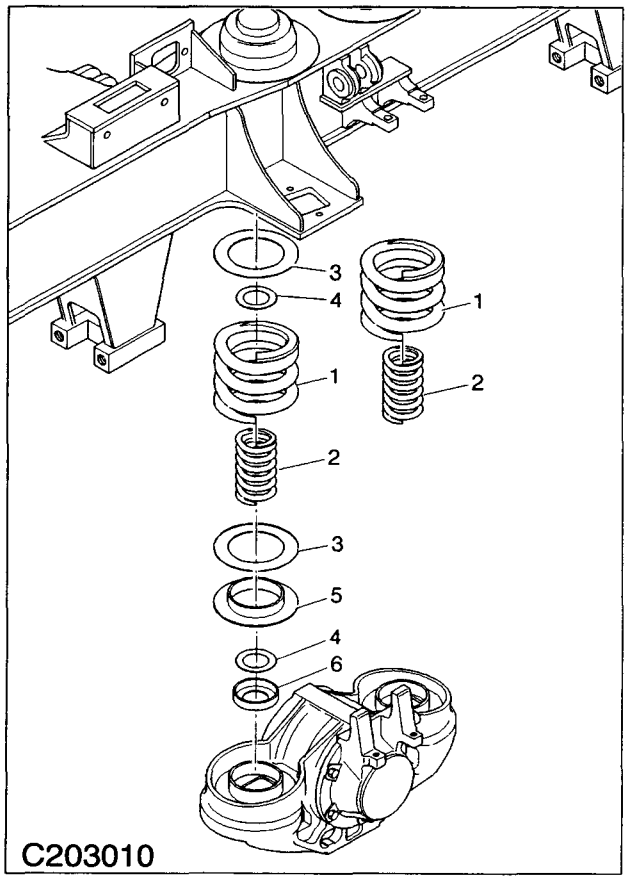
Torque the nuts at the axle box to 670 Nm and those at the bogie frame to 670 Nm.

Install the traction motor and gear housing as described in Chapter 2.6.

Refill the gear box with lubricant as described in Chapter 2.6.

Install the vertical dampers and middle axle safety link between the axle box and bogie frame, as previously described.

Check and adjust if necessary the axle loading. Refer Chapter 2.00 Section Adjustments.



Install the middle axle inner springs (2), bases (6) and compensating plates (4) as tagged during disassembly.

Install the middle axle outer springs (1), bases (5) and compensating plates (3) as tagged during disassembly.

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Compensation Plates

NOTE:

Never install shims above the springs or weld the shims to the axle box.

The variations that occur in springs, described in PRIMARY SUSPENSION SPRINGS, and softening over time is offset by compensation plates (shims). The shims are always positioned between the spring and the axle box. Springs are marked in production with one or two aluminium bands to indicate their tolerance range. Whenever installing new springs, place the number of 2 mm shims below the spring corresponding to the number of aluminium bands.

Both springs in a set on an axle box must be packed with an equal thickness of compensation plates. Shims are available in 2 and 3 mm thicknesses.

Adjustment of the axle loads is described in Chapter 2.00 Section Adjustments.

2.4 Secondary Suspension

General Notes on Hazards in the Work Area

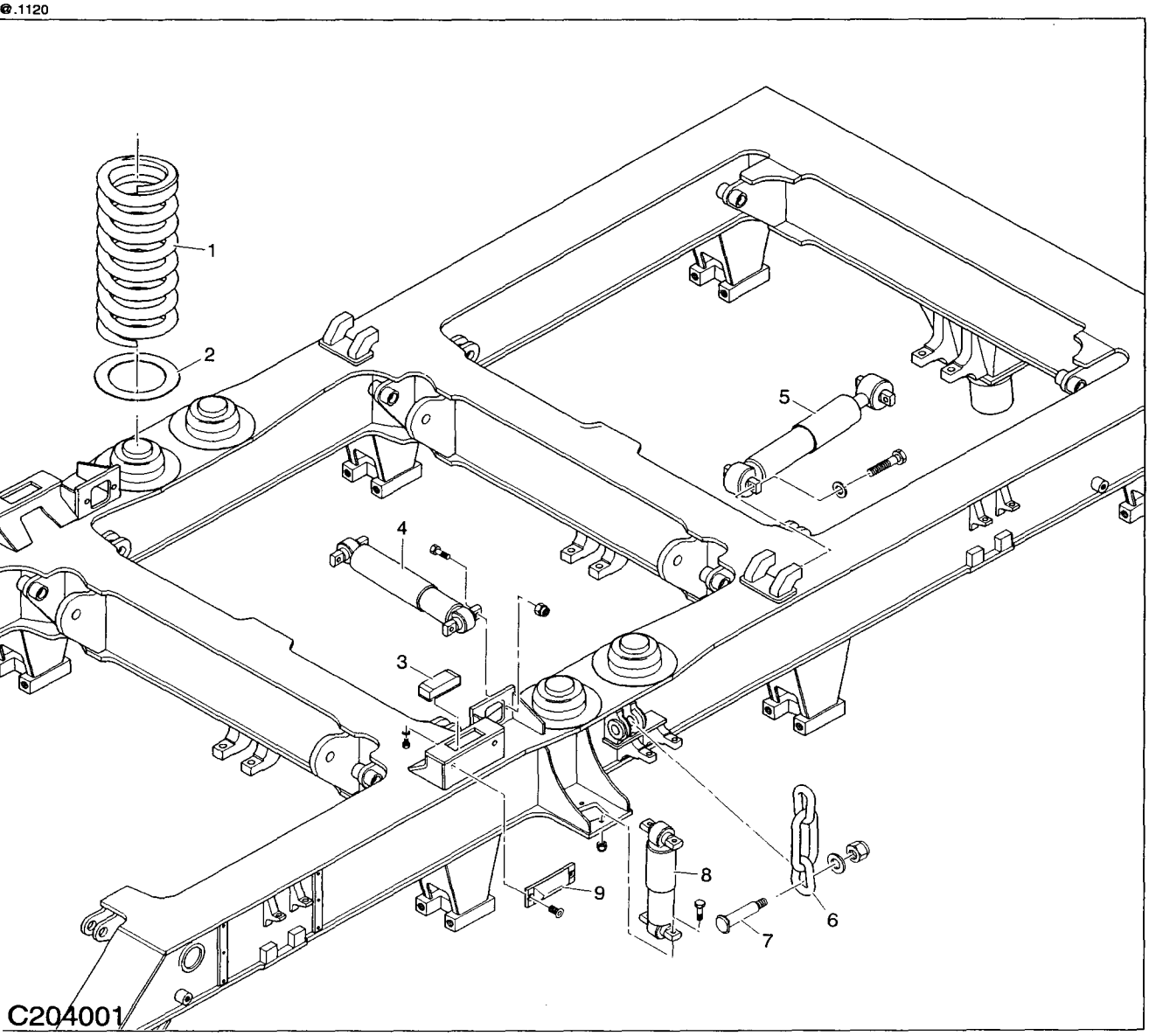
@.1040

WARNING:

The secondary suspension springs are heavy, over 120 kg. Use lifting equipment to raise or lower heavy parts.
The secondary suspension springs are under compression with the weight of the locomotive. Whenever removing the springs use care to ensure the springs do not jump from their seats and cause injury or damage.

Overview

@.1120



1	Coil Springs	6	Safety Chains
2	Compensating Plates	7	Pins
3	Vertical Bump Stops	8	Vertical Hydraulic Dampers
4	Lateral Hydraulic Dampers	9	Lateral Bump Stops
5	Yaw Hydraulic Dampers		

Functional Description

@.1140

The primary and secondary suspension absorbs and isolates shock loads, due to track deformities and other variations. The primary suspension is described in Section 2.03.

The secondary suspension consists of coil springs and vertical, lateral and yaw dampers, located between the bogie frame and the locomotive underframe on each side of the bogie. The springs support the weight of the locomotive car body and allow free movement between the car body and the bogie. This "FlexiFloat" arrangement of the secondary suspension allows the locomotive car body to move both laterally and vertically within certain limits relative to the bogies.

Although the springs allow movement in any direction, lateral buffers and dampers limit the amount and rate of lateral movement, while rebound limit chains and vertical dampers limit the amount and rate of the vertical rebound of the locomotive car body. Longitudinal (yaw) dampers are provided to dampen the rate of pitch of the car body. Traction rods, connected between the bogie and locomotive underframe, control the fore and aft movement between the bogies and the locomotive.

Insulating bases and compensating plates (shims) are installed between each spring and the bogie frame. Shims may be added to establish the correct wheel load levels.

Technical Data

@1160

Vertical Damper

– Maximum length	518 – 525 mm
– Minimum length	365 – 372 mm
– Installed length	430 mm
– Stroke	150 mm
– Damping force, at 0.1 m/s *	11,000 N
– Damping force, at 0.3 m/s *	20,000 N
(* damping force test stroke = 50 mm)	

Lateral Damper

– Maximum length	688 – 695 mm
– Minimum length	460 – 467 mm
– Installed length	574 mm
– Stroke	225 mm
– Damping force, at 0.1 m/s *	7,000 N
– Damping force, at 0.3 m/s *	14,000 N
(* damping force test stroke = 50 mm)	

Yaw Damper

– Maximum length	818 – 825 mm
– Minimum length	600 – 607 mm
– Installed length	700 mm
– Stroke	215 mm
– Damping force, at 0.1 m/s *	3,000 N
(* damping force test stroke = 50 mm)	

Secondary Suspension Springs

– Material	51CrMoV4
– Bar Diameter	53 mm
– Active Coils	8
– Total Coils	9.5
– Winding Direction	Clockwise
– Winding Ratio	4.74:1
– Weight	123.0 kg
– Mean Spring Diameter	251 mm
– Free Height (max)	733.2 mm (tolerance group 1)
– Free Height (max)	TBA mm (tolerance group 2)
– Loaded Height	575 mm
– Spring Rate	612.0 N/mm, Linear
– Lateral Stiffness (static)	TBA N/mm
– Lateral Stiffness (stop)	TBA N/mm

Compensation Plate

– Thicknesses	3 and 5 mm (use as required)

Insulating Base

– Spring Pad Thickness	18 mm (unladen)
– Spring Pad Thickness	16 mm (laden)

Safety Chain

– Weight	6.5 kg
– Breaking Force	1,120 kN
– Chain Diameter	30 mm
– Overall Length	415 mm
– Top Link Inside Length	105 mm
– Centre Link Inside Length	135 mm
– Lower Link Inside Length	115 mm

Safety Chain Pin

– Shank Diameter	52 mm
– Thread	36 mm

Lateral Bump Stop

– Pad Thickness	25 mm
– Clearance to underframe	50 mm

Tolerances and Wear Limits List

@1170

Hydraulic Dampers

Tolerances and wear limits for the lateral, yaw and vertical dampers are described in the Maintenance and Repair Handbook for KONI Adjustable Railway Damper, see Volume F2.

Suspension Springs

Spring heights at given loadings are described in Section Inspection and Repair.

Safety Chain

– Maximum Wear	2 mm
– Maximum Length	419 mm

Lateral Bump Stop

– Minimum Wear Plate Thickness	2 mm (measured at edge)
– Minimum Height	TBA

Vertical Bump Stop

– Minimum Thickness	5 mm

Tools and Special Tools

@.1180

Normal heavy repair work shop equipment is required for the procedures in this Section. A conventional fixture for measuring springs at load is required.

Miscellaneous Materials

@.1200

[Not Required]

Before Removal Operations

@.1220

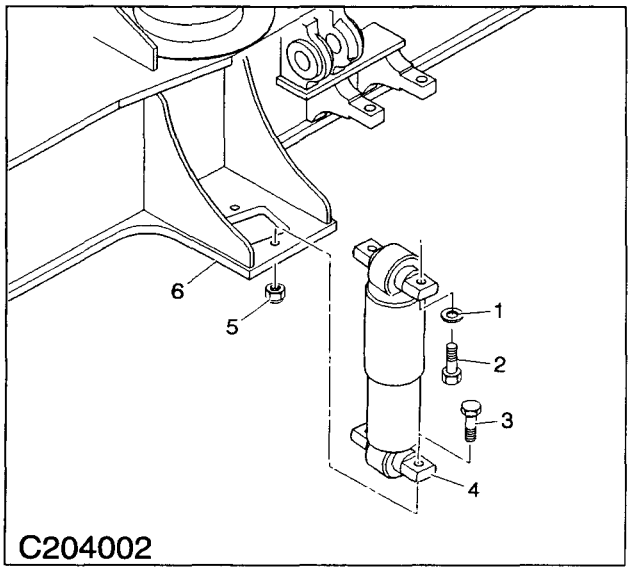
Locomotive to be safely parked.
Lifting jacks positioned under the locomotive body lifting points, wheels chocked.

Removal

@1230

Vertical Dampers

Position lifting jacks under the locomotive jacking points and chock the wheels.



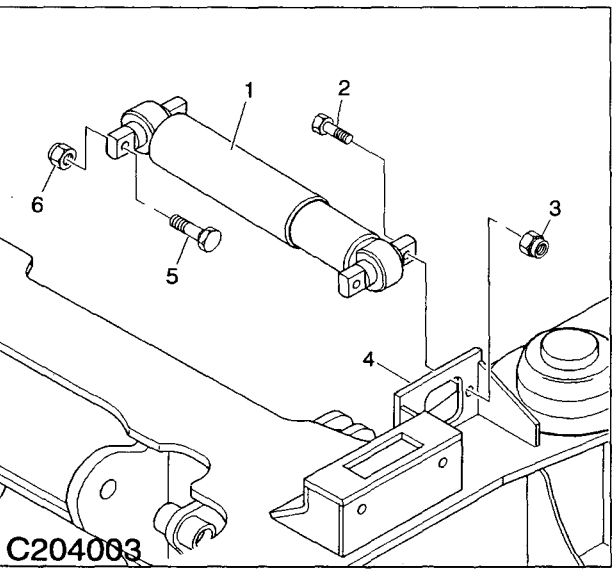
Loosen and remove the bolts (3) and nuts (5) securing the vertical damper (4) to the mounting bracket (6) on the bogie frame.

Loosen and remove the bolts (2) and washer (1) securing the vertical damper (4) to locomotive underframe, then remove the damper (4).

Repeat the procedure for the vertical damper on the opposite side, if necessary.

Inspect the dampers as described in Section Inspection and Repair.

Lateral Dampers



Position lifting jacks under the locomotive jacking points.

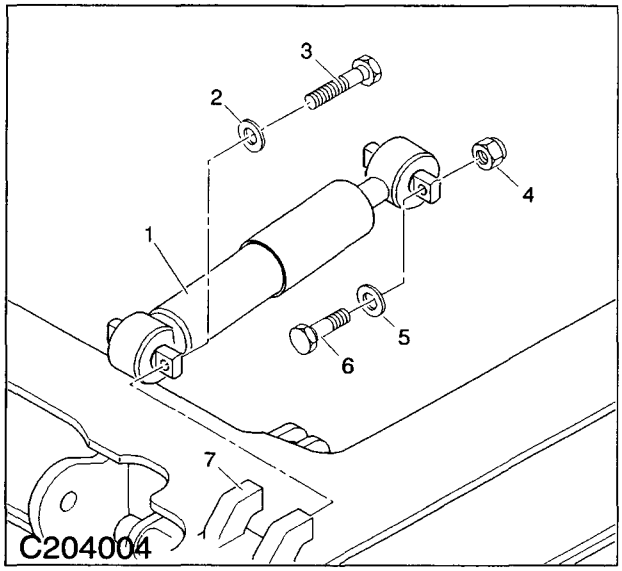
Remove the bolts (5) and nuts (6) securing the lateral damper (1) to the locomotive underframe.

Remove the bolts (2), nuts (3) securing the lateral damper (1) to the bogie frame web (4), then remove the damper (1).

Repeat the procedure for the lateral damper on the opposite side, if necessary.

Inspect the dampers as described in Section Inspection and Repair.

Yaw Dampers



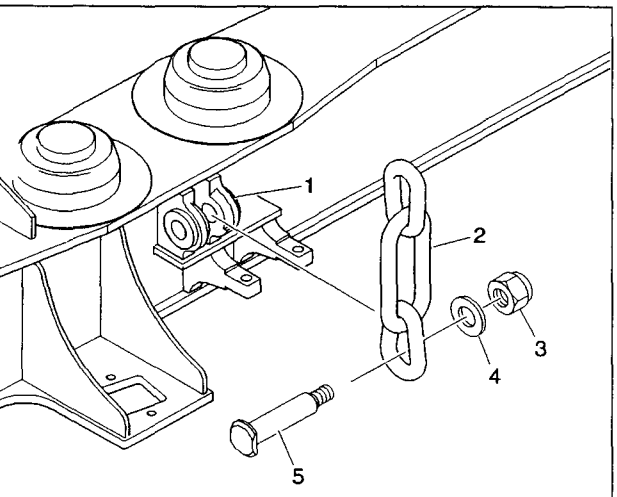
Remove the bolts (6), nuts (4) and washers (5) securing the yaw damper (1) to the locomotive underframe.

Remove the bolts (3) and washers (2) securing the yaw damper (1) to the bogie frame mounting lug (7), then remove the damper (1).

Repeat the procedure for the yaw damper on the opposite side, if necessary.

Inspect the dampers as described in Section Inspection ands Repair.

Secondary Suspension Springs



C204005

Position lifting jacks under the locomotive jacking points.

Tag the springs to identify their location for reinstallation and inspection.

Remove the nut (3) and washer (4) from the bogie safety chain pin (5) at the bogie frame lugs (1), then withdraw the pin (5) from the lugs (1). Discard the lock nut (3). Remove safety chain (2).

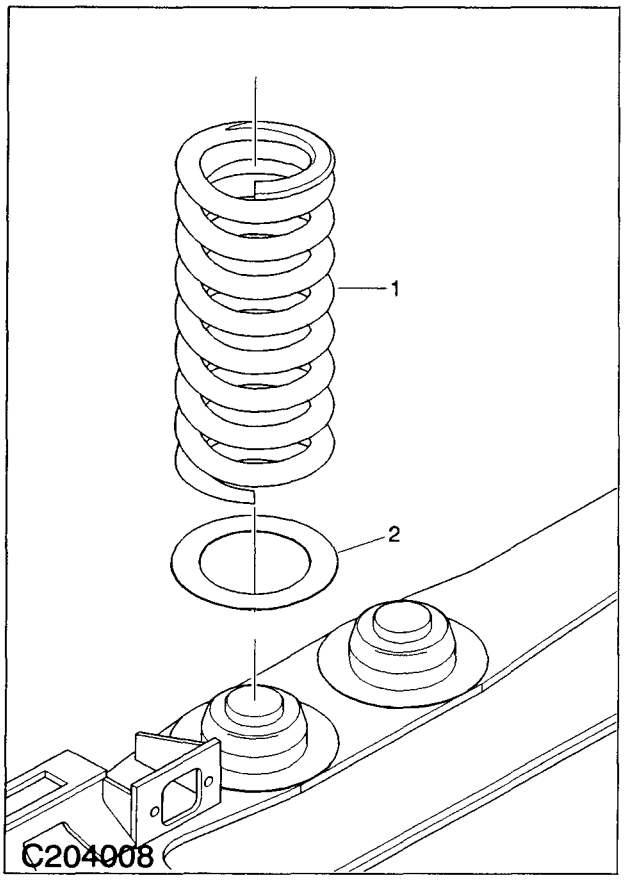
Disconnect all electrical and pneumatic connections body to bogie.

Position suitable lifting equipment below the locomotive jacking pads. The locomotive body must be raised evenly on each side.

WARNING:

The secondary suspension springs are under compression by the weight of the locomotive. Whenever removing the springs use care to ensure the springs do not jump from their seats and cause injury or damage.

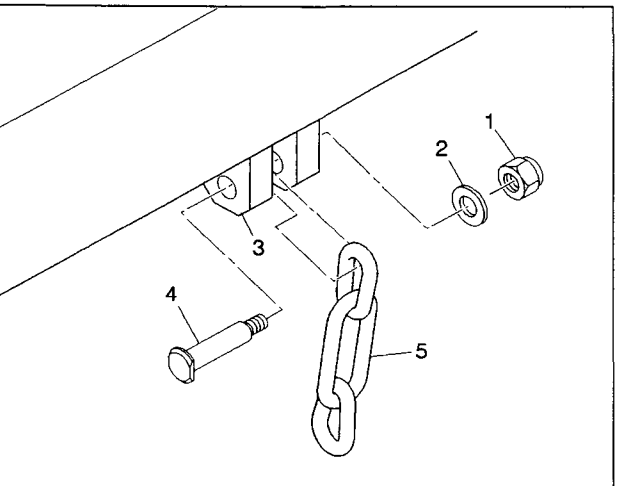
Evenly raise the lifting equipment until there is sufficient clearance to remove the four secondary suspension springs.



Position safety stands under the locomotive, then remove the springs (1) and compensation plates (2). Tag the plates and bases with respect to each spring to aid reinstallation.

Inspect the springs as described in Section Inspection and Repair.

Safety Chain



C204009

NOTE:

The safety chain pins may bind if bent or oxidised. If necessary, apply a suitable rust penetrating solution and drive out the pin using a drift. Severely bent pins can be removed by cutting the pin as close as possible to the lugs, then drive out the remainder using a drift.

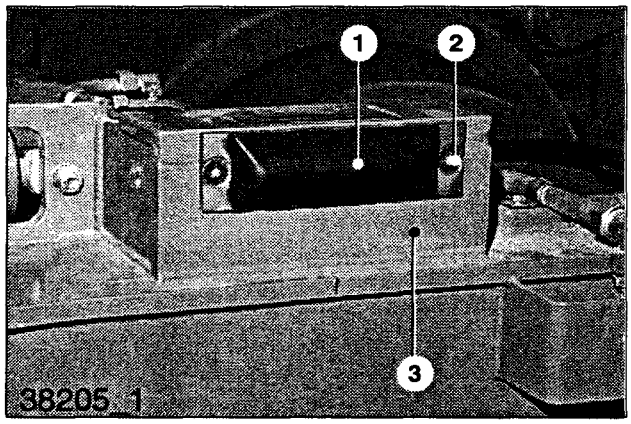
Undo the nut (1) and remove the washer (2) from the safety chain pin (4) at the locomotive underframe lugs (3). Discard the lock nut (1).

Hold the safety chain (5) to prevent it falling, then withdraw the pin (4) from the lugs (3).

Inspect the safety chain (5) and both pins (4) as described in Section Inspection and Repair. Replace if required.

Bump Stops

Lateral Bump Stops



Undo the bolts (2) securing the lateral bump stop pad (1) from the bogie frame web (3).

Remove the pad from the webbing.

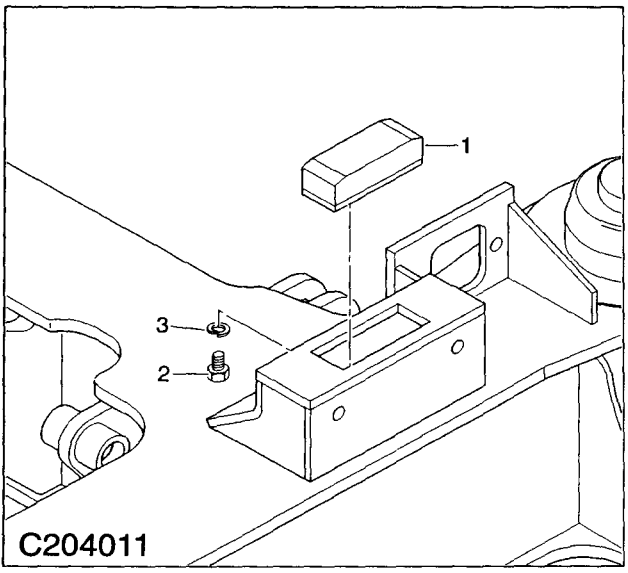
Repeat the procedure for the opposite side bump stop pad, if necessary.

Inspect the bump stop pads as described in Section Inspection and Repair. Replace if required.

Inspect the webbing on the bogie frame for evidence of wear as described in Section 2.00 Inspection and Repair. Rectify any faults found.

Vertical Bump Stops

The vertical bump stops are located on the locomotive under body directly above the bump stop webbing on the bogie.



From below the webbing undo the bolts (2) and washers (3) securing the vertical bump stop (1).

Lift the stop from the webbing.

Repeat the procedure for the opposite side bump stop pad, if necessary.

Inspect the bump stop pads as described in Section Inspection and Repair. Replace if required.

Inspect the underframe webbing for evidence of wear and rectify any faults found.

Disassembly

@1240

Disassembly of the hydraulic dampers is described in the Maintenance and Repair Handbook for KONI Adjustable Railway Dampers.

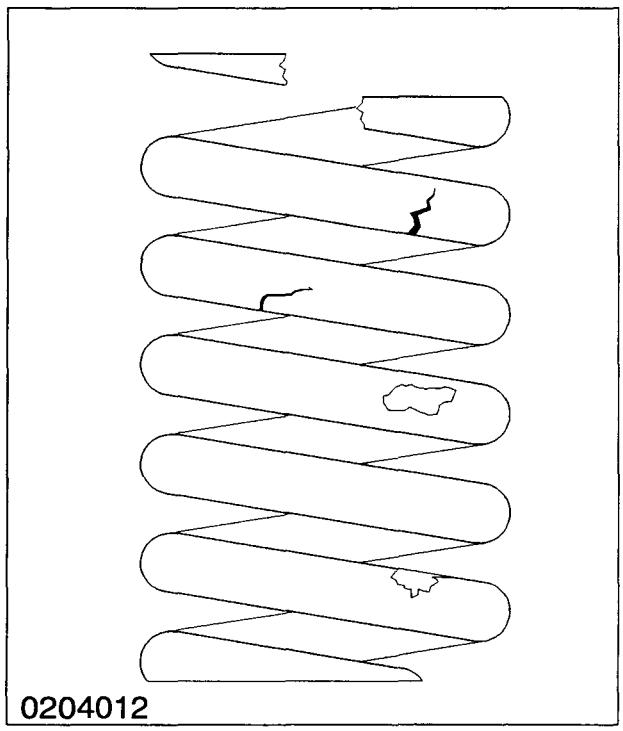
Inspection and Repair

@1250

Hydraulic Dampers

Inspection and repair of the hydraulic dampers are described in the Maintenance and Repair Handbook for KONI Adjustable Railway Dampers.

Secondary Suspension Springs



Inspect the springs for broken ends. Replace if damaged.

Inspect the springs for cracks or damage. Replace if damaged.

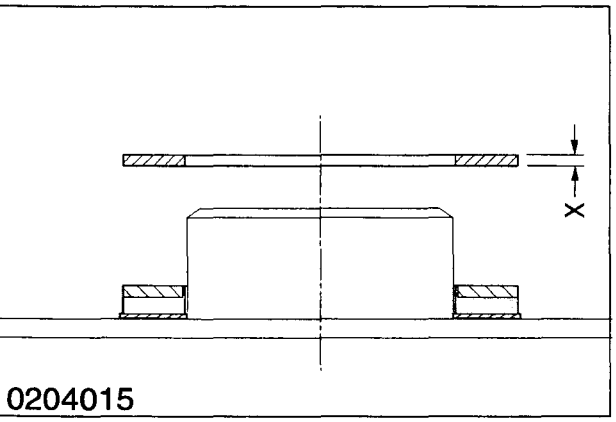
Check the surface of the springs for chipped paint or oxidation. Remove any oxidation and touch–up any chipped paint.

Measure the free height of the spring. Replace if below the specification described in Section Technical Data.

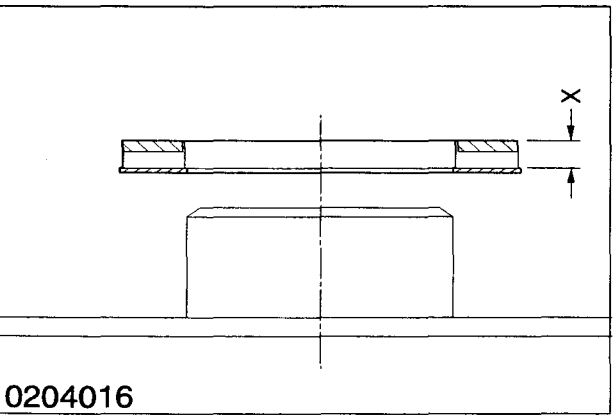
Position the spring in a spring testing fixture. Apply the loads in the following table and measure the spring height at each given load. Replace any springs not within specification.

SPRING CONDITION	DEFLECTION mm	SPRING HEIGHT mm	LOAD kN
Unloaded	0	733.2	0
Static load	158.2	575.0	96.8
Load at stop	195.2	540.0	118.2
Load at solid length	250.9	482.3	153.6

Compensating Plates & Insulating Pads



Check the compensation plates for wear, cracks or damage. Measure the plate thickness in four places 90º apart. Replace with identical plates if worn, damaged or cracked.



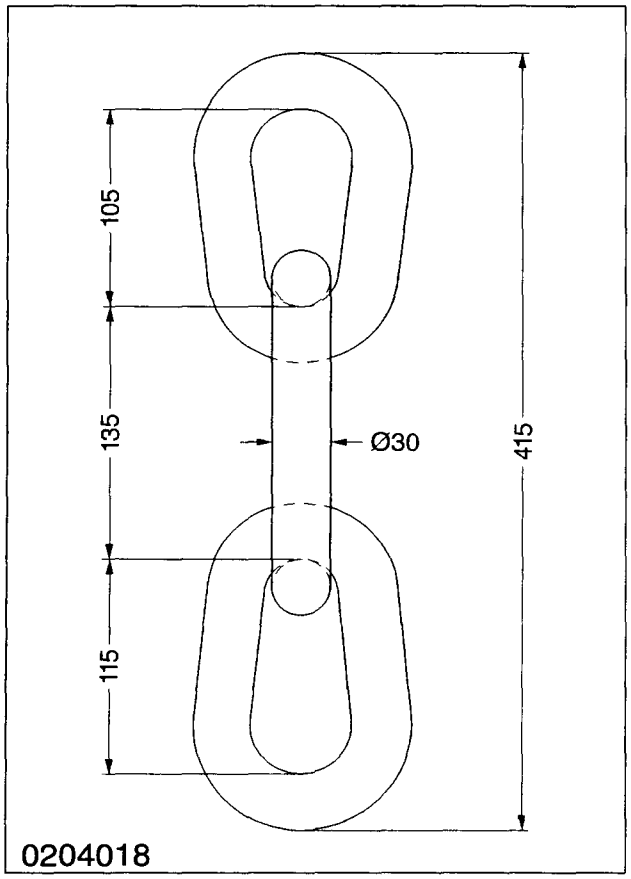
Inspect the insulating bases for wear, cracks or damage. Measure the thickness of the spring seat in four places 90º apart. Measure the thickness of the spring seat. Replace the base if worn, damaged or cracked.

Inspect the spring seats on the bogie frame and locomotive underframe. Check for cracks, damage or wear. Rectify any faults found.

Safety Chain

NOTE:

The top chain link is shorter then the lower link.



Inspect the end links of the safety chain in the pin contact areas. Replace the chain if cracked, damaged or if wear exceeds 2 mm.

Inspect the chain in the contact areas between the links. Repeat the procedure for all links on the chain. Replace the chain if cracked, damaged or if wear exceeds 2 mm.

Inspect the chain for signs of rust. Replace if required.

Pins

Inspect the pins for wear, damage or bend.

Inspect the condition of the thread. Repair the thread using a M36 thread chaser, if necessary.

Inspect the pin for wear. Replace the pin if the wear grooves exceed 2 mm in depth.

Inspect the pin for rust or surface oxidation. Remove oxidation using fine emery paper or replace if required.

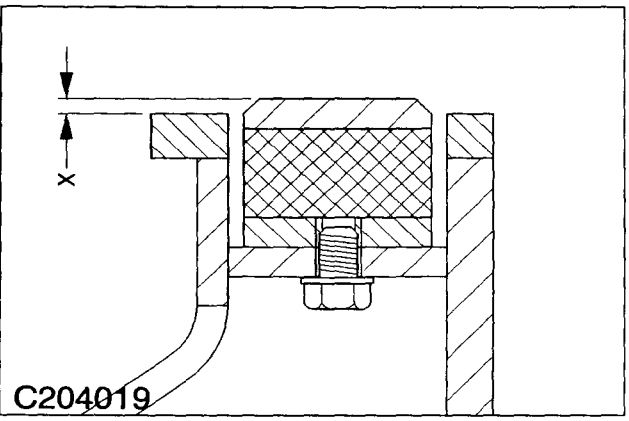
Inspect the condition of the lugs on the bogie frame and locomotive underframe. Refer Section 2.00 Inspection and Repair. Rectify as required.

Lateral Bump Stop

Inspect the condition of the rubber and pad. Replace if deteriorated or cracked.

With the stop installed, measure the thickness of the plate above the web. Replace if the wear plate is less than 2 mm thick.

Vertical Bump Stop



Inspect the condition of the plate. Replace if cracked or damaged.

Measure the thickness of the plate, Replace if below the specification in Section Tolerances and wear Limits.

Sanitation Parts/Operating Materials

@1260

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Assembly

01270

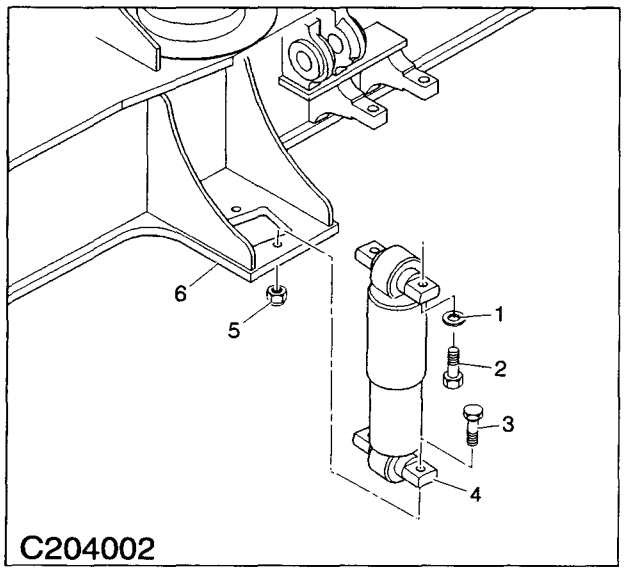
Assembly of the hydraulic dampers is described in the Maintenance and Repair Handbook or KONI Adjustable Railway Dampers.

Installation

@1280

Hydraulic Dampers

Vertical Dampers



Ensure the locomotive is supported by suitable safety stands and the wheels are chocked.

Position the vertical damper (4) between the bogie frame (6) and the locomotive underframe.

Check the damper (4) is correctly orientated with the smaller cylinder towards the bogie (6). Align the holes in the cross–pin and underframe.

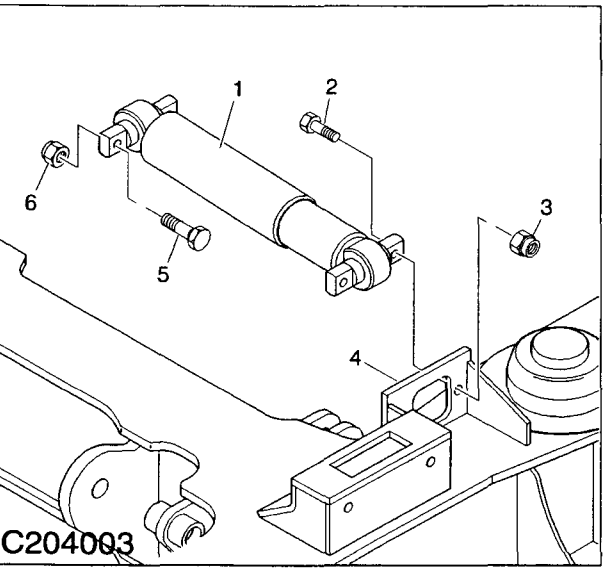
Install bolts (2) between the underframe and the damper (4) and torque to 192 Nm.

Ensure the cross–pin is correctly positioned on the upper face of the bogie frame bracket (6), then install the bolt (3) through the cross–pin and bracket (6).

Install the nut (5), then torque to 192 Nm.

Repeat the procedure for the other vertical damper on the bogie as necessary.

Lateral Dampers



Ensure the locomotive is supported by suitable safety stands and the wheels are chocked.

Position the lateral damper (1) between the bogie frame (4) and the locomotive underframe mounting bracket.

NOTE:

Correct orientation of the lateral damper is important. The damper has a "bottom" stamping and/or an identification plate on the side that MUST face towards the rail.

Check the damper (1) is correctly orientated with the larger cylinder towards the bogie centre line. Ensure the identification plate or "bottom" stamping faces towards the rail.

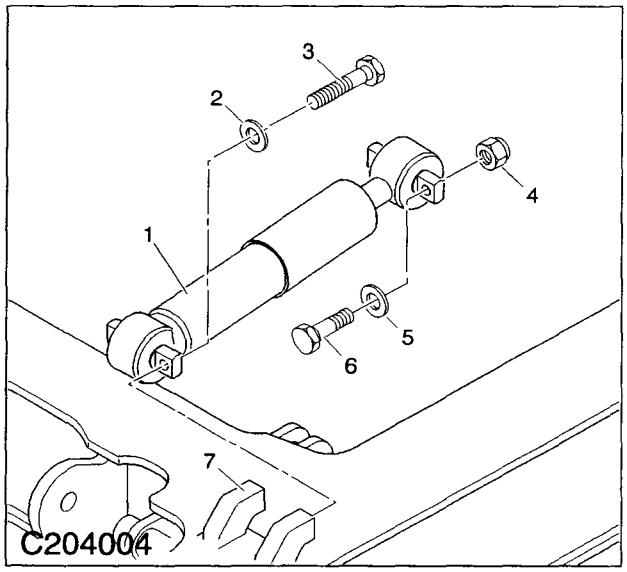
Align the holes in the cross–pin and bogie frame bracket (4), then install bolts (2). Install the nut (3) and torque to 192 Nm.

Ensure the cross–pin is correctly positioned on the inside face of the underframe bracket, then install the bolt (5) and washers through the cross–pin and bracket.

Install the nut (6), then torque to 192 Nm.

Repeat the procedure for the other lateral damper on the bogie as necessary.

Yaw Dampers



Ensure the locomotive and the wheels are chocked.

Position the yaw damper (1) between the bogie frame (7) and the locomotive under-frame mounting brackets.

NOTE:

Correct orientation of the yaw damper is important. The damper has a "bottom" stamping and/or an identification plate on the side that MUST face towards the rail.

Check the damper is correctly orientated with the smaller cylinder towards the bogie frame lugs (7). Ensure the identification plate or "bottom" stamping faces towards the rail.

Align the holes in the cross–pin and bogie frame bracket (7), then install bolts (3) and torque to 386 Nm.

Align the holes in the cross–pin and under-frame bracket, then install bolt (6) and washer (5) through the bracket and cross–pin.

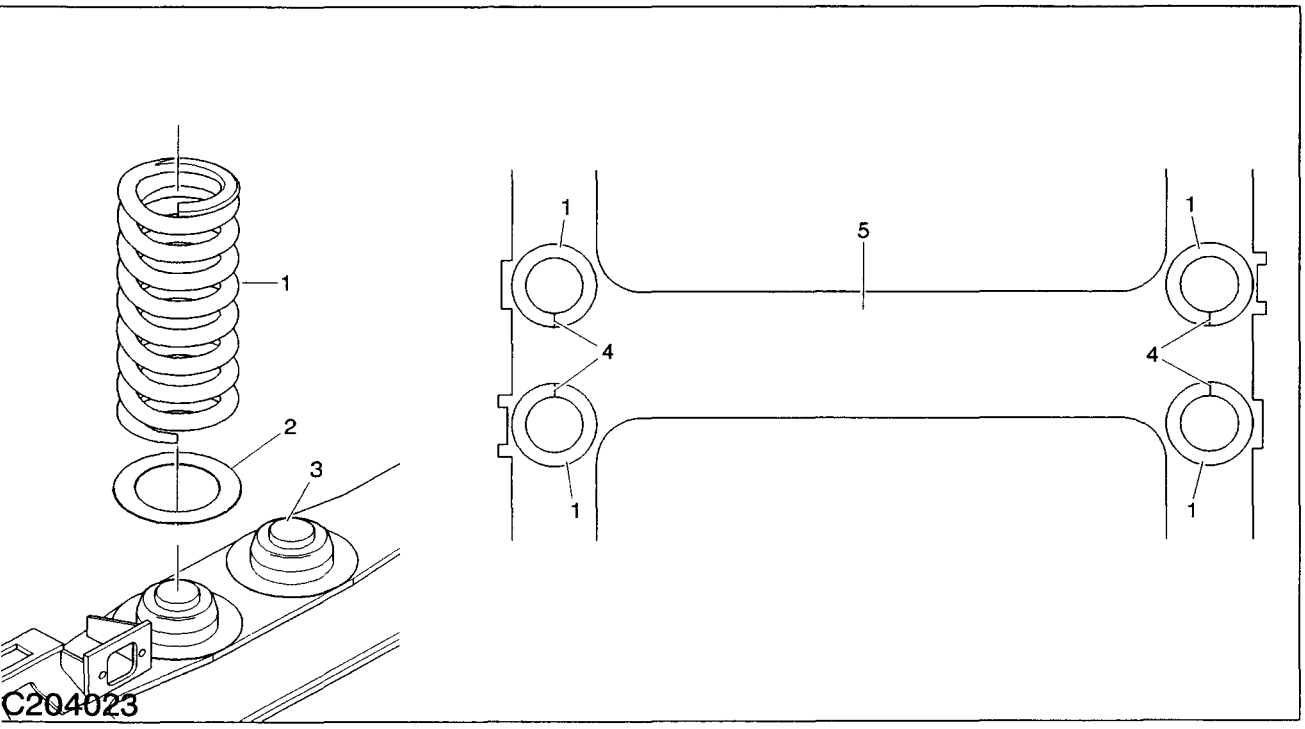
Install the nut (4), then torque to 385 Nm.

Repeat the procedure for the other yaw damper on the bogie as necessary.

Secondary Suspension Springs

All springs vary slightly due to the manufacturing process. In smaller springs this difference is generally negligible, but on larger springs, such as used on the WAG–9 suspension, small variations can have a marked impact on performance. WAG–9 locomotive springs are manufactured to exact standards, but variations between different batches do occur. Springs are marked with one or two aluminium bands during manufacture to identify the spring's tolerance range. All springs on the bogie must be within the same tolerance range. Do not mix springs with different numbers of aluminium bands on a bogie.

During the removal procedure the springs, insulating bases and compensation plates were tagged to identify their location, reinstall the suspension components into the same position from which they were removed. Whenever replacing a spring, always use a new spring with the same tolerance range as the other springs on the bogie.



Place the correct number of compensation plates (2) over the ends (3), refer compensation plates. The plates were tagged during the removal procedure reinstall the plates into the original locations. Whenever installing new plates the thickness must be equal to the plates removed during disassembly.

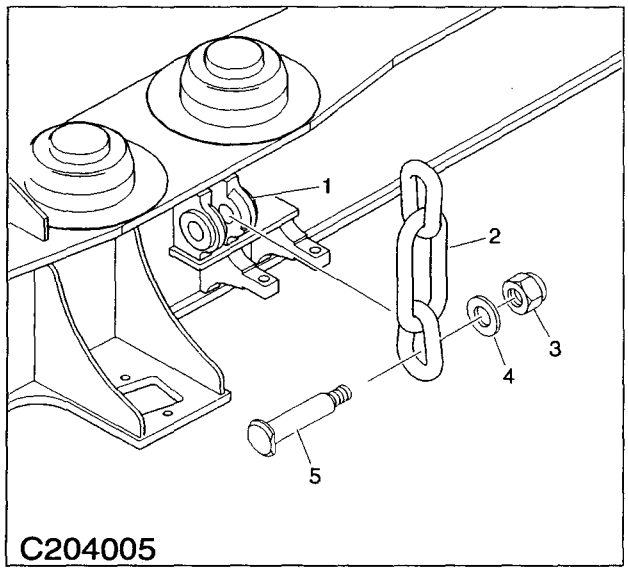
Install the springs (1) with the ends (3) of each spring facing one another at the centre line of the middle transom (5).

Carefully lower the locomotive. Ensure the springs are correctly seated on the bogie frame and locomotive underframe spigots.

Install the safety chain as described under Section 2.00 Removal Safety chain.

Install the dampers, then check and adjust, if necessary, the axle loading. Refer Section 2.00 After Installation Operation.

Safety Chain



C204005

Check the safety chains (2) and pins (5) are in good order.

Coat the pins (5) and mounting lugs (1) with a thin film of lubricant.

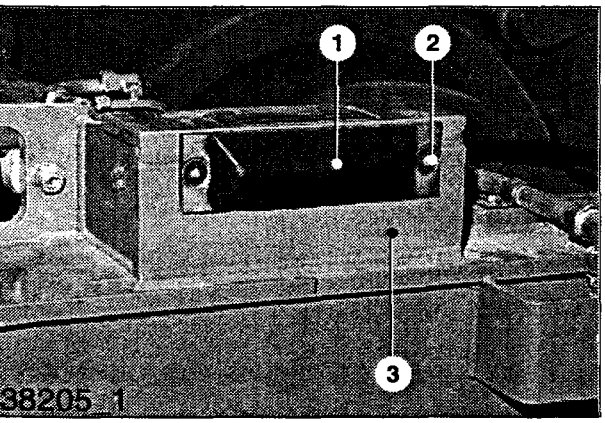
Position the chain (2) between the lugs on the underframe. The shorter link is connected to the underframe. The top link is 165 mm long, whereas the lower link is 175 mm long.

Insert the pin (5) through the lugs (1) ensuring the chain (2) is engaged.

Install the washer (4) and new lock nuts (3). Torque the nut to specification.

Bump Stops

Lateral Bump Stops

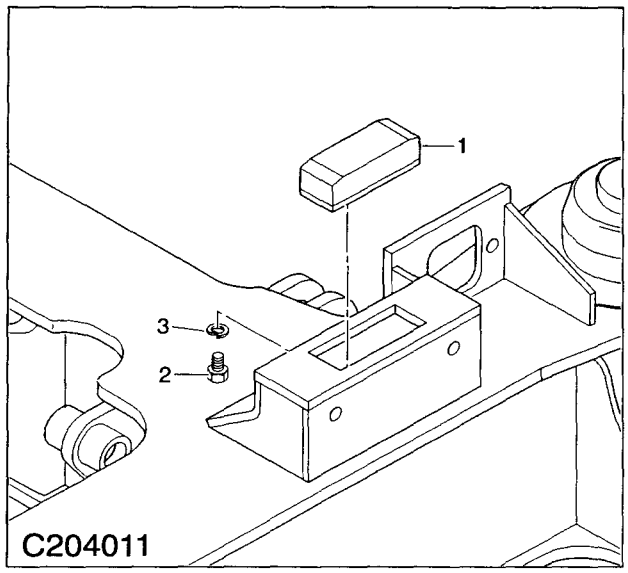


Position the bump stop (1) on the bogie frame web (3).

Install the screws (2) and torque to 80 Nm.

Vertical Bump Stops

The vertical bump stops are located on the locomotive under body directly above the bump stop webbing on the bogie.



Install the stop (1) into the bogie frame web recess.

Install the bolts (2) and washers (3), then torque to 80 Nm.

Check the stop protrudes above the webbing as described in Section Inspection and Repair.

Compensation Plates

NOTE:

Never install shims above the springs or weld the shims to the bogie frame of locomotive underframe.

The variations that occur in springs, described in SECONDARY SUSPENSION SPRINGS, and softening over time is offset by compensation plates (shims). The plates are always positioned between the spring and bogie frame. Springs are marked in production with one or two aluminium bands to indicate their tolerance range. Whenever installing new springs, place the number of 3 mm plates below the spring corresponding to the number of aluminium bands on the spring.

Both springs in a spring set (one side of one bogie) must be packed with an equal thickness of compensation plates. Plates are available in 2 different thicknesses; 3 and 5 mm.

Adjustment of the axle loads is described in Section 0200.

After–Installations Operations

.1290

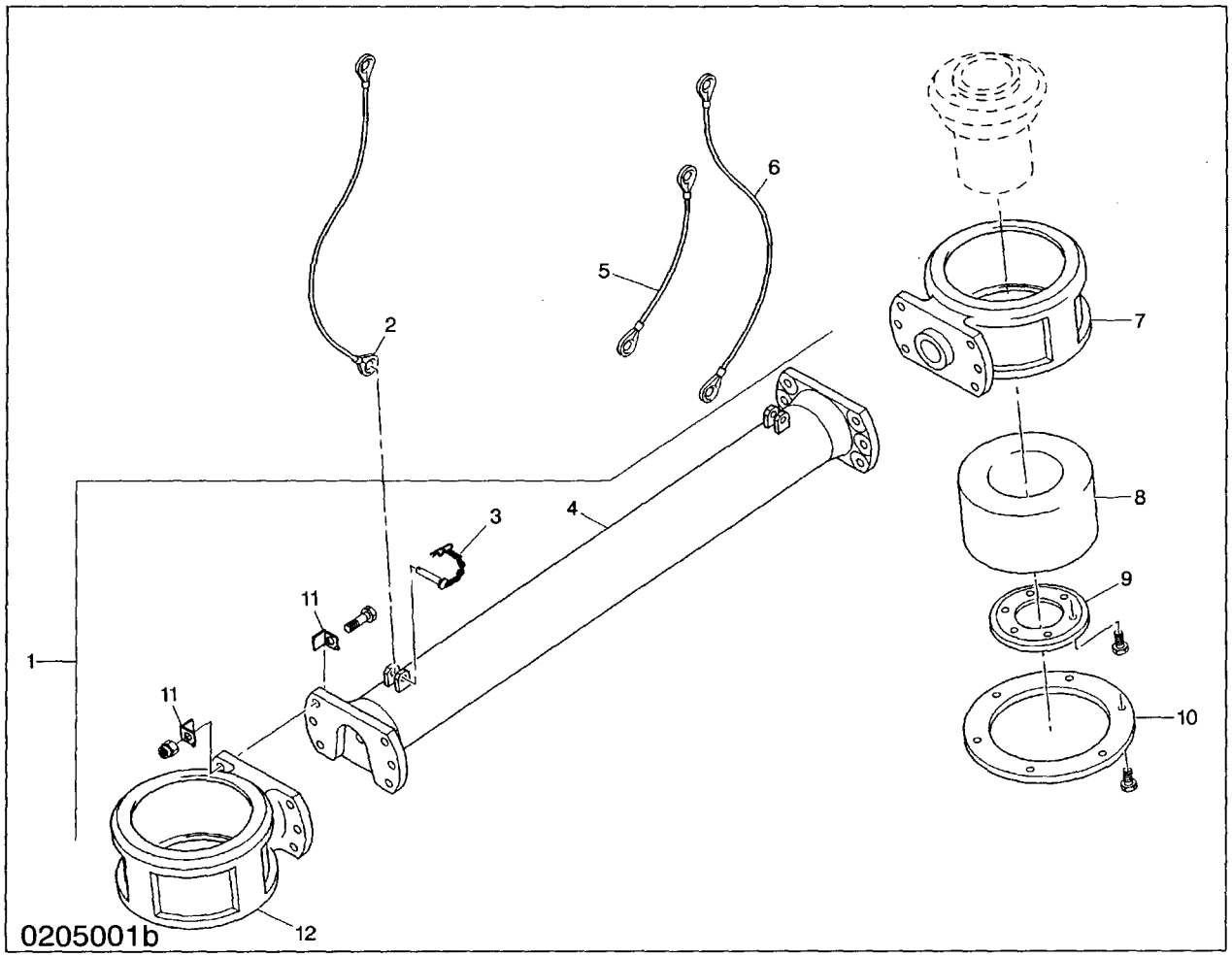
Not Required]

2.5 Traction Link

Group Summary

@1120

This chapter contains information regarding the traction link which consists of; link rod, pivot heads, ring and safety cables.



1	Traction link	7	Pivot head
2	Safety cable, bogie end	8	Ring
3	Chain	9	Inner retaining plate
4	Link rod	10	Outer retaining ring
5	Safety cable, short	11	Locking tab
6	Safety cable, long		

Functional Description

@1140

The traction link transmits traction and braking forces from the bogie to the locomotive superstructure (underframe). Although the traction link maintains the relative longitudinal position of the bogie to the locomotive underframe, it permits lateral movement between the two structures. The link rod is situated between two pivot points, one on the locomotive underframe, the other on the end transom of the bogie, permitting lateral movement but restraining longitudinal movement. Under normal conditions the rod is inclined at a 1:10 slope towards the centre of the locomotive underframe.

A pivot head, situated at each end of the link rod, has a ring of pliable material between the pivot post and head. The rings are secured to the pivot head by an outer retaining ring and a retaining plate bolted to the post.

The rod is symmetrical end to end and the pivot heads are identical and interchangeable between the bogie and underframe. The link rod is secured to the locomotive underframe by safety cables.

Technical Data

@1160

Link Rod

- Weight, assembled	46.7 kg
- Overall length	1,299 – 1,301 mm
- Tube diameter	133 mm
- Installed inclination	1 in 10
- Spigot diameter	80 mm

Ring

- Material	Aclanthan 2800
- Outside diameter	248 - 251 mm
- Inside diameter	149 - 151 mm
- Height	143 - 145 mm
- Weight	5.7 kg
- Radial deflection at 90 kN	5.0 - 6.4 mm

Outer Retaining Ring

- Outside diameter	320 mm
- Inside diameter	225.5 - 226.0 mm
- Thickness	16 mm

Inner Retaining Plate

- Outside diameter	184 mm
- Inside diameter	90 mm
- Thickness	16 mm

Pivot Post

- Diameter	160 mm
- Length	149.8 - 150.2 mm

Pivot Head

- Weight	31 kg
- Inside diameter	250 mm
- Bore length	150 mm
- Installed angle	5.71 °

Tolerances and Wear Limits List

@1170

Pivot Head

- Maximum inside diameter	251.5 mm

Tools and Special Tools

@1180

In addition to conventional railways workshop tools and equipment, the following tools are also required for the procedures described in this chapter:

- Fixed and portable presses for the removal and installation of some components.
- A special tool to install the pivot heads to the locomotive underframe or bogie. The tooling must be fabricated to ABB drawing VO1875118.
- M12 thread chaser

Miscellaneous Materials

@1200

Miscellaneous materials required for the procedures described in this chapter include:

- ALTEMP Q NB50 paste
- Glycerin, as lubricant.

Before Removal Operations

@1220

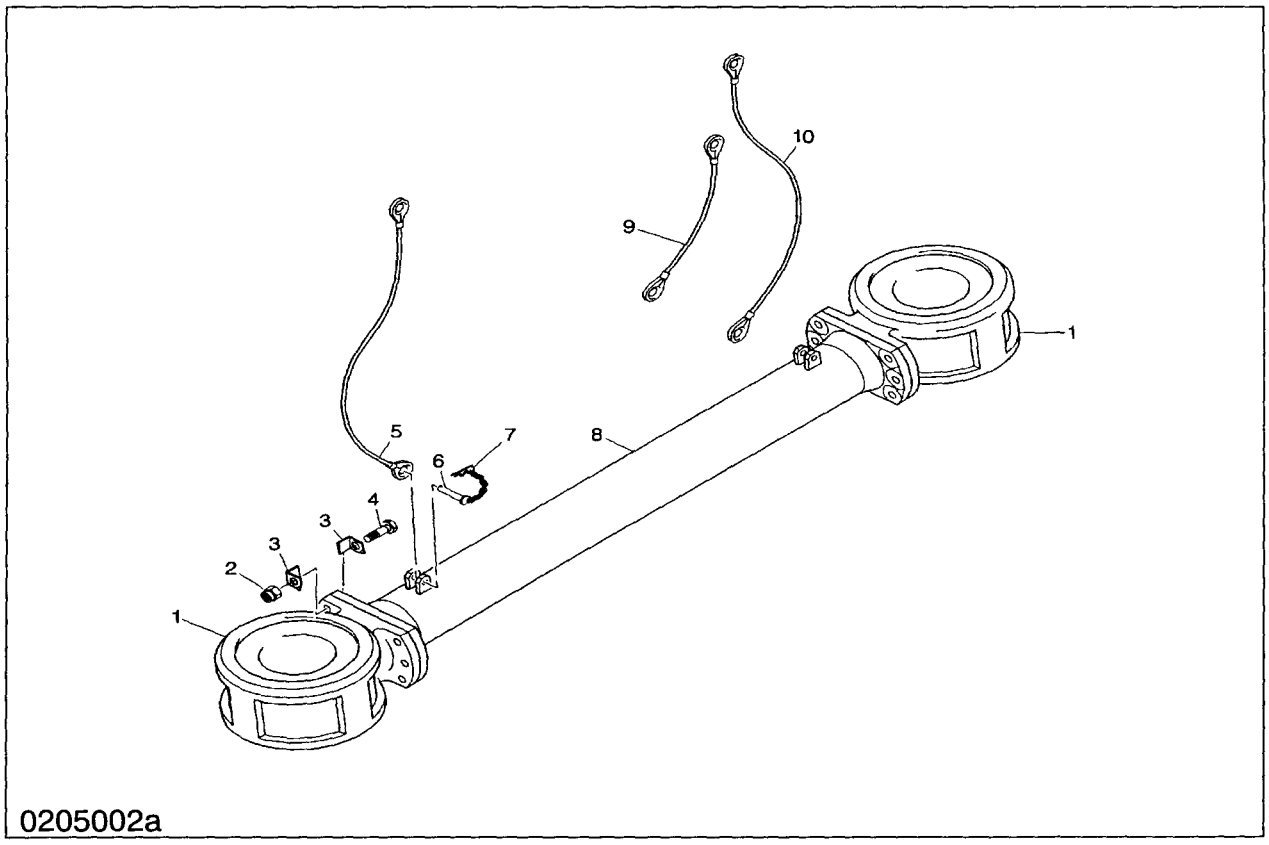
Steam clean the link rod and pivot heads and surrounding area. Remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of Volume D1, Maintenance and Repair. Damage to the components can result from improper application of the steam cleaning equipment.

Do not direct the spray stream into the axle box drain holes or into the traction motor ventilation openings.

Removal

@1230

Link Rod



0205002a

The link rod (8) must be disconnected before removal of the pivot heads (1).

Position lifting equipment under each end of the link rod (8) and raise to support the weight.

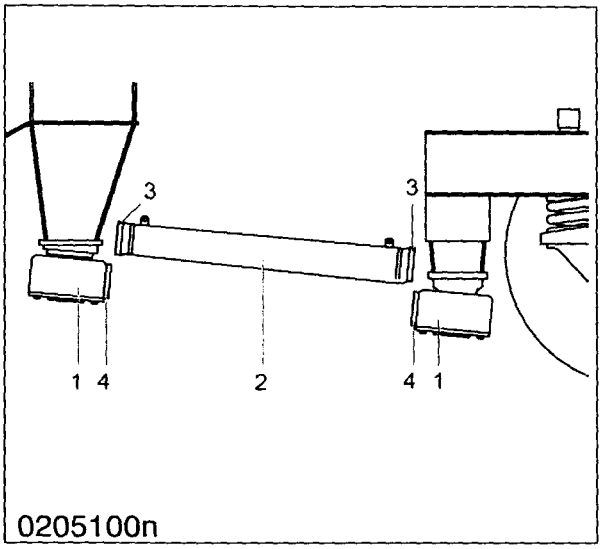
Withdraw the R-clip (7) from the safety cable pin (6). Then withdraw the pin (6).

Secure the safety cable (5) clear of the work area.

Repeat the procedure for the cable (9, 10) at the other end of the rod.

Bend open the locking tabs (3) on the bolts (4) and nuts (2) securing the link rod (8) to the pivot heads (1).

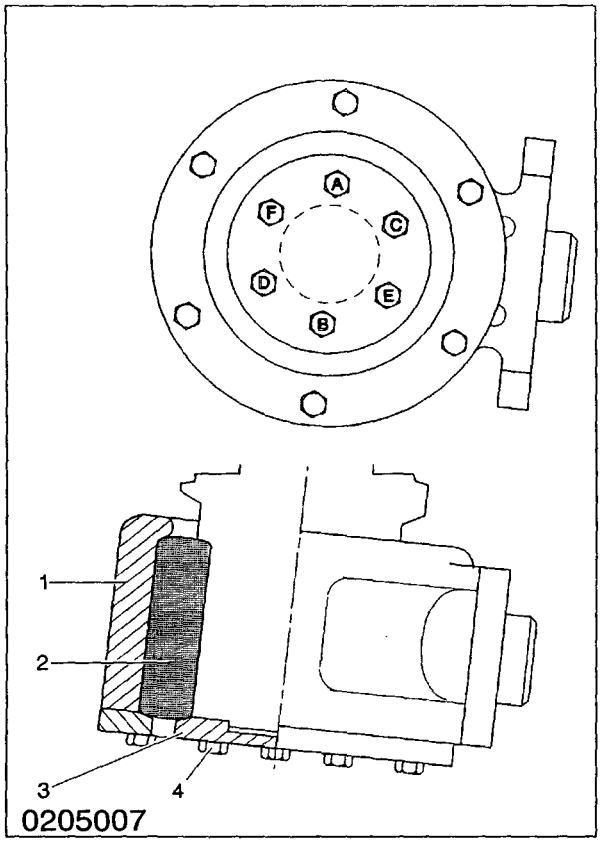
Remove the bolts (4), locking tabs (3) and nuts (2) on each side of the link rod (8) flange that secure the rod to the pivot heads (1).



0205100n

Evenly raise the lifting equipment until the flanges (3) are clear of the pivot heads (1). It is important to raise the rod (2) evenly to prevent the rod flanges (3) binding on the pivot head flanges (4).

Pivot Head



Remove the link rod as previously described.

Loosen the inner retaining plate bolts (4) approximately one turn in the following sequence; A, B, C, D, E, F.

Remove the retaining plate bolts (4) in diagonally opposed pairs.

Remove the inner retaining plate (3).

NOTE:

Do not use levers to remove the pivot head. Levers will cause damage to the pivot head or surrounding area.

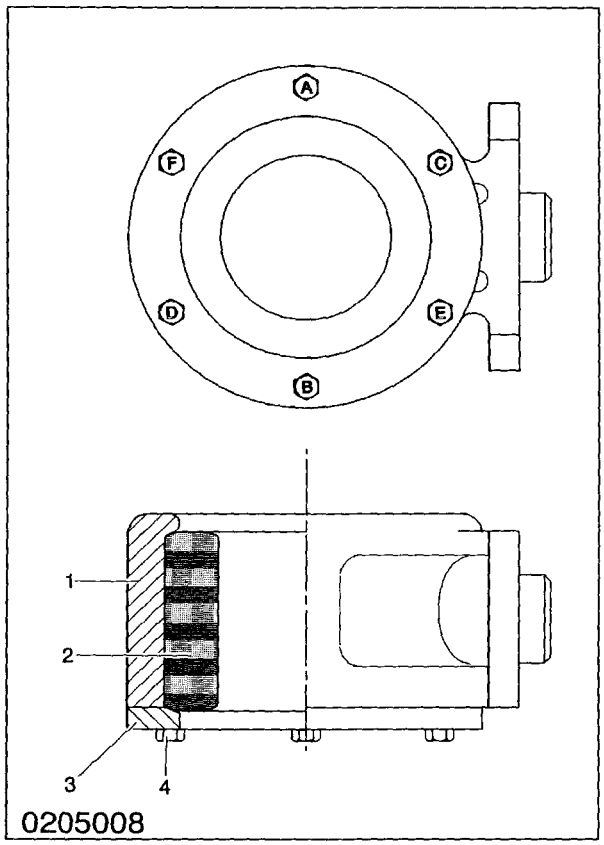
Secure suitable hydraulic pulling equipment and attachments to the pivot head (1) It is permissible for the hydraulic ram to press against the underframe, bogie frame or pivot post.

Carefully pull the pivot head (1) and ring (2) from the post. Support the head during the last phase of removal. The head is heavy and may move suddenly once the ring (2) is free of the post.

Disassembly

@1240

Ring



Loosen the outer retaining ring bolts (4) approximately one turn in the following sequence; A, B, C, D, E, F.

Remove the bolts (4) in diagonally opposite pairs.

Remove the retaining ring (3).

Position the pivot head (1) in a suitable press with supports below the flange. Allow sufficient clearance for the ring (2).

Press the ring (2) from the pivot head.

Inspection and Repair

@1250

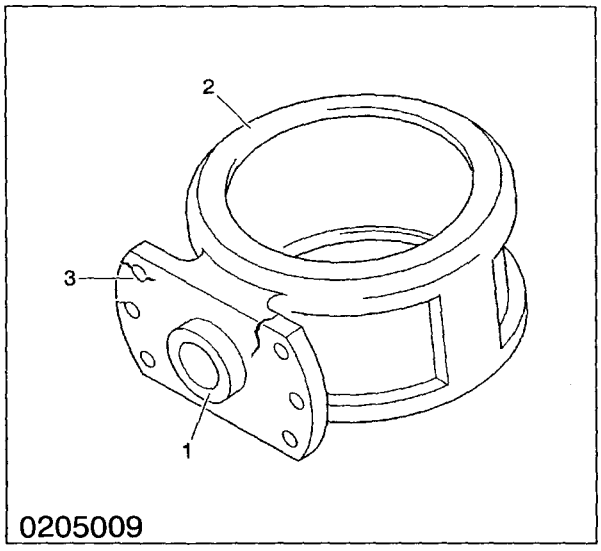
Ring

Clean and degrease the ring.

Inspect the condition of all surfaces of the ring for wear, damage, tears or cracks. Replace the ring if damage exceeds 10 mm in depth and for covers more than 10% of the surface area.

Check the ring material for deterioration. Replace the ring if deterioration is evident.

Pivot Head



0205009

Steam clean the pivot head (2); remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

Visually inspect the pivot head (2) for cracks, wear or damage, particularly around the bolt holes.

Inspect the flange for evidence of pitting. Small imperfections can be removed using fine emery paper.

Check the flatness of the flange (3). The flange (3) must be perfectly flat.

Test the pivot head for cracks, flaws or other discontinuities using ultrasonic or magnetic test equipment. Particular attention must be paid to the flange area. Sub-surface flaws that are not apparent during a visual inspection will show up as peaks or spikes or as a noticeable change in the magnetic flux in the output from the test equipment. Refer to the Preface of this Volume for more information on non-destructive testing techniques.

Inspect the condition of the threaded holes. Repair damaged threads using an M12 thread chaser.

Check the surface of the bore for pitting or scratches. Small imperfections can be removed using fine emery paper.

Measure the inside diameter of the pivot head. Check for out-of-round or taper. Replace the pivot head if the diameter is greater than the specification in Section Tolerances and Wear Limits List.

Remove any sharp edges and burrs from around the circumference of the bore using a honing stone.

Check the pivot head spigot (1) for wear. Measure the diameter and replace if below the specification in Section Tolerances and Wear Limits List.

Replace the pivot head if cracked, worn or damaged.

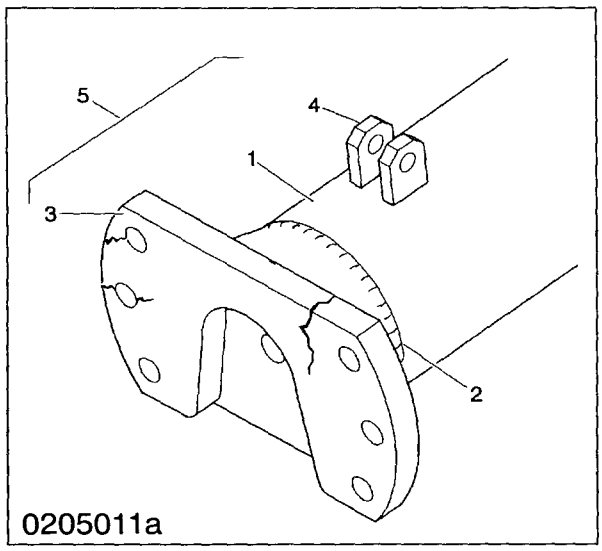
NOTE:

The face of the pivot head flange must not be painted.

Check the pivot head for chipped paint and oxidation. Remove any oxidation and touch-up any damaged paint, or repaint the head as necessary. Refer to Chapter 1.2, Exterior Finish.

Check the condition of the locking tabs. Replace the tabs if cracked, damaged or excessively bent. Flatten the ends of serviceable tabs for reuse.

Link Rod



Steam clean the link rod (5); remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

Check the flatness of the flange (3).

Visually inspect the link rod flange (3) for cracks, particularly around the bolt holes.

Visually inspect the safety cable lugs (4) for evidence of wear or cracks.

Test the link rod for cracks, flaws or other discontinuities using ultrasonic or magnetic test equipment. Particular attention must be paid to the flange and the weld (2) between the rod (1) and flange (3). Sub-surface flaws that are not apparent during a visual inspection will show up as peaks or spikes or as a noticeable change in the magnetic flux in the output from the test equipment. Refer to the Preface of this Volume for more information on non-destructive testing techniques.

Check the rod (1) for bend or damage.

Replace the link rod (5) if the flange (3), weld (2) or rod (1) is cracked, damaged or bent.

NOTE:

The face of the flange must not be painted.

Check the link rod (5) for chipped paint and oxidation. Remove any oxidation and touch-up any damaged paint, or repaint the rod as necessary. Refer to Chapter 1.2, Exterior Finish.

Safety Cable

Inspect the condition of the safety cable and chain. Replace if damaged or worn.

Inspect the cable for fraying. Pay particular attention to the area near the clevis.

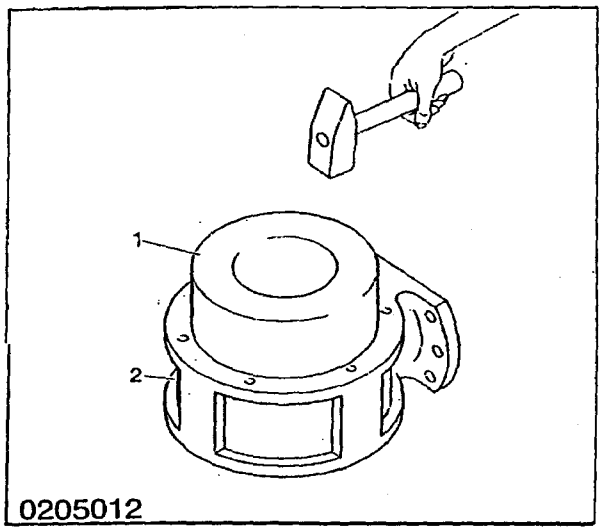
Inspect the pin for wear or damage, replace if required.

Check the condition of the clevis at each end of the cable. Replace the cable if worn or damaged.

Assembly

@1270

Ring



Remove all burrs from the edge of the pivot housing bore using a honing stone.

Remove any scratches from the bore of the pivot housing using fine emery paper.

Place the pivot head (2) on a clean bench with the lower side facing upwards.

Ensure the pivot head (2) bore is completely clean, free of all debris and foreign material.

Coat the entire surface of the pivot head (2) bore with glycerin.

Ensure the ring (1) surfaces are completely clean, free of all debris and foreign material.

Coat the entire outside surface of the ring (1) with glycerin.

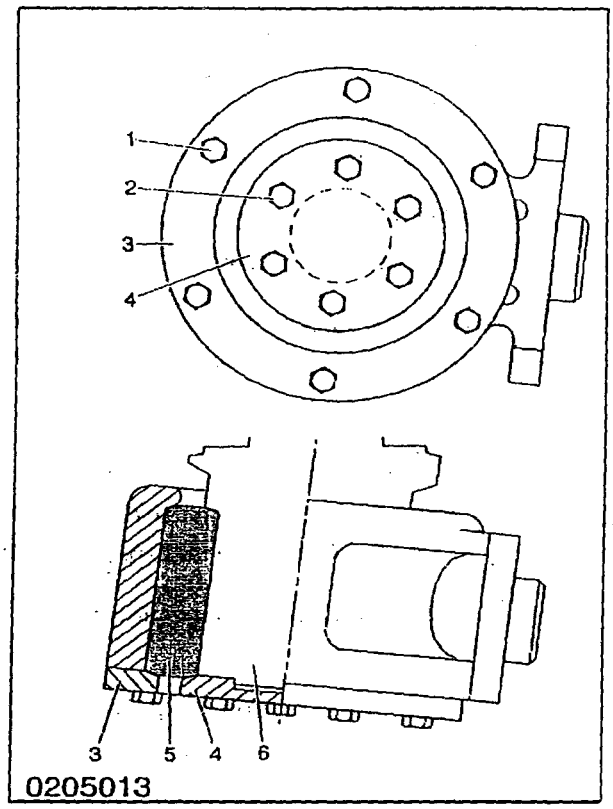
Position the ring (1) squarely on the pivot head (2).

Tap around the circumference of the ring (1) until ring is seated in the pivot head (2) using a non-marking hammer.

Installation

@1280

Pivot Head



Installation of the pivot head to the locomotive underframe or bogie frame is identical. It is advisable to work with the locomotive over a pit due to the clearance requirements of the press and tooling. When installing onto a bogie frame detached from the locomotive, it will be necessary to elevate the frame sufficiently to provide clearance for the tooling.

Ensure that the pivot posts (6) are clean and free of grease. If necessary, steam clean the posts and surrounding area, remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

Install the cone base from special tool VO1875118 on the pivot head. It is important that the cone base is concentric with the pivot posts (6).

Screw the cone onto the base of the special tool.

Install the ring (5) into the pivot head as described in Section Assembly.

Install special tool VO1875118 onto the pivot head.

Lubricate the pivot post (6) and the inside surface of the ring (5) with glycerin.

Position the pivot head and the pressing attachments below the cone.

NOTE:

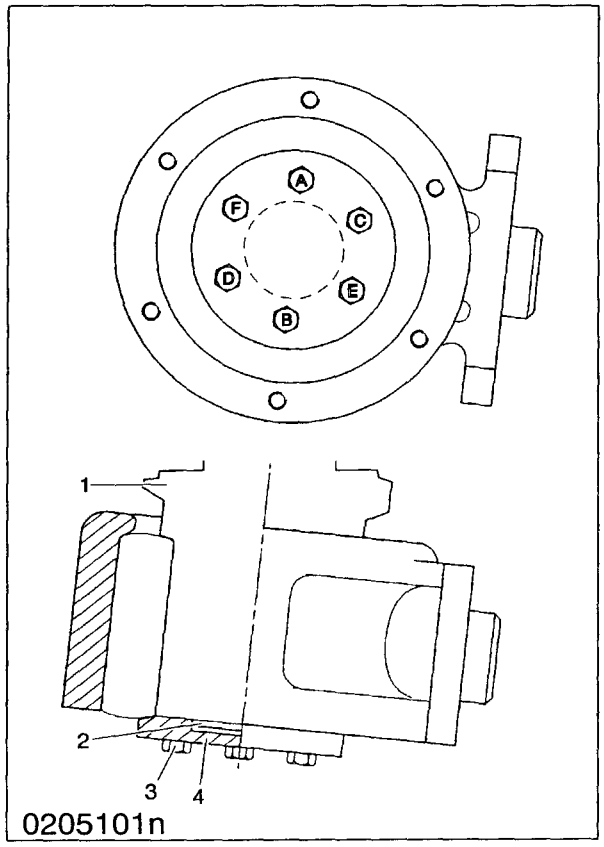
If the head is not correctly aligned, the ring (5) may be damaged during installation.

Ensure the pivot head is square and correctly aligned with the pivot post (6).

Install the lower plate and hydraulic cylinder from the special tool.

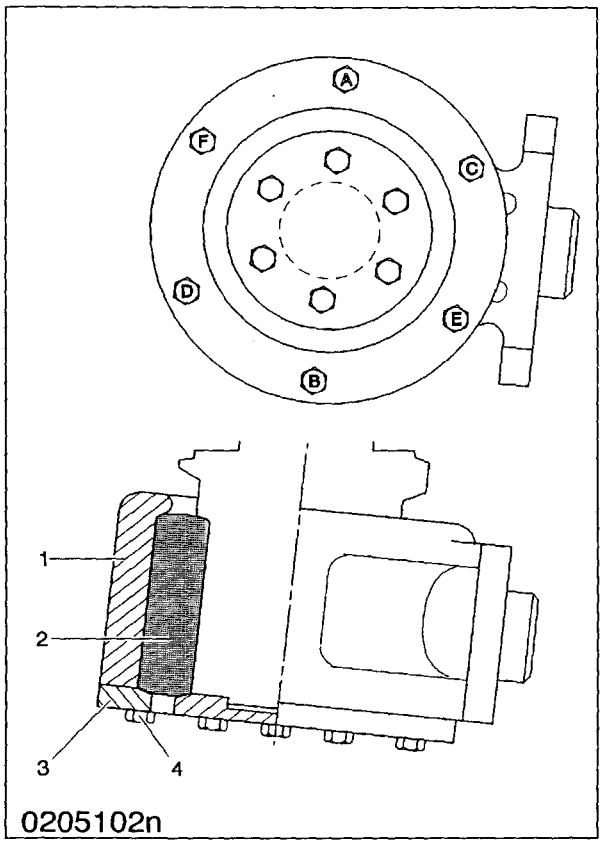
Press the pivot head into position. Do not allow the pressure to exceed 60 kN. If the pivot head is not installing correctly, lower the head and check the alignment of the components.

Dismantle and remove the installation tool.



Position the inner retaining plate (4) on the pivot post (1). Ensure the recess in the plate is correctly seated on the post spigot (2).

Install the retaining plate bolts (3), then progressively torque the bolts (3) in the following sequence; A, B, C, D, E, F to 80 Nm.

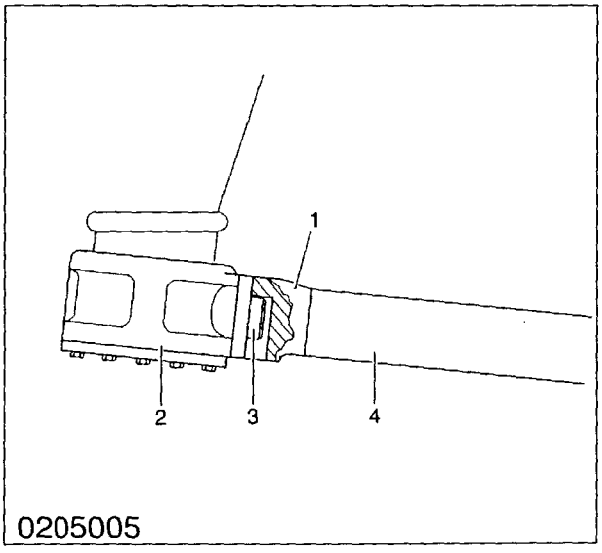


0205102n

Position the outer retaining ring (3) on the pivot head (1) with the bevel on the retaining ring (3) towards the ring (2).

Install the retaining plate bolts (4), then progressively torque the bolts (4) in the following sequence; A, B, C, D, E, F to 80 Nm.

Link Rod



0205005

The link rod (4) is symmetrical end to end and can be installed either way around.

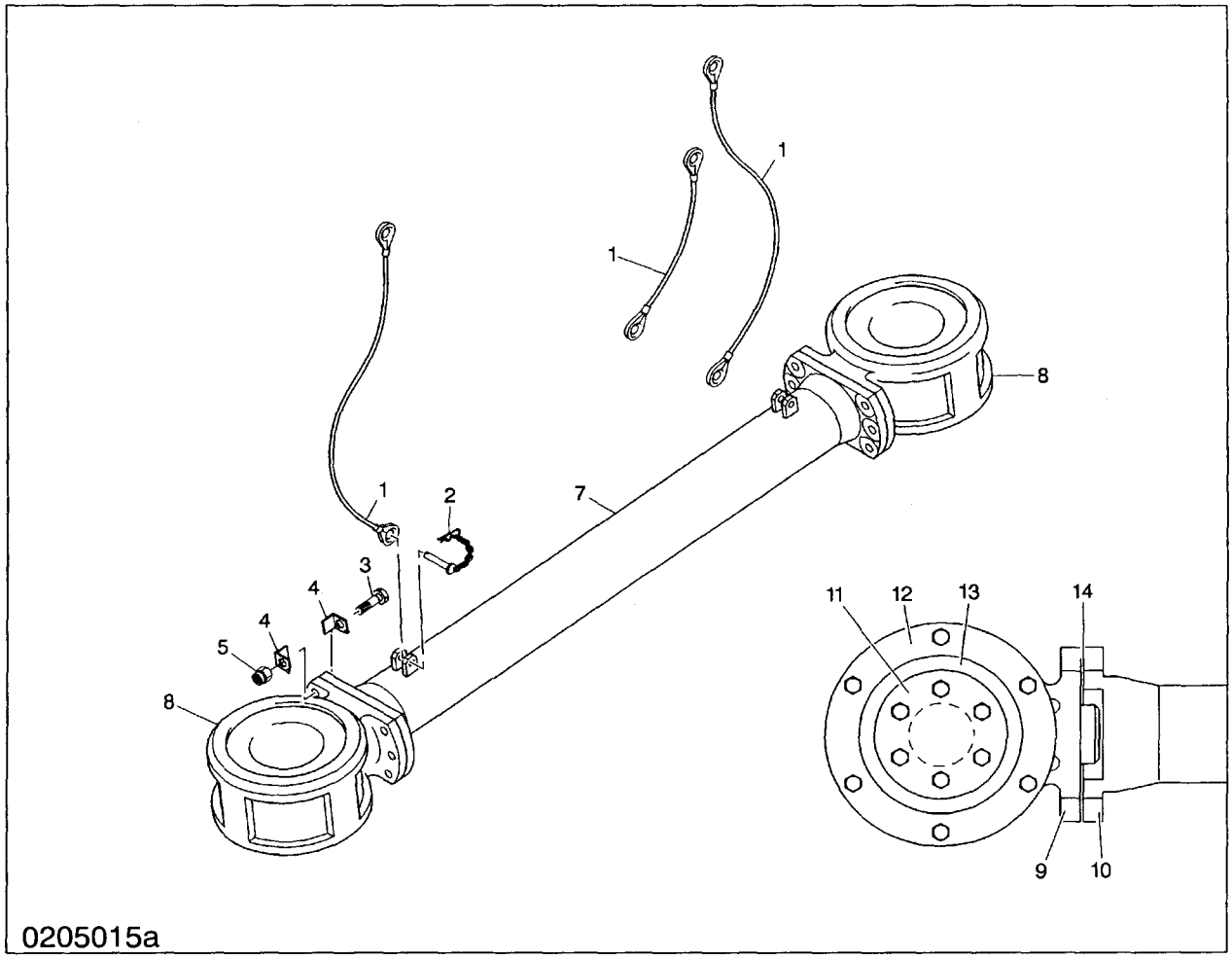
Ensure the flange surfaces (1) of the rod (4) and each pivot head (2) are clean and free from paint or other foreign material.

Apply ALTEMP Q NB50 paste over the entire surface of the link rod (4) and pivot head (3) flange faces. Completely coat the spigot (3) with paste.

Position the link rod (4), below the locomotive, using suitable lifting equipment.

NOTE:

The rod must be installed from above the pivot heads.



0205015a

Position the link rod (7) above the pivot heads (8) and align the pivot head spigot (14) with the recesses in the link rod flange (10).

Lower the rod (7) into position. Ensure the flanges (9,10) are kept parallel during installation to avoid binding.

Install the bolts (3) and locking tabs (4) through the link rod flange (10) and pivot head flange (9).

Install the locking tabs (4) and nuts (5). Torque the nuts (5) to 193 Nm.

Install the safety cables (1) and secure the R-clip (2).

Clean the area (13) between the retaining ring (12) and plate (11), then seal the gap (13) using ALTEMP Q NB50 paste.

Seal the gap (14) between the pivot head flange (9) and link rod flanges (10) with ALTEMP Q NB50 paste.

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2.6 Transmission

CAUTION:

Never operate or tow the locomotive when the transmission oil level is below the minimum mark.

General Notes On Hazards in the Work Area

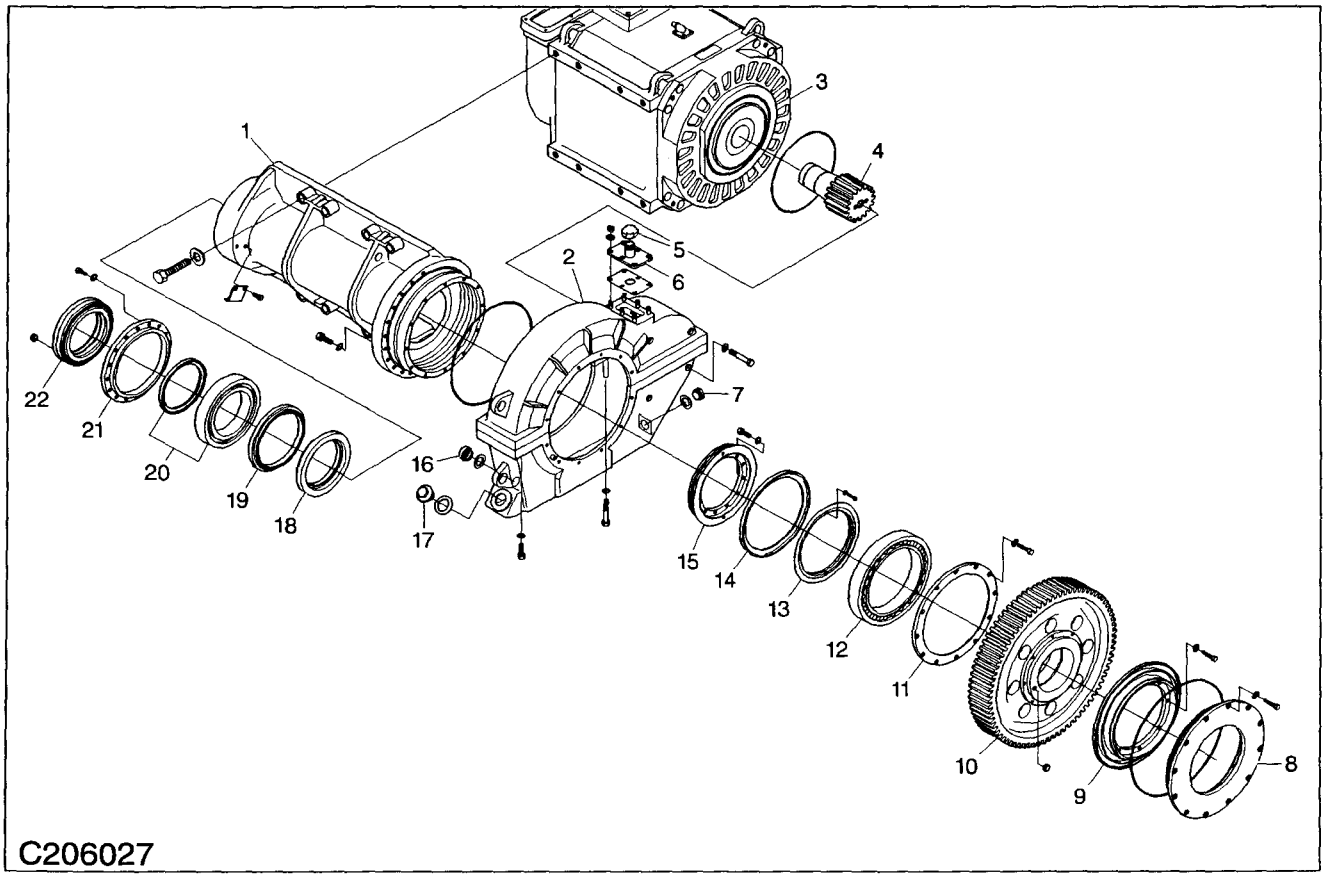
@.1040

WARNING:

Many of the components of the drive assembly are very heavy. Always use suitable lifting equipment to handle components.

Some components require to be heated for installation. Always exercise proper care and wear suitable protective clothing to avoid personal injury.

Group Summary



1	Suspension tube	12	Drive end bearing
2	Gear case	13	Labyrinth ring
3	Traction Motor	14	Labyrinth ring
4	Pinion gear	15	Labyrinth ring
5	Breather cap	16	Oil level gauge
6	Cover plate	17	Filler plug
7	Drain plug	18	Labyrinth ring
8	Labyrinth ring	19	Labyrinth ring
9	Labyrinth ring	20	Non–drive bearing
10	Main gear	21	Labyrinth ring
11	Supporting ring	22	Labyrinth ring

Functional Description

@.1140

[NOT REQUIRED]

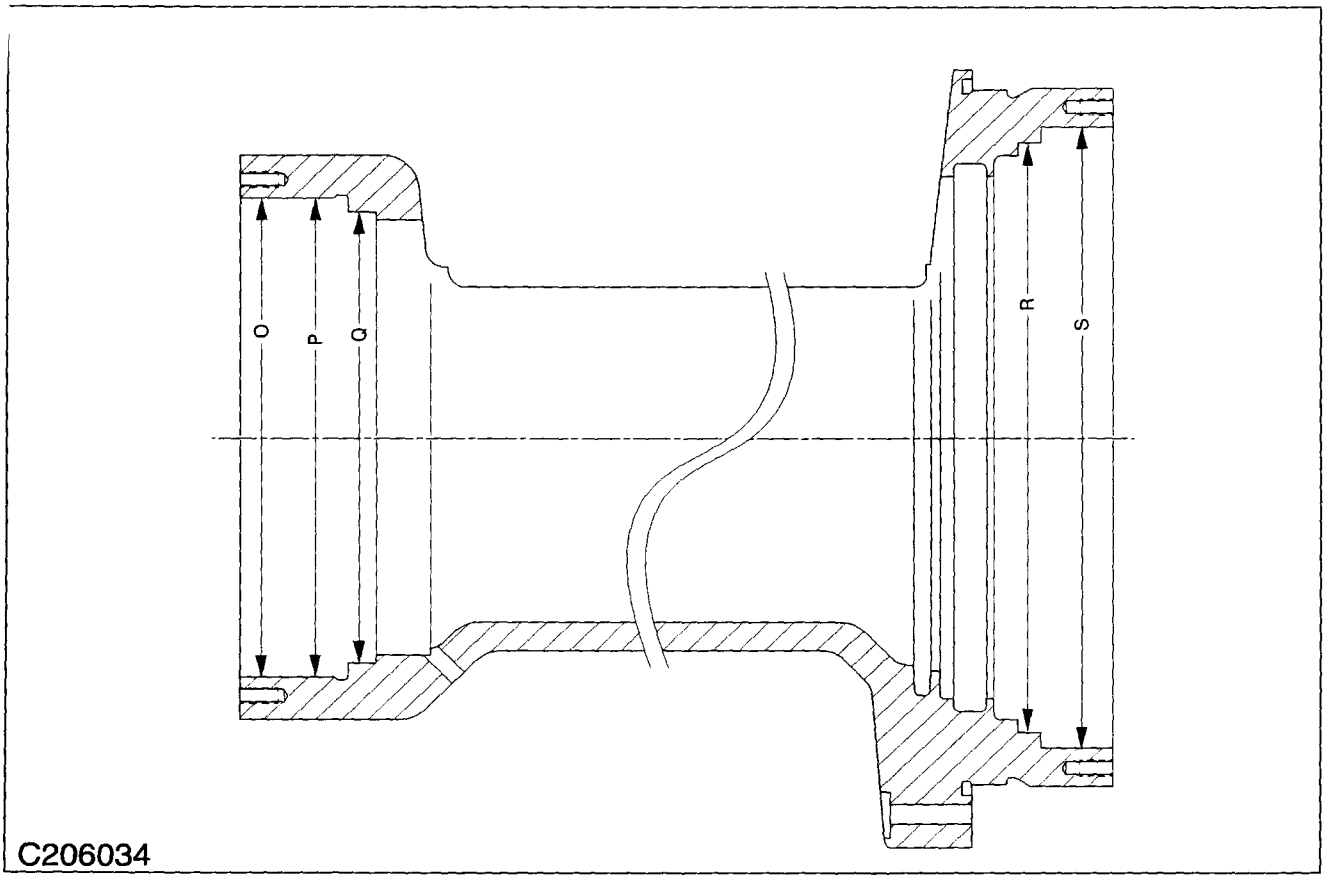
Technical Data

Labyrinth rings

– Labyrinth ring (9) inside diameter:	313.810 – 314.320 mm
– Labyrinth ring (8) inside diameter:	314.110 – 314.240 mm
– Labyrinth ring (21) outside diameter:	415.845 – 416.000 mm
– Labyrinth ring (22) outside diameter:	504.845 – 505.000 mm
– Labyrinth ring (13) inside diameter:	320.062 – 320.151 mm
– Labyrinth ring (14) inside diameter:	219.000 – 219.029 mm
– Labyrinth ring (15) seat outside diameter:	339.860 – 340.000 mm
– Labyrinth ring (18) outside diameter:	319.860 – 320.000 mm
– Labyrinth ring (19) inside diameter:	220.100 – 220.215 mm

Suspension Tube

@.1160



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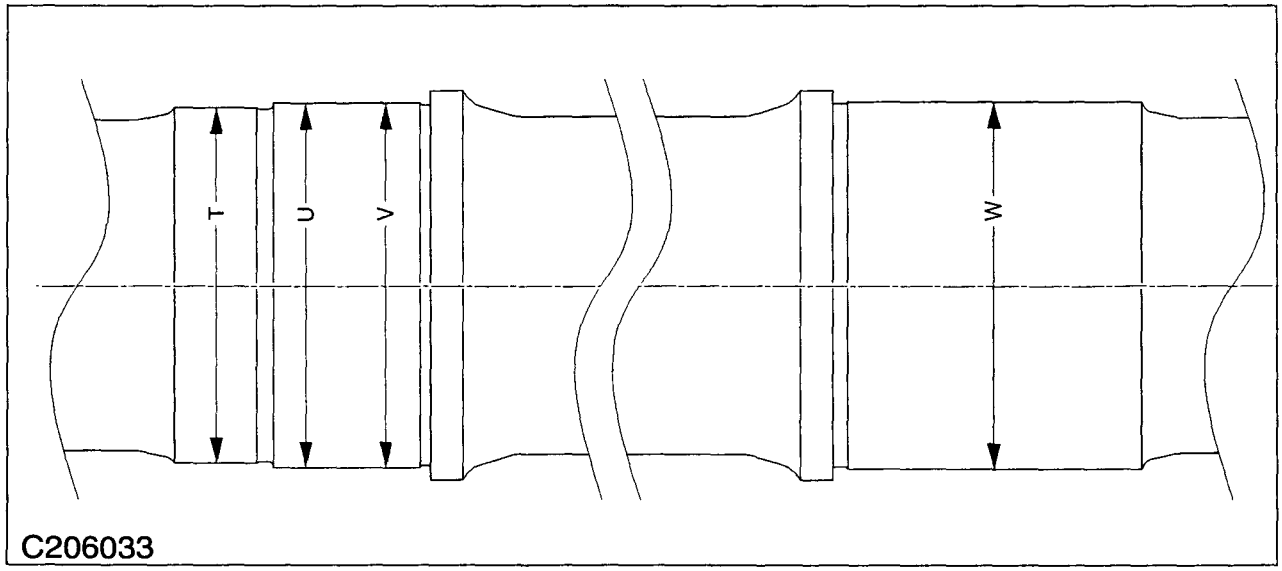
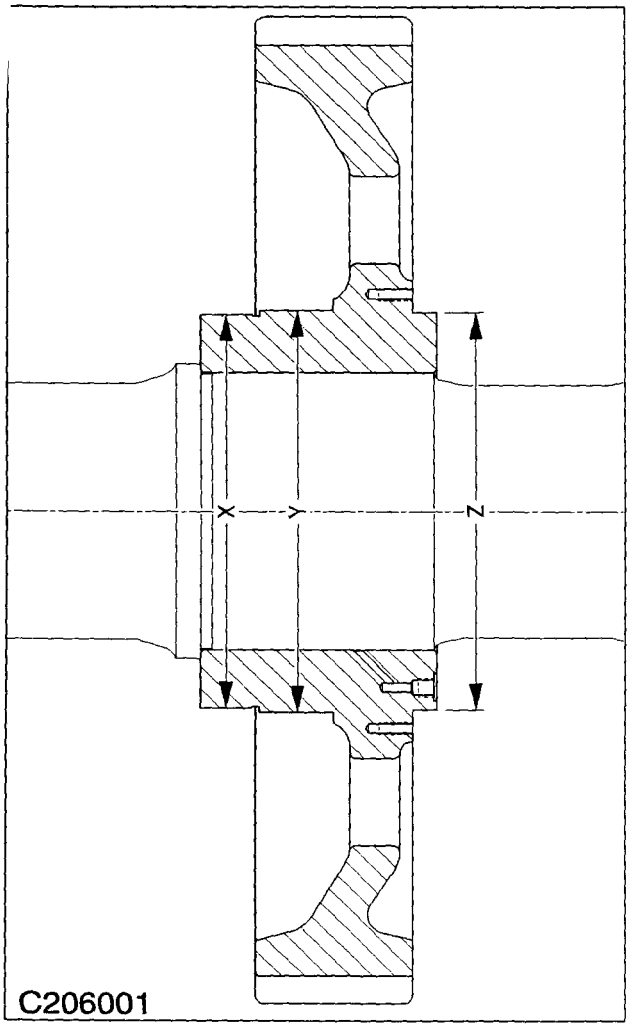
– Seat for labyrinth ring (O):	339.954 – 339–990 mm
– Seat for non–drive end bearing (P):	339.954 – 339.990 mm
– Seat for labyrinth ring (Q):	320.125 – 320.265 mm
– Seat for labyrinth ring (R):	416.135 – 416.290 mm
– Seat for drive end bearing (S):	439.950 – 439.990 mm

Axle Journals



– Labyrinth ring (T):	219.360 – 219.390 mm
– Non–drive end bearing (U):	220.000 – 220.029 mm
– Labyrinth ring (V):	220.000 – 220.029 mm
– Drive gear (W):	219.360 – 219.390 mm

Main Gear Journals



– Labyrinth rings (X):	313.968 – 314.000 mm
– Drive end bearing (Y):	320.062 – 320.087 mm
– Labyrinth ring (Z):	319.860 – 320.000 mm

Non–drive End Bearing

– Manufacturer:	FAG
– Model:	FAG NJ.1044.566 185
– Outside diameter (nominal):	340 mm
– Inside diameter (nominal):	220 mm
– Width (nominal):	56 mm
– Thrust collar model:	FAG–HJ 1044.F55

Drive End Bearing

– Manufacturer:	FAG
– Model:	FAG NU1964 MIA.C4
– Outside diameter (nominal):	440 mm
– Inside diameter (nominal):	320 mm
– Width (nominal):	56 mm
– SKF Equivalent:	NU1964ECMA/C4VA327

Tolerances and Wear Limits List

@.1170

– Non–drive end bearing axial end play:	0.25 – 0.48 mm
– Labyrinth ring to the main gear hub:	0.1 – 0.8 mm
– Main gear to suspension tube:	44.65 – 45.60 mm

Tools and Special Tools

©.1180

Normal workshop tools; including overhead lifting equipment, a railway wheel press, induction and flame heating equipment.

NOTE:

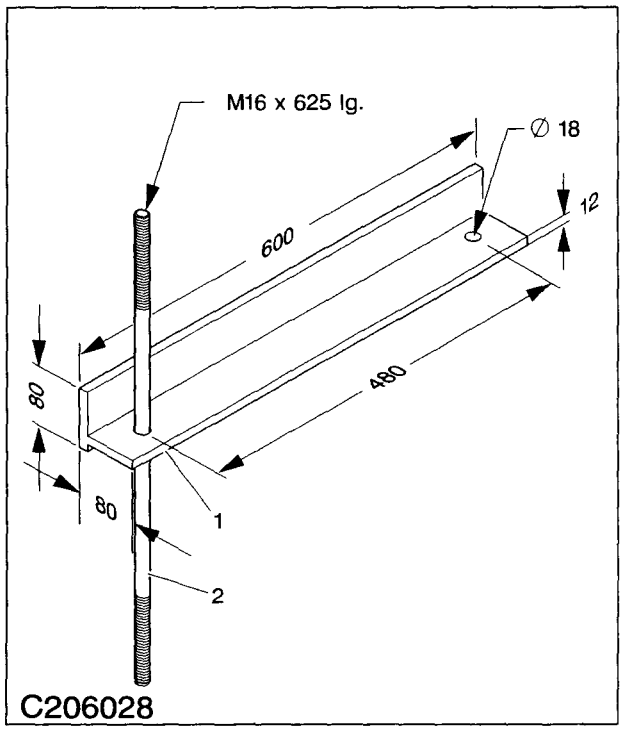
Special tools or kit specifications and contents may vary according to the availability from the supplier. Consult the supplier for the latest specifications.

Floating off of labyrinth ring

Thyssen Henschel provides a special oil injection tool kit for "floating off" interference fit components. The kit form comprises: oil injector, adaptor block, high pressure hose (3/4 – 1/4 inch BSP), connection nipples (1/4 to 1/8, 1/4 to 1/2, 1/4 to 3/4 inch BSP) and pressure gauge (0 – 300 Mpa).

– Supplier:	Thyssen Henschel
– Suppliers Special Tool No.:	729101B

Axle Shaft Pulling Tool



Fabricate the following parts of the axle shaft pulling tool to disassemble the axle shaft from the suspension tube.

Part 1	Angle steel, 80 x 12 x 600 mm. Drill two 18 mm diameter holes 480 mm apart symmetrically from the ends
Part 2	Threaded rods, M16 x 625 mm

Miscellaneous Materials

@.1200

Recommended Bearing Lubricant

– Lubricant brand:	Optimol
– Lubricant type:	Longtime PD2 grease

Recommended Transmission Lubricant

– Lubricant brand:	Optimol
– Lubricant type:	Optigear 220 oil

Other

- Thermocup 1200, or equivalent paste
- Suitable thread sealant
- Plastseal, or equivalent sealant
- Wooden spacers 3 mm thick

Before–Removal Operations

@.1220

[NOT REQUIRED]

Removal

@.1230

[NOT REQUIRED]

Disassembly

@.1240

Suspension Tube

NOTE:

Drive assembly and bearings are precision components. Use care whenever handling to avoid damage. Care must be taken to ensure the bearings are kept clean and free of foreign material at all times. After removing drive assembly components store them on cardboard or wood and cover to prevent damage or contamination with foreign material.

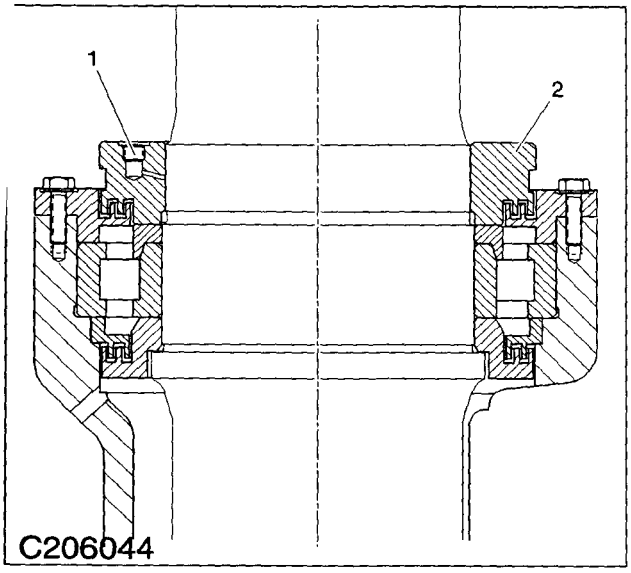
Remove the bogie from the locomotive as described in Chapter 2.00 Bogies & Running Gear, Section Removal.

Remove the wheelset from the bogie as described in Chapter 2.02 Wheelset, Section Removal.

Dismount the traction motor from the suspension tube as described in Chapter 4.04 Traction Motor, Section Removal.

Remove the wheel from the non–drive end of the axle shaft as described in Chapter 2.02 Wheelset, Section Disassembly.

Remove the gear case as described in Chapter 4.04 Traction motor, Section Removal.



Dismounting of the labyrinth ring (2) is achieved by "floating off" using hydraulic pressure and a suitable bearing puller tool. The procedure uses pressurised fluid to separate the interference fits between the cylindrical surfaces of the labyrinth ring (2) and axle journal. An oil gallery is located within labyrinth ring (2) for "floating off" the ring from the axle using hydraulic pressure. Once the hydraulic pressure exceeds the pressure created by the interference fit, an oil film builds up between the contact areas. The film reduces friction between the surface. The parts can easily be displaced without scoring the mating surfaces.

The gallery is sealed with a screw plug (1) to prevent the ingress of foreign material.

NOTE:

Do not remove the oil gallery plug (1) until just prior to removing the labyrinth ring (2).

Assemble the high pressure pipe, oil injector and pressure gauge to the injector attachment. Dip the injector nozzle into pure mineral oil, Shell Hypoid GX or equivalent.

Fill the oil feeder with oil. Hold the nozzle upwards and depress the valve slightly to bleed the air while filling.

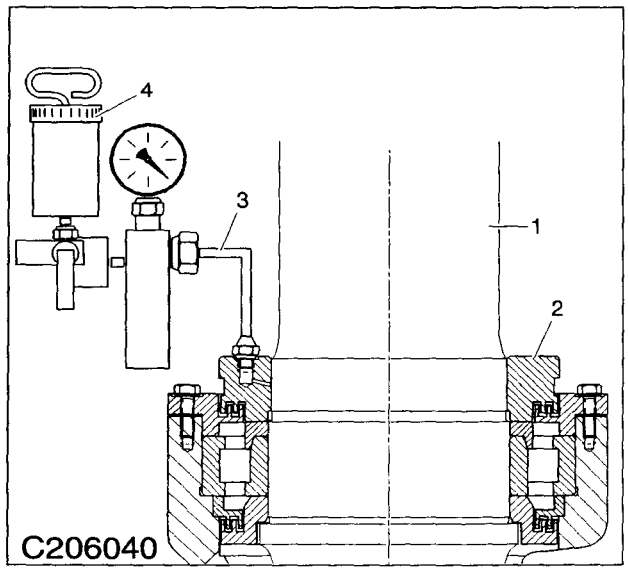
Attach the feeder to the oil injector, then open the valve.

Operate the pump handle until clean oil, free from air, is expelled from the high pressure pipe. Close the valve.

NOTE:

The work area, joint surfaces and oil gallery must be completely clean; free of all swarf, dirt and other contaminates. Entry of foreign material to the oil gallery will damage the axle journal or labyrinth ring (2).

Clean around the plug (1) using compressed air. Ensure that no dirt or debris is located near, or around the plug. When the area around the plug is completely clean, remove the plug (1) from the labyrinth ring (2).



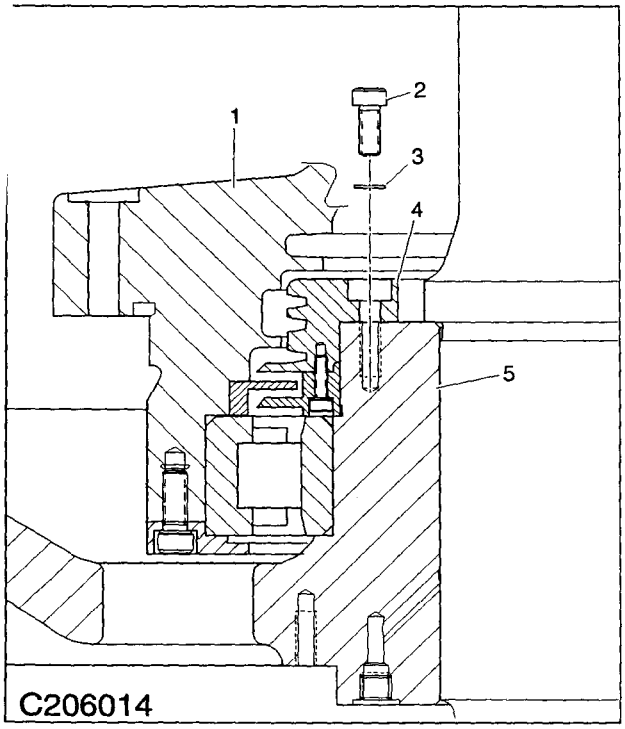
Connect the high pressure hose (3) to the labyrinth ring (2) using suitable adaptors.

Slowly pump the injector (4) until oil exudes at the joint between the labyrinth ring (2) and axle shaft (1). The oil needs some time to fill the gallery and seat. Trying to pull off the labyrinth ring (2) too soon will damage the labyrinth ring (2) or axle journal.

Slowly pull the labyrinth ring (2) from the axle using a suitable bearing puller. Sufficient oil is trapped within the seat for removal. Keep the pressure constant until the ring is removed.

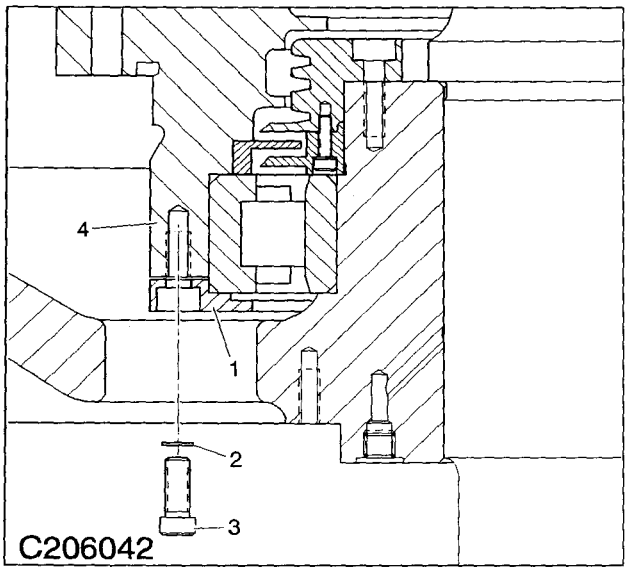
NOTE:

Do not interrupt the pressing–off of the labyrinth ring. Stopping or pausing will cause the oil film to leak away from the contact surfaces.

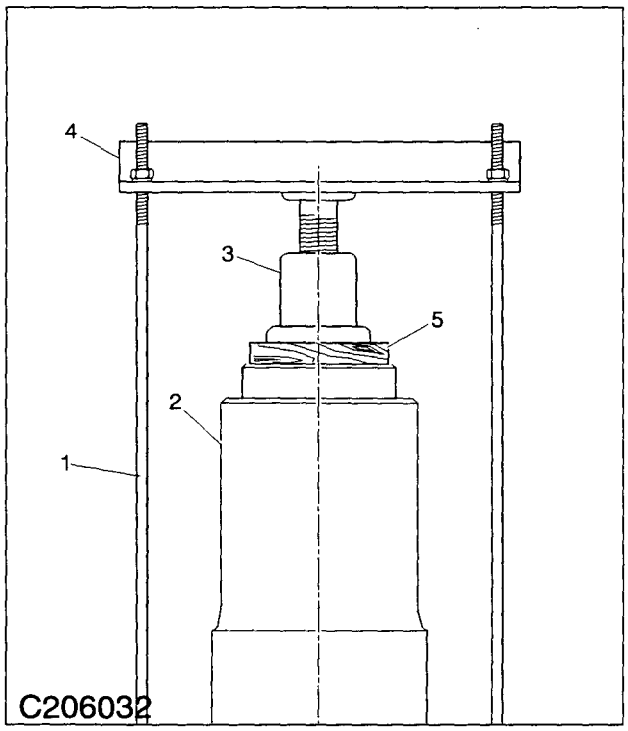


Stand the suspension tube (1) vertically with the non–drive end facing upwards. Support the axle using suitable overhead lifting equipment.

Remove the bolts (2) and washers (3) securing the labyrinth ring (4) to the main gear hub (5). Rotate the suspension tube (1) as necessary to gain access to the bolts through the opening.



Remove the socket head bolts (3) and washers (2) securing the supporting ring (1) to the suspension tube (4)



Insert the threaded rods part (1) of axle puller tool (refer Section Special Tools) into the suspension tube non–drive end flange.

Place a suitable wooden packer (5), approximately 15 mm thick on the end of the axle shaft (2).

Position a suitable hydraulic jack (3) on the wooden packer (5), then position angle part (4) of the axle puller tool (refer Section Special Tools) on top of the jack (3). Ensure the threaded rods (1) pass through the drilled holes in part (4).

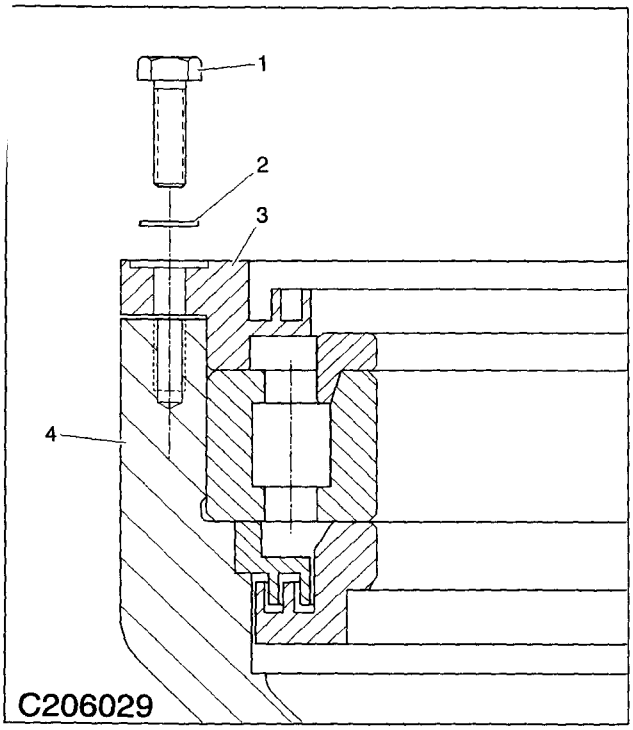
Install suitable M16 washers and nuts on the ends of the threaded rod (1), then tighten the nuts finger tight.

Raise the lifting equipment until the axle is approximately 30 mm above the floor or work bench.

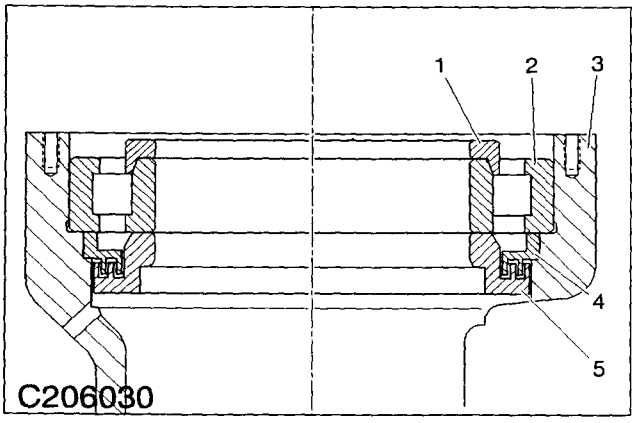
Operate the hydraulic jack (3) until the suspension tube is free of the axle shaft (2). A stroke of approximately 75 mm is required to free the components from the axle shaft (2).

Lower the lifting equipment and secure the drive assembly on the work bench. Remove threaded rods (1) and angle part (4) of the axle pulling tool from the suspension tube.

Slowly lift the suspension tube from the axle assembly. Support the axle (2) on the work area. Lower the suspension tube and secure it at the work area with the non–drive end facing upwards. Disconnect the lifting equipment from the suspension tube.



At the non–drive end of the suspension tube (4), remove the bolts (1) and washers (2) securing labyrinth ring (3) to the tube (4), then remove the ring (3).



Carefully heat the non–drive end of the suspension tube (3) to 100 °C using flame heating.

WARNING:

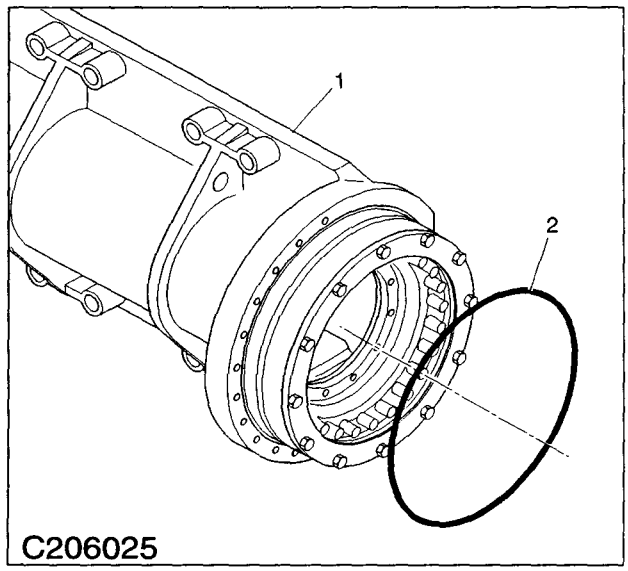
The suspension tube (3) is HOT. Use protective clothing and suitable tools to avoid personal injury.

Withdraw the thrust collar (1), bearing race (2), labyrinth ring (4) and labyrinth ring (5) from the suspension tube (3).

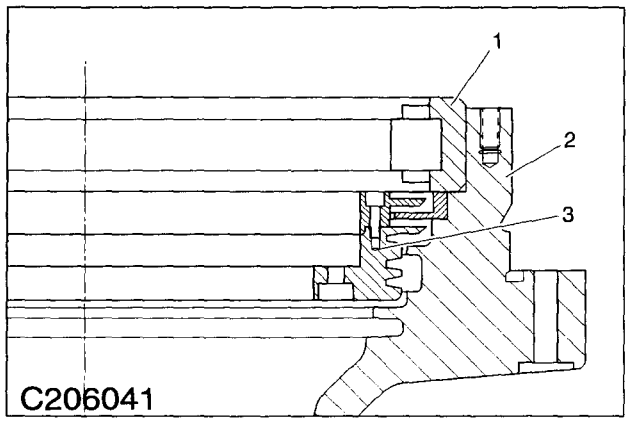
WARNING:

The suspension tube (3) is very heavy. Use lifting equipment to avoid personal injury.

Stand the suspension tube (3) vertically with the drive end facing upwards. Support the suspension tube.



Remove and discard the O–ring (2) from the end of the suspension tube (1).

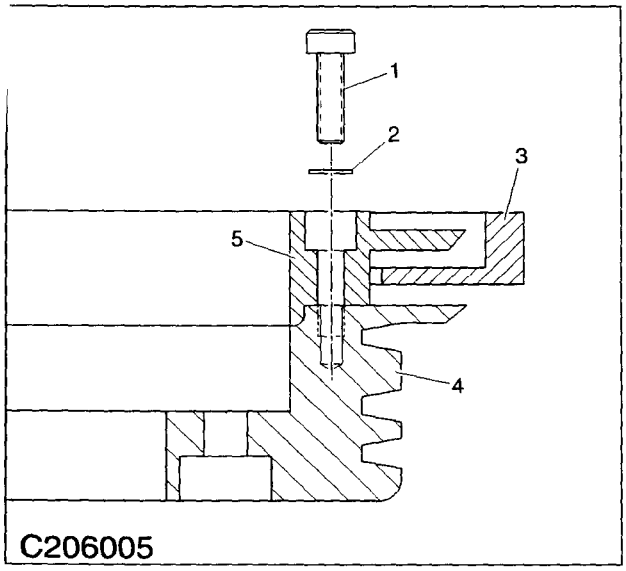


Carefully heat the drive end of the suspension tube (2) in the vicinity of the bearing cage (1) to 100 °C using flame heating.

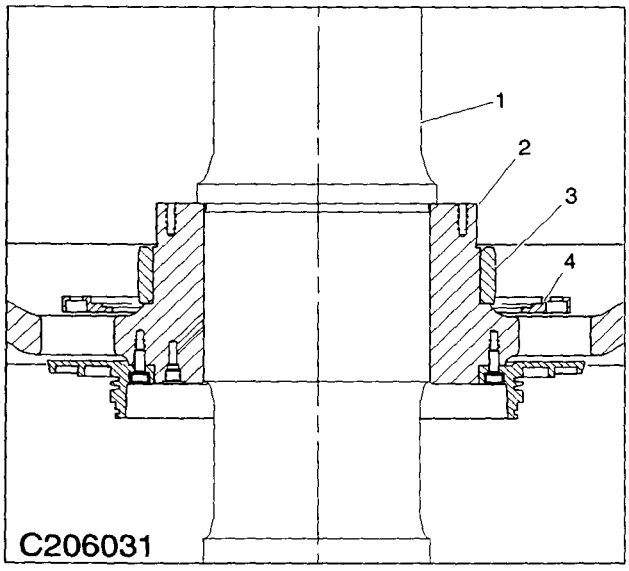
WARNING:

The suspension tube (2) is HOT. Use protective clothing and suitable tools to avoid personal injury.

Withdraw the bearing race (1) and labyrinth ring assembly (3) from the suspension tube (2).



Remove the socket head bolts (1) and washers (2) securing labyrinth ring (5) to the labyrinth ring (4). Separate the labyrinth rings, (3, 4, 5).



Stand the axle and drive gear assembly vertically with the non–drive end facing upwards. Support the axle using suitable overhead lifting equipment.

Remove supporting ring (4) from the axle shaft (1).

Carefully heat the inner bearing ring (3) on the main gear hub (2) to 100 °C using flame heating.

WARNING:

The axle (1) and main gear (2) is HOT. Use protective clothing and suitable tools to avoid personal injury.

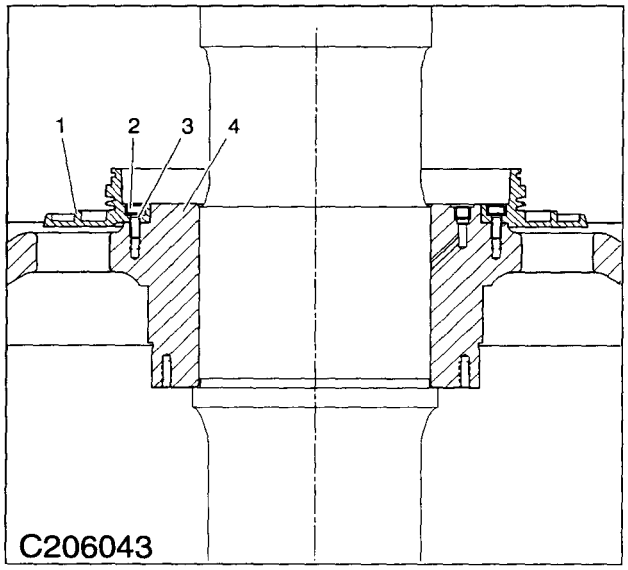
Pull the bearing ring (3) from the main gear hub (2).

WARNING:

The suspension axle (1) is very heavy. Use lifting equipment to avoid personal injury.

Remove the wheel from the drive end of the axle shaft (1) as described in Chapter 2.02 Wheelset, Section Disassembly.

Stand the axle and drive gear assembly vertically with the drive end facing upwards. Support the axle using suitable overhead lifting equipment.



Remove the socket head bolts (2) and washers (3) securing labyrinth ring (1) to main gear hub (4), then separate the ring (1) from the hub.

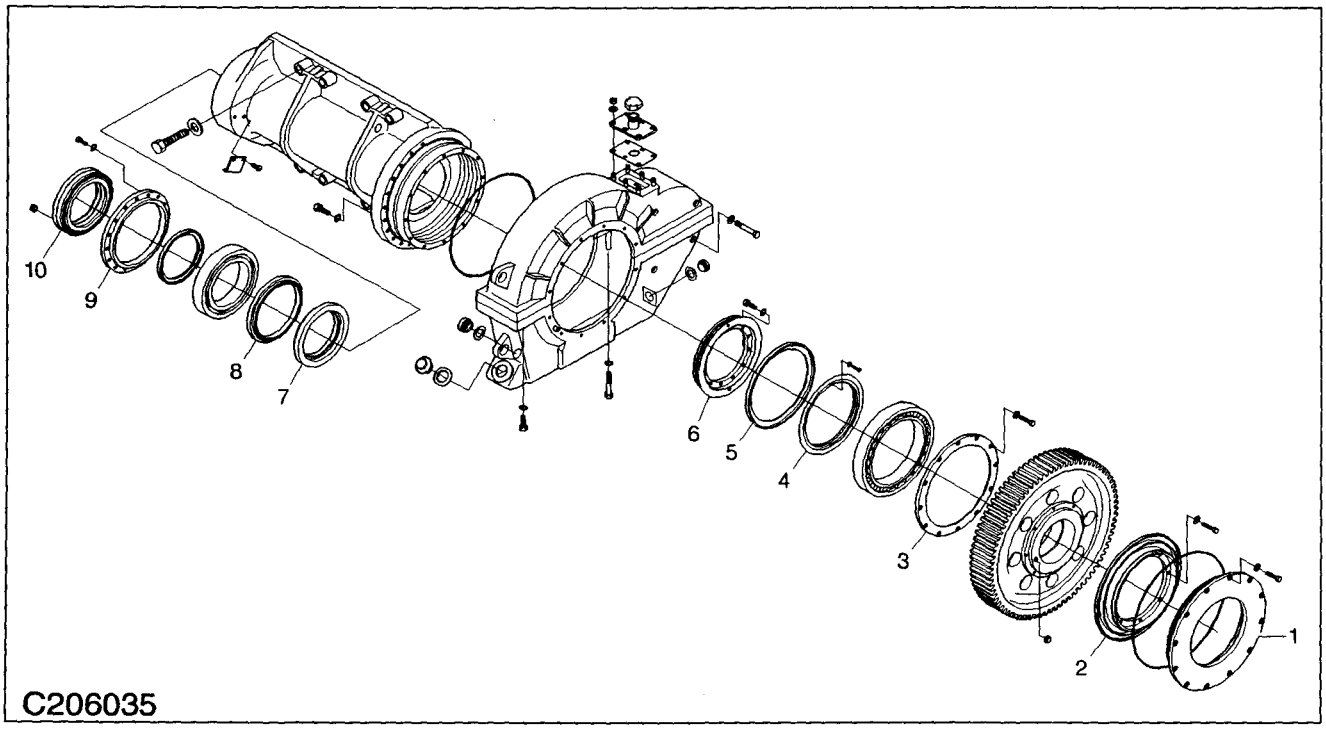
Remove the main gear (4) from the axle shaft as described in Chapter 2.02 Wheelset, Section Disassembly.

Inspect the drive components for wear or damage as described in Section Inspection and Repair.

Inspection and Repair

.1250

Suspension Tube



C206035

Clean the drive assembly components. Remove all traces of dirt and debris, then pack the parts in a suitable rust preventative to minimise oxidation. Cover components to prevent damage and contamination with foreign material, and store on wood or cardboard.

Inspect the gear cases and suspension tube for damage. Test the gear case and suspension tube for cracks using ultrasonic, x–ray or other non–destructive testing techniques. If necessary small cracks and minor damage can be repaired by welding. The repair procedure is described in the Gear Box Casting and Weld Repair Procedure, Volume TBA.

Measure the labyrinth ring and bearing seats in the suspension tube. Specifications are given in Section Technical Data. Recondition the suspension tube if out of specification.

Check the mating surfaces of the suspension tube, and gear case. Surfaces must be in perfect condition to seal correctly. Small imperfections and burrs can be removed using fine emery paper.

Check the labyrinth rings (1), (2), (4), (5), (6), (7), (8), (9), and (10) for wear or damage. Dimensions are given in Section Technical Data. Replace any out of specification labyrinth rings.

Check the supporting ring (3) for wear or damage. Replace the ring (3) if out of specification.

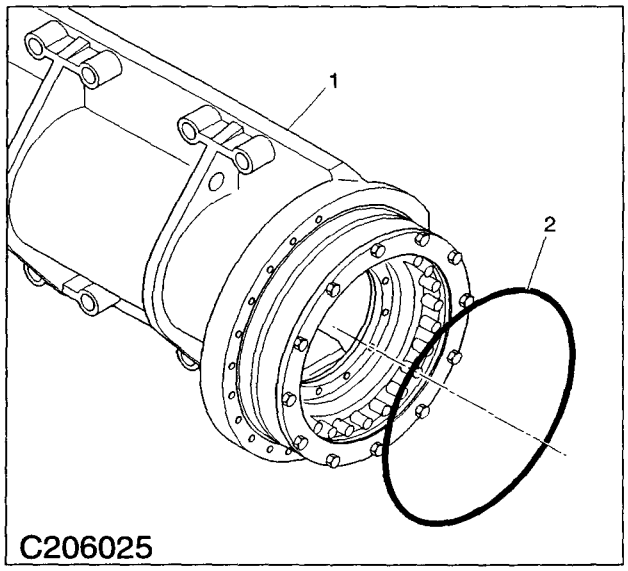
NOTE:

Bearings are precision parts and critical to the longevity of the drive assembly. Never use damaged, dirty or out of specification bearings.

Clean the bearings, removing all traces of oil, grease and other foreign material. Inspect the bearings (7, 8). Replace the entire bearing if worn, damaged or pitted. The bearings must be in perfect condition if they are to be reinstalled.

Check all the bolts for wear or damage. Replace the bolts if the shank is worn or damaged. Inspect the condition of the threads. If necessary, repair the thread using an appropriate thread chaser, or replace the pivot bolt.

Do not reuse worn or damaged locking nuts. Discard locking nuts after 5 uses.



Discard the O–ring (2) from the suspension tube (1). Install new O–ring during assembly.

Gear case

Inspect and repair the gear case as described in Chapter 4.04 Traction motor, Section Inspection and Repair.

Sanitation Parts/Operating Material

@.1260

[NOT REQUIRED]

Assembly

@.1270

Suspension Tube

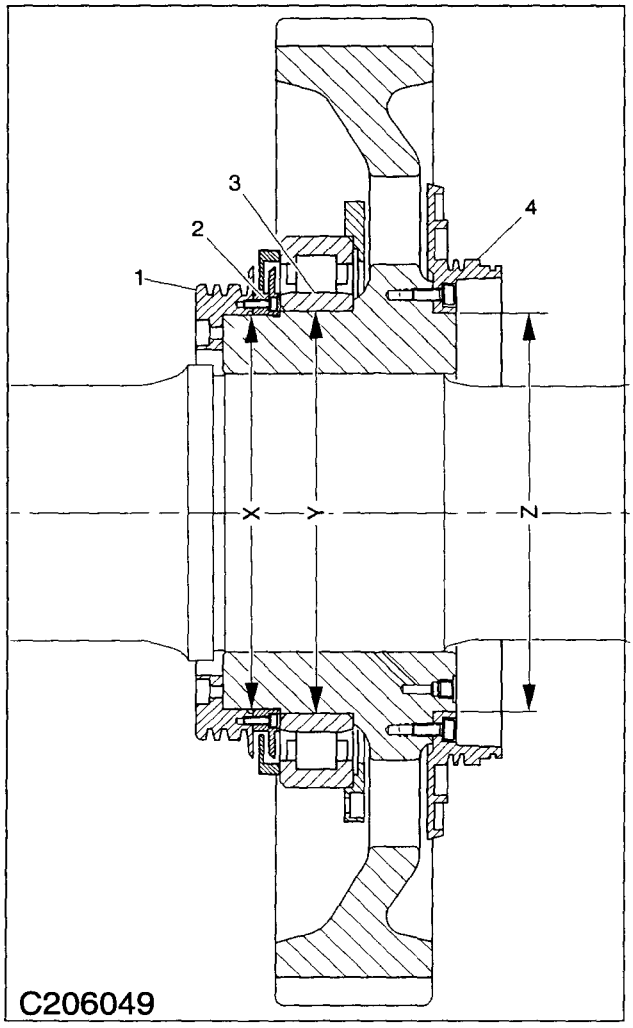
NOTE:

New drive assembly components are packed in rust preventative. Remove this material from suspension tube bearing and labyrinth ring seats, and the traction motor mounting face. Also remove the rust preventative material from new bearings and labyrinth rings.

Always check components for oxidation or rust before installation. Small imperfections can be removed with fine emery paper.

Drive assembly and bearings are precision components. Use care whenever handling to avoid damage. Care must be taken to ensure the bearings are kept clean and free of foreign material at all times. Damaged or out of specification components must be replaced.

Install the main gear onto the axle shaft as described in Chapter 2.02 Wheelset, Section Assembly.



Measure the diameter of the drive end bearing (3) journal (Y) on the main gear hub. Refer Section Technical Data. Recondition the main gear if not within specification.

Measure the diameter of the labyrinth ring (4) journal (Z) on the main gear hub. Refer Section Technical Data. Recondition the main gear if not within specification.

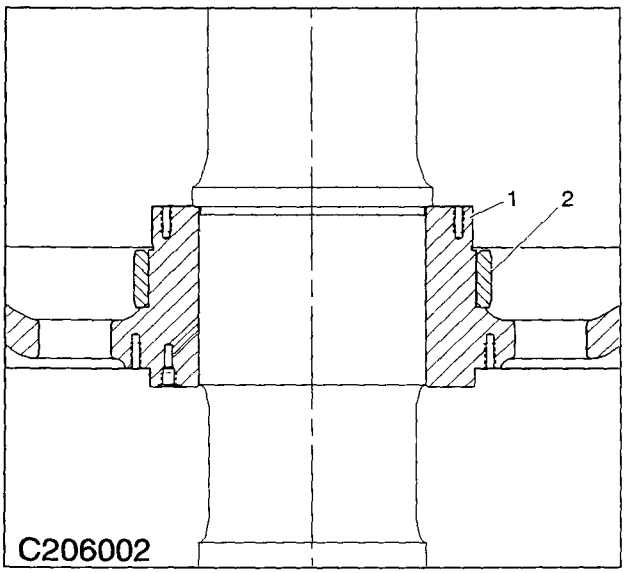
Measure the inside bore diameter of labyrinth rings (1,2) (X). Refer Section Technical Data. Replace the labyrinth rings if not within specification.

Measure the inside bore diameter of labyrinth ring (4) seat. Refer Section Technical Data. Replace the labyrinth ring if not within specification.

Stand the axle and drive gear assembly vertically with the non–drive end facing upwards. Support the axle using suitable overhead lifting equipment.

NOTE:

The drive end bearing is installed in two parts. The inner bearing ring is installed at this time. The bearing race is installed later in the procedure.

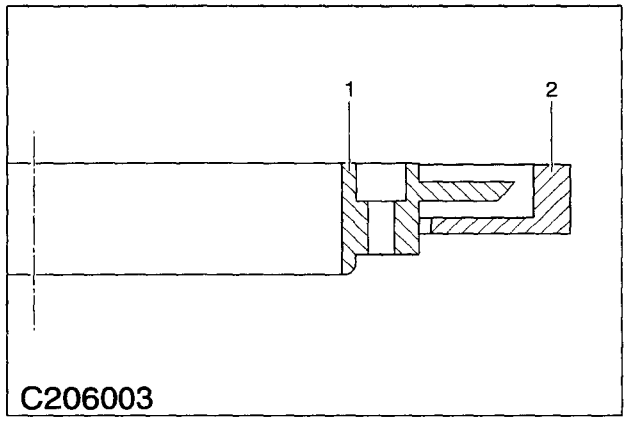


Heat the inner bearing ring (2) to 100 °C using suitable induction heating equipment.

WARNING:

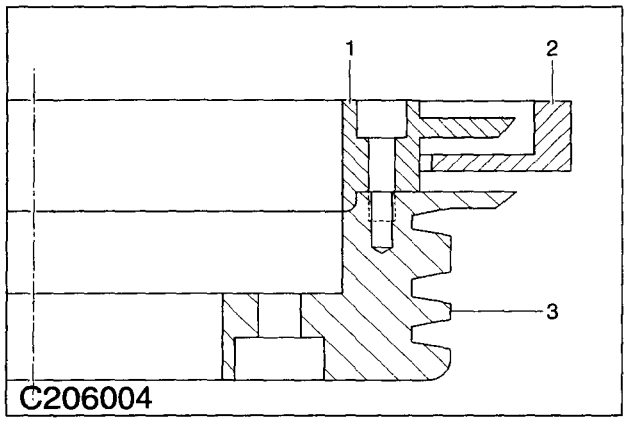
The inner bearing ring is HOT. Use protective clothing and handle the ring with suitable tools to avoid personal injury.

Position the inner bearing ring (2) on the main gear journal (1). Press the ring (2) up against the shoulder and hold until cool.

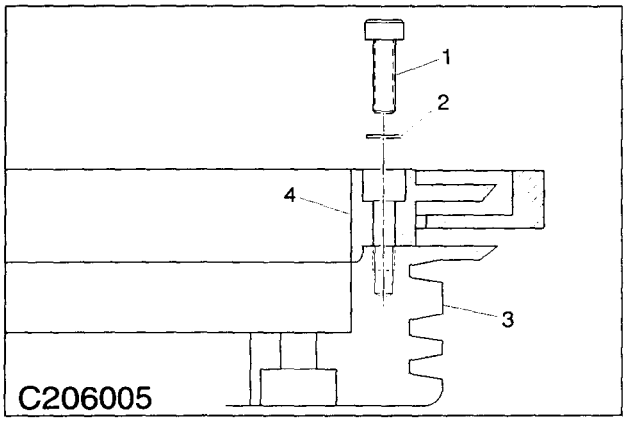


Turn the axle vertically so the drive end is facing upwards. Support the axle shaft to prevent it falling during the assembly procedure.

Position labyrinth ring (1) over labyrinth ring (2).



Position labyrinth rings (1, 2) onto labyrinth ring (3). Ensure the lip of the labyrinth ring (1) seats correctly in the groove of labyrinth ring (3).

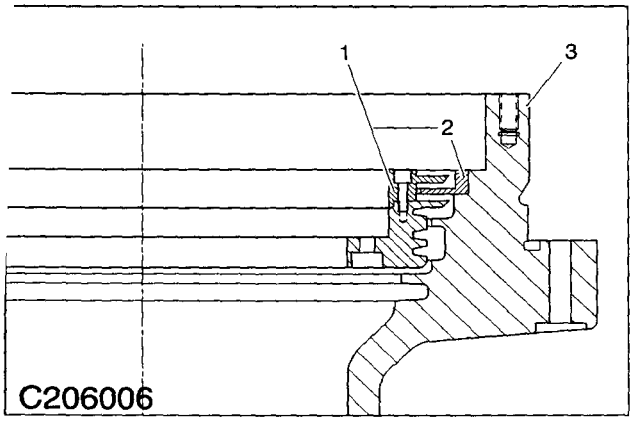


Apply Thermocup 1200, or equivalent, paste to the socket head bolts (1), then install the bolts (1) with washers (2) through the labyrinth ring (4) into the labyrinth ring (3).

CAUTION:

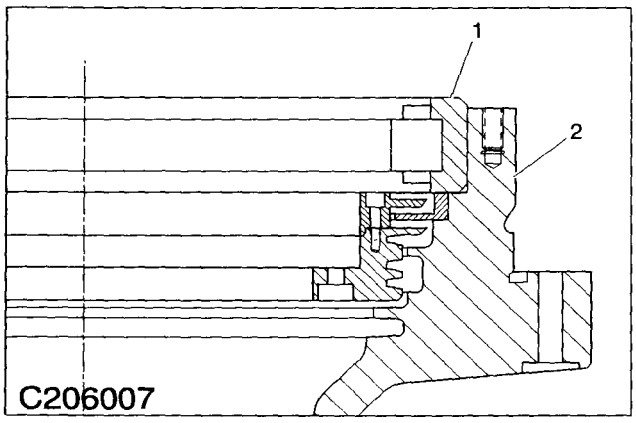
Do not over–tighten the socket head bolts (1).

Torque the socket head bolts (1) in an alternating cross pattern. M_A = 9.5 Nm.



Stand the suspension tube (3) vertically with the drive end upwards. Support the suspension tube (3)

Install the labyrinth ring assembly (1) into the drive end of the suspension tube (3).Push labyrinth ring (2) up to the shoulder stop in the suspension tube (3). The labyrinth ring (2) seats inside the suspension tube (3), while labyrinth ring assembly (1) remains loose.



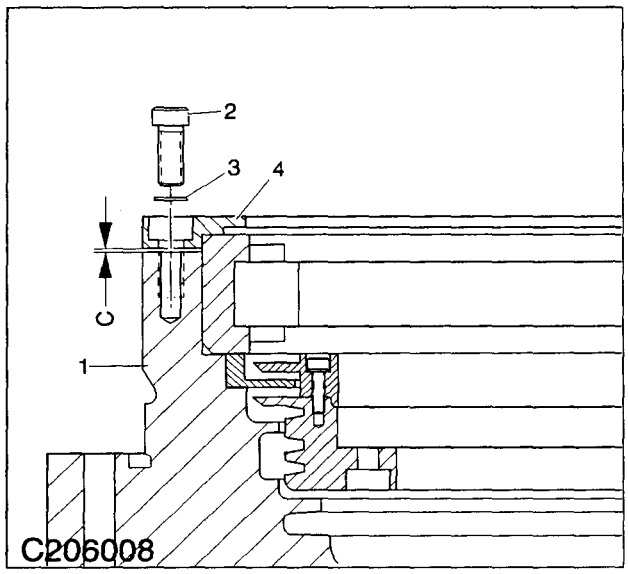
Heat the drive end of the suspension tube (2) to 100 °C using suitable induction heating equipment.

WARNING:

The suspension tube (2) is HOT. Use protective clothing and suitable tools to avoid personal injury.

Install the bearing race (1) into the drive end of the suspension tube (2) seat. The serial number on the bearing race (1) must be facing towards the drive end of the suspension tube (2). Press the bearing race (1) up against the stop until the suspension tube (2) has cooled. The bearing race (1) will sit slightly above the lip of the seat, and be correctly positioned later in the procedure.

Lubricate the bearing race (1) with Optigear 220, or equivalent, oil. Work the lubricant into the bearing. Do not over–lubricate. Clean any excess lubricant from the suspension tube (2).

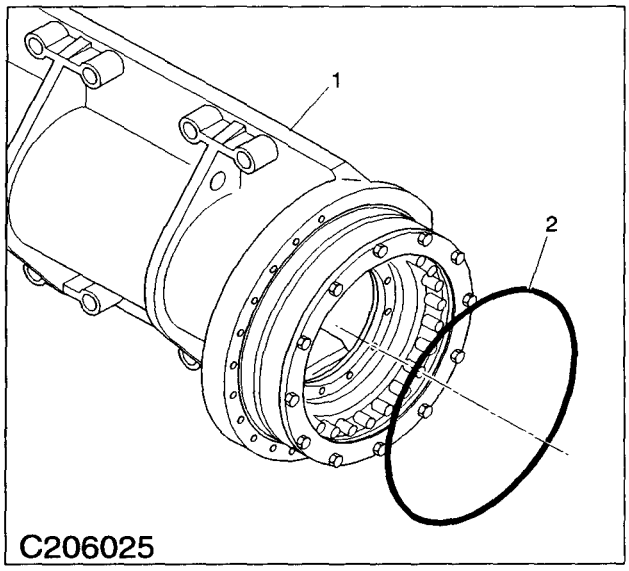


Install the supporting ring (4) with the lip facing upwards into the suspension tube (1).

Apply Thermocup 1200, or equivalent, paste to the socket head bolts (2), then install the bolts (2) with washers (3) through the supporting ring (4) into the suspension tube (1).

Torque the socket head bolts (2) around supporting ring (4) in an alternating cross pattern. M_A = 80 Nm.

After torquing the bolts (2), check the gap between the supporting ring (4) and suspension tube (1): distance 'C' = 0.1 – 0.7 mm.

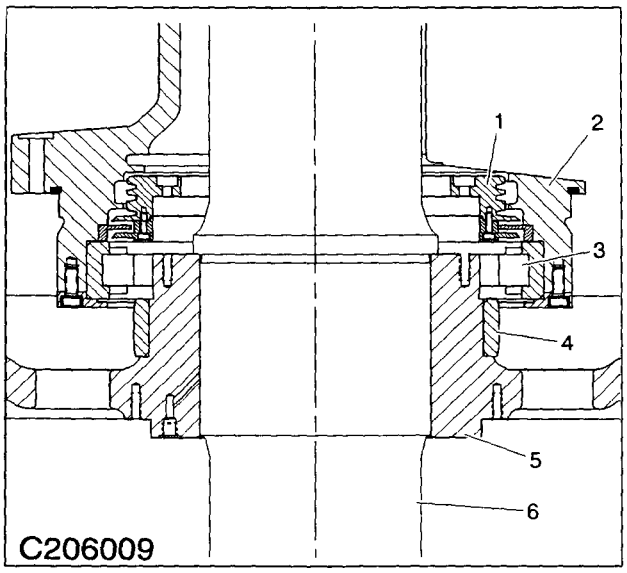


Install a new O–ring (2) into the groove at the drive end of the suspension tube (1). Ensure the O–ring is correctly seated in the groove and is not twisted.

Invert the suspension tube (1) so that the non–drive end is facing upwards. Install suitable lifting eyes to the transverse ribs of the suspension tube (1). Suspend the tube (1) vertically, with the drive end facing upwards, using suitable overhead lifting equipment. Use a sprit level to ensure the suspension tube (1) is completely vertical.

WARNING:

To prevent damage to the drive assembly components, support the suspension tube (1) with wooden chocks whenever halting the assembly procedure.

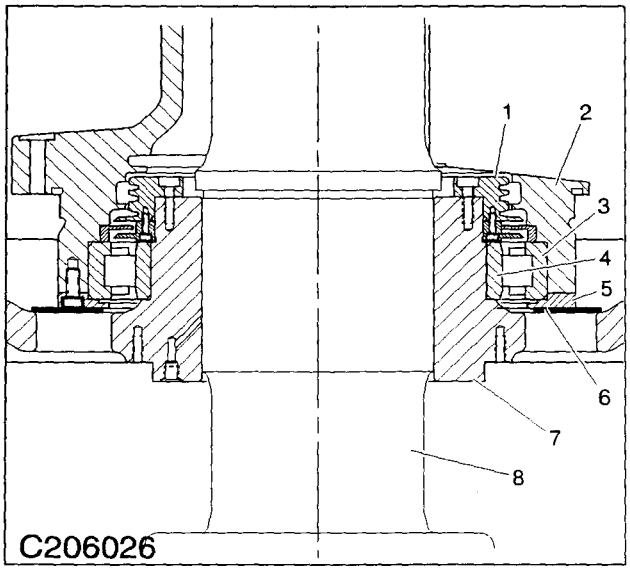


Move the suspension tube (2) into position above the axle assembly.

Slowly lower the suspension tube (2) onto the axle assembly (6). Stop lowering the suspension tube (2) before the bearing race (3) contacts the inner bearing ring (4) on the main gear (5). Support the suspension tube (2) using suitable wooden chocks.

Centralise the bearing race (3) over the inner bearing ring (4), and the labyrinth ring assembly (1) over the main gear (5) hub. Align the components as necessary.

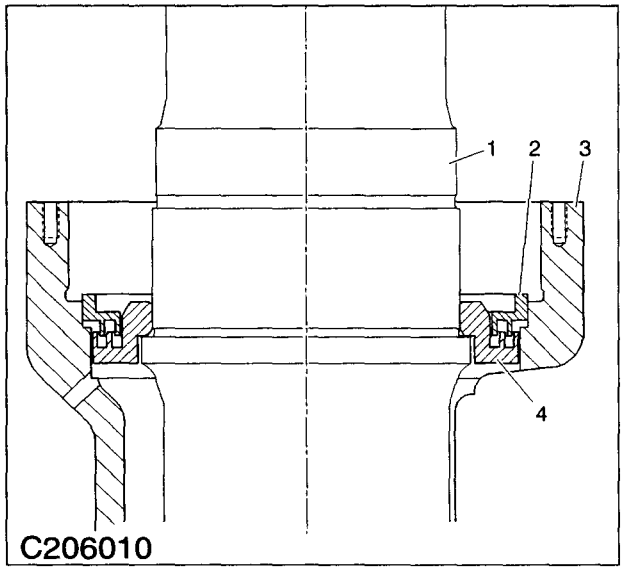
Rotate the labyrinth ring assembly (1) as necessary to align with the threaded holes in the main gear (5).



Carefully lower the suspension tube (2) onto the axle (8) until the clearance between the main gear (7) and supporting ring (5) is approximately 3 mm. Ensure the bearing race (3) slides correctly over the inner bearing ring (4), and that the labyrinth ring assembly (1) slides onto the main gear (7) hub.

Support the suspension tube (2) with suitable wooden chocks.

Use 3 mm thick wooden packers between the main gear web (7) and the supporting ring (5) to prevent damage to the labyrinth ring assembly (1).



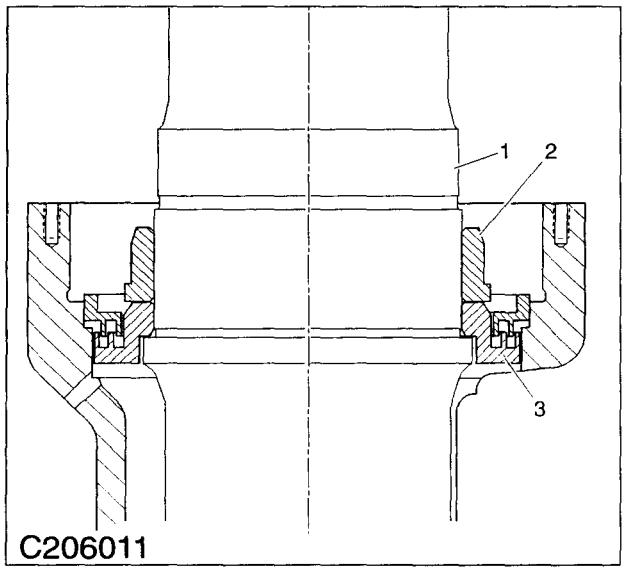
Lubricate the reservoir of labyrinth ring (4) with approximately 50 grams of Optimol Longtime PD2, or equivalent, grease. Spread the grease evenly around the reservoir.

Position labyrinth ring (4) with the grooves facing upwards onto the non–drive end of the axle (1). Push the ring (4) up to the axle stop collar.

Install the labyrinth ring (2) with the grooves facing downwards into the non–drive end of the suspension tube (3). At this time the axle (1) and suspension tube (3) are not properly aligned, the ring (2) will sit about 3 – 4 mm above the labyrinth ring (4).

NOTE:

The drive end bearing is installed in three parts. The inner bearing ring is installed at this stage. The bearing cage and thrust collar are installed later in the procedure.



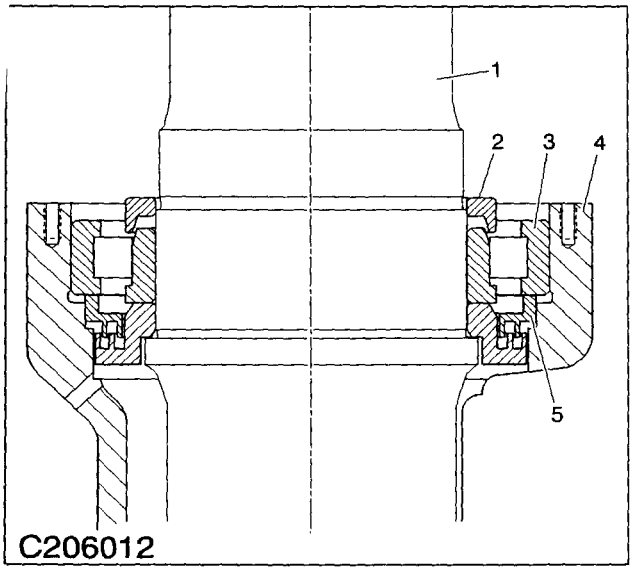
Heat the inner bearing ring (2) to 100 °C using suitable induction heating equipment.

WARNING:

The inner bearing ring (2) is HOT. Use protective clothing and handle the ring using suitable tools to avoid personal injury.

Position the inner bearing ring (2) onto the axle shaft (1) until it stops against the labyrinth ring 3). Press the ring (2) up against the ring (3) and hold until cool.

Lubricate the bearing cage with approximately 300 grams of Optimol Longtime PD2, or equivalent, grease. Work the grease into the bearing.



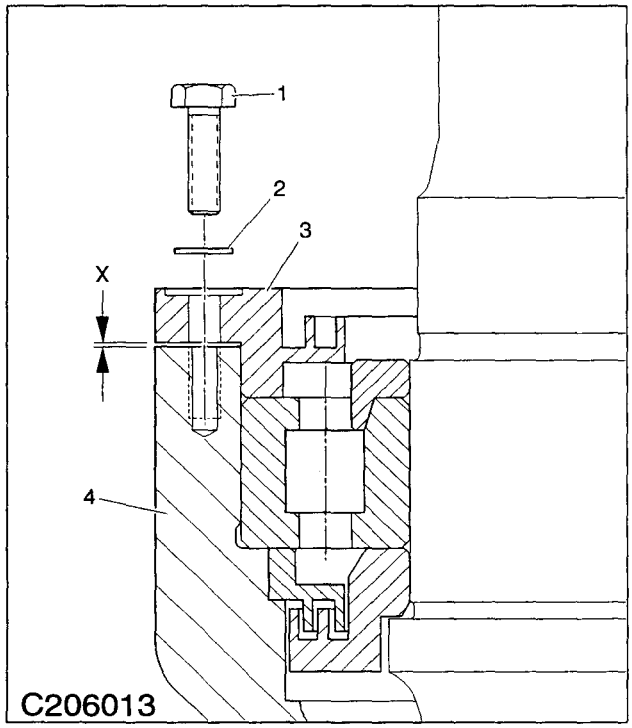
Heat the non–drive end of the suspension tube (4) to 100 °C using suitable induction heating equipment.

WARNING:

The suspension tube (4) is HOT. Use protective clothing and suitable tools to avoid personal injury.

Install the bearing race (3) into the non–drive end of the suspension tube (4). Press the bearing race (3) up until it stops against labyrinth ring (5).

Install the bearing thrust collar (2) with the lip facing downwards onto the axle (1).



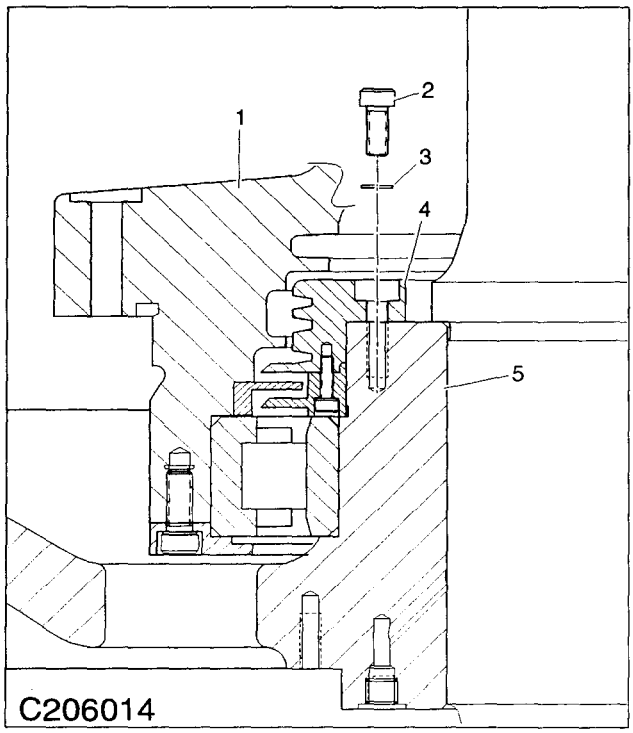
Install the labyrinth ring (3) with the grooves facing upwards into the non–drive end of the suspension tube (4).

Apply Thermocup 1200, or equivalent, paste to the hex head bolts (1), then install the bolts (1) with washers (2) through the labyrinth ring (3) into the suspension tube (4). Tighten the bolts (1) until firm. Do not over–tighten the bolts (1).

Raise the lifting equipment slightly to support the weight of the suspension tube (4), then at the drive end remove the spacers between the supporting ring and main gear hub.

At the non–drive end, torque the bolts (1) on labyrinth ring (3) progressively in an alternating cross pattern. M_A = 80 Nm.

Check the gap between labyrinth ring (3) and suspension tube (4): distance 'X' = 0.7 – 1.8 mm.



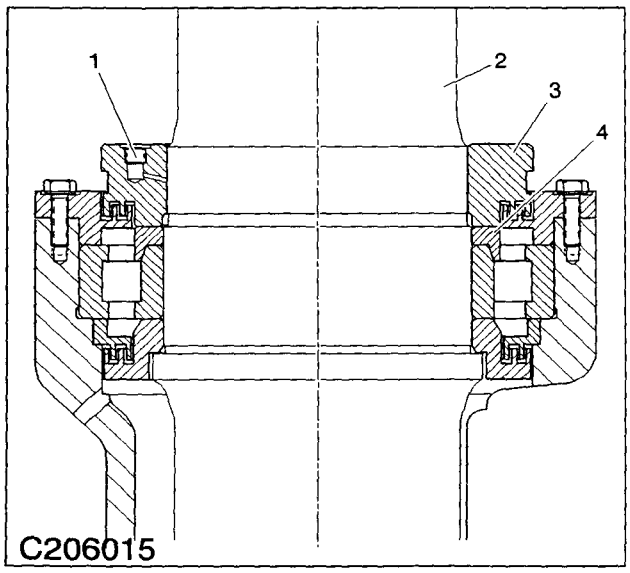
NOTE:

The axle and suspension tube are axially aligned as the bolts (2) are tightened. Take care to torque the bolts (2) progressively and ensure all components are seating correctly.

Apply Thermocup 1200, or equivalent paste to the socket head bolts (2), then install the bolts (2) with washers (3) through the labyrinth ring (4) into the main gear hub (5). Carefully rotate the suspension tube (1) as necessary to gain access to the bolts through the opening. When all the bolts are installed, torque the bolts (2) in an alternating pattern. M_A = 80 Nm.

Rotate the suspension tube around the axle to ensure the bearings operate smoothly and free. Check that no components interfere during rotation. Rectify any faults found.

Lubricate the reservoir of labyrinth ring (3) with approximately 50 grams of Optimol Longtime PD2, or equivalent grease. Spread the grease evenly around the reservoir.



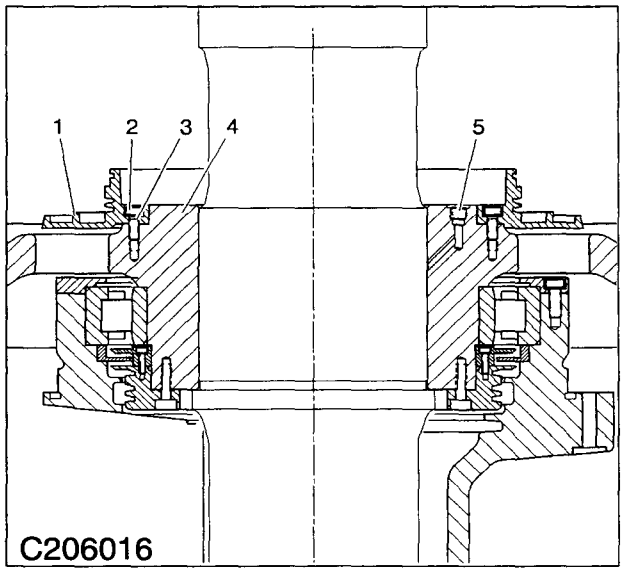
Heat the labyrinth ring (3) to 100 °C using suitable induction heating equipment.

WARNING:

The labyrinth ring (3) is HOT. Use protective clothing and handle the ring using suitable tools to avoid personal injury.

Install the labyrinth ring (3) with the grooves facing downwards on the journal of the axle shaft journal (2). Press the ring (3) up against the bearing thrust collar (4) and hold until cool.

Install the plug (1) into the labyrinth ring (3). Tighten the plug securely.



Position labyrinth ring (1) with the lip facing outwards on the face of the main gear (4) and align the bolt holes.

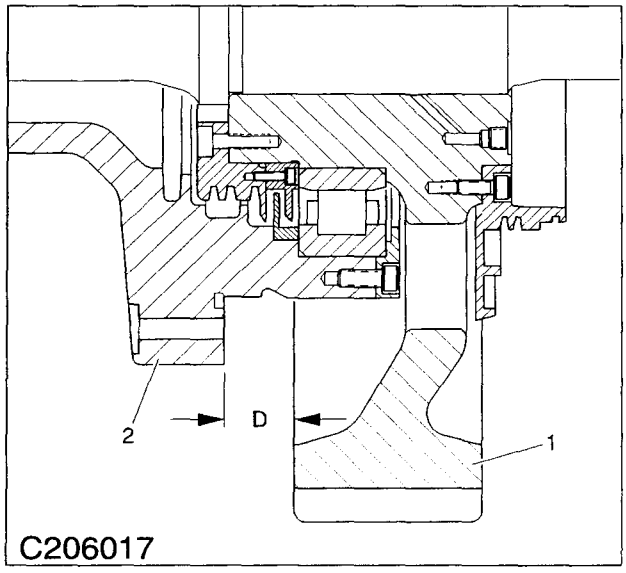
Apply Thermocup 1200, or equivalent, paste to the socket head bolts (2), then install the bolts (2) with washers (3) through the labyrinth ring (1) into the main gear (4).

NOTE:

Labyrinth ring (1) is a loose fit on the main gear hub (4). Use feeler gauges to centralise the ring (1) while torquing the bolts.

Torque the socket head bolts (2) in an alternating cross pattern. M_A = 80 Nm.

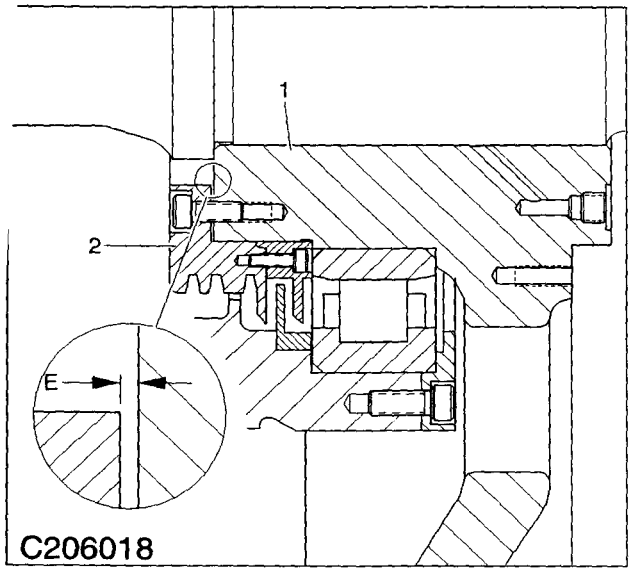
Install the plug into the main gear (5) oil gallery. Tighten the plug securely.



NOTE:

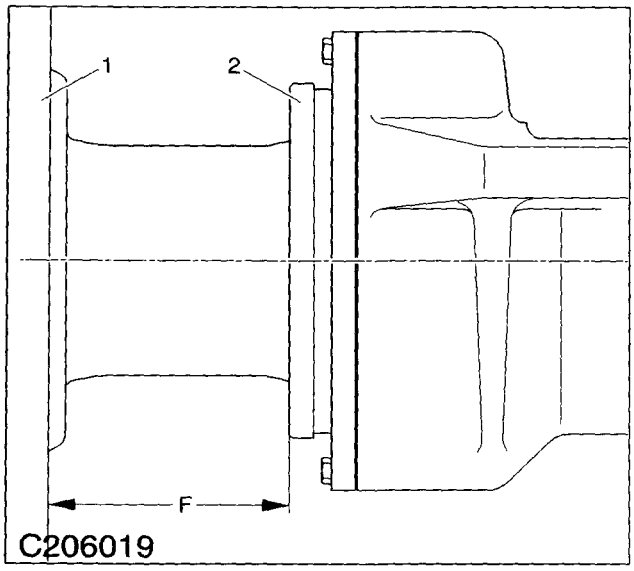
The minimum dimension of distance 'D' could be lower if greater than specified free play exists in the bearings.

Measure the clearance from the inner face of the suspension tube (2) to the face of the main gear (1): clearance 'D' = 44.65 – 45.60 mm

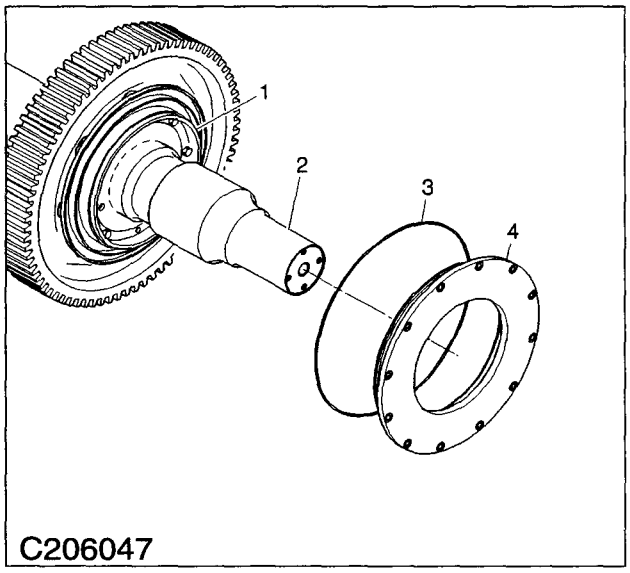


Check the axial end play in the non–drive end bearing. (Non–drive end bearing axial end play = 0.25 – 0.48 mm)

Measure the clearance between the labyrinth ring (2) and the main gear hub (1): clearance 'E' = 0.1 – 0.8 mm



Install the wheel (1) at the non–drive end as described in Chapter 2.02 Wheelset, Section Assembly. Measure the distance between the labyrinth ring (2) and wheel (1). (distance 'F' = 126 – 128 mm)



Install a new O–ring (3) into the groove in the drive end of labyrinth ring (4). Ensure the O–ring is correctly seated in the groove and is not twisted.

Place labyrinth ring (4) on the axle (2) with the lip facing inwards towards labyrinth ring (4). Place suitable packing, such as cardboard, between the labyrinth rings (1) and (4) to prevent damage. Temporally secure labyrinth ring (4) to the axle assembly.

Assemble the wheel to the drive end of the axle shaft (2) as described in Chapter 2.02 Wheelset, Section Installation. Measure the distance between the hubs of the wheel discs. (distance = 1,596 mm)

Assemble the traction motor to the suspension tube, as described in Chapter 4.04 Traction Motor, Section Assembly.

Assemble the two halves of the gear case as described in Chapter 4.04. Traction Motor, Section Assembly.

Install the wheelset into the bogie as described in Chapter 2.02 Wheelset, Section Installation.

Install the bogie to the locomotive as described in Chapter 2.00 Bogies & Running Gear, Section Assembly.

Installation

9.1280

[NOT REQUIRED]

After–Installations Operations

9.1290

[NOT REQUIRED]

Adjustments

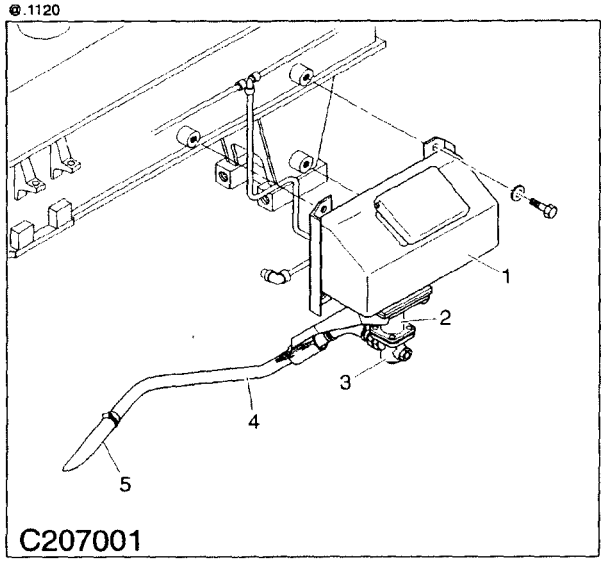
9.1310

[NOT REQUIRED]

2.7 Sanding Equipment

Group Summary

@.1120



1	Sand box	4	Sand pipe
2	Adaptor	5	Sanding nozzle
3	Sanding valve		

Functional Description

@.1140

Release of the sand is controlled by the locomotive traction control system incorporated into the E70 brake unit. Sand is released from pneumatically controlled valves at the sand boxes and is exhausted through nozzles just ahead of wheels.

Each bogie has four sand boxes adjacent to the end axle wheels.

Technical Data

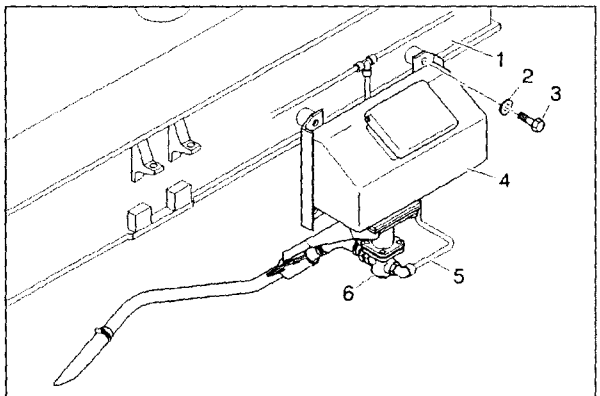
@.1160

– Sanding nozzle height from rail [Y]	28 – 32 mm
– Distance to inner wheel flange [X]	68 – 72 mm
– Sand Box Capacity	27.5 litres

Removal

@.1230

Sand Box



C207002

Isolate the locomotive air supply to the sanding equipment.

Remove the sanding pipe as described under Sanding Pipe.

Disconnect the air line (5) from the valve (6), then plug the air line (5) and valve union (6) with suitable plastic plugs to prevent the ingress of foreign material.

Position a suitable support under the sand box (4).

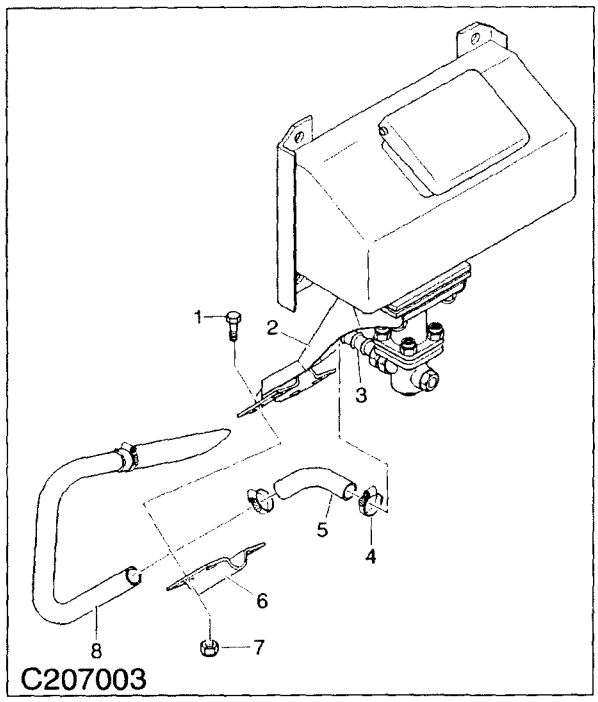
Remove the bolts (3) and washers (2) securing the sand box (4) to the bogie frame (1).

NOTE:

The sand box is heavy. An empty sand box weighs over 30 kg. A box full of sand weighs considerably more. Have an assistant help remove the sand box.

Remove the sand box (2) from the bogie (1).

Sanding Pipe



Isolate the locomotive air supply to the sanding equipment.

Loosen the clamp (6) connecting the hose (5) to the union (3) on the sanding valve.

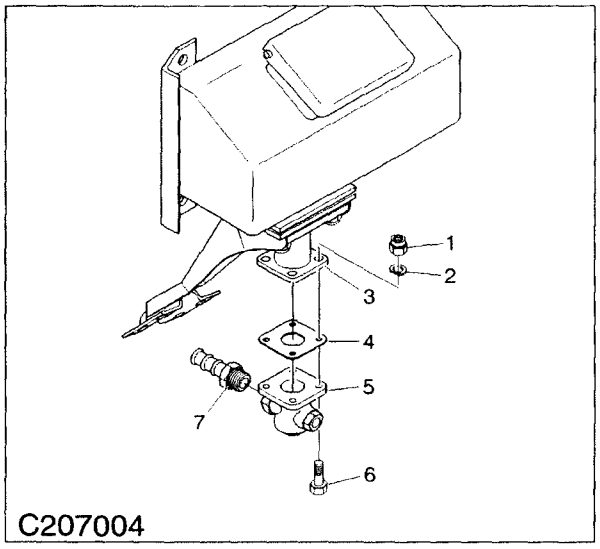
Disconnect the hose (5) from the union (3).

Loosen the bolts (1) securing the sanding pipe clamp (6) to the bracket (2). Support the sanding pipe (8). Remove the bolts (1) and nuts (7), then separate the pipe (8) and clamp (6) from the bracket (2).

Disassembly

@.1240

Sanding Valve



C207004

The valve can be removed from the sand box either on or off the bogie.

Purge all sand from the sand box using the following procedure, if necessary.

Place a suitable receptacle below the sand box.

Attach a length of suitable hose to the union (7).

Isolate the locomotive air supply to the sanding equipment, then disconnect the air line from the valve (5). Plug the air line using suitable plastic plugs to prevent the ingress of foreign material.

Connect an external source of compressed air to the valve.

Apply air pressure to open the valves and allow all the sand to be discharged into the receptacle.

Withdraw the air supply, then remove the length of hoses form the valve union (7). Disconnect the air supply and seal the valve union to prevent the ingress of foreign material using a suitable plastic plug.

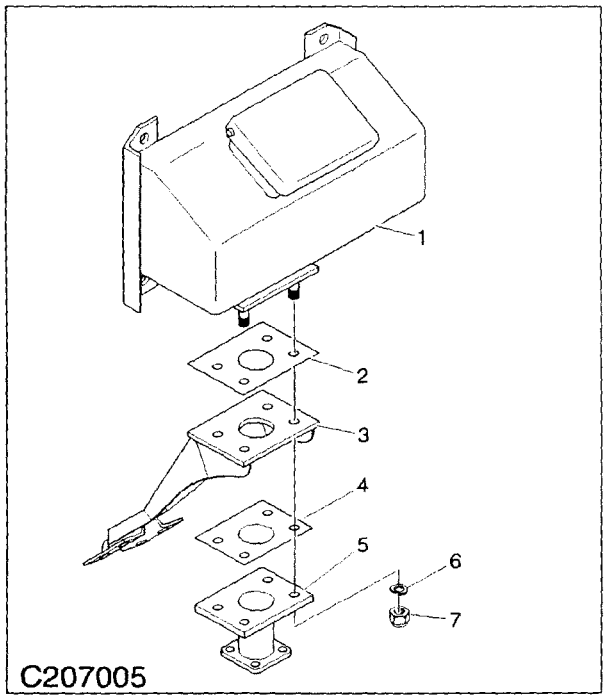
Crack loose the four nuts (1) securing the valve (5) to the adaptor (3).

Undo the nuts (1) then remove the washers (2), bolts (6), valve (5) and gasket (4). Discard the gasket (4) if damaged during removal.

Scrape any remaining gasket material from the valve and adaptor mating surfaces.

Unscrew the hose union (7) from the valve (5), if necessary.

Adaptor



NOTE:

Ensure all sand is purged from the sand box before removing the adaptor.

The adaptor (5) can be removed from the sand box (1) either on or off the bogie.

Remove the sanding pipe as described in Section Removal.

Remove the sanding valve as previously described.

Loosen and remove the four nuts (7) securing the adaptor (5) to the sand box (1).

Separate the adaptor (5), gaskets (2,4) and bracket (3) from the sand box (1).

Inspection and Repair

@.1250

Sand Boxes

Inspect the sand boxes for damage, cracks or tears. Repair any damage.

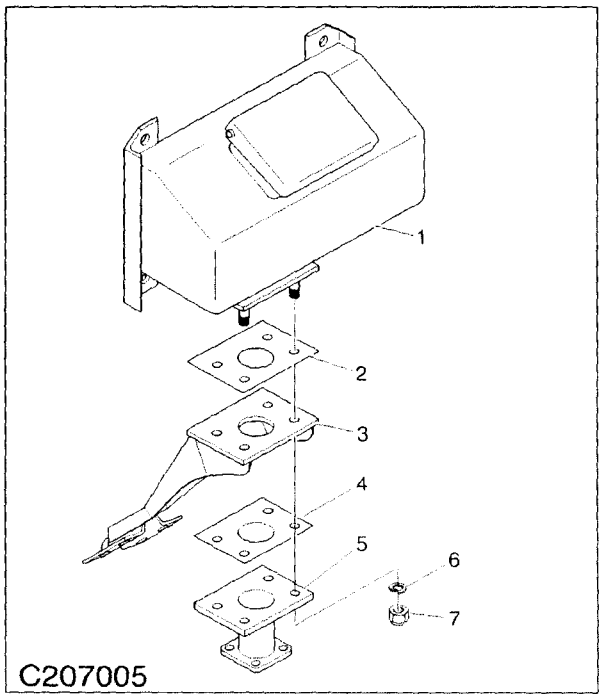
Check the adaptor for built–up deposits that could restrict sand flow. Clean the adaptor bore if required.

Check the bracket for damage. Rectify any damage found and ensure the sanding pipe is correctly aligned with the wheel and rail as described in Section Adjustments.

Assembly

@.1270

Adaptor

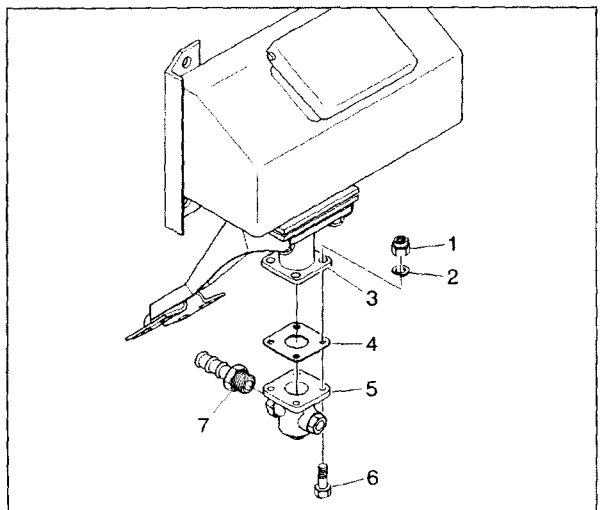


Check the condition of the gaskets. Replace if damaged or torn.

Install the gasket (2), bracket (3), adaptor gasket (4) and adaptor (5) onto the sand box (1).

Install the nuts (7) and securing ring (6) onto the sand box studs. Torque the nuts (7) to specification.

Sanding Valve



C207004

Install the hose union (7) into the valve (5), if necessary.

Clean any remaining gasket material from the valve and adaptor mating surfaces.

Position the gasket (4) and valve (5) on the adaptor (3). Ensure the sand hose union (7) faces towards the wheel.

Install the bolts (6) through the valve (5), gasket (4) and adaptor (3). Install the washers (2) and nuts (1) then tighten to specification.

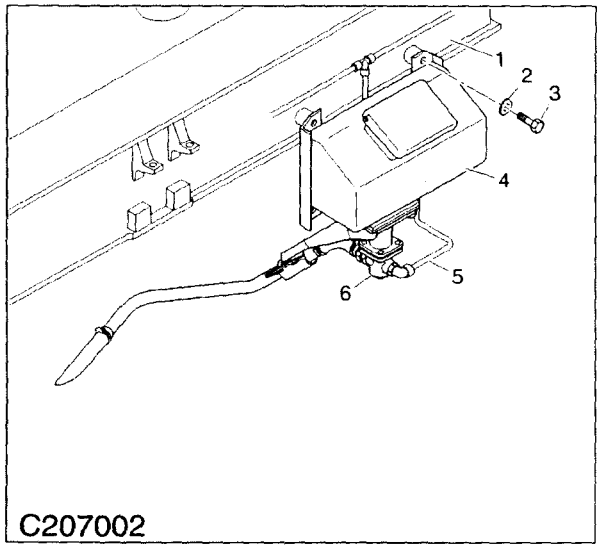
Install the sanding pipe as described Section Installation, then refill the sand box with sand and test the operation of the sanding equipment. Rectify any faults found.

Install the sanding pipe as described in Section Installation.

Installation

@.1280

Sand Box



C207002

NOTE:

The sand box is heavy. An empty sand box weighs over 30 kg. A box full of sand weighs considerably more. Have an assistant help install the sand box.

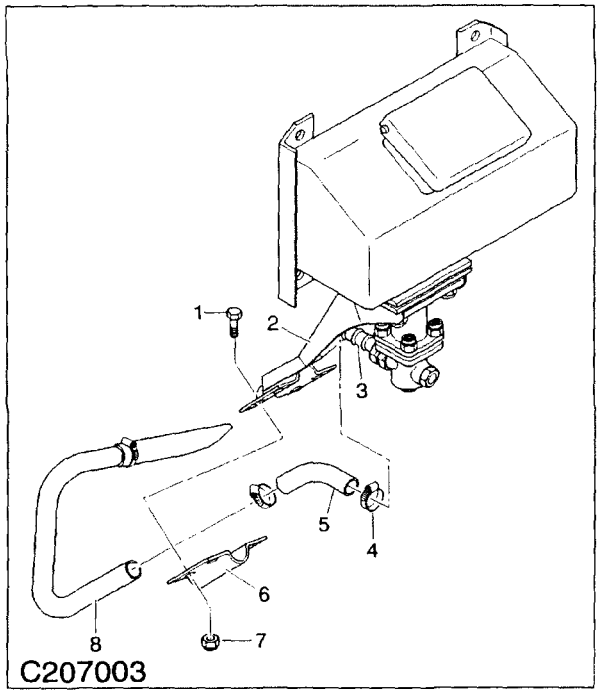
Position the sand box (4) on the bogie frame (1). Align the holes in the sand box flange with those in the bogie frame (1).

Install the bolts (3) and washers (2) securing the sand box (4) to the bogie frame (1).

Remove any plugs from the air line (5) and valve (6), then connect the air supply line to the valve (6).

Install the sanding pipe as described under Sanding Pipe.

Sanding Pipe



Install the union (3) into the sanding valve, if necessary.

Place a hose clamp (4) on the hose (5), then position the hose (5) on the pipe (8). Press about 30 mm of the hose (5) onto the pipe (8) and secure the clamp (4).

Place a hose clamp (4) on the other end of the hose (5), then position the hose (5) on the valve union (3).

Rotate the pipe (8) until its seats correctly in the bracket (2).

Position the clamp (6) onto the bracket (2), then install the bolts (1) and nuts (7).

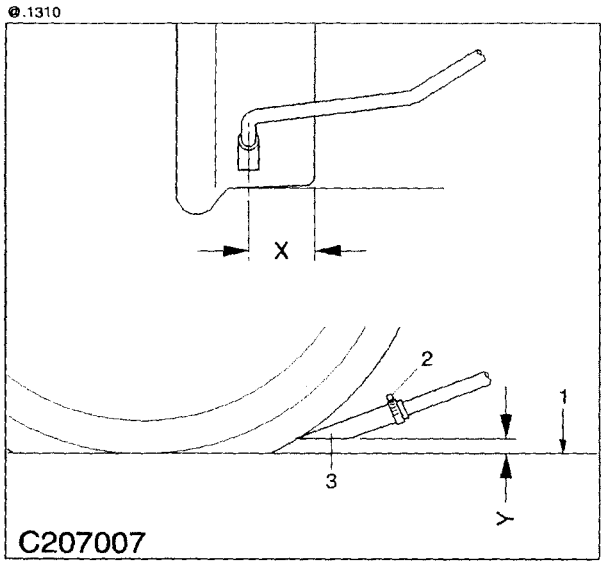
Ensure the nozzle is correctly aligned with the wheel and rail as described in Section Adjustments.

Torque the nuts to specification.

Secure the clamp (4) around the hose (5,8).

Open the air supply and test the operation of the sanding equipment. Rectify any faults found.

Adjustments



Check the position of the sanding nozzle in relation to the wheel and rail.

If necessary, loosen the nuts securing the clamp to the bracket, then adjust the position of the nozzle until it is within the range listed in Tolerances and Wear Limits.

Torque the nuts at the clamp to specification.

If necessary, loosen the clamp (2) around the sanding nozzle (3) and rotate the sanding nozzle (3) so the outlet is level with the rail (1).

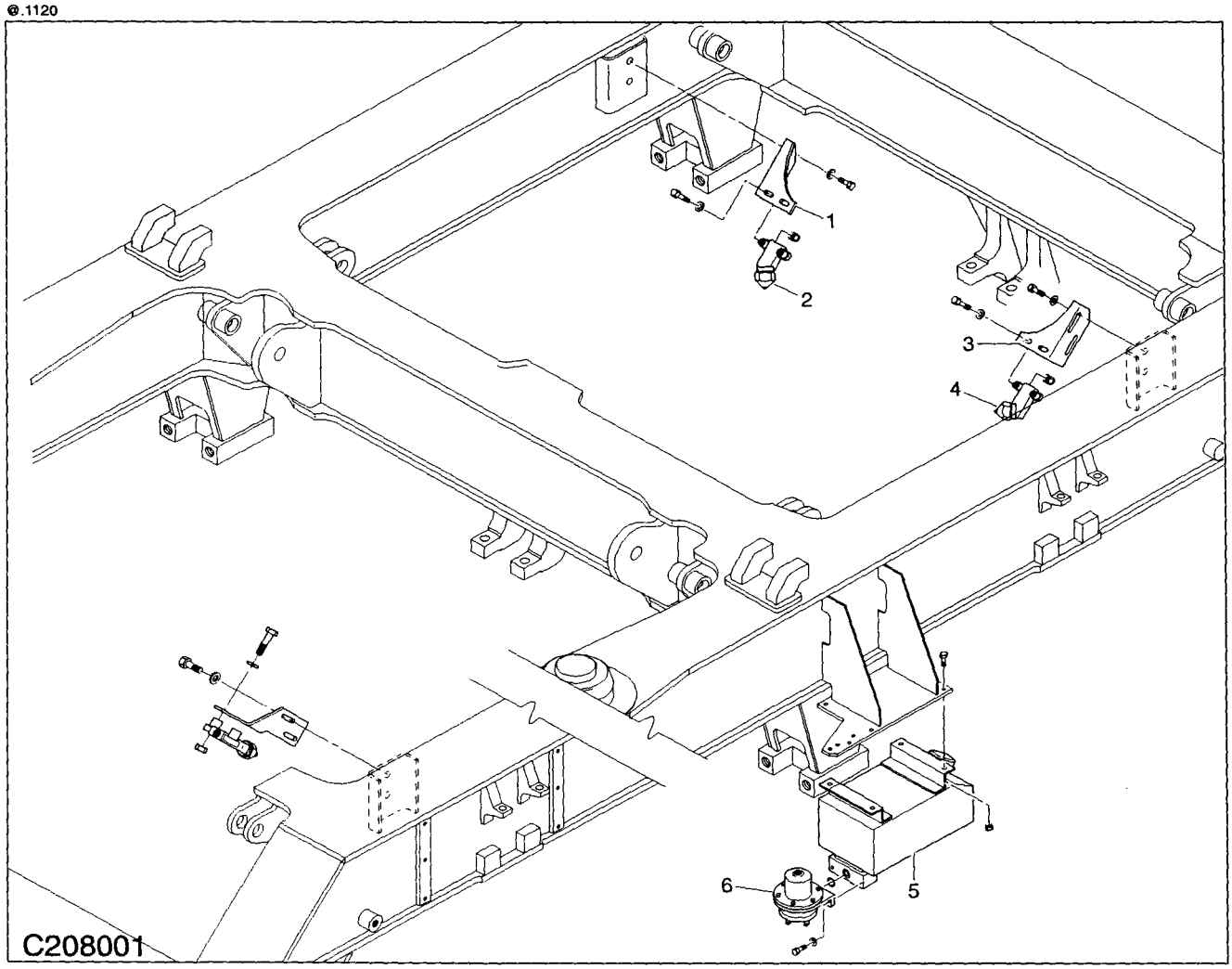
Tighten the clamp (2) around the nozzle (3).

Open the air supply and test the operation of the sanding equipment. Rectify any faults found.

2.8 Wheel Flange Lubrication

Overview

@.1120



1	Holder nozzle 1	4	Nozzle
2	Nozzle	5	Tank
3	Holder nozzle 2	6	Distributor

Functional Description

@.1140

The flange lubrication is pneumatically operated by control valves located on the Brake Frame, which are controlled by the Memotel system. Lubricant is periodically released from the reservoir tank through a pneumatically operated distribution valve and is sprayed onto the wheel flanges from nozzles situated above each end wheel.

A pneumatic and hydraulic pipe is connected to each nozzle. The hydraulic piping connects the distribution valve to the nozzles on the individual wheels. The pneumatic piping provides pressured air to create a low pressure point at each nozzle. The low pressure point at the tip of the nozzle draws oil through the hydraulic piping and sprays atomised oil onto the wheel flanges.

Technical Data

@.1160

Reservoir Tank

– Capacity	12 l
– Required lubricant	Shell Malleus B

Nozzle

– Manufacturer	Sécheron
– Model	GB-L
– Distance from wheel flange [y]	24 – 26 mm

Tolerances and Wear Limits

@.1170

[Not Required]

Tools and Special Tools

@.1180

[Not Required]

Miscellaneous Materials

@.1200

Plastic plugs, or alike suitable to seal pneumatic pipes.

Before–Removal Operations

@.1220

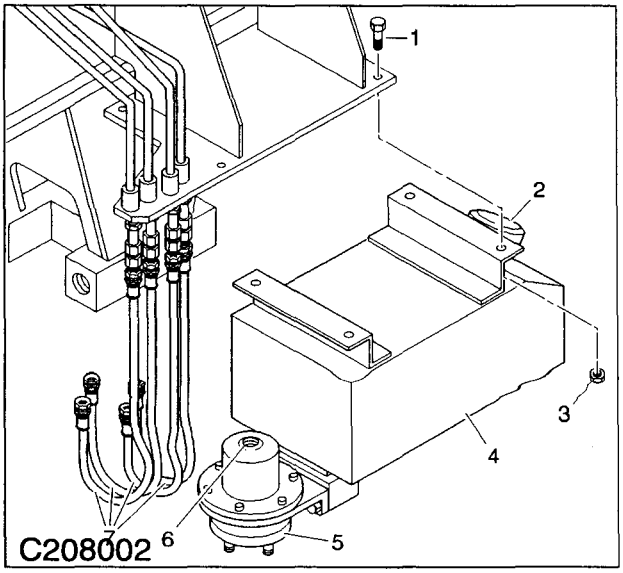
WARNING:

High Pressure Pneumatic Systems. Ensure the bogie pneumatic system is depressurised before commencing maintenance work.

Removal

.1230

Reservoir Tank



Close the air supply to the bogie.

Crack loose the pneumatic connection (6) at the distribution valve union (5). Allow any residual pressure to vent, then disconnect the pneumatic from the union (5). Seal the pneumatic and distribution valve using suitable plugs to prevent the ingress of foreign material.

Tag the location of the four hoses (7) connecting to the unions on the distribution valve (5).

Place a suitable receptacle below the distribution valve (5) , then disconnect the four hoses (7) from the underside of the valve. Allow any excess lubricant to drain from the hoses (7) into the receptacle, then seal the hoses with suitable plastic plugs.

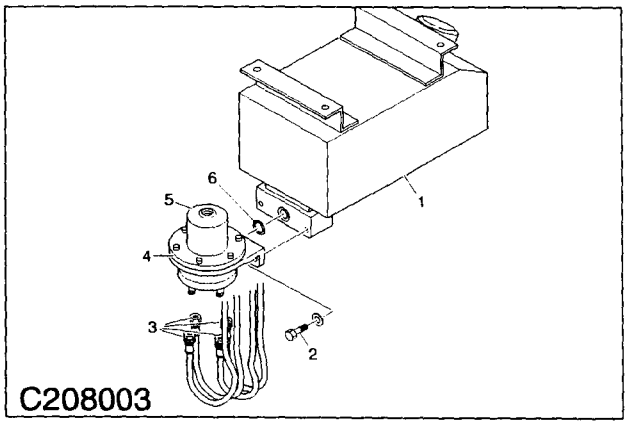
Seal the apertures on the distribution valve (5) with suitable plastic plugs.

Unscrew the bolts (1) and nuts (3) securing the reservoir (4) to the bogie frame brackets, then remove the reservoir (4) from the bogie. Use care not to spill any remaining oil in the reservoir.

Remove the filler cap (2), invert the reservoir over a suitable receptacle and drain the lubricant.

Inspect the reservoir (4) as described in Section Inspection and Repair.

Valve



The valve can be removed when the reservoir tank (1) is either attached or disconnected from the frame.

Close the air supply to the bogie.

If necessary, remove the reservoir tank (1) from the bogie frame.

Crack loose the union at the air supply (5) to the distribution valve (4) and allow the residual pressure to vent.

Unscrew the distribution valve air supply (5), then seal the pipe and valve using suitable plastic plugs.

Place a suitable receptacle below the distribution valve (4), then disconnect the four hoses (3) from the underside of the valve. Allow any excess lubricant to drain from the hoses (3) into the receptacle, then seal the hoses (3) with suitable plastic plugs.

Seal the apertures on the distribution valve (4).

If a large amount of oil remains in the reservoir (1) either, pump it out or place a receptacle below the valve large enough to hold the volume of oil in the reservoir (1).

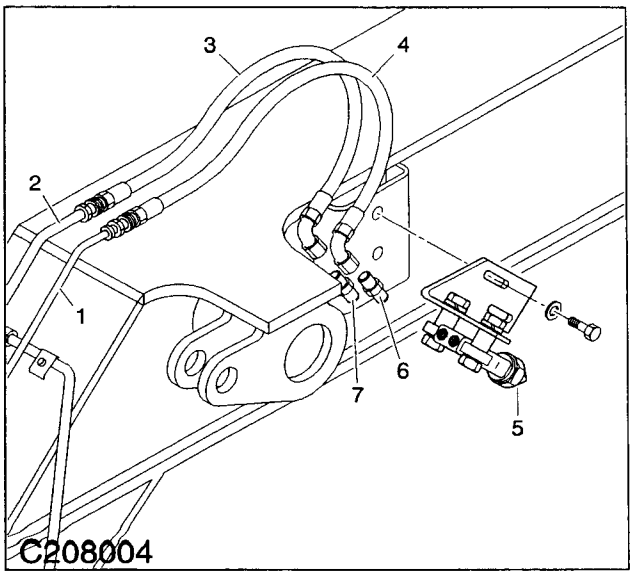
Crack loose the bolts (2) securing the distribution valve (4) to the reservoir (6). Loosen both bolts (2) about one turn, separate the valve (4) from the reservoir (1) and allow the residual lubricant to drain into the receptacle.

After all the lubricant has been drained from the reservoir (1), remove the bolts (2) and disconnect the distribution valve (4) from the reservoir (1).

Remove and discard the O–ring (6).

Inspect the valve as described in Section Inspection and repair.

Piping



Two types of piping are associated with the flange lubrication system. The pneumatic system (2) provides pressured air to operate the distribution valve and to atomise the lubricant at the nozzle (5). The hydraulic system (1) distributes the lubricant from the reservoir to the nozzles (5) on the individual wheels.

Pneumatic Piping

The pneumatic piping (3) can be removed as required using normal workshop practices.

Close the air supply to the bogie.

Crack loose the pneumatic connection (7) at the union. Allow any residual pressure to vent, then disconnect the pneumatic piping (3) from the union.

Seal the pneumatic piping (3) using suitable plugs to prevent the ingress of foreign material.

Hydraulic Piping

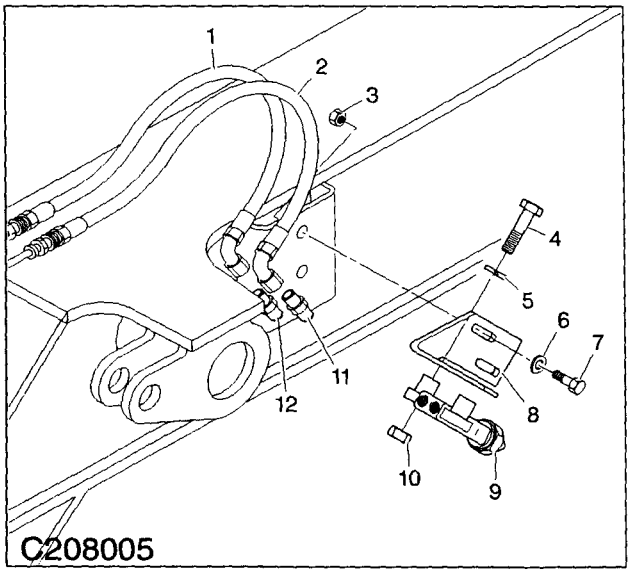
The hydraulic piping (4) can be removed as required using normal workshop practices.

Place a suitable receptacle below the area.

Crack loose the hydraulic connection (6) at the union. Allow any residual lubricant to drain, then disconnect the pipe (5) from the union.

Seal the pipe (4) and union using suitable plugs to prevent the ingress of foreign material.

Nozzle and Bracket



Close the air supply to the bogie.

Tag the pipes at the nozzles (9) to assist in reinstallation.

Crack loose the pneumatic connection (12) at the union. Allow any residual pressure to vent, then disconnect the pneumatic pipe (1) from the union. Seal the pipe (1) and nozzle (9) using suitable plastic plugs.

Place a suitable receptacle below the area.

Crack loose the hydraulic connection (11) at the union. Allow any residual lubricant to drain into the receptacle, then disconnect the hydraulic pipe (2) from the union. Seal the pipe (2) and nozzle (9) using suitable plastic plugs.

Match mark the flange lubrication bracket (8) to the bogie frame.

Remove the bolts (7) with washer (6) and nut (3) securing the bracket (8) to the frame.

Match mark the nozzle (9) to the bracket (8), then undo the bolts (4) with washer (5) and nuts (10) securing the nozzle (9) to the bracket (8).

Disassembly

@.1240
[Not Required]

Inspection and Repair

@.1250

Reservoir Tank

Inspect the reservoir for damage or cracking. Repair any damage found.

Check the mounting flanges for cracks or damage, rectify any faults found.

Check the distribution valve mounting. Ensure the plate is flat and free of pitting or valleys. Machine the face of the mounting if necessary.

Check the condition of the reservoir cap and replace as required.

Inspect the seal in the reservoir cap. Replace if deteriorated or damaged.

Valve

Inspect the O–ring seat. Ensure it is free of burrs or damage.

Inspection of the distribution valve is described in the Sécheron manual [Intentionally left blank].

Nozzle

Inspection of the distribution valve is described in the Sécheron manual [Intentionally left blank].

Check the mounting bracket for wear, damage or cracks. Carefully inspect the area where the nozzle spacers seat on the bracket. A loose nozzle can cause excessive wear. Replace if required.

Check to ensure the bracket is flat and square.

Sanitation Parts/Operating Material

@.1260
[Not Required]

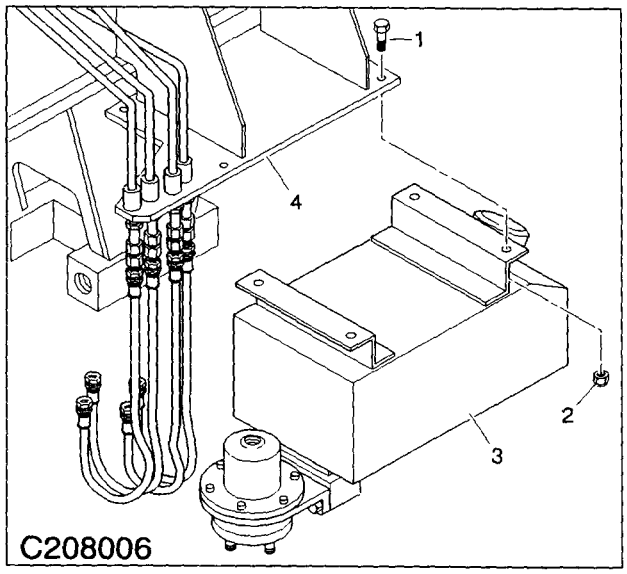
Assembly

@.1270
[Not Required]

Installation

@.1280

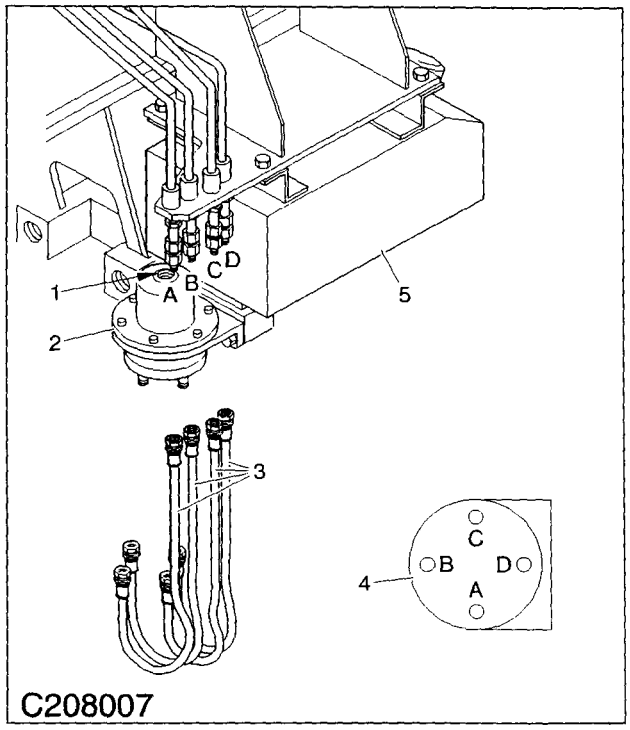
Reservoir Tank



Position the reservoir (3) on the bogie frame brackets (4).

Install the bolts (1) through the holes in the reservoir (3) and bogie frame.

Install the nuts (2) and torque to specification.



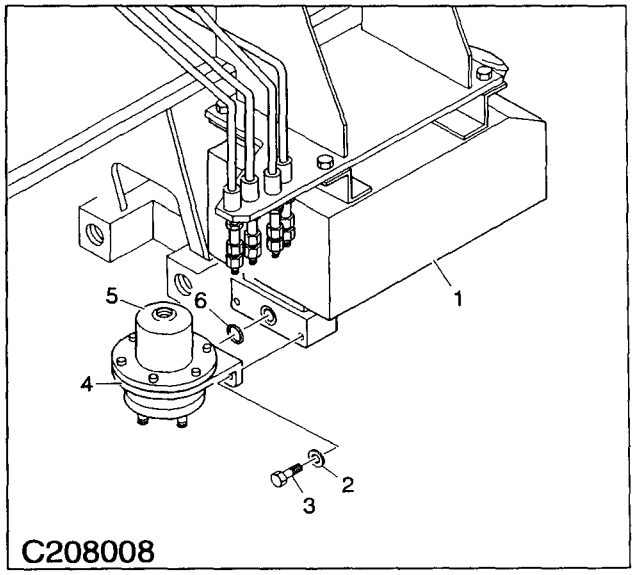
Install the distribution valve (2) , if required. Use a new O–ring.

Remove the sealing plugs from the pneumatic connection (1) and union on top of the distribution valve (2). Connect the pneumatic connection (1) to the union.

Remove the sealing plugs from the hoses (3) and unions on the bottom of the distribution valves (2). Connect the four hoses (3) as tagged during removal to the unions in the distribution valve (2). The hose locations (4) are also shown in the figure.

Fill the reservoir (5) with about 0.5 litres of lubricant. Check for leaks at the joint between the distribution valve (2) and reservoir (5). Rectify any leaks found, then fill the reservoir (5).

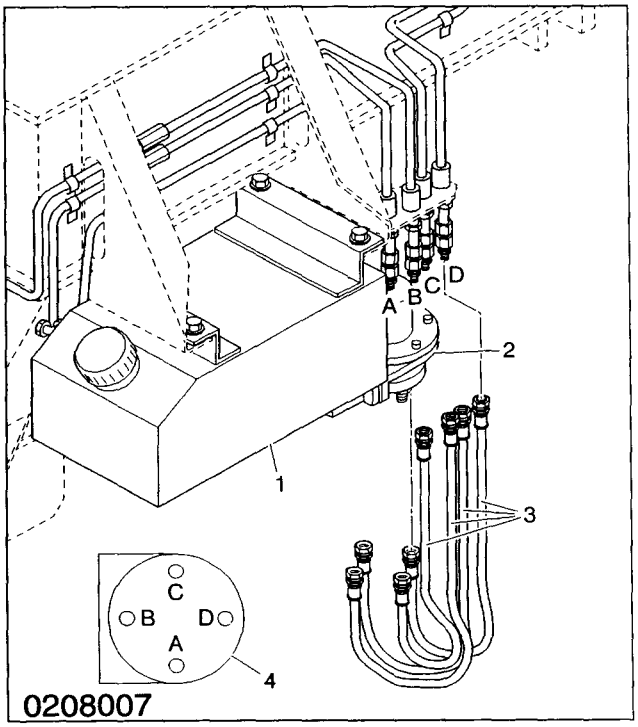
Valve



Check the condition of the distribution valve mounting flange (4) on the reservoir (1), as described in Section Inspection and Repair.

Install a new O–ring (6) into the recess in the distribution valve (4).

Position the valve (4) on the reservoir (1). Install the bolts (3) and washers (2), then torque to specification.



Remove the sealing plugs from the pneumatic connection and union on top of the distribution valve (2). Connect the pneumatic connection to the union.

Remove the sealing plugs from the hoses (3) and unions on the bottom of the distribution valve (2). Connect the four hoses (3) as tagged during removal to the unions in the distribution valve (2). The hose locations (4) are also shown in the figure.

Fill the reservoir (1) with about 0.5 litres of lubricant. Check for leaks at the joint between the distribution valve (2) and reservoir (1). Rectify any leaks found, then fill the reservoir (1).

Piping

NOTE:

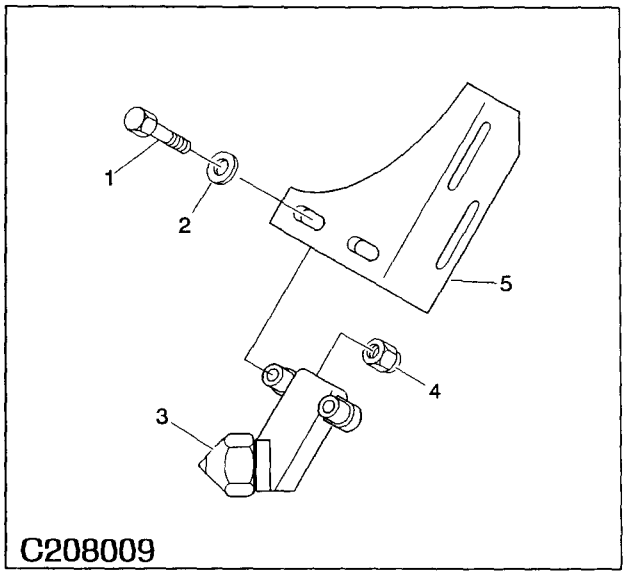
Do not use pipes that have been stored unsealed. Unsealed pipes may be contaminated with scale, oxidation or foreign material that will have an adverse effect on the performance of the flange lubrication system.

Remove the sealing plugs and install either the pneumatic of hydraulic piping using normal workshop practices.

Apply a film of Kopper Kote to unions and joints to prevent binding during future removal.

After installation pressure check the pipes and fittings for leakage. Pressure drop may not exceed 20 kPa in 10 minutes.

Nozzle and Bracket



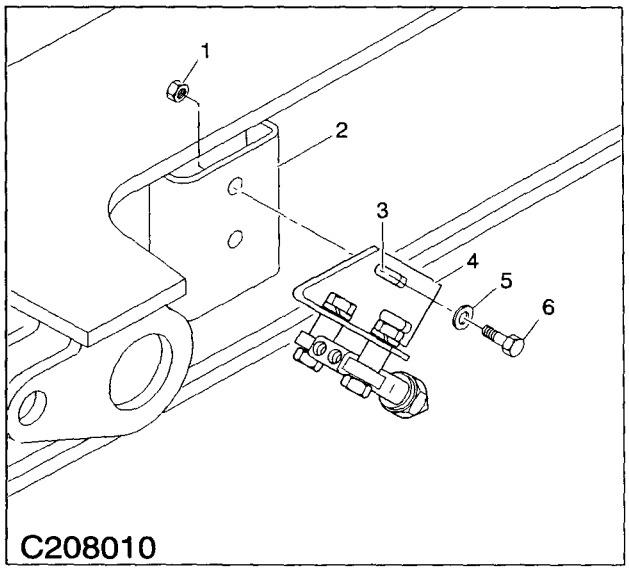
C208009

If necessary, assemble the nozzle (3) to the bracket (5).

Position the nozzle (3) inside the bracket (5) with the nozzle pointing away from the bracket fold line.

Install the bolts (1) and washers (2) through the bracket (5) and nozzle (3) .

Install the nuts (4). Align the match marks then torque the nuts (4) to specification. Install the nozzle (3) in the centre of the bracket (5) if there are no match marks.

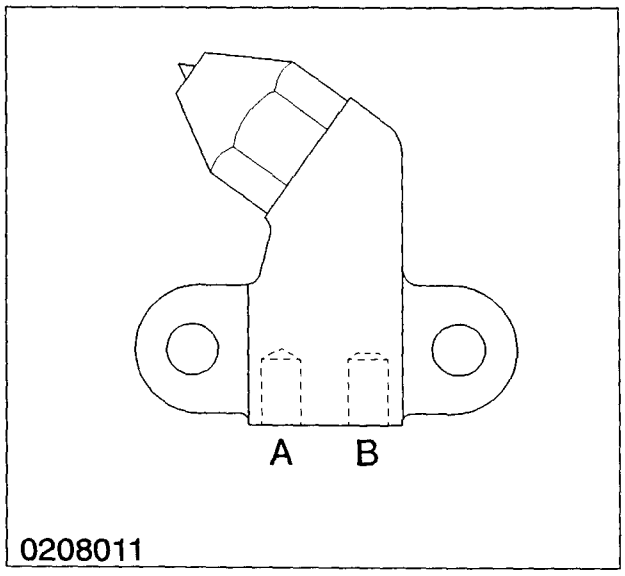


C208010

Position the nozzle and bracket (4) assembly on the bogie frame (2).

Insert the bolts (6) and washers (5) through the bracket (4) and bogie frame (2).

Install the nuts (1) and tighten finger tight. Align the match marks, or position the bracket (4) centrally on the elongated holes (3), then torque the nuts (1) to specification.



Remove the plugs sealing the pneumatic pipe and the pneumatic connection at the nozzle. The pneumatic pipe is 10 mm diameter and the pneumatic connection is on the outside of the nozzle (the side opposite the spray direction). Connect the pneumatic pipe to the connection B on the nozzle using the flexible hose .

Remove the plugs sealing the oil pipe and the oil connection at the nozzle. The oil pipe is 6 mm diameter and the oil connection is on the inside of the nozzle (the same side as the spray direction). Connect the oil pipe to the connection (A) on the nozzle using the flexible hose .

Adjust the position of the nozzle as described in Section Adjustments.

After–Installation Operations

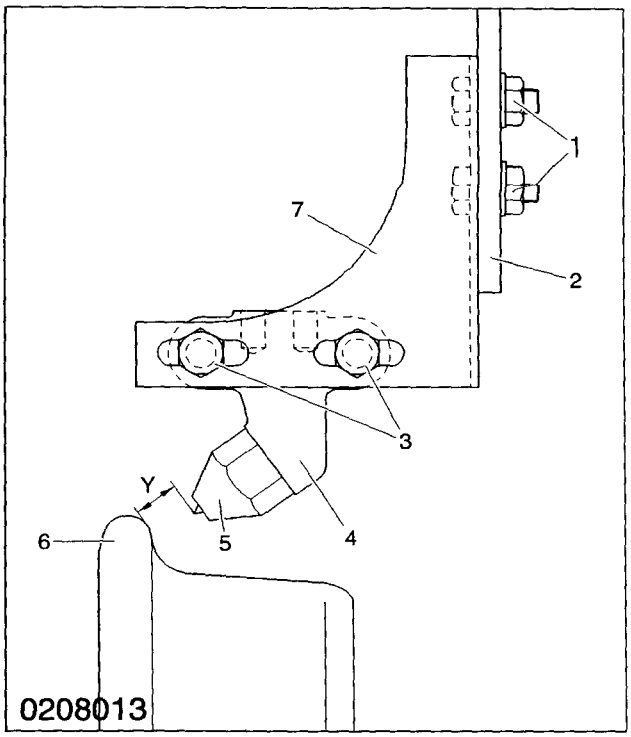
@.1290

For supplementary information see Volume F2.

Adjustments

@.1310

Nozzle Adjustment



Loosen the nuts (1) securing the flange lubrication nozzle bracket (7) to the bogie frame (2).

Adjust the position of the nozzle (4) to specification.

Tighten the nuts (1) to specification.

Check the height and re–adjust if necessary.

Measure the distances [X] and [Y] from the wheel flange (6) to the tip (5) of the flange lubrication nozzle.

Adjust the position of the nozzle (4) if it is not within the dimension specified in Section Technical Data

Loosen the nuts (3) securing the flange lubrication nozzle (4) to the bracket (7).

Adjust the position of the nozzle (4) to specification.

Tighten the nuts (3) to specification.

Check the distance and re-adjust if necessary.

Repeat the procedure for all other flange lubrication nozzles on the locomotive.

BOMBARDIER TRANSPORTATION

IR WAG9

Volume D1

Power Supply

3.00	Power Supply	1
3.01	Roof Line	2
3.02	Pantograph	3
3.03	Main Circuit Breaker	4
3.04	Surge Arrester	5
3.05	Main Transformer	6
3.06	Transformer Oil Cooling	7
3.07	Transducer	8
3.08	Primary Earth	9
3.09	Filter	10
		11
		12

3 Power Supply

For complementary information see following Chapters in Volume D1:

Roof line	3.1
Pantograph	3.2
Main Circuit Breaker	3.3
Surge Arrester	3.4
Transformer	3.5
Transformer Oil Cooling	3.6
Transducers	3.7
Primary Earth	3.8
Filter	3.9

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3.1 Roof Line

General Notes on Hazards in the Work Area

@.1040

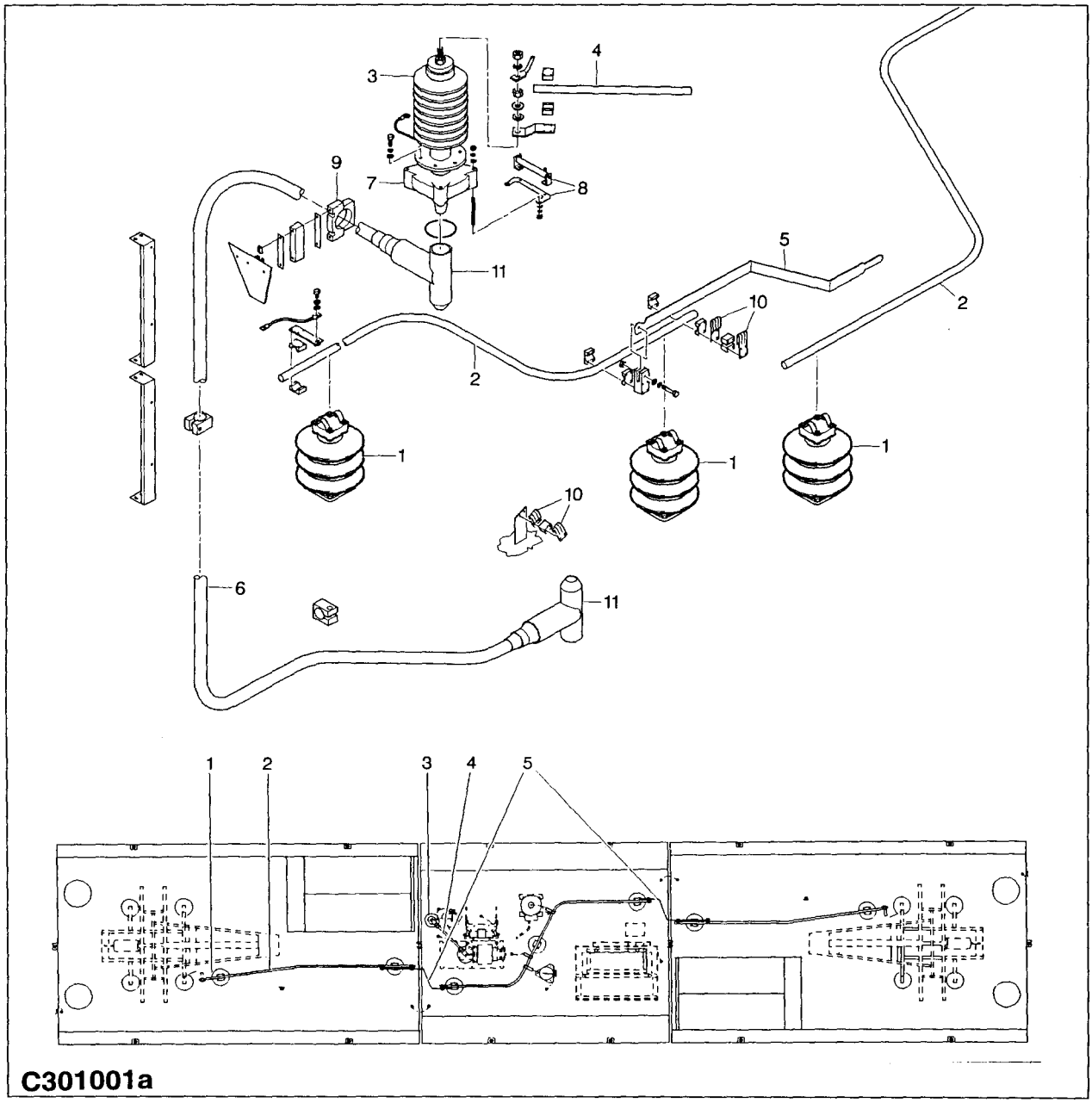
WARNING:

HIGH VOLTAGE! DANGER OF ELECTROCUTION. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVER-HEAD.
Lower the pantograph and isolate the overhead catenary power whenever working on the roof.

Group Summary

@.1120

This chapter contains information on the locomotive roof line electrical system, which incorporates the electrical connections between the pantographs, pin insulators, isolator switches and the high voltage bushing.



C301001a

1	Pin insulator	7	Primary current transformer (6.1)
2	Roof line	8	Primary current transformer resistor (6.11)
3	High voltage bushing (1010)	9	High voltage cable clamp
4	High voltage connection	10	Contact springs
5	Isolator switch	11	High voltage cable plug
6	High voltage cable		

Numbers in brackets () denote the electrical equipment apparatus item number used in the locomotive schematics, refer to Volume G, Cabling Documentation.

Functional Description

@.1140

The roof line carries the current from the pantograph via the isolator switches. The line is electrically insulated from the roof by the pin insulators. Current from the roof line passes through the vacuum circuit breaker and high voltage connection to the high voltage bushing on the roof. Current is carried to the transformer, situated in the machine room, along the high voltage cable. The primary current transformer is situated on the underside of the converter roof hatch, below the high voltage bushing. The control electronics uses the signal to measure the current flowing through the high voltage cable from the catenary.

The isolator switches allow the roof line to be broken for removal of the locomotive roof hatches. Spring contacts hold the isolator switches in either position.

The high voltage cable connects to the high voltage bushing with a push on-pull off connection. The cable is secured to the converter roof hatch by a clamp and to the machine room along a support arm.

Technical Data

@.1160

High voltage bushing

- Type	RMF 30Y/ 630 SL

Pin insulator type BDI25

- Resistance	3.3 Ω ± 10%
- Rated power	100 W

Pin insulator

- Type	BDI25
- Nominal voltage	25 kV
- Weight	18 kg

Tolerances and Wear Limits

@.1170

Refer to the component manufacturers technical documentation for tolerances of individual components.

Tools and Special Tools

@.1180

Conventional railway workshop tools are required for the procedures described in this chapter.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Rhodorsil Paste 4 silicon grease is required as a moisture-proofing agent for the roof bushing and pin insulators
- Clean plastic is required as a covering to protect the high voltage bushing and cable electrical contact surfaces
- Tape to secure the plastic
- Sécheron Grease L3, NBT 400344 P2, is required to coat the earthing switch contact blades and spring contacts
- Silicon spray to lubricate the high voltage cable connections
- Clean, dry lint free cloth
- Paper towelling

Before Removal Operations

@.1220

Lower the pantograph and isolate the overhead catenary. Earth the locomotive at the vacuum circuit breaker. Refer to the Preface of this Volume.

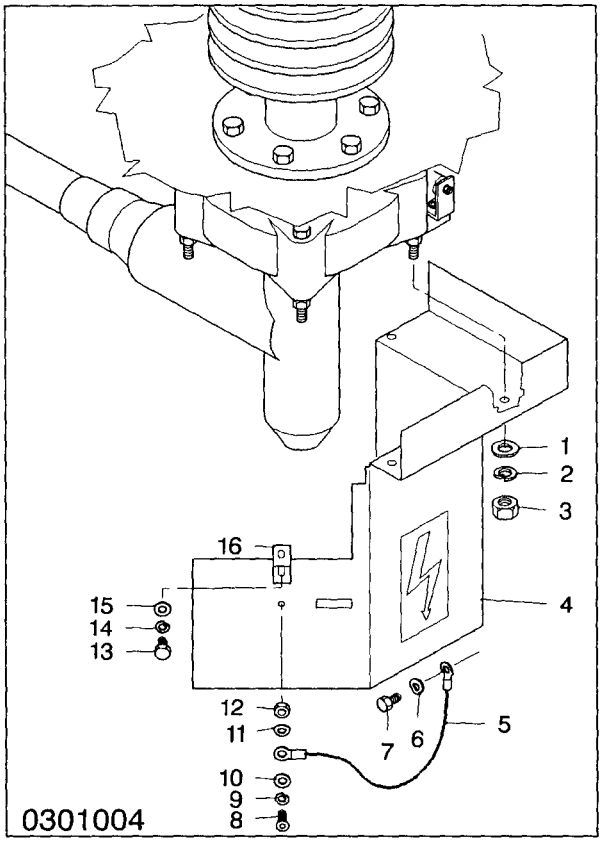
Earth the traction converter as described in Chapter 4.1, Traction Converter. Operation of the key interlocking system is described in Chapter 3.11, Protection Concept of Volume A, Driver's Manual.

Steam clean the roof line and surrounding area, paying particular attention to the contact springs. Remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

Removal

@.1230

High voltage cable

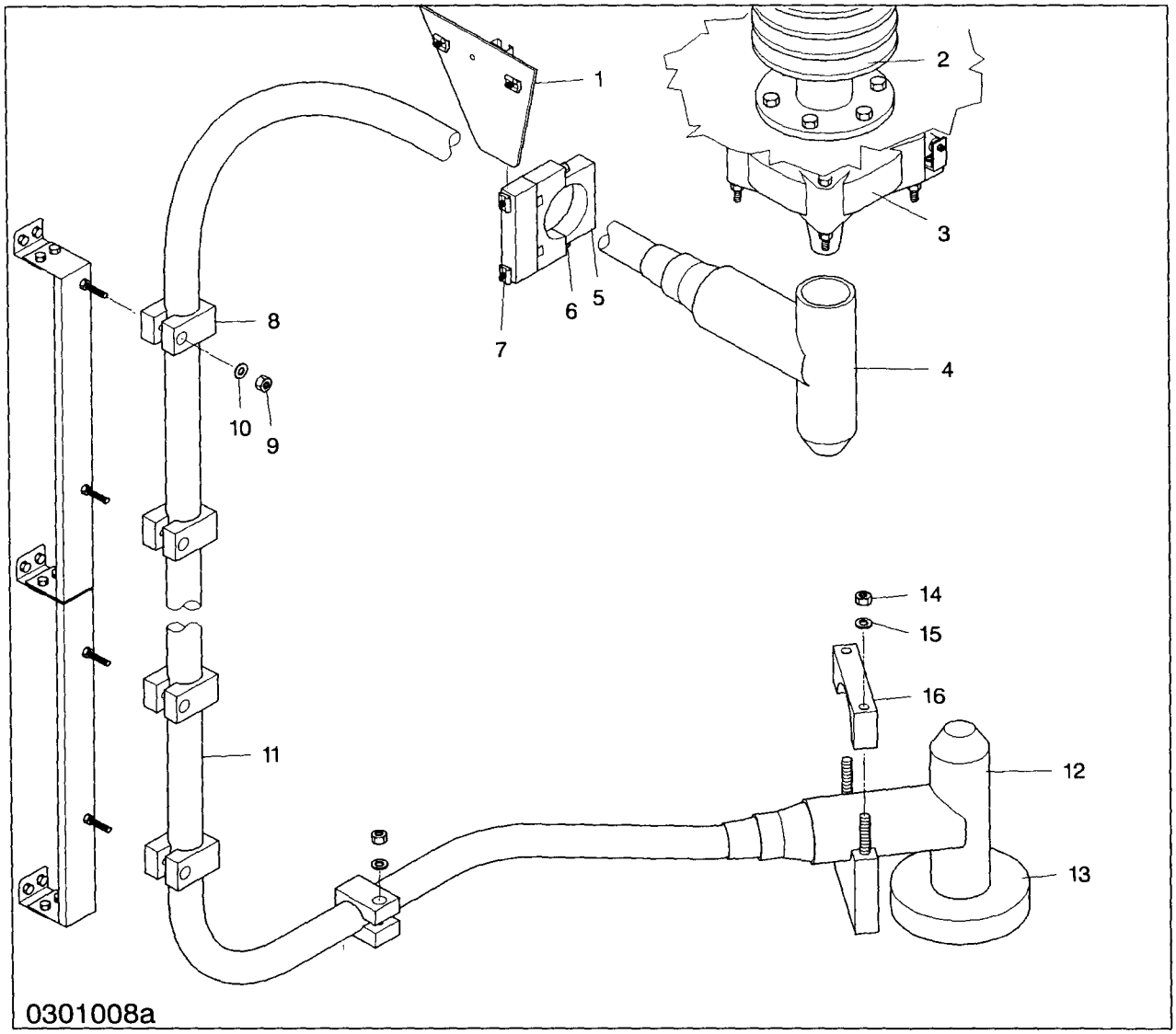


From within the machine room, remove the screws (7) and washer (6) from the earthing strap (5).

Remove the nut (12) and washer (11) securing the earthing strap (5) to the cover (4). Remove the strap (5), screw (8) and washers (9, 10).

Remove the screws (13) and washers (14, 15) from the support bracket (16).

Remove the nuts (3) and washers (1, 2) securing the cover (4) to the primary current transformer.



Remove the nuts (9) and washers (10) securing the high voltage cable clamps (8) to the support bracket.

Loosen the screws (6) of clamp (5) until the clamp (5) is loose in the channel (1).

Pull the high voltage cable plug (4) from the bushing (3), simultaneously sliding the clamp (5) downward from the channel (1).

In the bottom of the traction converter, remove the nuts (14) and washers (15) from the clamp (16) securing the high voltage cable (11) at the transformer bushing.

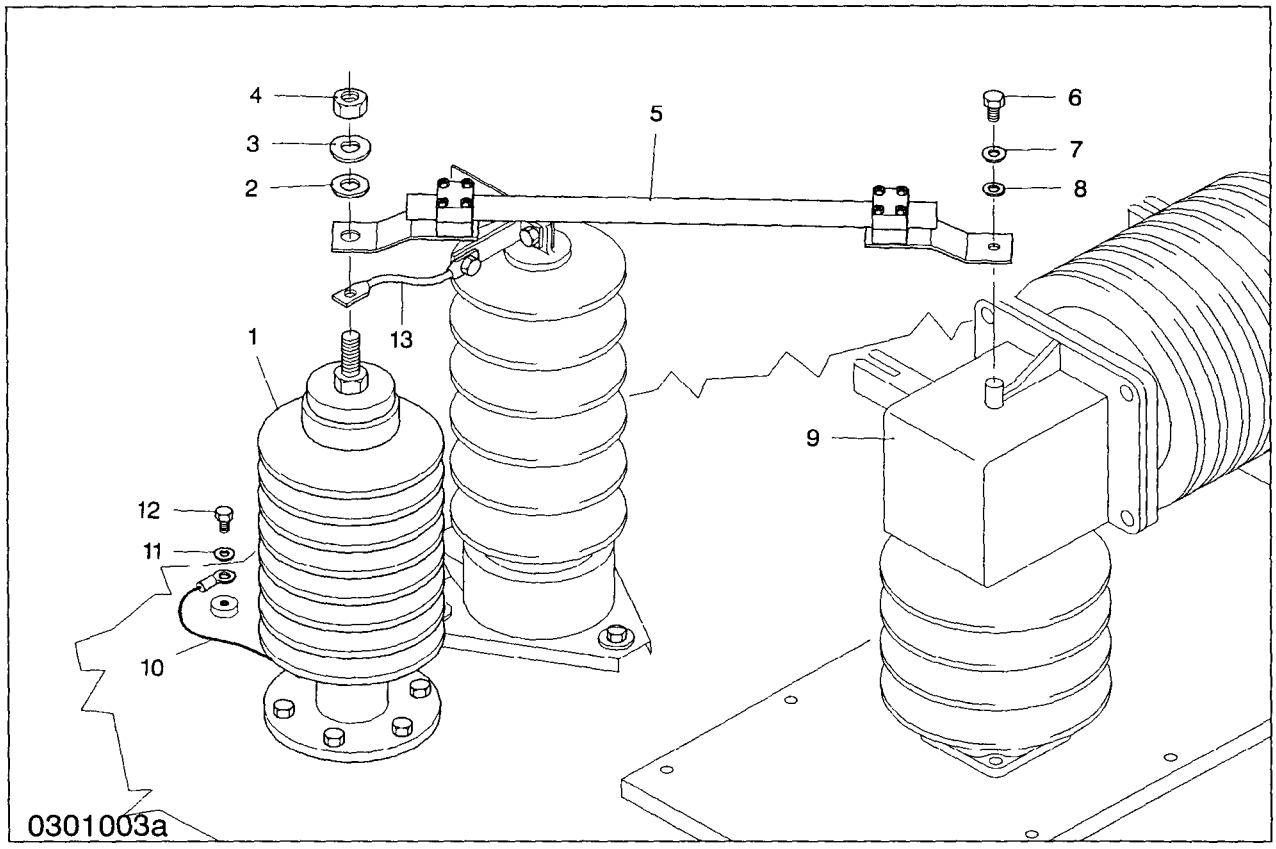
Pull the plug (12) from the transformer bushing (13), then remove the high voltage cable (11).

Cover the high voltage bushing (3) and transformer bushing connector (13) with plastic to prevent contamination with dirt or oil. The high voltage bushing is not oil resistant.

Cover the connector sockets on both ends of the high voltage cable (11) with plastic to prevent contamination.

Tape the plastic securely. The tape adhesive must not touch any part of the bushing (3) or socket (4, 12) electrical contact surfaces.

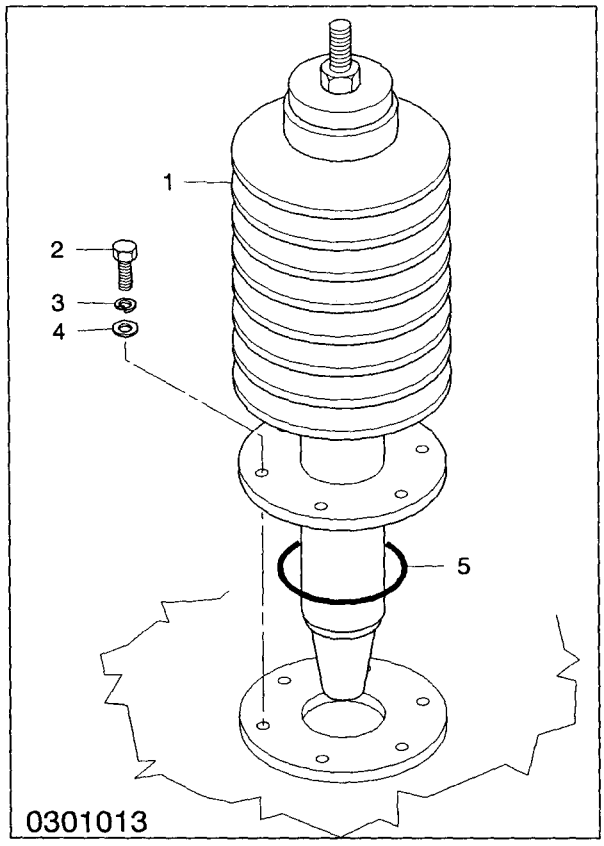
High voltage bushing



Remove the screw (6) and washers (7, 8) securing the high voltage connection (5) to the vacuum circuit breaker (9).

Remove the nut (4), spring and plain washers (2, 3) securing the high voltage connection (5) to the high voltage bushing (1), then lift the connection bar (5) and surge arrester jumper cable (13) from the bushing.

Remove the screw (12) and washer (11) securing the earthing strap (10) to the converter roof hatch.

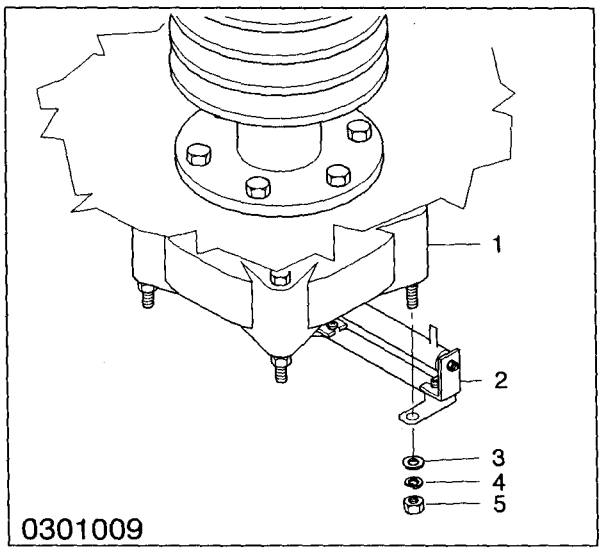


Remove the screws (2) and washers (3, 4) securing the high voltage bushing (1) to the converter roof hatch.

Lift the bushing (1) from the roof.

Remove and discard the O-ring (5) from the bushing flange.

Primary current transformer



The resistor (2) is held in position by two of the four nuts (5) securing the primary current transformer (1). Hold or support the resistor (2) when removing the nuts (5) to prevent it falling.

Cut the cable ties securing the electrical cables to the transformer (1).

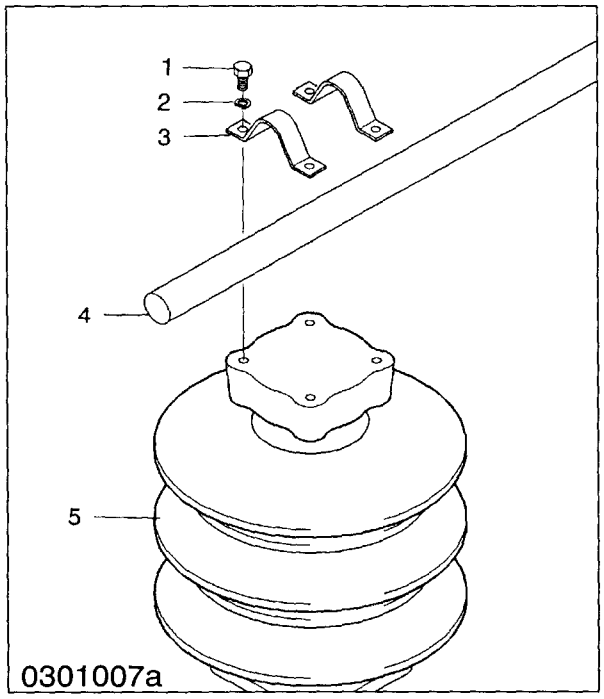
Tag and disconnect the electrical cables from the terminals on the resistor (2).

Tag and disconnect the electrical cables from the terminals on the primary current transformer (1).

Remove the two nuts (5) and washers (4, 3) securing the resistor bracket to the transformer (1). Remove the resistor and bracket assembly from the transformer (1).

Support the transformer then remove the remaining two nuts (5) and washers (4, 3) securing the transformer (1) to the converter roof hatch.

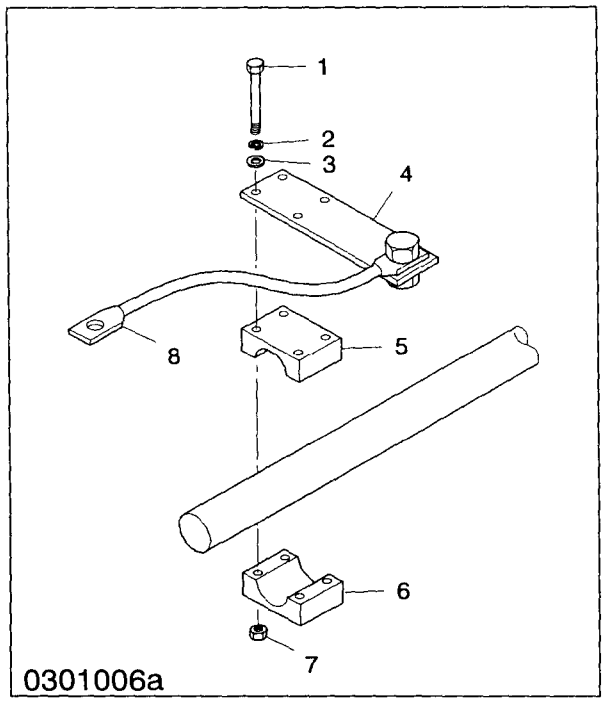
Roof line



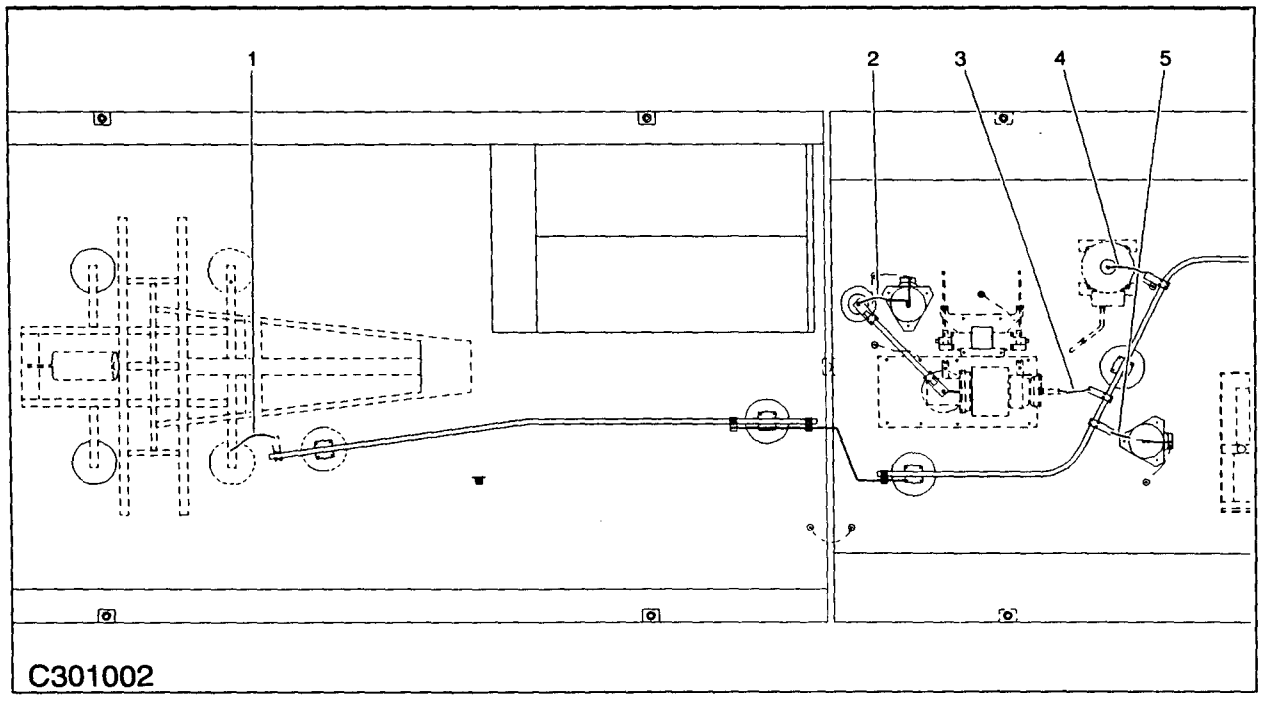
Lift the isolator switches from the contact springs, or if necessary, remove the isolator switches.

Remove the screws (1) and washers (2) from the line clamps (3).

Repeat the procedure for the remaining line clamps (3) securing the roof line (4).



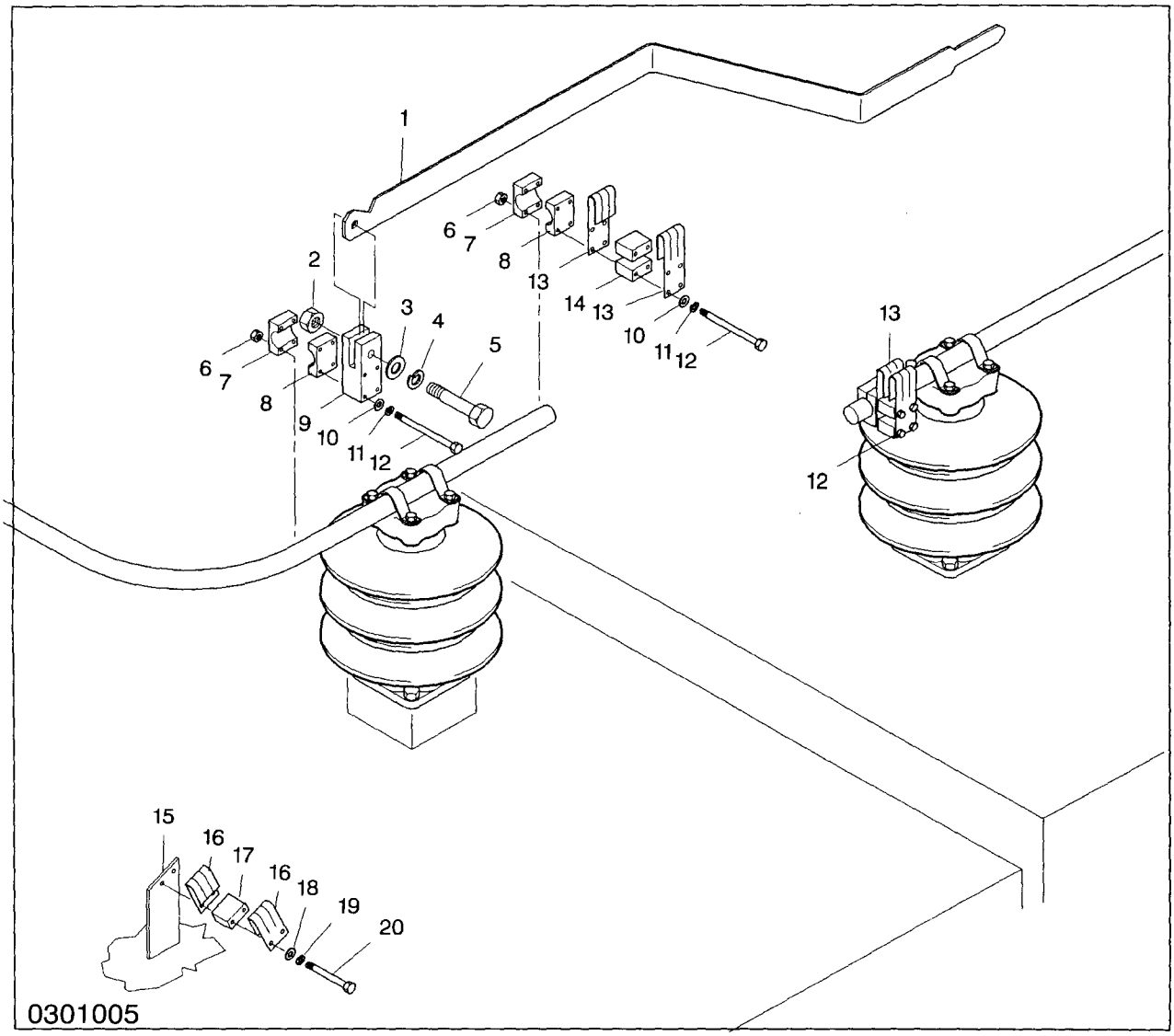
Remove the nuts (7), clamps (5,6), washers (2,3), bolts (1) and cable support plate (4) from the pantograph end of the roof line. If there is no need to remove the support plate (4), the jumper cables (8) may be disconnected from the support bracket (4).



Locations of the jumper cables (1 - 5) along the roof line are shown in the figure. Configuration of the support plate varies according to the location.

Remove the roof line from the locomotive.

Isolator switches



Lift the isolator switch (1) from the contact spring (13).

Remove the bolt (5), washers (3, 4) and the nut (2) from the pivot point. Then lift the switch (1) from the holder (9).

If necessary, remove the contact springs, pivot from either the roof line or roof hatch (15).

Remove the bolts (20) and washers (18, 19) from the holder on the roof hatch.

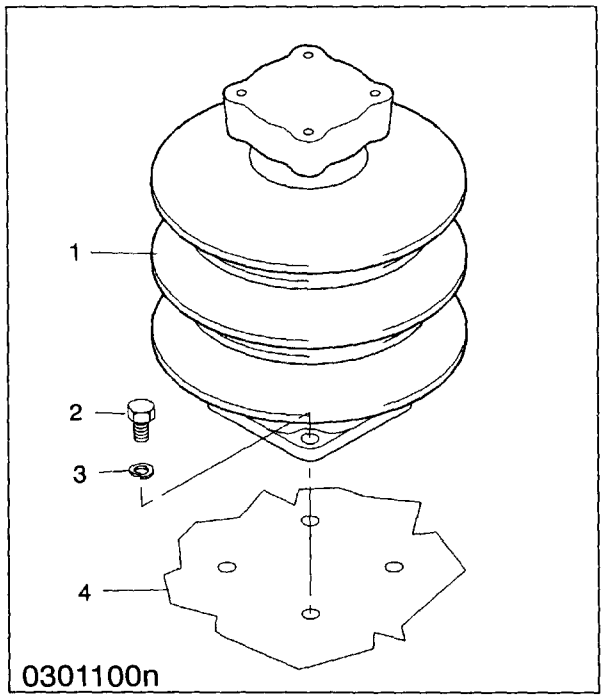
Separate the contact springs (16) and spacer (17) from the bracket.

At the pivot end of the isolator switch, remove the bolts (12), washers (10, 11) and nuts (6).

Remove the contact springs (13), spacers (14) and clamps (7, 8).

At the contact end of the roof line, remove the bolts (12), washers (10, 11) and nuts (6) securing the holder (9) and clamps (7, 8) to the roof line.

Pin insulators



Remove the roof line as described in this Section.

Remove the jumper cables as described in this Section.

Remove the bolts (2) and washers (3) securing the pin insulator (1) to the roof hatch (4).

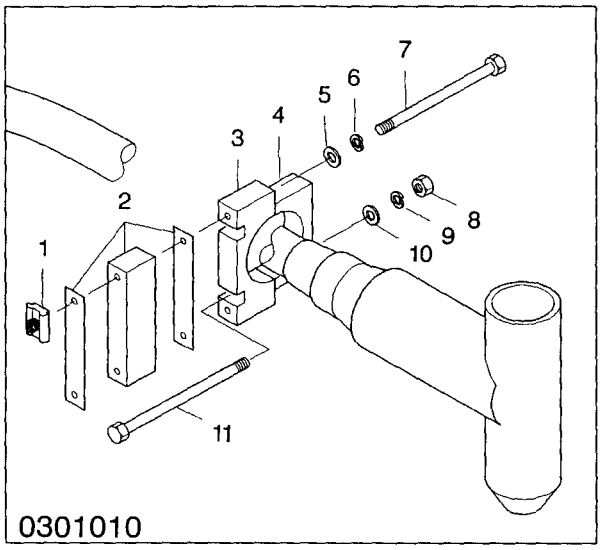
Carefully lift the insulator (1) from the roof.

Repeat the procedure for the other insulators (1) as required.

Disassembly

@.1240

High voltage cable

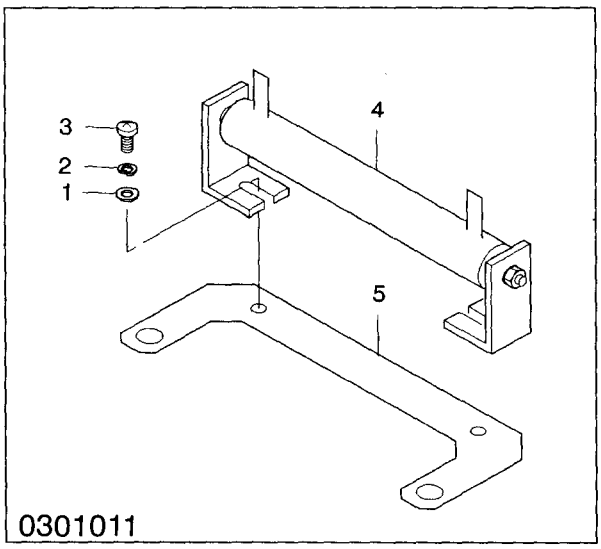


Remove the bolts (7), washers (5, 6) and sliding nuts (1).

Separate the spacers and plates (2) from the clamp (3, 4).

Remove the bolts (11), washers (9, 10) and nuts (8) securing the two halves of the clamp (3, 4), then separate the clamp from the cable.

Primary current transformer resistor



Tag and disconnect the cables from the resistor terminals.

Remove the screws (3) and washers (1, 2) securing the resistor (4) to the bracket (5).

Inspection and Repair

@.1250

High voltage cable

Check for external damage to the cable case and the connectors. Replace the cable if damaged.

Check the electrical connectors. The contact surfaces must be in good condition and completely clean.

High voltage bushing

Check the condition of the bushing and replace if damaged or cracked.

Inspect the electrical connector. Replace the bushing if worn, damaged or if there is any sign of arcing or carbon build-up.

Clean the electrical connectors. The contact surfaces must be in good condition and completely clean.

Inspect the condition of the silicon coating. Contaminants in the silicon coating reduce the insulating effect of the high voltage bushing insulator. Water applied to the surface of the insulator should bead and not wet the surface. If the coating is contaminated or is wetted by water, the coating must be renewed. Audible discharges or flashovers that are visible in the dark are an indication that the insulator needs to be re-coated.

Remove the contaminated silicon coating using paper towelling. Wipe any remaining silicon coating from the insulator using a clean, dry, lint free cloth. Clean the surface of the insulator thoroughly using a cloth soaked in alcohol.

Ensure the glazed surface of the high voltage bushing insulator is clean, dry and shiny. The silicon grease described in Section Miscellaneous Materials should be applied evenly to the entire glazed surface of the insulator to a thickness of 0.2 to 1 mm.

Take care when handling the high voltage bushing after coating to avoid contamination of the silicon grease on the insulator.

Roof line

Inspect the condition of the roof line and clamps. Replace any bent or damaged parts.

Inspect the condition of the jumper cables for damage, evidence of arcing or fraying. Replace the cables if damaged or defective.

Isolator switches

Inspect the condition of the contact springs. Replace the contact springs if worn, cracked, damaged or bent.

Check the condition of the spacers. Replace if damaged.

Inspect the electrical connection areas. Replace the arm or contact springs if worn, damaged or if there is any sign of arching or carbon build-up.

Clean the electrical connections. The contact surfaces must be in good condition and completely clean.

Pin insulators

Inspect the condition of the pin insulators, replace if cracked, chipped or damaged.

Inspect the condition of the silicon coating. Contaminants in the silicon coating reduce the insulating effect of the insulator. Water applied to the surface of the insulator should bead and not wet the surface. If the coating is contaminated or is wetted by water, the coating must be renewed. Audible discharges or flashovers that are visible in the dark are an indication that the insulator needs to be re-coated.

Remove the contaminated silicon coating using paper towelling. Wipe any remaining silicon coating from the insulator using a clean, dry, lint free cloth. Clean the surface of the insulator thoroughly using a cloth soaked in alcohol.

Ensure the glazed surface of the insulator is clean, dry and shiny. The silicon grease described in Section Miscellaneous Materials should be applied evenly to the entire glazed surface of the insulator to a thickness of 0.2 to 1 mm.

Take care when handling the insulator after coating to avoid contamination of the silicon grease.

Waste Disposal

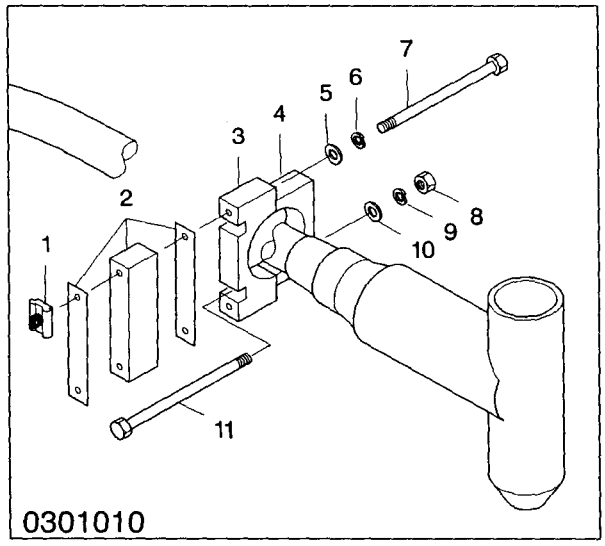
@.1260

Dispose of waste parts, materials and fluids according to the prevailing environmental standards or workplace practices.

Assembly

@.1270

High voltage cable



Position the two halves of the clamp (3, 4) over the cable connector.

Install the bolts (11) and washers (9, 10) through the clamp halves (3, 4).

Install the nuts (8) and tighten finger tight.

Position the bolts (7) and washers (5, 6) through the clamp (3).

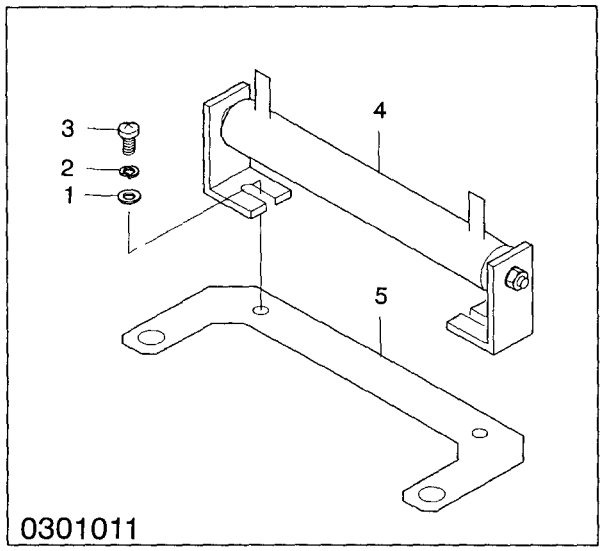
Install the spacers and plates (2) over the bolts (7).

Install the sliding nuts (1), then tighten the bolts (7) finger tight.

Install the cable as described in Section Installation. Tighten the bolts (11) around the connector when the cable is correctly positioned.

Tighten the bolts (7) to secure the clamp to the bracket.

Primary current transformer resistor



Position the resistor (4) on the bracket (5). Install the screws (3) and washers (1, 2).

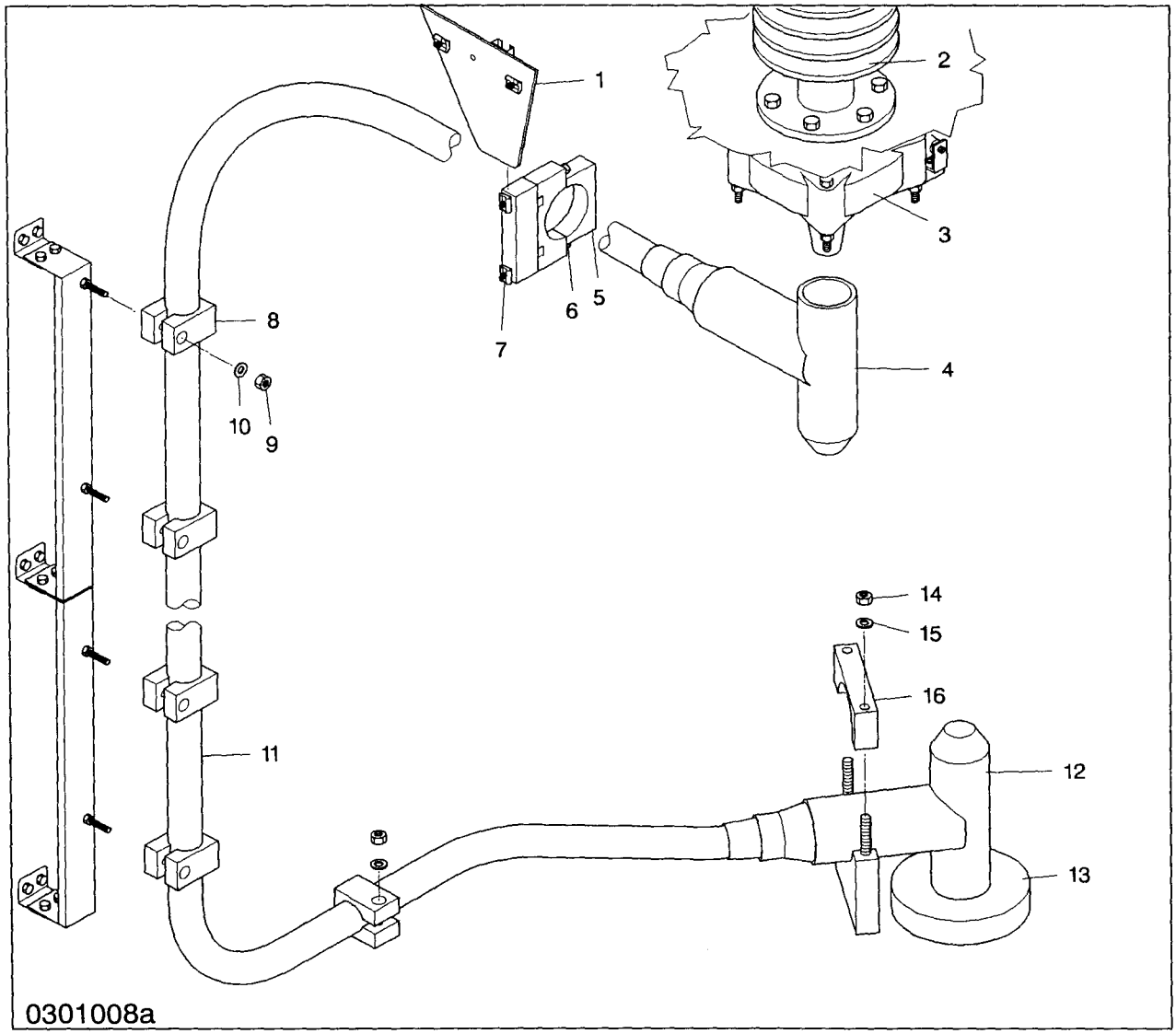
Tighten the bolts (3).

Reconnect the wires, as tagged during disassembly, to the resistor. Refer to Chapter 2, Main Power Circuit, Sheet 01A, Primary Current of Volume G1, Cabling Documentation.

Installation

@.1280

High voltage cable



Install the high voltage bushing (2) and primary current transformer (3), if necessary.

Remove any protective coverings from the connectors on the high voltage (3) and main transformer bushings (13). Remove any protective covering from the high voltage cable connectors (4, 12).

Thoroughly clean the cable sockets (4, 12) and the high voltage (3) and the main transformer bushings (13), using a clean, dry lint free cloth. All dirt, debris, dust or oil must be completely removed. Dirty connections will result in poor electrical performance.

Apply a film of a silicon lubricant to the high voltage (3) and main transformer bushings (13). A small amount of silicon lubricant will aid installation.

From within the machine room, push the high voltage cable plug (4) onto the high voltage bushing (3), simultaneously sliding the clamp (5) upwards into the channel (1).

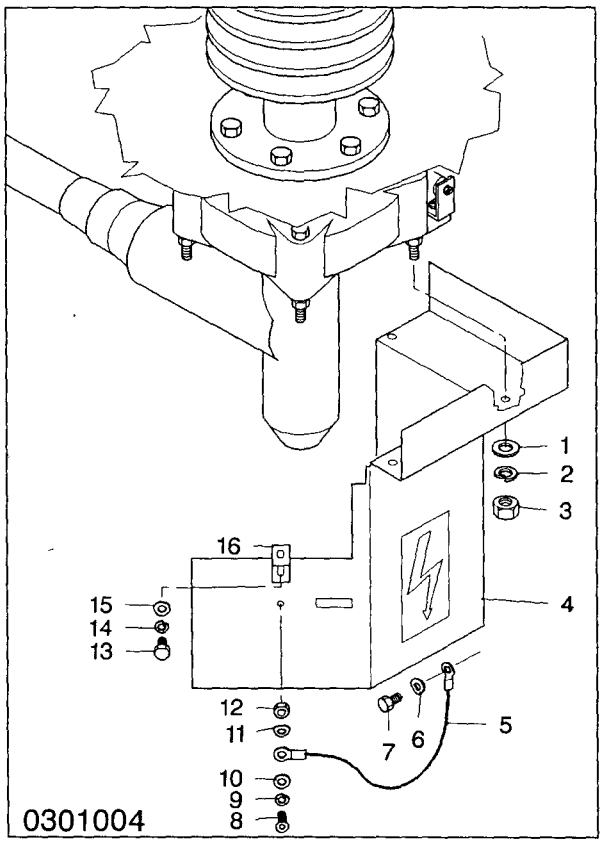
Ensure that no air is trapped between the connector and the bushing. Air can be vented during installation by placing a thin nylon thread positioned along the bushing. After installation, the thread can be withdrawn to vent any air trapped between the connector and bushing.

Install and tighten the screws (6) in the clamp (5).

Place the clamps (8) over the studs on the support bracket. Install the nuts (9) and washers (10) to the high voltage cable (11), then tighten the nuts (9).

In the bottom of the traction converter, push the high voltage cable (11) plug (12) onto the transformer bushing (13).

Install the clamp (16), nuts (14) and washers (15) over the high voltage cable (11) at the transformer. Then tighten the nuts (14).



Position the cover (4) onto the primary current transformer.

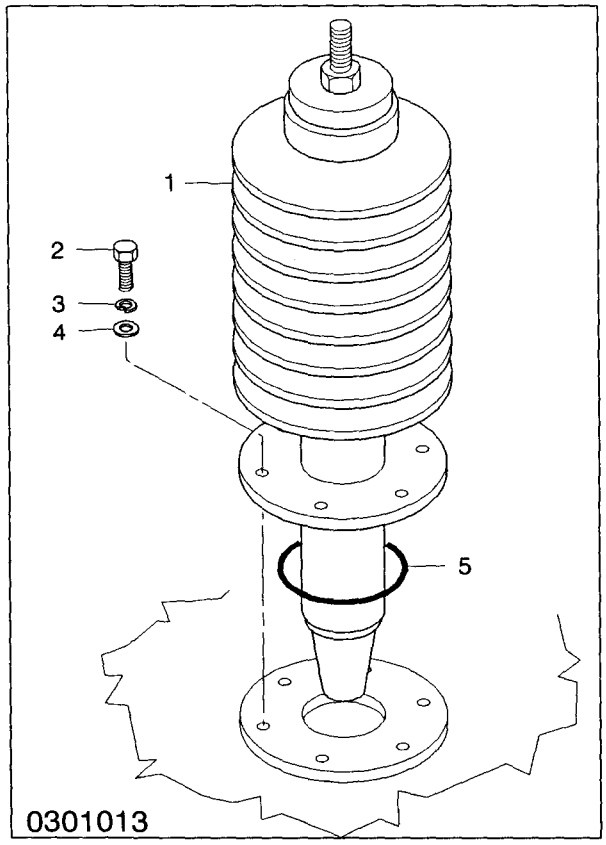
Install the nuts (3) and washers (1, 2) to secure the cover (4). Tighten the nuts (3).

Install the screws (13) and washers (14, 15) through the support bracket (16). Tighten the screws (13).

Position the earthing strap (5), then install the screw (8), washers (9, 10), nut (12) and washer (11) securing the earthing strap (5) to the cover (4).

Install the screws (7) and washer (6) at the opposite end the earthing strap (5).

High voltage bushing



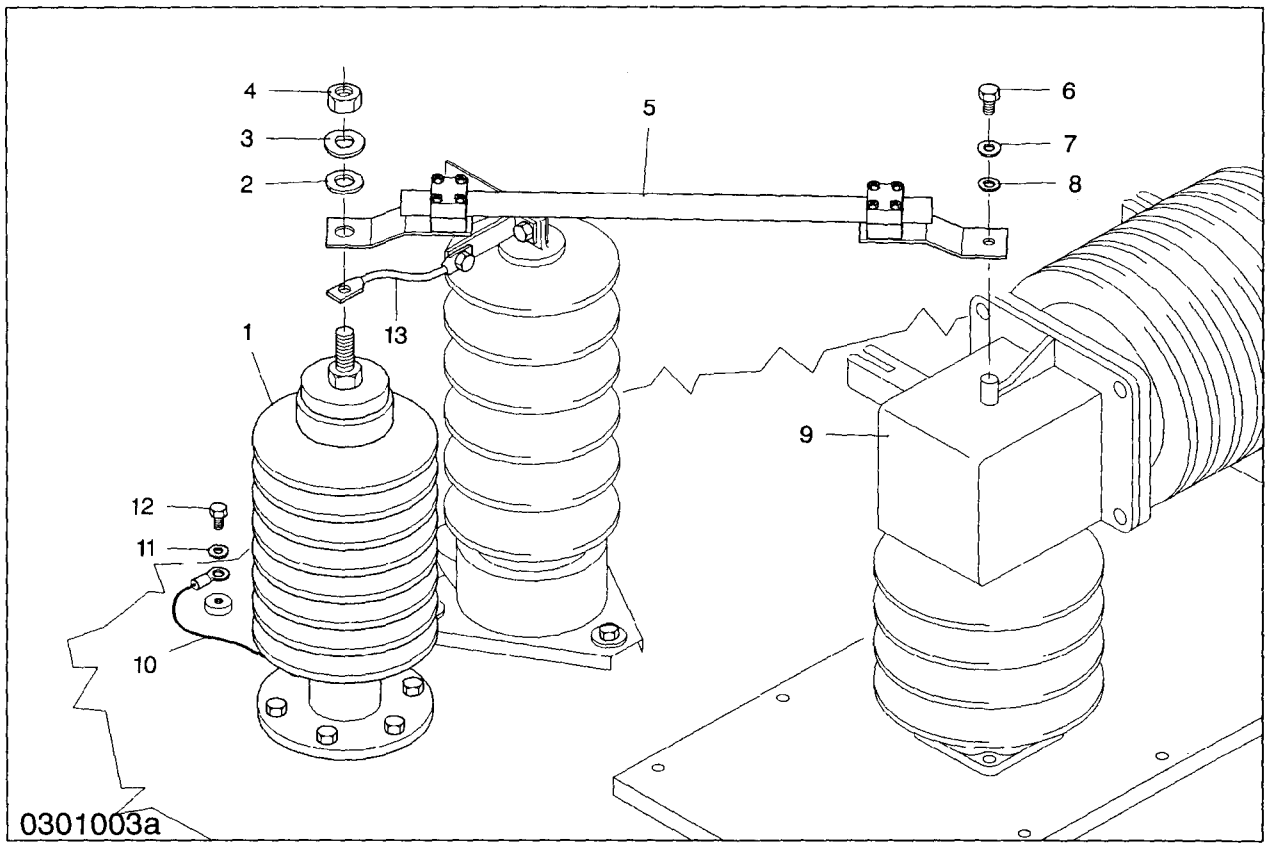
Take care when handling the high voltage bushing to avoid contamination of the silicon grease coating.

Grease a new O-ring (5) with Shell Rhodorsil Paste 4, then install the O-ring (5) onto the groove in the high voltage bushing (1) flange.

Position the bushing (1) onto the converter roof hatch.

Install the screws (2) and washers (3, 4) through the high voltage bushing (1) flange into the converter roof hatch.

Tighten the screws (2).



Install the surge arrester jumper cable (13) onto the high voltage bushing (1).

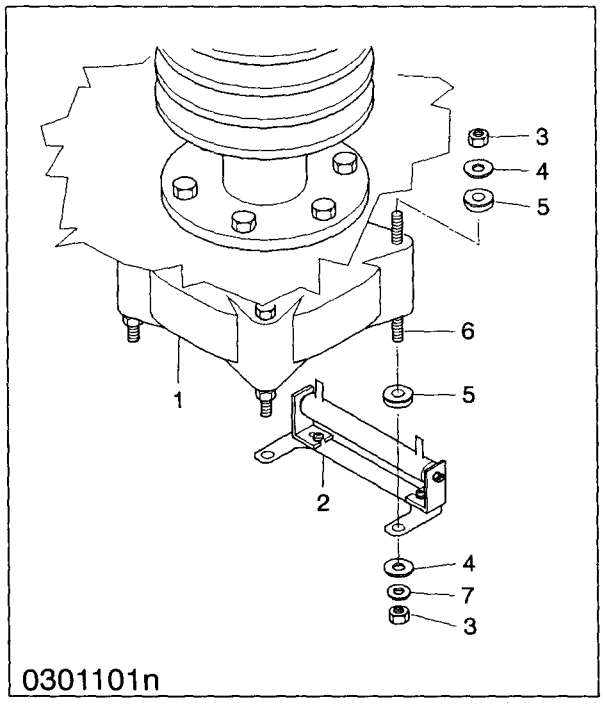
Position the high voltage connection (5) between the vacuum circuit breaker (9) and the high voltage bushing (1).

Install the screw (6) and washers (7, 8) to secure the high voltage connection (5) to the vacuum circuit breaker (9).

Install the nut (4) and washers (2, 3) to secure the high voltage connection (5) to the high voltage bushing (1).

Install the screw (12) and washer (11) to secure the earthing strap (10) to the converter roof hatch.

Primary current transformer



The resistor (2) is held in position by two of the four nuts (3) securing the primary current transformer (1).

Place a large flat washer (4) and an insulator (5) on each stud (6), then position the primary current transformer (1) onto the studs (6). Ensure that the electrical terminals face toward the harness.

Install a large flat washer (4), an insulator (5), spring washer (7) and nut (3) on the two studs (6) that are not used to mount the resistor. Tighten the nuts (3) finger tight.

Install a large flat washer (4) and an insulator (5) on the two remaining studs (6), then install the resistor and bracket assembly (2). Install a large flat washer (4), an insulator (5), spring washer (7) and nut (3) on the two studs (6) holding the resistor bracket (2).

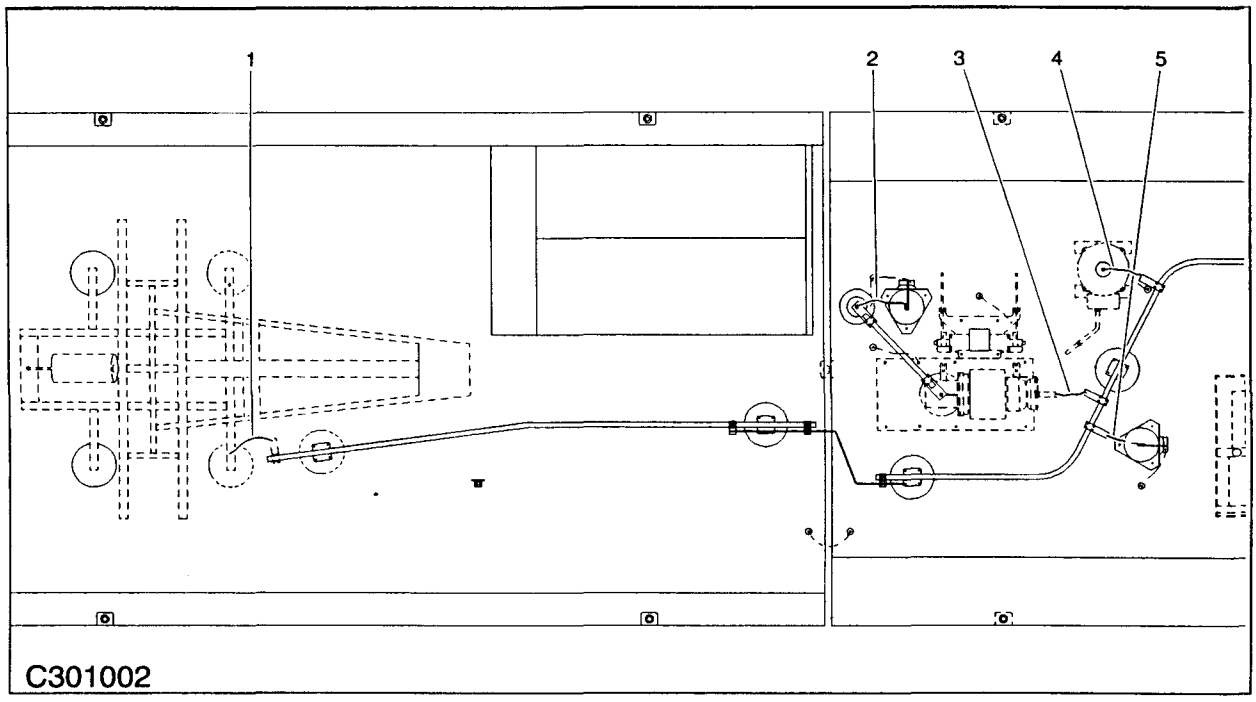
Tighten the nuts (3) on all four studs (6).

Reconnect the wires, as tagged during disassembly, to the primary current transformer. Refer to Chapter 2, Main Power Circuit, Sheet 01A, Primary Current of Volume G1, Cabling Documentation.

Reconnect the wires, as tagged during disassembly, to the resistor. Refer to Chapter 2, Main Power Circuit, Sheet 01A, Primary Current of Volume G1, Cabling Documentation.

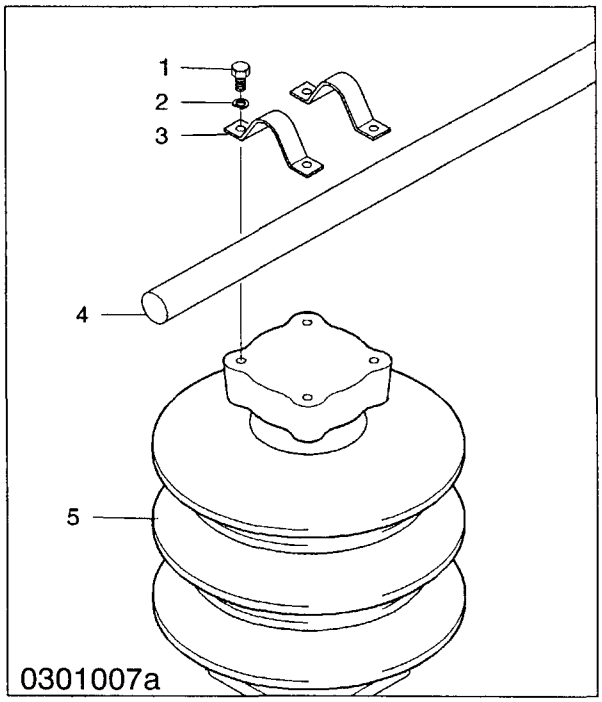
Secure the harness and cables using cable ties.

Roof line



Locations of the jumper cables (1 - 5) along the roof line are shown in the figure. Configuration of the support plate varies according to the location.

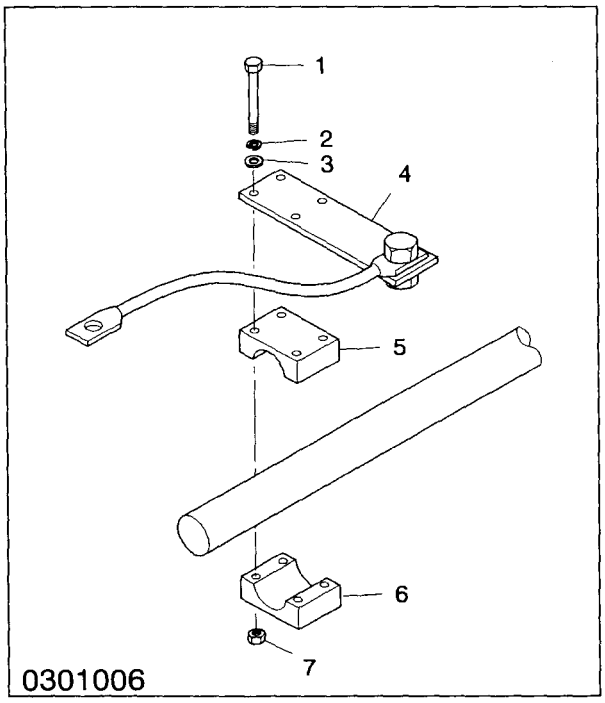
Place the roof line in position on the pin insulators.



Place the two clamps (3) over the roof line (4) and pin insulator (5).

Align the holes, then install the screws (1) and washer (2) through the clamps (3) into the pin insulator (5).

Repeat the procedure for the remaining line clamps (3) on the roof line (4).

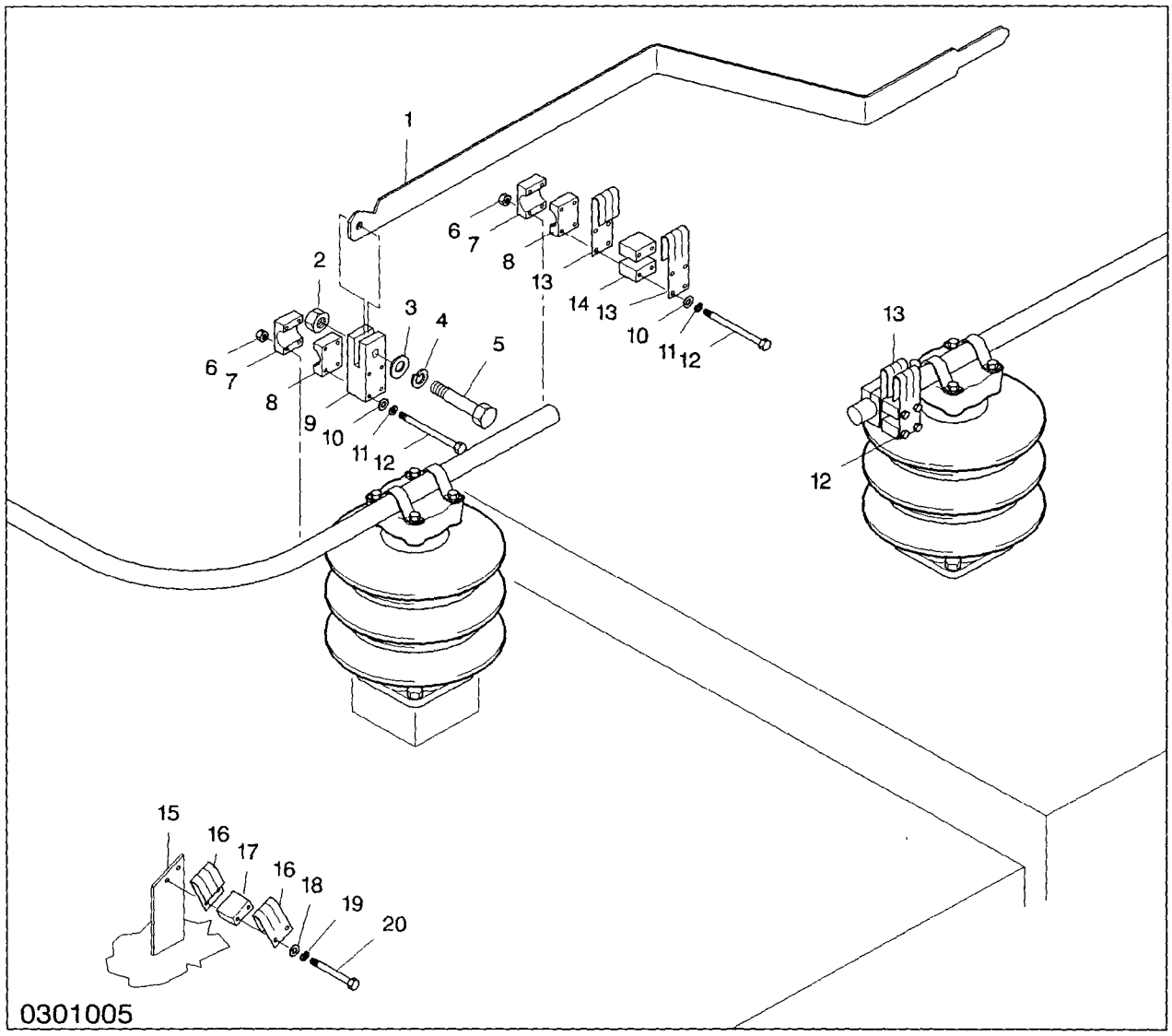


Place the two halves of the clamps (5, 6) above and below the roof line.

Place the cable support plate (4) over the clamps (5, 6). Install the bolts (1) and washers (2, 3), then install and tighten the nuts (7).

If necessary, reconnect the jumper cables.

Isolator switches



At the contact end of the roof line, position the clamps (7, 8) and holder (9) onto the roof line. Install the bolts (12), washers (10, 11) and nuts (6), then tighten the bolts (12).

Insert the isolator switch (1), then install the bolts (5), washers (3, 4) and nut (2). Tighten the bolt (5). Ensure the switch (1) is secure but still able to be swung.

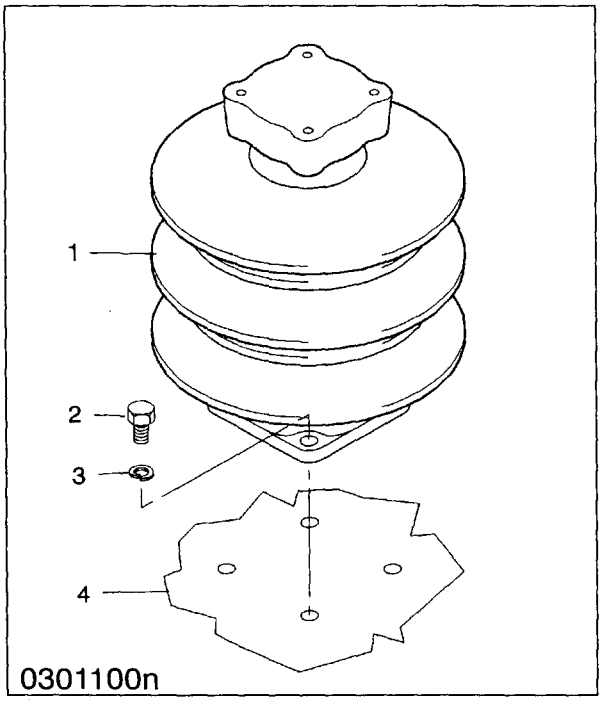
Position the clamps (7, 8), contact springs (13) and spacers (14) in the roof line.

Install the bolts (12), washers (10, 11) and nuts (6). Tighten the bolts (12).

Position the contact springs (16) and spacer (17) onto the bracket (15) on the roof hatch.

Install the bolts (20) and washers (18, 19), then tighten the bolts (20).

Pin insulators



Take care when handling the pin insulators to avoid contamination of the silicon grease coating.

Carefully position the insulator (1) onto the roof.

Install the bolts (2) and washers (3) through the pin insulator (1) to the roof hatch (4). Tighten the bolts (2).

Repeat the procedure for the other insulators (3) as required.

Install the roof line as previously described.

Install the jumper cables as previously described.

After-Installation Operations

@.1290

Conduct a water test around the high voltage bushing checking for leakage. Refer to Water Test in the Preface of this Volume. Rectify any faults found.

Close the isolator switch to reconnect the length of the roof line.

Apply a liberal coating of Sécheron grease L3 to the contact springs on the roof line. Ensure the surfaces are completely coated.

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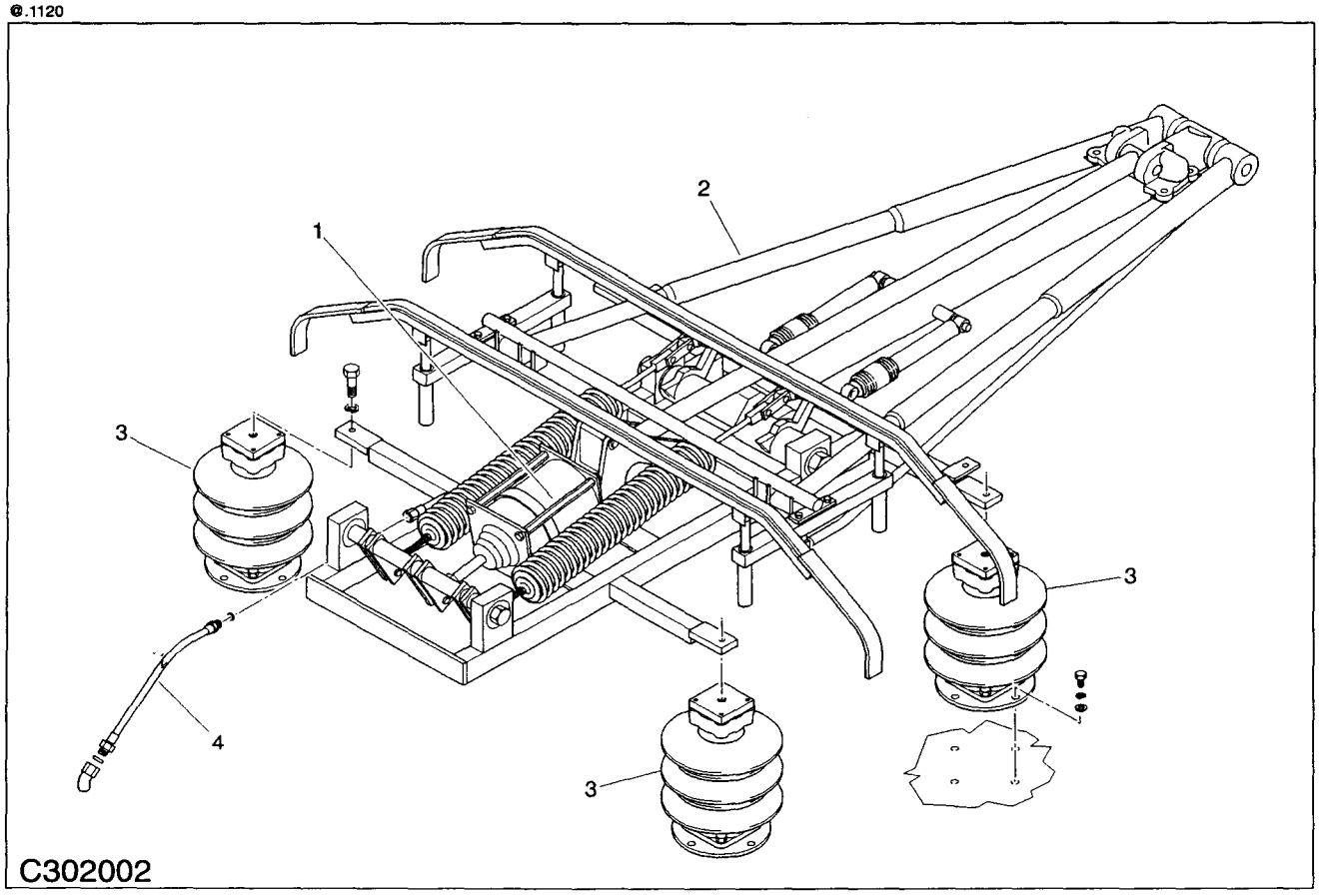
3.2 Pantograph

Overview



1 pneumatic cylinder
2 pantograph
3 pin insulator
4 pressure hose

Functional Description

@.1140

Main features and purpose

The single–arm pantograph type ESiD 103–2500 was primarily adapted to suit the needs of Indian Railways. The well proved single–arm pantograph, type ES, was used as the basic model. The brief was to realise a compactly constructed pantograph with an installation height that was as low as possible. The solution was found with the help of a new technical driving system in, which the tension springs are stretched by an pneumatic drive, then fully released again in a lowered position by the same means. The following characteristics were achieved by means of these and other new adaptions:

Compact, robust construction

Installation height of 330 mm without insulator

Simple air cylinder with no compression spring system

No expensive pneumatic control system

Good dynamic properties independent of the direction of travel

No lifting of the lowered pantograph at high speeds

Constant contact pressure on the separately and individually suspended sliding strips

Predetermined breaking–point by means of a mechanical shearing pin as a fast–operating safeguard against catenary damage

Automatic lowering device at a lifting height of 2000 mm

Increased operating safety through use of stainless steel in essential parts of the pantograph

Construction

Base frame

The base frame is carried by 4 support insulators. It consists of a welded assembly with rectangular profiled steel pipes. The bearings for the main shaft and the auxiliary shaft, the arms for the support insulators and the air connector are located on the two longitudinal supports. The damper fixings, the current connectors, the bearings for the push rod and the supports for the air cylinder and the safety valves are located on crossbeams.

Lower and upper arms

The lower arm consists of a steel pipe assembly with the main shaft system held by the shearing pin. The bearings to receive the upper arms are attached to the top end, and the bearings for installing the damper to the bottom part.

The upper arms are made of graduated aluminium tubing; the bosses to receive the lower arm and the bearing bushes for receiving the collector head tube are welded on to the ends of these. A bearing plate for mounting the support bracket linking the upper arms is fixed to the lower part of each upper arm. This support bracket also serves as the top bearing for the push rod and to receive the upper shearing pin.

Push rod

The push rod consists of a steel tube with a bearing bush welded to the upper end and a screwed bolt welded into the lower end to adjust its length.

Collector head tube and collector head

The collector head tube constructed of aluminium, links the two upper arms of the collector head and serves to receive the straight–line guide rod.

The collector head consists of two rustproof collector head bearers with two vertical sliding–strip spring actions attached to either end of both. These support two sliding strip bearers and these in turn each support a sliding strip made of unhardened, silver–coated spring steel. The two sliding strip are suspended independently of one another, providing optimum adaptation to the catenary. The spring action on the sliding strips works by means of a cylindrical compression spring which makes it possible for the sliding strips to react quickly to irregularities in the catenary.

Deflector plates which have been tested in the wind tunnel are used to achieve a balanced dynamic component where contact pressure with the catenary is concerned, when the pantograph is at different lifting heights and with different directions of travel.

The four end–horns are made of plastic reinforced with fibre glass.

Pneumatic drive

The low installation height required for the pantograph led to the adaption of a new driving system in which the tension springs are stretched by an air cylinder to raise the pantograph, and released by it to lower the pantograph. Because of this it was possible for the air cylinder to be very short in size, and to be simply constructed. Neither restoring springs nor gas com-

pression springs are now necessary and this makes completely safe dismantling and assembly possible.

Automatic lowering device

The brief given by Indian Railways resulted in the construction of a lowering valve that comes into operation completely automatically when the lifting height reaches 2000 mm. Therefore it is not possible to exceed the specified lifting height.

When this safety valve responds at a height of 2000 mm the pantograph drops and remains in the lowered position.

Operation method

Raising the current collector

Activating the control switch «pantograph up» in the locomotive, gives the command for the pantograph to rise. The compressed air then flows from the main air reservoir through the electro–pneumatic valve into the automatic lowering valve (2000 mm), through it in to the fast lowering valve and then into the air cylinder. The piston of the air cylinder activates the auxiliary shaft and extends both tension springs. Thereupon the rising movement of the pantograph begins.

A fixed nozzle in the fast lowering valve with a hole diameter of 2.2 mm determines the speed at which the pantograph rises.

Operation

The pantograph must collect current from the catenary without any interruption. Great changes in the height of the catenary, brought about by level crossings, tunnels and underbridges, are compensated for by the movement of the upper arms and the lower arm. Smallish, rapid, high–frequency changes in height as a result of the suspension of the catenary or oscillations due to catenary interlinking are absorbed by the individual spring actions of the sliding strips which have a lifting height of 50 mm.

The two dampers attached to the lower arm working unilaterally in the lowering movement prevent the collector head from jumping off the catenary, so reducing the formation of sparks.

Deflector plates on the upper arms and air flaps on the collector head tube make it possible for the pantograph to be used at high speeds, irrespective of the direction of travel.

If the height of the catenary were to go above the lifting height of 2000 mm while it is in operation or the catenary were to fail completely for any reason, the automatic lowering valve

would respond. Air empties out of the air cylinder via the lowering valve and the pantograph is lowered, and remains in the lowered position until further action is taken. To be able to raise the pantograph again, the locomotive driver must place the control switch to the «pantograph down» position. Only after that has been done the pantograph can be raised again by switching the control switch to the «pantograph up» position.

The lowering device which operates automatically and mechanically if there is damage to the catenary, blockages in the catenary sector or damage to the collector head lowers the pantograph in a fraction of a second. The pantograph, which is normally then faulty, cannot be used again and must be put back into working order in the locomotive depot or the repair workshop.

This exceptionally fast–operating lowering device prevents the catenary being destroyed. How it works is described in greater detail in section 4.5.

Lowering the pantograph

When the control switch is turned back to the «pantograph down» position, the electro–pneumatic valve drops. The pantograph's fast lowering valve responds to the drop in compression, reverses it, and opens the large exhausting cross–section. The air can thus be released into the open directly at the pantograph. The air cylinder empties and releases the tension springs. The pantograph is lowered by its own weight, with the speed at which it drops being reduced by the two shock absorbers attached to the lower arm.

The fast lowering valve is constructed in such a way that the pantograph is damped even more by pneumatic means in the down position to prevent a hard impact as it goes down.

The automatic lowering of the pantograph when the height of the catenary goes above 2000 mm lifting height or when the catenary is missing has already been described in the previous section.

Damping the pantograph

In order to achieve good contact by the pantograph between the sliding strips and the catenary, two dampers are installed between the basic framework and the upper arms. These work unilaterally as damper when the pantograph is being lowered whereas the rising movement can take place with no damping. The damping can be adjusted by putting in the damper in reception holes which differ from the normal position.

The individual spring actions on the sliding strips which react very sensitively support the damper in an appropriate manner.

Mechanical predetermined breaking–point

The mechanical predetermined breaking–points serve to lower the pantograph rapidly and automatically if there is damage to the catenary or to a current collector. In the event of power–related high loading caused by mechanical overload the built–in, shearing strips break at the predetermined breaking–points between the main shaft and the lower arm and between the push rod and the upper arms. Consequently, the tension springs of the main shaft are separated and the pantograph collapses into itself in fractions of seconds. By this device the part of the pantograph not yet damaged – generally the basic frame and lower arm – can be saved before it is totally destroyed, or at least it prevents the faulty pantograph from bringing down the catenary for the length of the breaking distance.

Technical Data

⊕.1160

Construction Single–arm with push rod link

Shearing pin and two dampers (shock absorber)

– Dimension drawing	SG 480025
– Erection	Horizontally as a unit on roof of vehicle
– Rated voltage	25 kV AC, 50 Hz
– Max. operating voltage	30 kV AC, 50 Hz
– Rated current	500 A
– Max. operating current	900 A
– Max. travelling speed	200 km/h
– Design height without insulators	330 mm
– Design height with insulators	650 mm
– Lowest point above roof	320 mm
– Max. rise height	2100 mm
– Automatic lowering at	2000 mm
– Overall length in lowered position	2610 mm
– Overall width	1800 mm
– Fixing points on roof	
– Length	1160 mm
– Width	807 mm
– Collector head	

Individually suspended sliding strips with 50 mm lifting

– Collector head width	1800 mm
– Collector head length	446 mm
– Distance between sliding strips	400 mm
– Material used for sliding strips	55 Si7 silver–coated spring steel
– Length of sliding strips, straight	1040 mm
– Overall length of sliding strips	1370 mm
– Cross–section of sliding strips	25 x 7 mm
– Hardness of sliding strips	230 BHN +/– 10%
– Pneumatic drive	
– Operating pressure (vehicle)	0.45 – 1.0 MPa
– Min. actuating pressure (pantograph)	0.45 MPa
– Static contact pressure	
– Normal	64 – 72 N
– Adjustable	50 – 100 N
– Dynamic lifting at	200 km/h
– 0° forwards, 1/2 & 1/1	23 – 45 N
– 180° backwards, 1/2 & 1/1	18 – 13 N
– Rising force in lowered position	33 N
– Rising time 0 – 2000 mm	5.0 – 6.0 sec
– Lowering time 2000 – 0 mm	3.0 – 4.0 sec
– Lowering time 1200 – 0 mm	1.6 – 2.0 sec
– Lowering time 400 – 0 mm	0.4 – 0.6 sec
– Mechanical shearing pin	
– Lower arm diameter	7.0 mm
– Upper arm diameter	8.0 mm
– Weight without insulators	186 kg
– Ambient temperature	–25° to ~80 ° C
– Left–handed or right handed	hole diameter 14 mm current connection
– Compressed air connection	
– Normal	G 3/4
– Possible	G 1/2

Tolerances and Wear Limits

@.1170

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Tools and Special Tools

@.1180

Standard Workshop Equipment.

Miscellaneous Materials

@.1200

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Before–removal Operations

@1220

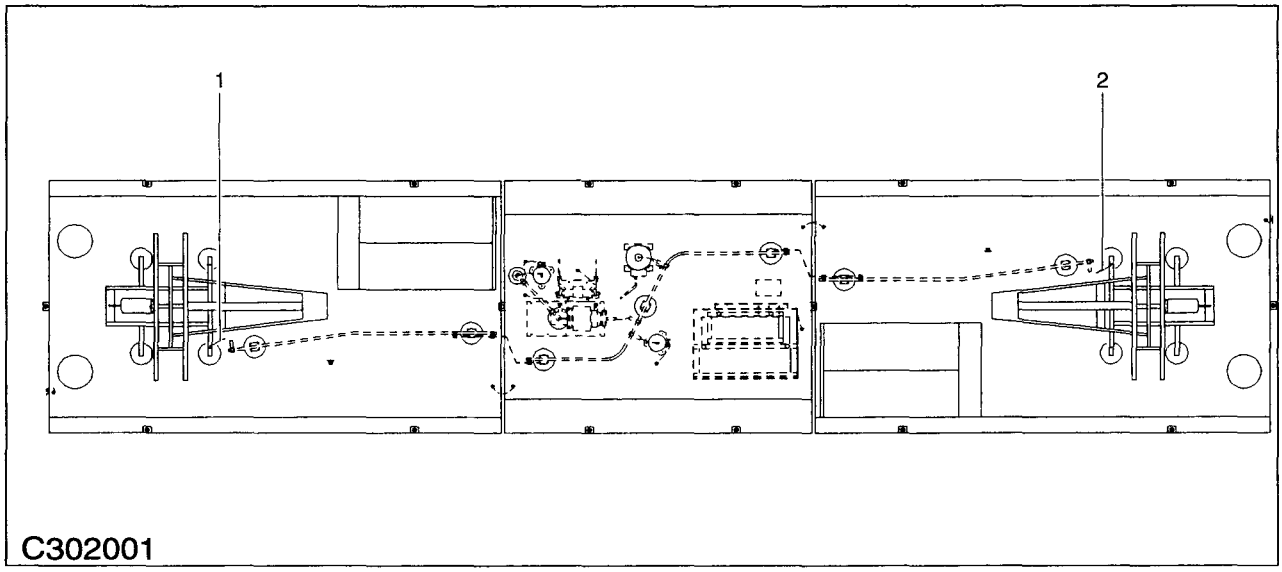
CAUTION:

To avoid accidents, it is imperativ:

- Never to climb on the roof when the pantograph is in contact with the catenary or to make absolutely sure that it is not live.
- To check that the pantograph is suitably retained on its low stop before climbing on the roof.
- To move the locomotive onto a section of railway without catenary before performing any inspection, lubrication, adjustement or repair operations.

This SECTION is addressed to the USER NETWORKS of locomotives. It includes INSPECTION SHEETS defining the PROCEDURES to be carried out on the equipment considered.

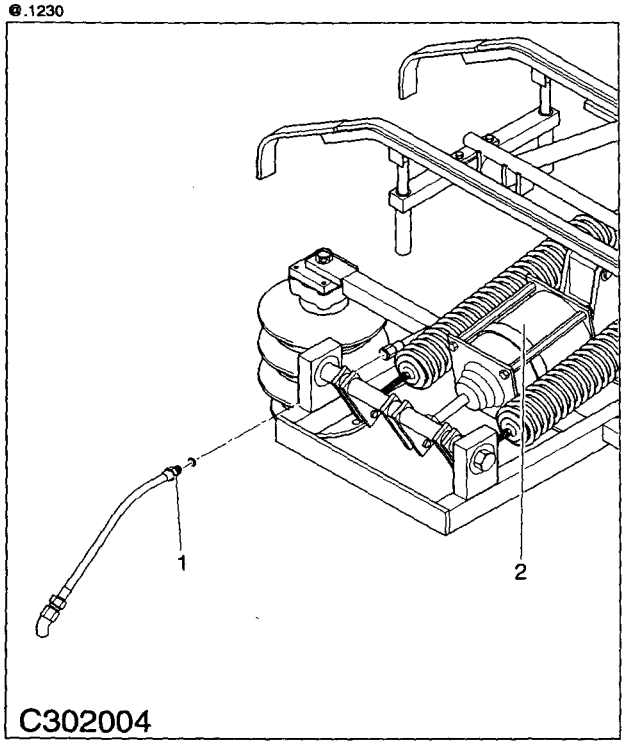
For a guidance, a SCHEDULED INSPECTION PROGRAM is given. This schedule should adapted by the network according to its specific need.



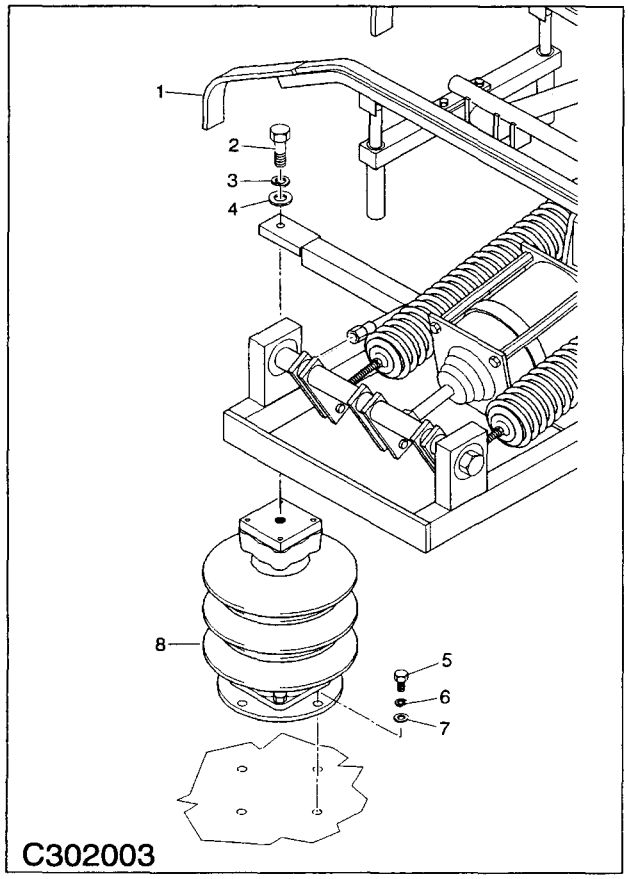
C302001

Loosen M12 screws of the stranded wires (1,2) on the pantograph and remove together with washer, spring washer and nut.

Removal



Loosen the pneumatic connection (1) to the pneumatic cylinder (2).



Secure pantograph (1) on crane with cable.

Loosen M18 screws (2) pantograph – pin insulator and remove together with high tension spring lock washers (3) and washers (4).

Lift pantograph (1) from roof with crane.

Loosen M12 screws (5) of pin insulators (8) and remove together with high tension spring lock washers (6) and washers (7).

Same procedure for 2nd. pantograph.

Disassembly

@.1240

Refer to manufacture's documentation Sécheron Single – arm pantograph ESiD 103–2500;

Technical description; Erection and maintenance instructions.

Inspection and Repair

@.1250

Refer to manufacture's documentation

Sanitation Parts / Operating Materials

@.1260

[Not applicable.]

Assembly

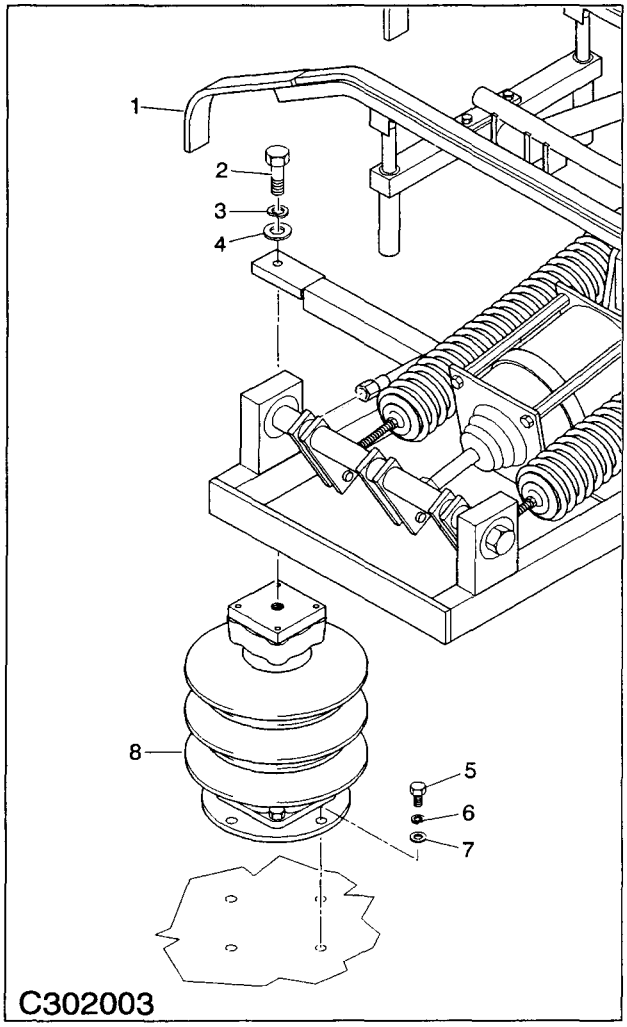
@.1270

See supplier's documentation Volume F3

Installation

@1280

Pin insulators of pantograph



Assemble pin insulators (8) with M12 screws (5), high tension spring lock washers (6) and washer (7) on the flanges on the roof.

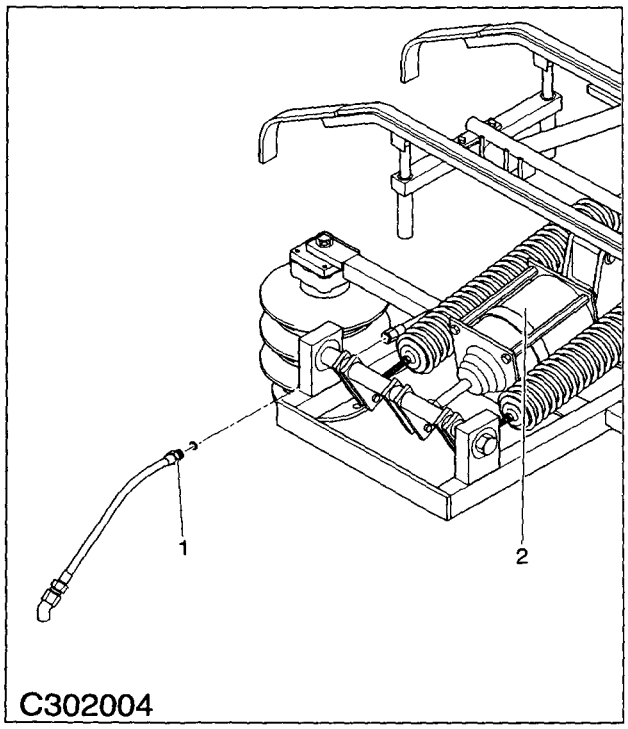
Hang pantograph (1) on crane with cable.

Position pantograph with crane in the proper position on the pin insulators (8) fastened on the roof.

Fasten pantograph with M18 screws (2), washers (4) and high tension spring lock washers (3) on the pin insulators.

Alingn pantograph and screw pin insulators (8) tight.

Same procedure for 2nd. pantograph.



C302004

Close the pneumatic connection (1) to the pneumatic cylinder (2).

After–installation Operations

@.1290

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3.3 Main Circuit Breaker

General Notes on Hazards in the Work Area

@.1040

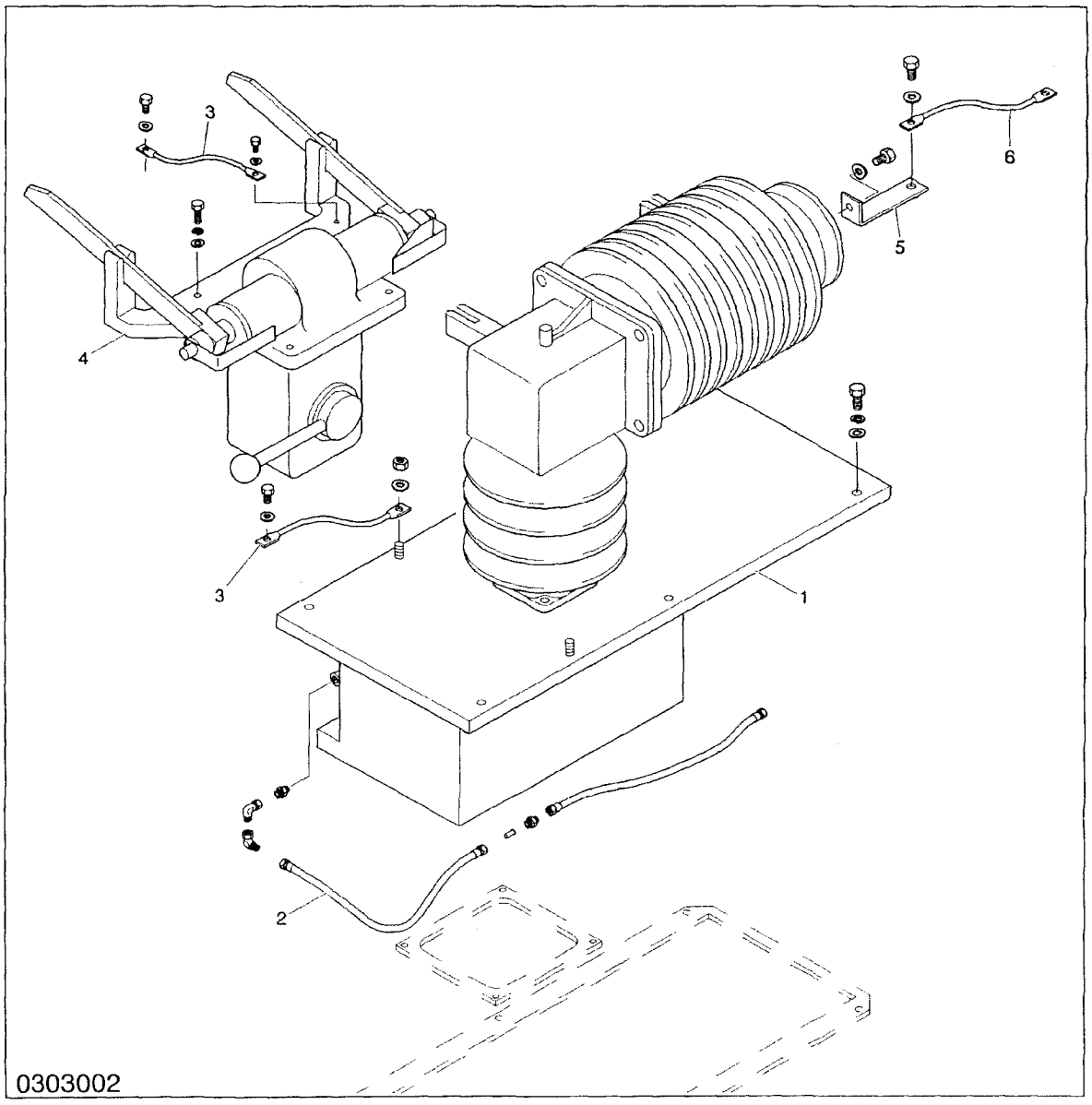
WARNING:

HIGH VOLTAGE! DANGER OF ELECTROCUTION. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVER-HEAD.
Lower the pantograph and isolate the overhead catenary power whenever working on the roof.

Group Summary

@.1120

This chapter contains information on the main circuit breaker, which comprises the vacuum circuit breaker and earthing switch.



1	Vacuum circuit breaker (5)	4	Earth switch (4)
2	Pressure hose	5	Support
3	Earth strap	6	High voltage wire

Numbers in brackets () denote the electrical equipment apparatus item number used in the locomotive schematics, refer to Volume G, Cabling Documentation.

Functional Description

@.1140

Vacuum circuit breaker

The vacuum circuit breaker serves to disconnect the locomotive from the catenary in the event of over-voltages, under-voltages, short circuits and power surges. Trouble shooting for the vacuum circuit breaker is described in Chapter 3, Main Circuit Breaker of Volume F3, Suppliers Documentation.

Earthing switch

The dual pole earthing switch is provided for the safety of operating and maintenance personnel during checks and repairs on the locomotive.

The earthing switch earths consists of two knife connectors that are connected together along their base of rotation by a connecting rod that is also earthed. Operation of the earthing rod is by a handle, which is attached to the connecting rod between the two knife blades. Rotation of the handle moves the knife connectors between the engaged and disengaged positions.

When the earthing switch is engaged, the two knife connectors rotate upwards from their seats and connect to seats in the roof line. One knife blade connects to the roof line before the vacuum circuit breaker and one connects after the vacuum circuit breaker. These connections ensure that the entire high voltage system is connected to earth, regardless of the current position of the vacuum circuit breaker.

Operation of the earthing switch requires the use of the locomotive key interlocking system. Refer to Chapter 7.6, Key Interlocking.

Technical Data

@.1160

Vacuum circuit breaker

- Vacuum circuit breaker type	SSA-BVAC25.10
- Manufacturer	Sécheron
- Weight	140 kg
- Rated voltage (Ue)	27.5 kV
- Nominal voltage (Un)	25 kV
- Dielectric test voltage	75 kV
- Rated impulse withstand voltage (Uimp)	145 kV
- Conventional free air thermal current (Ith)	1,000 A
- Rated frequency	50 - 60 Hz
- Rated breaking capacity	16 kA
- Opening time	30 ms
- Auxiliary voltage (DC)	110 V
- Number of auxiliary contacts	4+4
- Air supply pressure	4.5 - 10 bar
- Air supply pipe diameter	1/2 inch

Earthing switch

- Type	BTE 25.04
- Weight	29 kg
- Catenary voltage	25kV
- Rated current	400 A

Tolerances and Wear Limits

@.1170

Vacuum circuit breaker

- Vacuum switch tube contact distance	> 2 mm

Tools and Special Tools

@.1180

Conventional railway workshop tools are required for the procedures described in this chapter.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Suitable plastic plugs or alike are required to seal the pneumatic connections and pipes against the ingress of foreign material.
- An isopropanol or ethanol based cleaning agent is required to clean the insulators. Any cleaning agents containing halogens or sodium metasilicate must not be used.
- Sécheron Silicon Grease No. 4, NBT 400107 P0001, is required to coat the vacuum circuit breaker insulator.
- Sécheron Grease L3, NBT 400344 P2, is required to coat the earthing switch contact blades and spring contacts.
- Paper towelling

Before-Removal Operations

@.1220

Lower the pantograph and isolate the overhead catenary. Earth the locomotive at the vacuum circuit breaker. Refer to the Preface of this Volume.

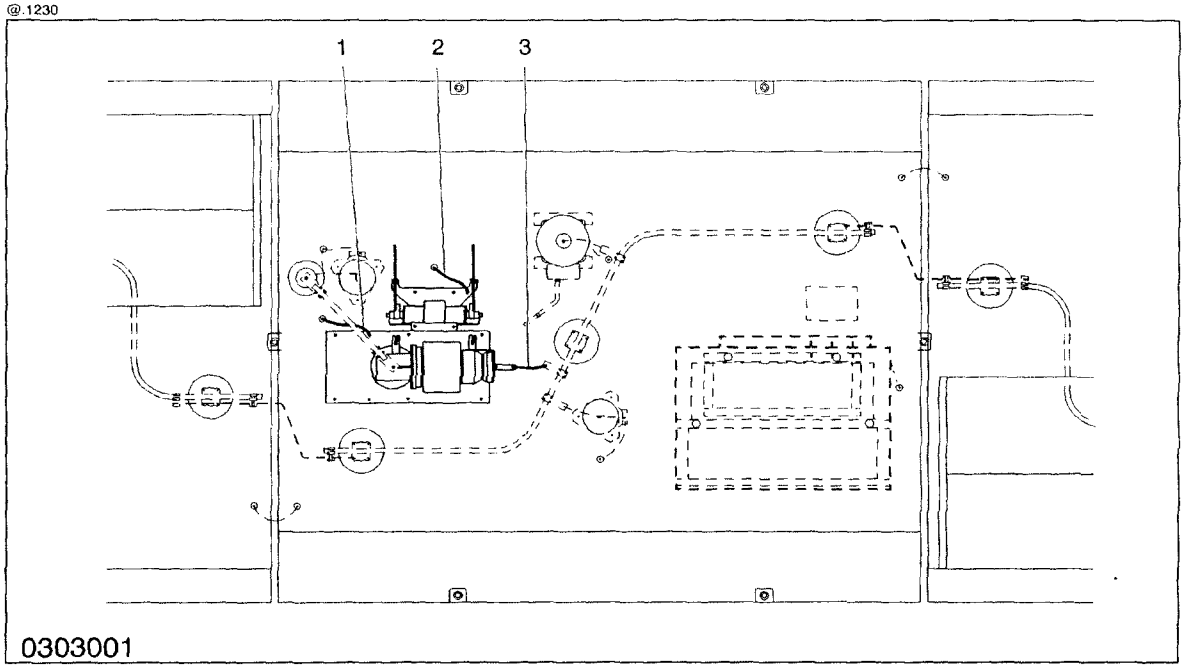
Earth the traction converter as described in Chapter 4.1, Traction Converter. Operation of the key interlocking system is described in Chapter 3.11, Protection Concept of Volume A, Driver's Manual.

Steam clean the vacuum circuit breaker and surrounding area, remove all traces of dirt, debris and build-up of grease. Pay particular attention to the contact springs. Refer to Steam Cleaning in the Preface of this Volume.

Remove the connection between the vacuum circuit breaker and the high voltage bushing as described in Chapter 3.1, Roof Line.

Removal

@.1230

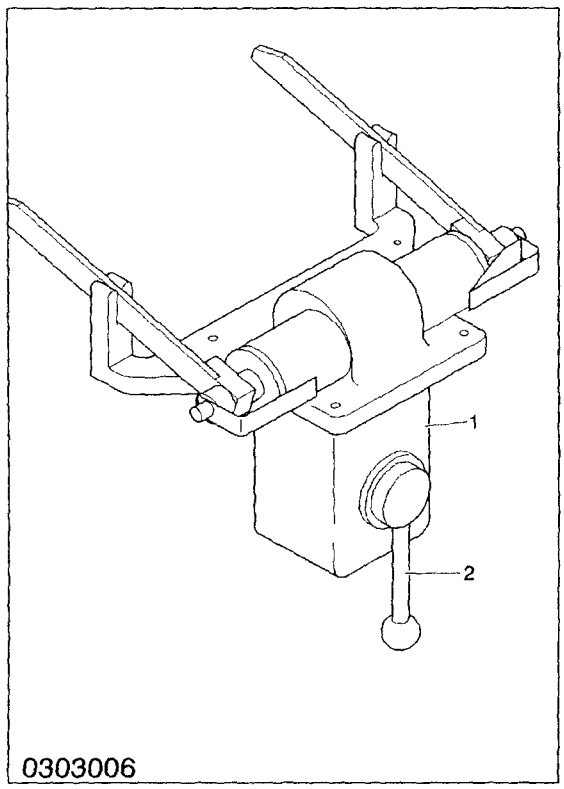


Remove the earth strap (1) between the vacuum circuit breaker panel and the converter roof hatch.

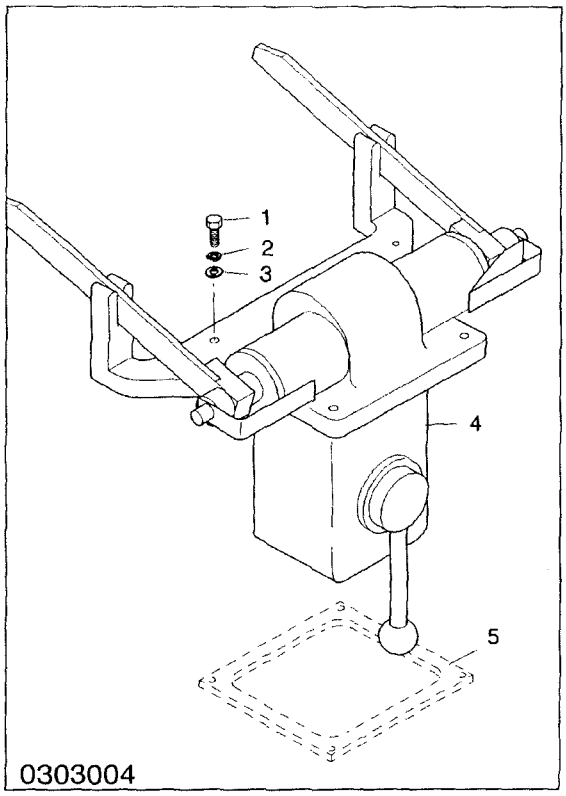
Remove the earth strap (2) between the earthing switch and the converter roof hatch.

Remove the high voltage cable (3) between the vacuum circuit breaker panel and the roof line.

Earthing switch



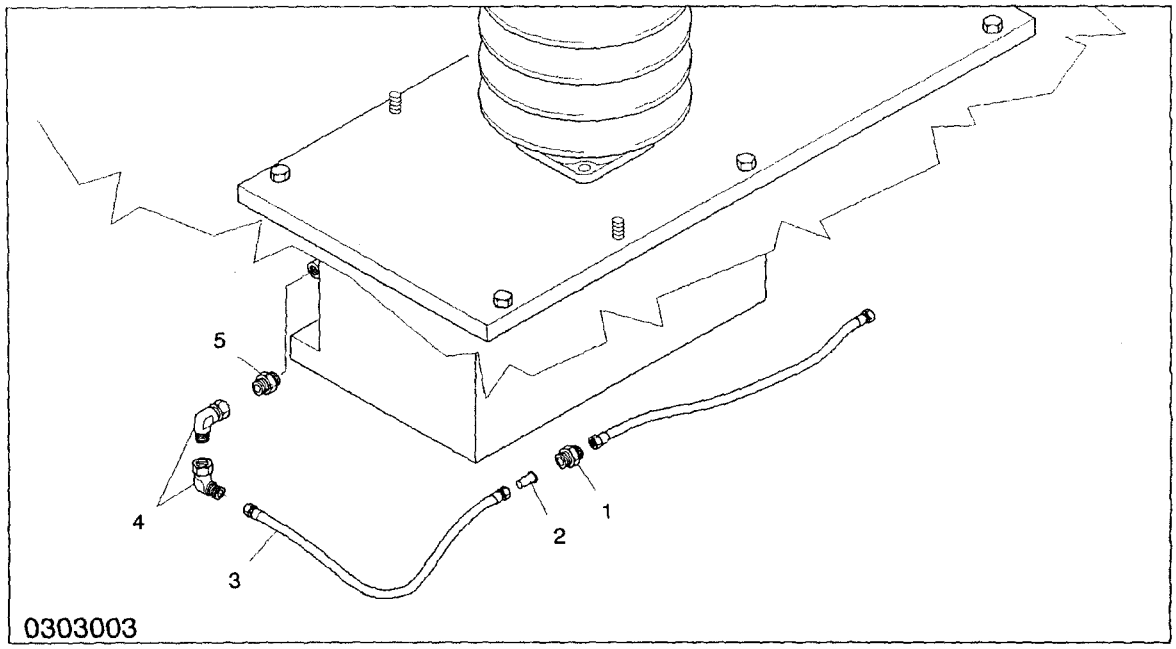
From within the machine room, move the earthing switch (1) lever (2) into the vertical position. Refer to Chapter 7.6, Key Interlocking. As part of the isolation procedure the key should have already been removed leaving the lever vertical.



Loosen the screws (1) plain and lock washers (2, 3) securing the earthing switch (4) to the converter roof hatch.

With the aid of an assistant, carefully lift the earthing switch (4) from the roof hatch opening (5).

Vacuum circuit breaker

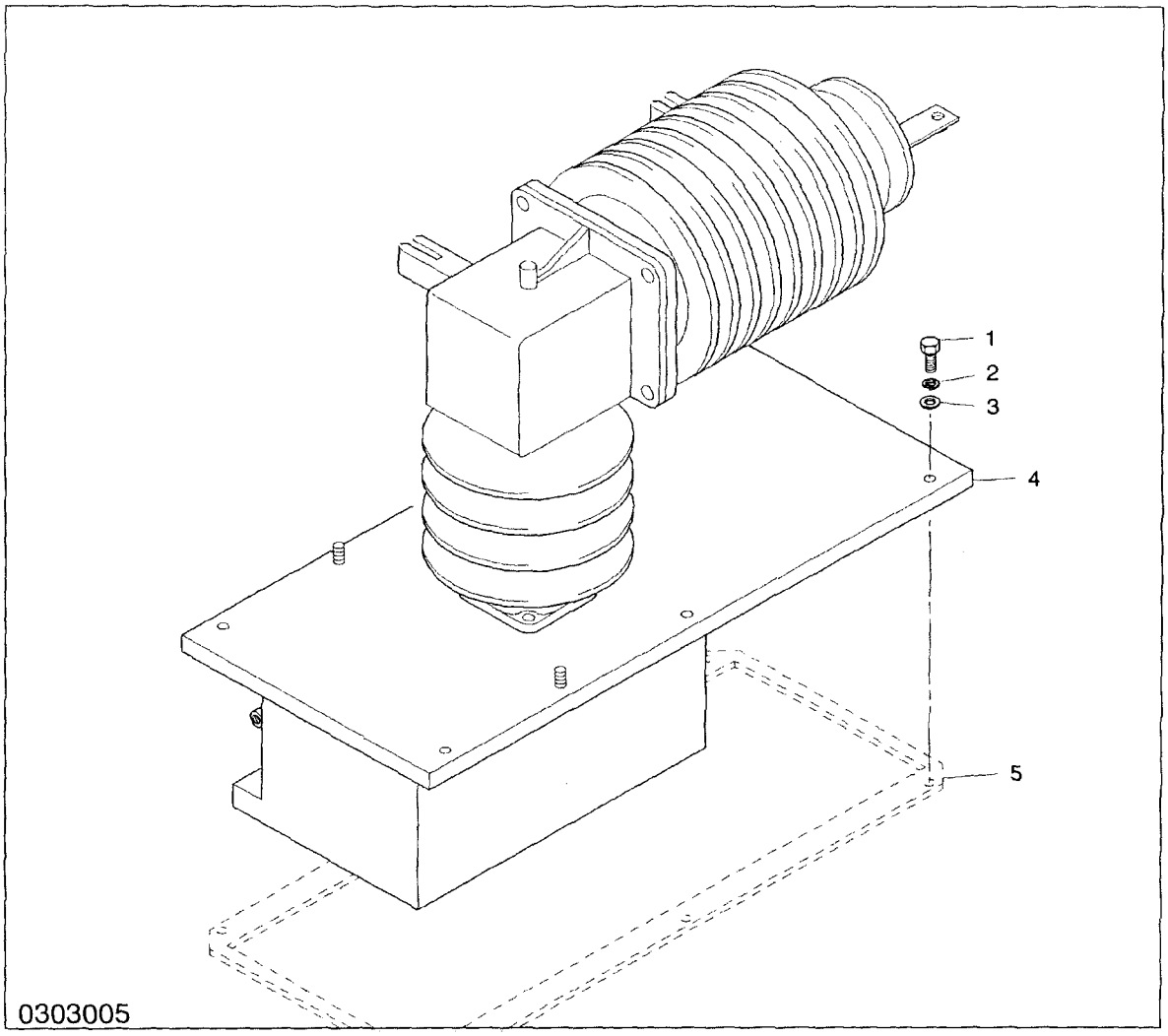


From within the machine room, disconnect the pneumatic supply hose (3) to the vacuum circuit breaker at the unions (4, 5).

If necessary, disconnect the supply hose (3) from the pipe union (1). Take care that the sleeve (2) does not fall from the pipe. Remove the sleeve (2) from the hose (3).

Seal the pipes and vacuum circuit breaker using suitable plastic plugs.

Disconnect the electrical harness from the vacuum circuit breaker at the connector.



Loosen and remove the screws (1), spring washers (2) and washers (3) securing the vacuum circuit breaker (4) to the roof.

Attach lifting eyes to the corners of the plate, then lift the vacuum circuit breaker carefully out of the roof opening (5) using suitable lifting equipment.

Disassembly

@.1240

Disassembly of the vacuum circuit breaker is described in Chapter 3, Main Circuit Breaker of Volume F3, Suppliers Documentation.

Refer to Chapter 8, Primary Earth of Volume F3, Suppliers Documentation for information on the earthing switch.

Inspection and Repair

@.1250

Inspect the condition of the roof seal on the main circuit breaker and earthing switch. The seals must be in perfect condition to prevent entry of water into the machine room. Replace the seal if worn or damaged.

Inspect the condition of the spring clips on the earthing switch. Replace if worn, cracked, bent or damaged.

Inspect the condition of the silicon coating on the vacuum circuit breaker insulators. Contaminants in the silicon coating reduce the insulating effect of the insulator. Water applied to the surface of the insulator should bead and not wet the surface. If the coating is contaminated or is wetted by water, the coating must be renewed. Audible discharges or flashovers that are visible in the dark are an indication that the insulator needs to be re-coated.

Remove the contaminated silicon coating using paper towelling. Wipe any remaining silicon coating from the insulator using a clean, dry, lint free cloth. Clean the surface of the insulator thoroughly using a cloth soaked in alcohol.

Ensure the glazed surface of the insulator is clean, dry and shiny. The silicon grease described in Section Miscellaneous Materials should be applied evenly to the entire glazed surface of the insulator to a thickness of 0.2 to 1 mm.

Take care when handling the insulator after coating to avoid contamination of the silicon grease.

Inspection, repair and testing of the vacuum circuit breaker is described in Chapter 3, Main Circuit Breaker of Volume F3, Suppliers Documentation.

Refer to Chapter 8, Primary Earth of Volume F3, Suppliers Documentation for information on the earthing switch.

Waste Disposal

@.1260

Dispose of waste parts, materials and fluids according to the prevailing environmental standards or workplace practices.

Assembly

@.1270

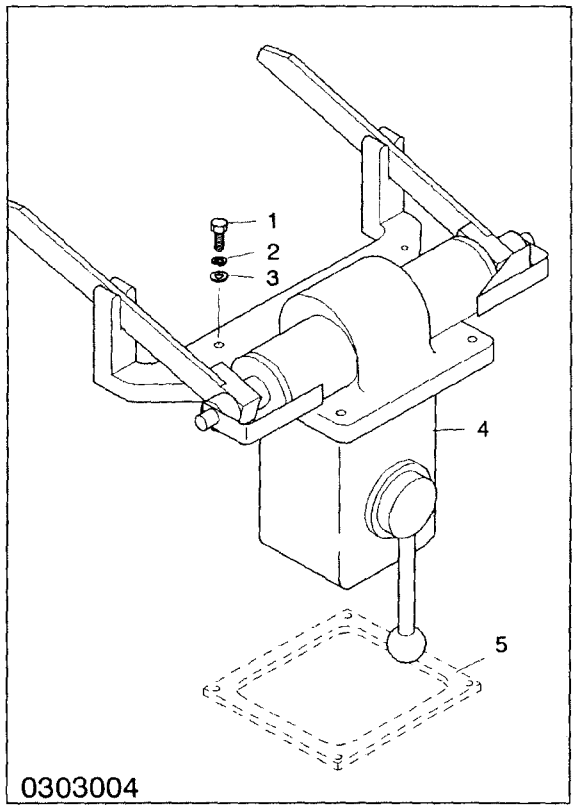
Assembly of the vacuum circuit breaker is described in Chapter 3, Main Circuit Breaker of Volume F3, Suppliers Documentation.

Refer to Chapter 8, Primary Earth of Volume F3, Suppliers Documentation for information on the earthing switch.

Installation

@.1280

Earthing switch



Ensure the handle is in the vertical position.

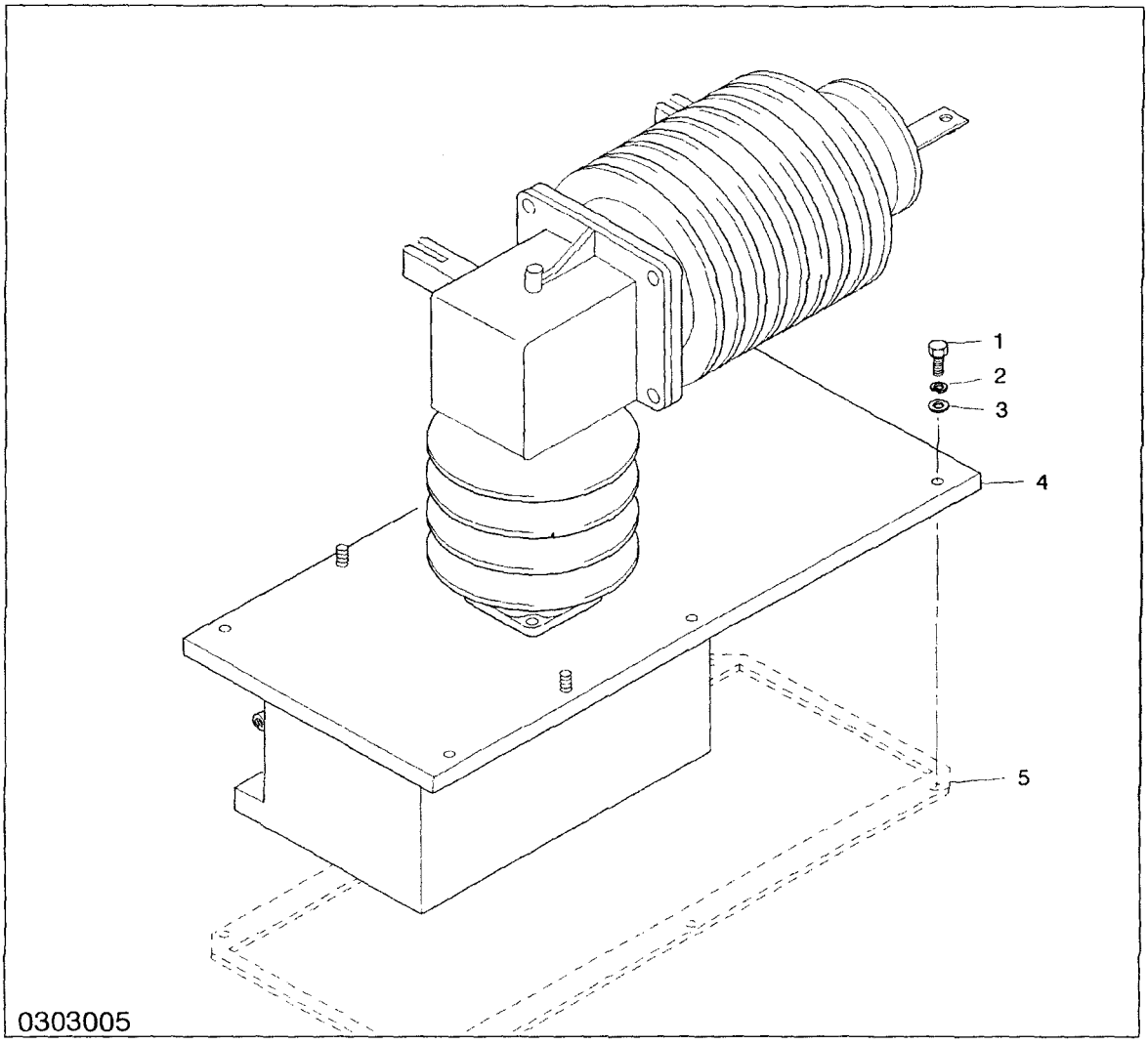
Position the seal into the flange.

With the aid of an assistant, carefully position the earthing switch (4) on the converter roof hatch opening (5). Ensure that the seal is correctly seated.

Install the screws (1), plain and locking washers (2, 3) and tighten.

With the aid of an assistant, check the operation of the handle. Ensure that the separating blades of the earthing isolator seat correctly in the spring clip contacts.

Vacuum circuit breaker



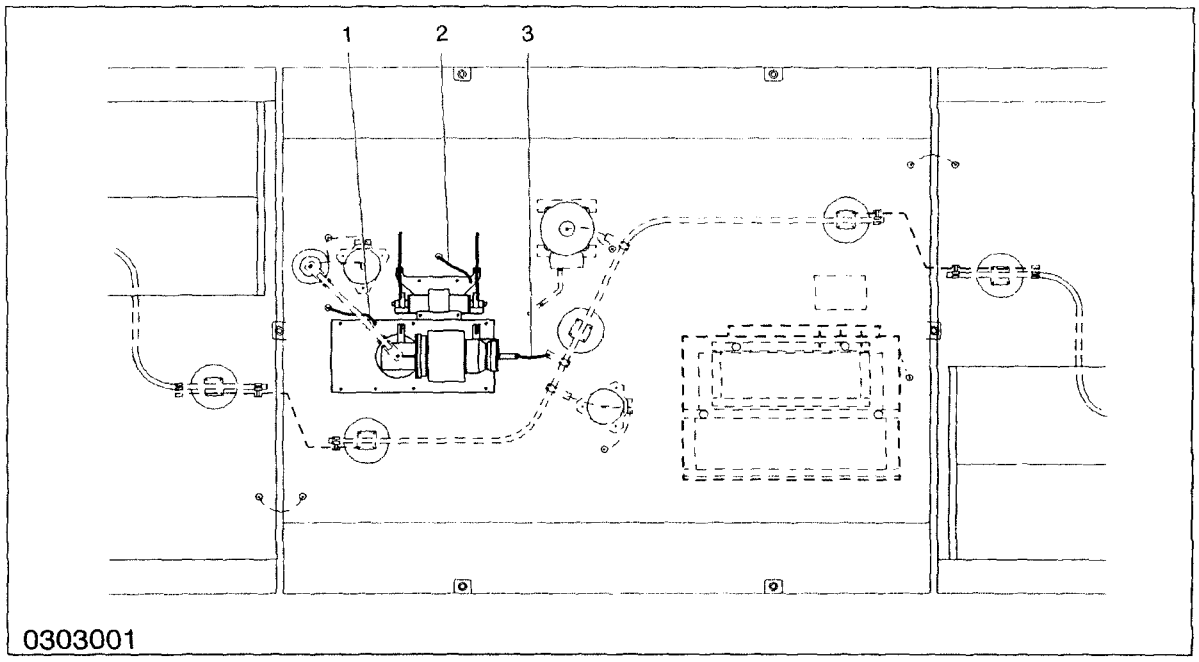
Take care when handling the insulator to avoid contamination of the silicon grease coating. Install lifting eyes to the corners of the plate, then attach suitable lifting equipment to the vacuum circuit breaker (4), then raise it into position on the converter roof hatch.

Ensure the seal is correctly seated in the base plate.

Position the vacuum circuit breaker into the opening. Ensure that the seal is correctly seated on the locomotive roof hatch.

Disconnect the lifting equipment, then remove the lifting eyes.

Install the screws (1), plain and locking washers (2, 3). Tighten the screws.



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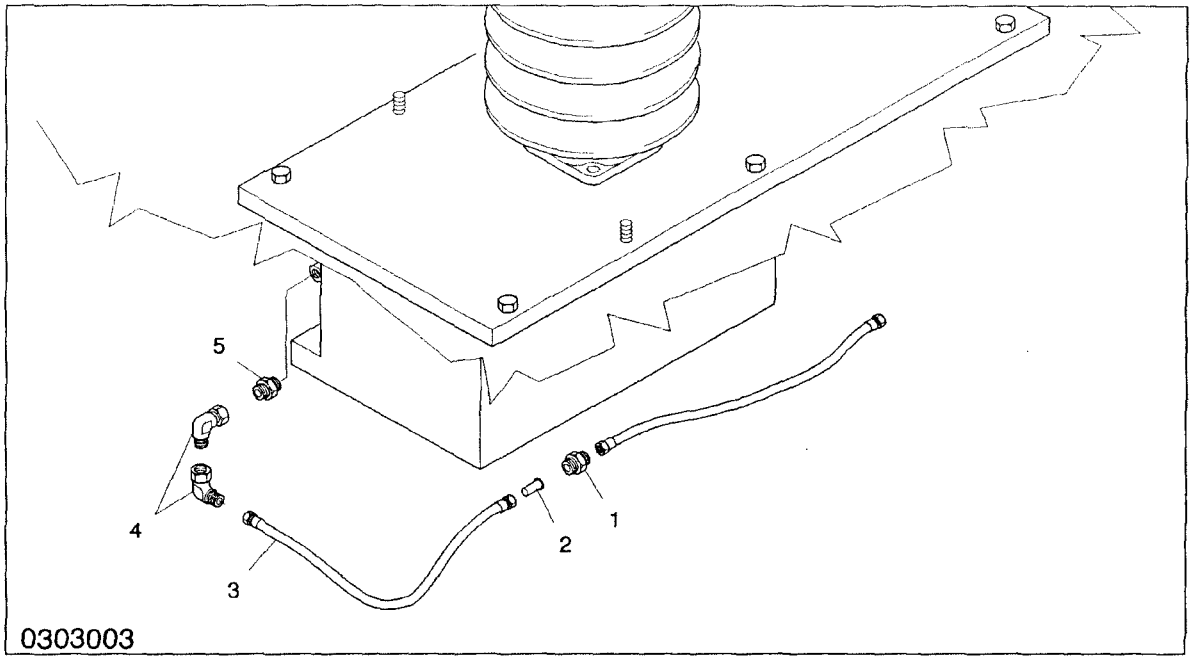
Install the earth strap (1) between the vacuum circuit breaker panel and the converter roof hatch.

Install the earth strap (2) between the earthing switch and the converter roof hatch.

Install the high voltage cable (3) between the vacuum circuit breaker panel and the roof line.



From within the machine room, connect the pneumatic supply hose (3) to the vacuum circuit breaker at the unions (4, 5).

If necessary, install the sleeve (2) into the hose (3). Connect the supply hose (3) to the pipe union (1).

Connect the electrical harness to the vacuum circuit breaker at the connector.

After-Installation Operations

@.1290

Connect the high voltage cable between the vacuum circuit breaker and roof bushing as described in Chapter 3.1, Roof Line.

Apply a thin film of Sécheron Grease L3 to the earthing switch contact blades.

Test the operation of the vacuum circuit breaker as described in Chapter 3, Main Circuit Breaker of Volume F3, Suppliers Documentation.

Conduct a water test around the vacuum circuit breaker and earthing switch and check for leakage. Refer to Water Test in the Preface of this Volume. Rectify any faults found.

Test the operation of the Earthing Switch as described in Chapter 8, Primary Earth of Volume F3, Suppliers Documentation.

3.4 Surge Arrester

General Notes on Hazards in the Work Area

@.1040

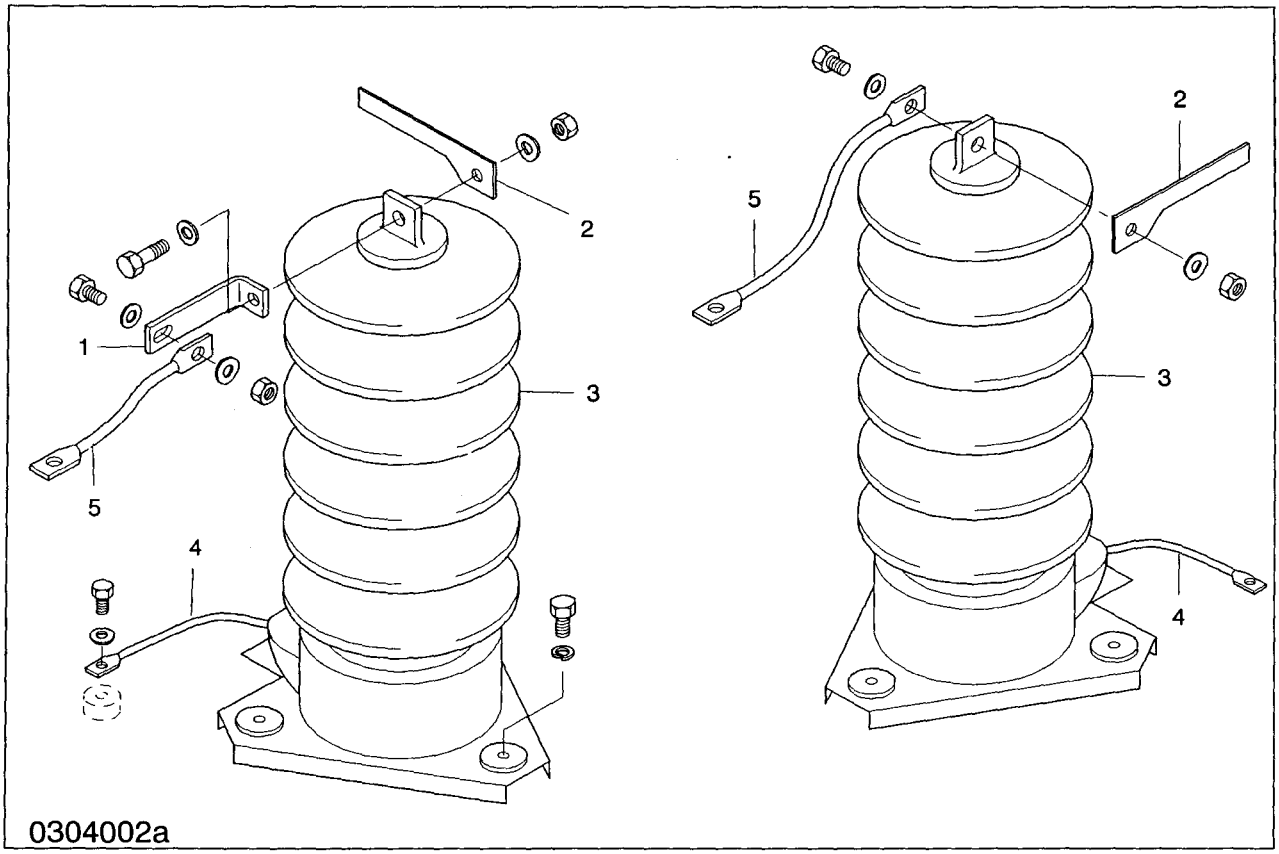
WARNING:

HIGH VOLTAGE! DANGER OF ELECTROCUTION. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVER-HEAD.
Lower the pantograph and isolate the overhead catenary power whenever working on the roof

Group Summary

@.1120

This chapter contains information on the surge arresters attached to the locomotive roof line. The surge arresters are Electrical Equipment Apparatus Item Number 9.



1	Angle support	4	Earthing cable
2	Flag	5	Jumper cables
3	Surge arrester		

Functional Description

@.1140

Two surge arresters are located on the converter roof hatch. One arrester is connected to the roof line, and another is connected to the high voltage bushing. They provide protection for the transformers, cables, switchgear and equipment against over-voltages from any source, including multiple lightning strikes.

The surge arresters are composed of non-linear metal-oxide resistors, connected in series, within a glazed insulator. The insulator is mounted on an aluminium alloy base which is attached to the locomotive roof. At normal operating voltage, a predominantly capacitive current of only a few milliampere flows through the resistors. When the voltage rises, the resistors immediately begin to conduct excess voltage from the roof line to earth. When the voltage returns to the normal range, the arrester immediately reverts to the original state.

Technical Data

@.1160

- Manufacturer	ABB
- Type	MWA 033
- Weight	36 kg
- Height (overall)	593 mm
- Voltage (operating)	33 kV
- Voltage (peak)	41.3 kV
- Frequency	16.66 - 60 Hz

Tolerances and Wear Limits

@.1170

There are no operational tolerances or wear limits applicable to the surge arresters. Defective surge arresters must be replaced.

Tools and Special Tools

@.1180

Conventional railway workshop tools are required for the procedures described in this chapter.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Sécheron Grease No. 4, NBT 400107 P0001, is required as a silicon coating for the surge arrester insulator.
- Paper towelling

Before-Removal Operations

@.1220

Lower the pantograph and isolate the overhead catenary. Earth the locomotive at the vacuum circuit breaker. Refer to the Preface of this Volume.

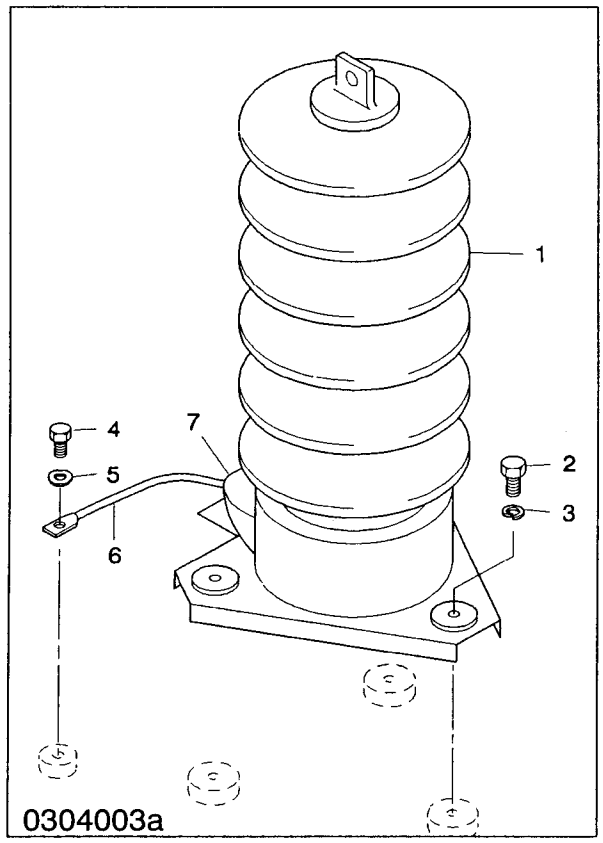
Earth the traction converter as described in Chapter 4.1, Traction Converter. Operation of the key interlocking system is described in Chapter 3.11, Protection Concept of Volume A, Driver's Manual.

Steam clean the surge arrester and surrounding area, remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

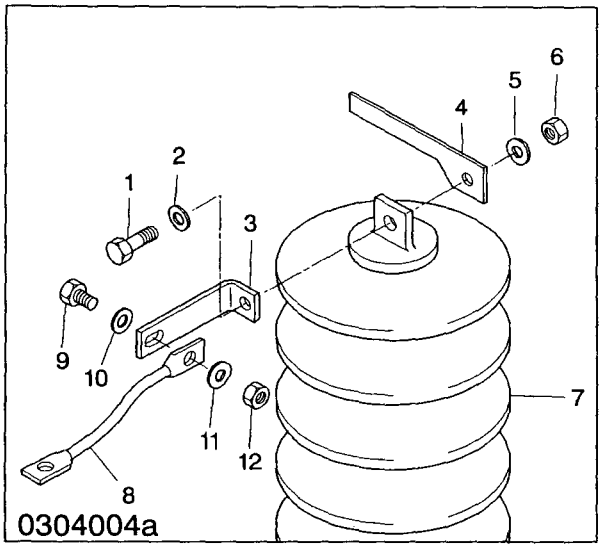
Removal

@.1230

High Voltage Bushing Surge Arrester



Remove the screw (4) and washer (5) securing the earthing cable (6) to the converter roof hatch.



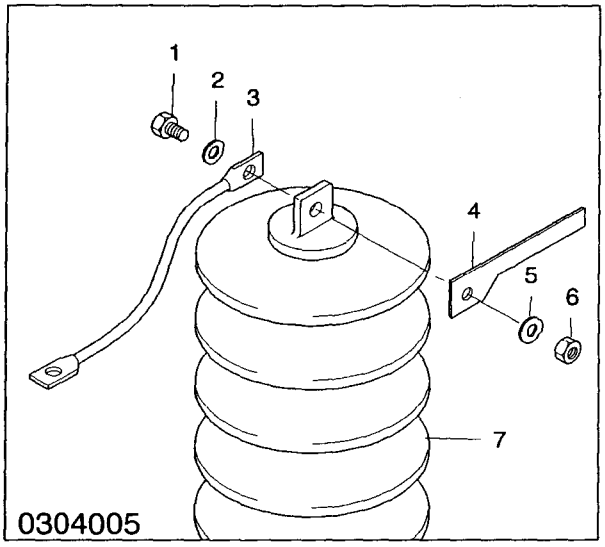
Remove the screw (9), nut (12) and washers (11, 10) securing the jumper cable (8) to the support angle (3).

Remove the screw (1), nut (6) and washers (2, 5) securing the support angle (3) and flag (4) to the surge arrester (7).

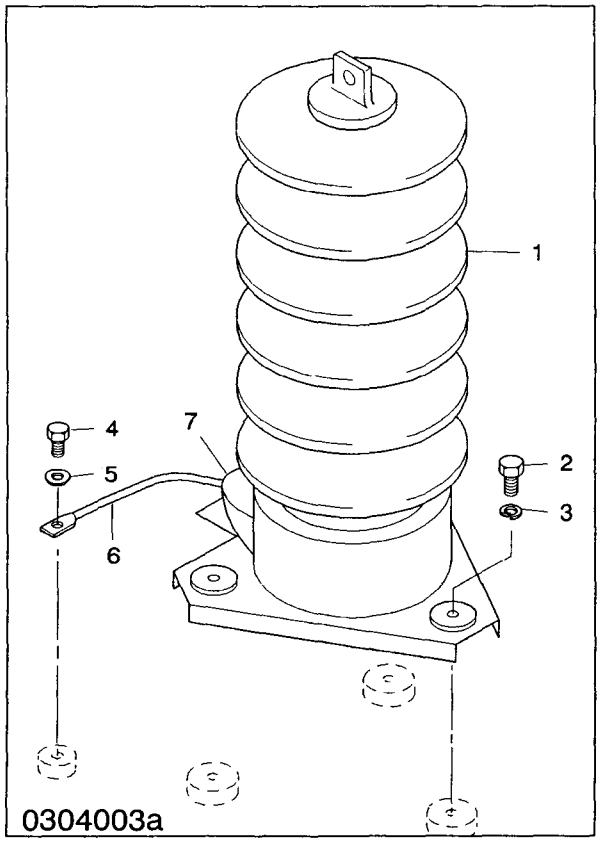
Remove the jumper cable (8), support angle (3) and flag (4) from the surge arrester (7). The cable (8) remains attached to the high voltage bushing.

Lift the surge arrester (1) from the locomotive with the aid of an assistant.

Roof Line Surge Arrester



Remove the screw (1), nut (6) and washers (2, 5) securing the flag (4) and roof line jumper cable (3) to the surge arrester (7). The cable (3) remains attached to the roof line.



Remove the screw (4) and washer (5) securing the earthing cable (6) to the converter roof hatch.

Remove the screws (2) and spring washers (3) securing the surge arrester (1) to the converter roof hatch.

Lift the surge arrester (1) from the locomotive with the aid of an assistant.

Disassembly

@.1240

There are no serviceable components within the surge arresters. The surge arresters are replaced if damaged or defective.

Inspection and Repair

@.1250

Clean any dirt, debris or residual coating from the insulator.

Inspect the surge arrester for chips, cracks or damage to the ceramic insulator.

Replace the surge arrester if damaged.

Inspect the condition of the jumper cables. Replace if damaged or frayed.

Inspect the condition of the silicon coating on the surge arrester insulator. Contaminants in the silicon coating reduce the insulating effect of the insulator. Water applied to the surface of the insulator should bead and not wet the surface. If the coating is contaminated or is wetted by water, the coating must be renewed. Audible discharges or flashovers that are visible in the dark are an indication that the insulator needs to be re-coated.

Remove the contaminated silicon coating using paper towelling. Wipe any remaining silicon coating from the insulator using a clean, dry, lint free cloth. Clean the surface of the insulator thoroughly using a cloth soaked in alcohol.

Ensure the glazed surface of the insulator is clean, dry and shiny. The silicon grease described in Section Miscellaneous Materials should be applied evenly to the entire glazed surface of the insulator to a thickness of 0.2 to 1 mm.

Take care when handling the surge arrester after coating to avoid contamination of the silicon grease on the insulator.

Waste Disposal

@.1260

Dispose of waste parts, materials and fluids according to the prevailing environmental standards or workplace practices.

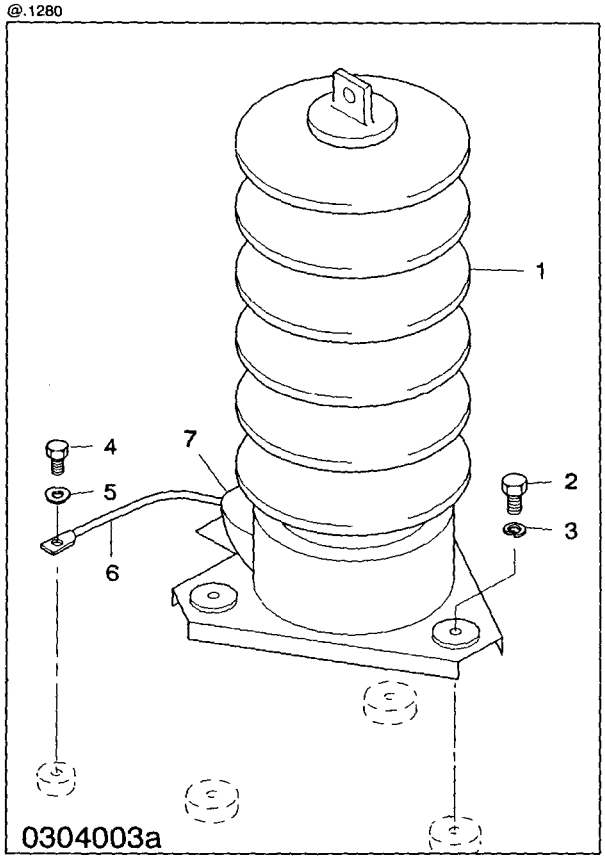
Assembly

@.1270

There are no serviceable components within the surge arresters. The surge arresters are replaced as an assembly if defective or damaged.

Installation

@.1280



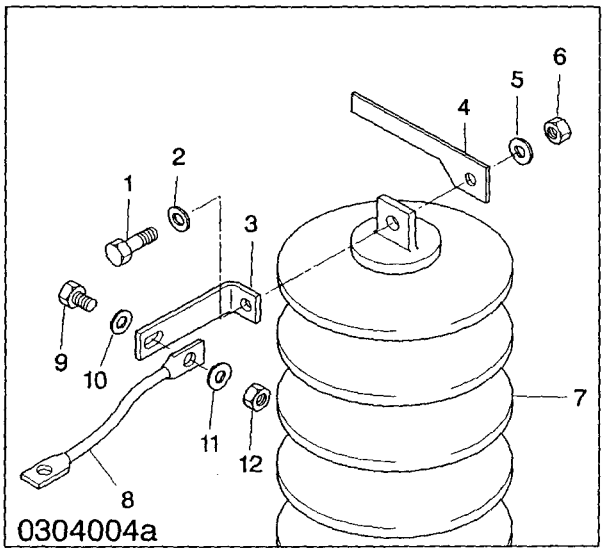
Lift the surge arresters onto the locomotive roof using suitable lifting equipment.

With the aid of an assistant, position the surge arresters (1) on the converter roof hatch. The trough (7) on the high voltage bushing surge arrester faces away from the vacuum circuit breaker. The trough (7) of the roof line surge arrester faces towards the filter block.

Install the screws (2) and spring washers (3) to secure the surge arrester (1) to the converter roof hatch. Tighten the screws (2).

Position the earthing cable (6) on the spigot, then install the screw (4) and washer (5).

High Voltage Bushing Surge Arrester

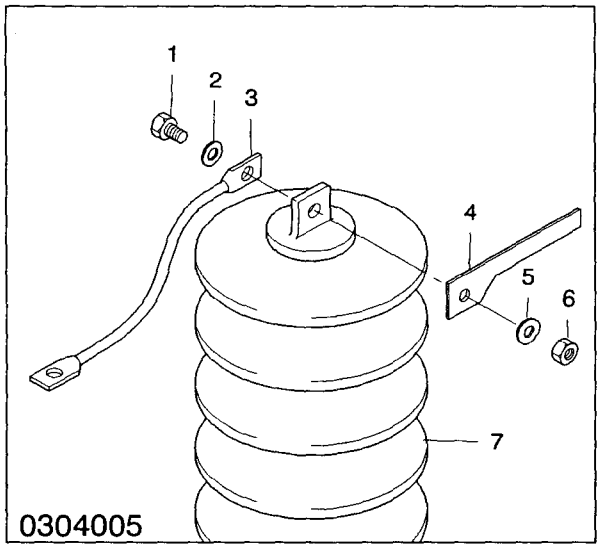


Position support angle (3) and flag (4) on the surge arrester (7) terminal, then install the screw (1), nut (6) and washers (2, 5). The flag (4) faces away from the vacuum circuit breaker, ending over the trough. Tighten the nut (6).

Secure the jumper cable (8) to the support angle (3) using the screw (9), nut (12) and washers (11, 10). Tighten the nut (12).

If necessary, connect the jumper cable to the high voltage bushing as described in Chapter 3.1, Roof Line.

Roof Line Surge Arrester



Position jumper cable (3) and flag (4) on the surge arrester (7) terminal. The flag (4) points towards the filter block, ending over the trough.

Install the screw (1), nut (6) and washers (2, 5). Tighten the nut (6).

After-Installation Operations

@.1290

Connect the jumper cables to the roof line as described in Chapter 3.1, Roof Line.

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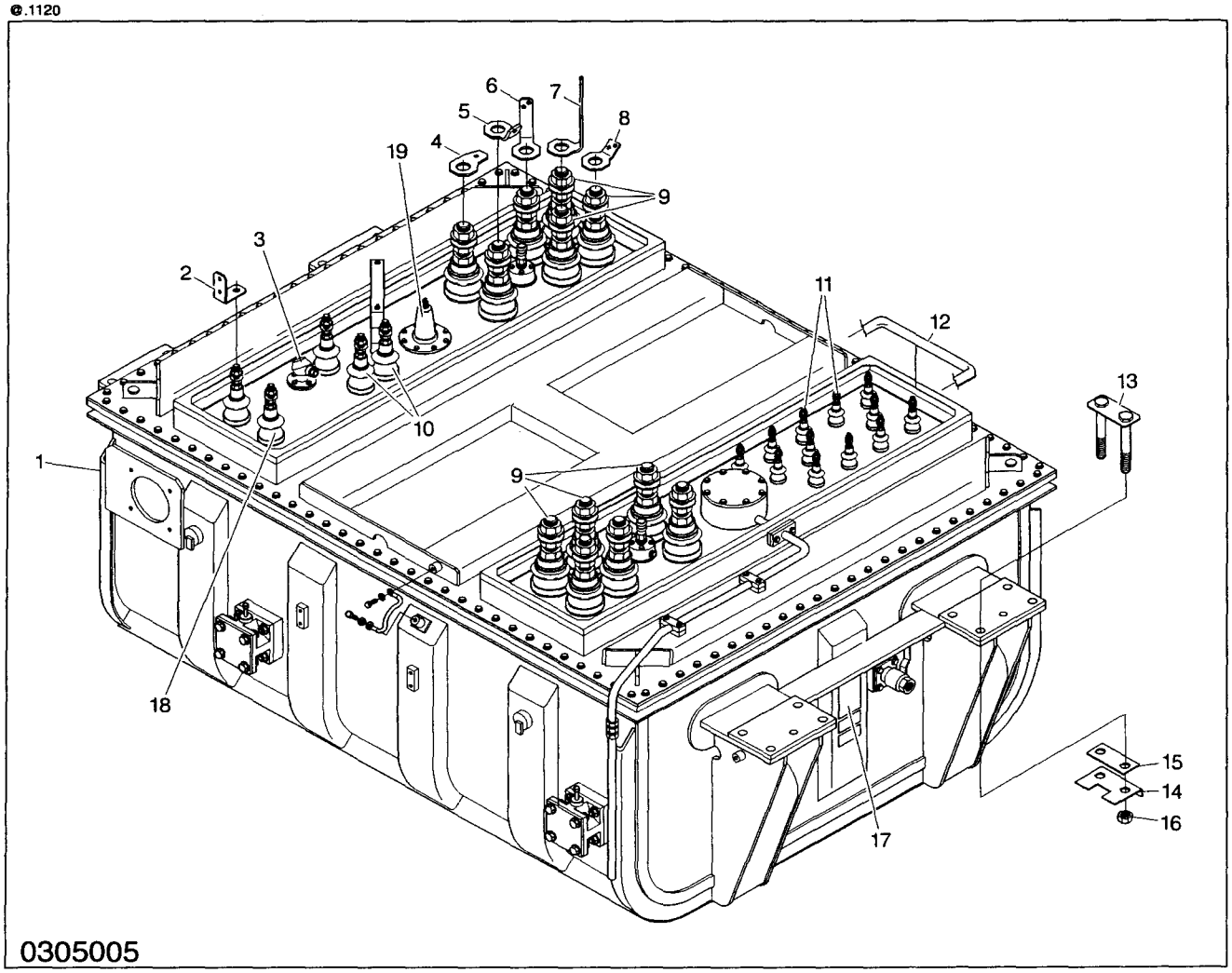
3.5 Transformer

Overview



1	Transformer general arrangement	11	Smoothing reactor bushing
2	Connection angle	12	Profiled joint
3	Thermometer	13	Fixing plate
4	Connection angle	14	Locking tab
5	Connection angle	15	Jacking plate
6	Connection angle, short	16	Hex. nut
7	Connection angle, long	17	Rating plate
8	Connecting plate	18	BUR bushing
9	Traction–Converter bushing	19	High voltage bushing
10	Filter bushings		

Functional Description

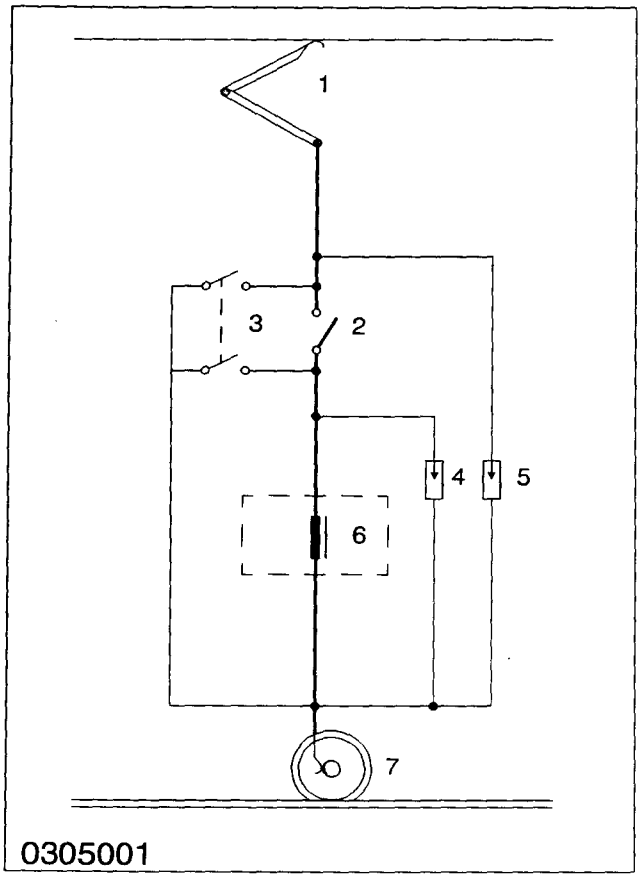
.1140

The Transformer unit consists of the main transformer active part and two different types of reactors, hosed in a tank.

The main transformer converts the overhead line voltage (25 kV) to the lower operating voltages for:

- traction power supply 1269 V
- auxiliary equipment 1 kV

The main transformer is integrated into the traction circuit between overhead line and rail return line:



1	Pantograph
2	Vacuum circuit breaker
3	Primary earthing switch
4	Surge arrestor
5	Surge arrestor
6	Main transformer
7	Earth return brush, 4 times

The primary current flows from the pantograph via roof line, vacuum circuit breaker, the roof bushing into the primary winding of the main transformer. It then flows back to the rail via the earth return brushes on four of the six axles.

NOTE:

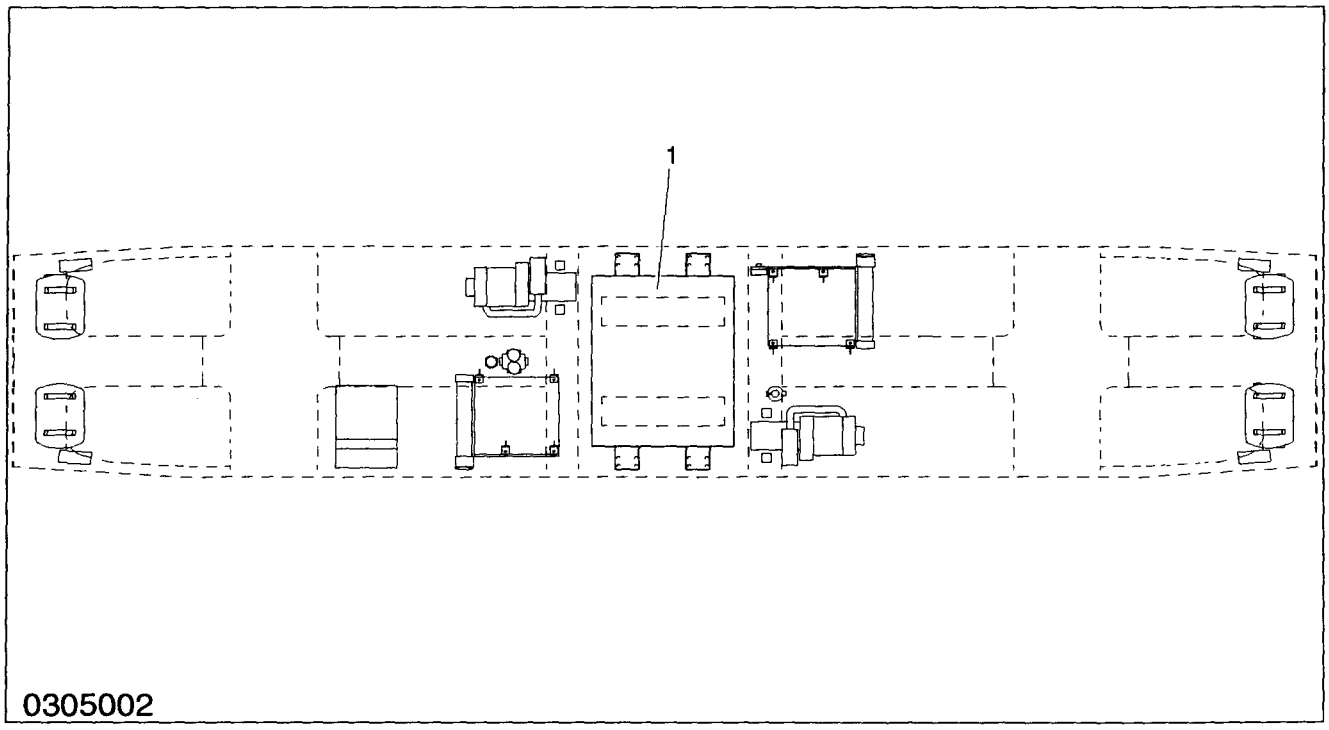
The "main transformer unit" should be understood in the present volume as the complete main transformer tank with main transformer, auxiliary converter chokes and series resonant chokes. The "main transformer" is the term used to describe the actual component.

The main transformer unit comprises following modules:

the main transformer

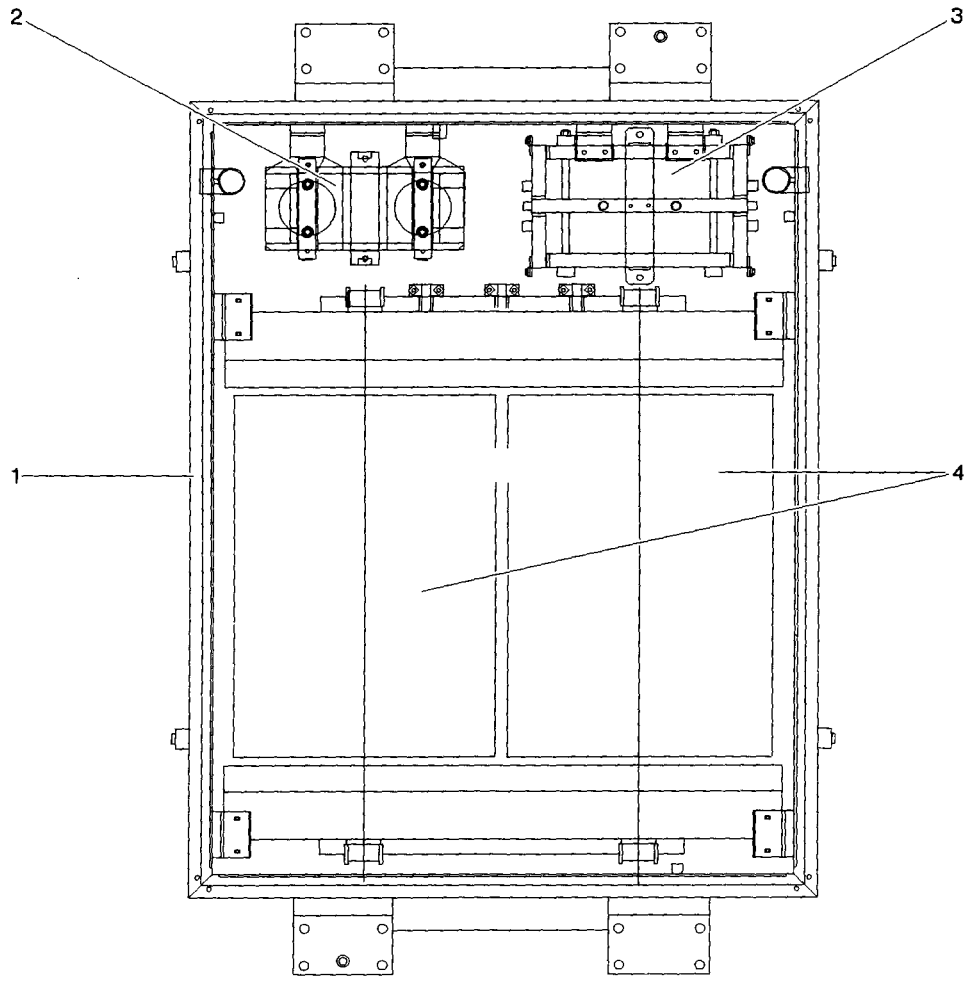
the auxiliary converter chokes for the power supply of the auxiliary circuits

the series resonant chokes for the traction power supply.



The main transformer unit (1) is installed centrally on the locomotive:

The components of the main transformer unit are arranged in the same aluminium tank, but they belong to different modules.



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1	Aluminium tank	3	Series resonant chokes
2	Auxiliary converter chokes	4	Main transformer

Mechanical

The main transformer is installed in an enclosed, oil–tight aluminium tank together with the 3 auxiliary converter chokes and the 2 series resonant chokes for the traction converters. This aluminium tank is divided into two chambers. The larger chamber contains the main transformer; the smaller chamber accommodates the series resonant chokes and the auxiliary converter chokes.

The tank is filled with transformer oil,

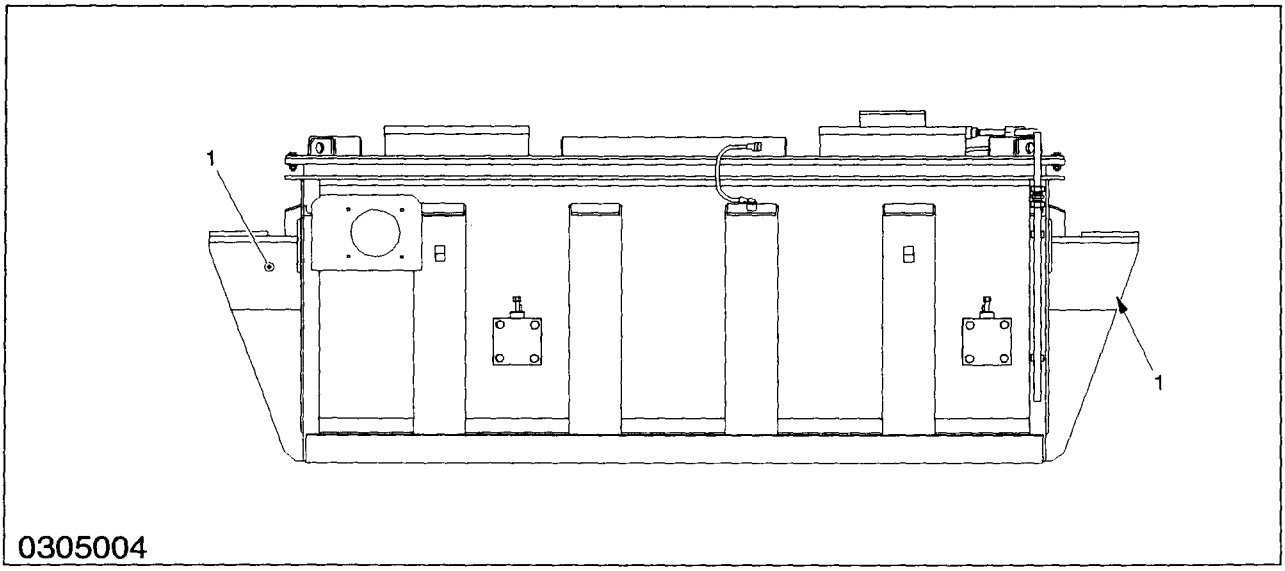
- in order to increase the insulation strength and
- so that the arising heat loss can be dissipated through the circulating oil.

The two parallel oil circuits with pumps and heat exchangers are described in Chapter 3.06.

The transformer has 4 fixing points each with 4 bolts. So that the bolts are relieved of any strains caused by share forces in the horizontal and vertical directions, a centring pin is provided on two diagonally opposite fixing points. The fixing plates are covered with a layer of paint to prevent corrosion which could occur between aluminium and steel.

The mounting surfaces are made in such a way that the exchange of the transformer is guaranteed; tolerances have been taken into account.

Earthing terminal

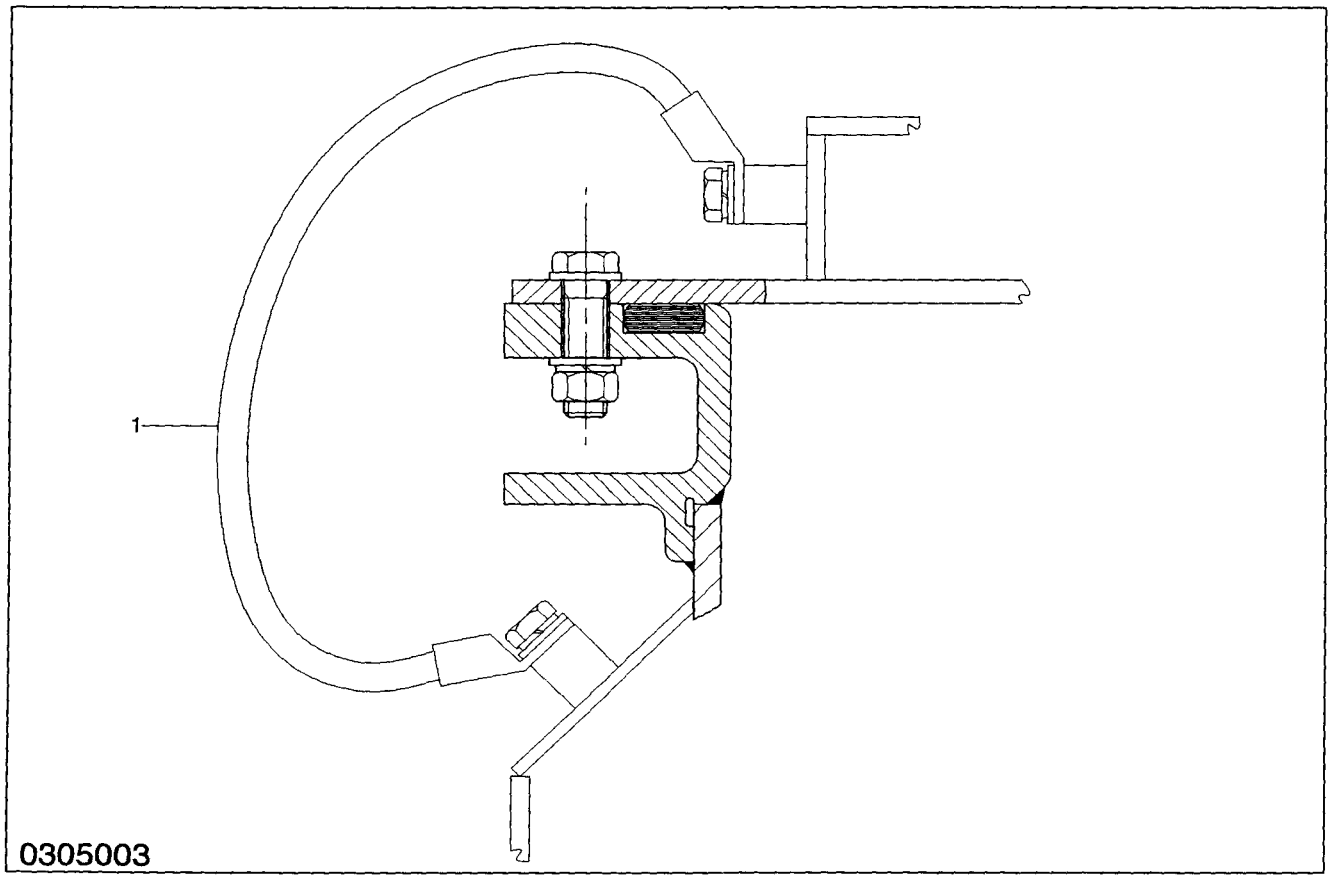


0305004

In order to avoid discharges and unwanted failures, all metallic parts inside and outside the transformer are earthed. The earthings (1) of the transformer active part and the reactors are connected with each other via the tank.

The marked earthing terminals (1) have to be connected to the locomotive's earthing terminal.

Ground connection



Sump and cover have a conducting connection to one another by means of an outer ground cable (1), which is attached at the top left on the front side (above the temperature indicator):

Magnetic circuit

The magnetic circuit of the main transformer is of two–legged design. The primary and secondary windings are in the form of disc windings and are distributed symmetrically between the two legs. They are interwound for the purpose of good coupling with serial and parallel connections.

Oil cooling

The cooling oil flows through pipes and barriers in such a way that it first cools the main transformer. The main transformer is subject to a symmetrical flow of oil from a chamber surrounding the middle of the transformer. The oil then flows from the large tank compartment at the top down into the smaller compartment, where it flows around the chokes from bottom to top.

All oil connections on the tank have stopcocks.

Transformer oil

The transformer unit is filled with ca 2000 kg of mineral oil. The oil serves as a cooling and insulating agent.

Breather/Filter

The purpose of the breather/filter is to dry the air that goes to and from the transformer oil expansion tank as a result of temperature fluctuations during operation.

The breather/filter is filled with 3 litres of silica gel crystals (SiO2). Silica gel is very porous and can absorb up to one third of ist own weight of water. At the manufacturing stage it is colourless. By treating the crystals with cobaltous chloride, the colour changes to blue when dry and pink when water is absorbed.

When the breather/filter is installed, the colour of the crystals indicates whether they need drying out or not.

Depending on the atmospheric conditions (higher or lower humidity) the breather/filter has to be checked more or less often. To prolong these intervalls there is a nozzle at the air intake, which opens with over or under pressure. With slight or no temperature fluctuations the nozzle stays closed.

Recirculation/Cleaning Valve

The recirculation/cleaning valve is situated between the relay and the transformer oil expansion tank.

It provides a means of stopping the oil flow from the transformer conservator to the main transformer.

The valve is of glandless construction, with none of the moving parts of the bonnet assembly coming into contact with the pipe fluid.

The bonnet assembly contains a compressor which supports the diaphragm at all stages of travel.

The valve works by «pinching off» the flow of fluid. As the handwheel is turned clockwise, the diaphragm presses against the body, so stopping the flow of fluid. The diaphragm should not be overclosed. Only a «nipping» onto the wear is required.

Prismatic level gauge

The prismatic level gauge is mounted on the side of the transformer expansion tank (breather/ filter). It is basically a glass tube for measuring the level of the transformer oil in the transformer expansion tank. It is held in position by a metal plate and twelve fixing screws. Oil enters the gauge through a hole in the bottom, whilst expelling air through a hole in the top (back into the transformer conservator).

To compensate for temperature expansion effects, a temperature scale is alongside the gauge.To compensate the correct oil level, the temperature must be read off the main transformer thermometer. The correct oil level can then be determined.

Current bushings

The electrical connections on the unit are brought out of the tank through ceramic wall bushings. The roof bushing, which provides the primary connection of the main transformer, is described separately.

Tank

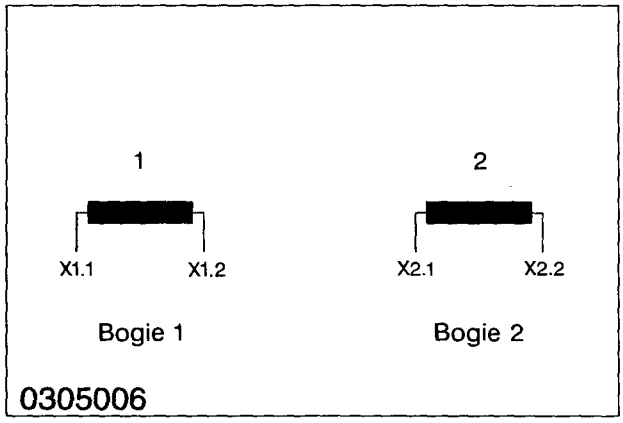
The tank insulates the internal high–voltage–carrying components. It all allows the dissipation of heat loss from windings and magnet cores via the oil surrounding them.

All penetrations in the wall of the tank as well as the connection between sump and cover are of oil–tight design.

On the right–hand narrow side of the tank, all connections of the main transformer are accessible via ceramic bushings, with those of the chokes being accessible on the left–hand narrow side.

Series resonant chokes

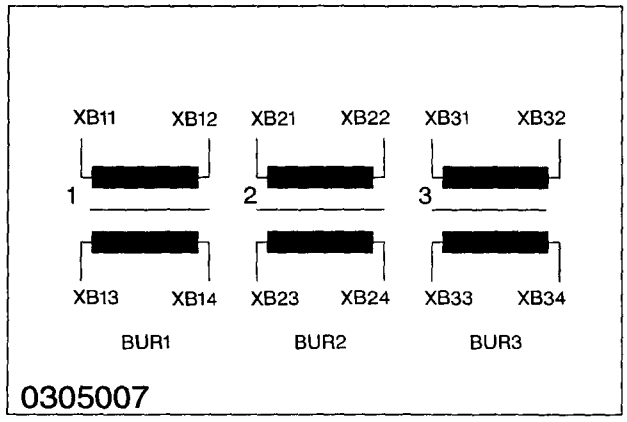
The two individual series resonant chokes, installed at the bottom in the smaller tank chamber, belong to the smoothing circuits of the two traction converters.



1 to traction converter 1
2 to traction converter 2

Auxiliary converter chokes

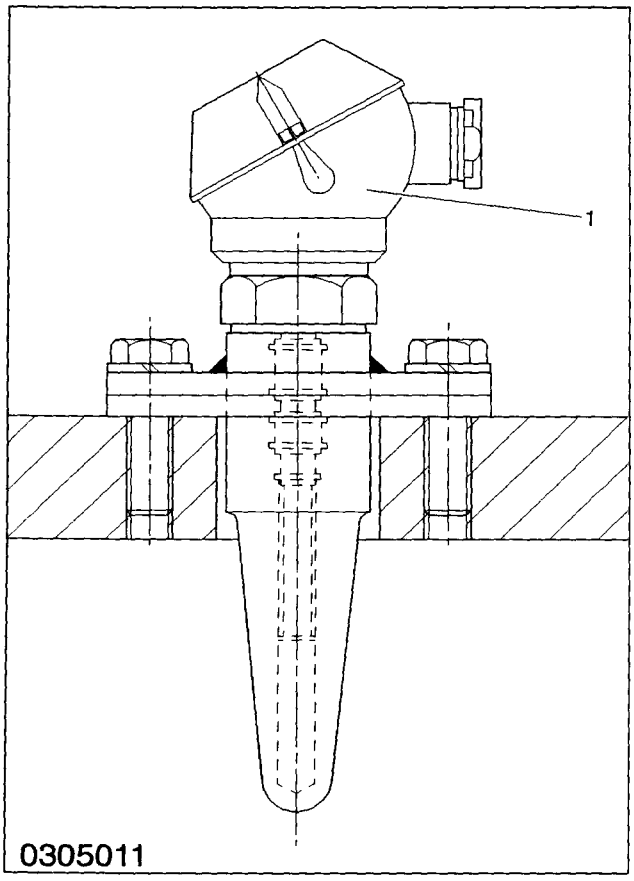
The auxiliary converter chokes, installed at the top in the smaller tank chamber, belong to the DC-link circuits of the three auxiliary power supplies.



1 to auxiliary converter 1
2 to auxiliary converter 2
3 to auxiliary converter 3

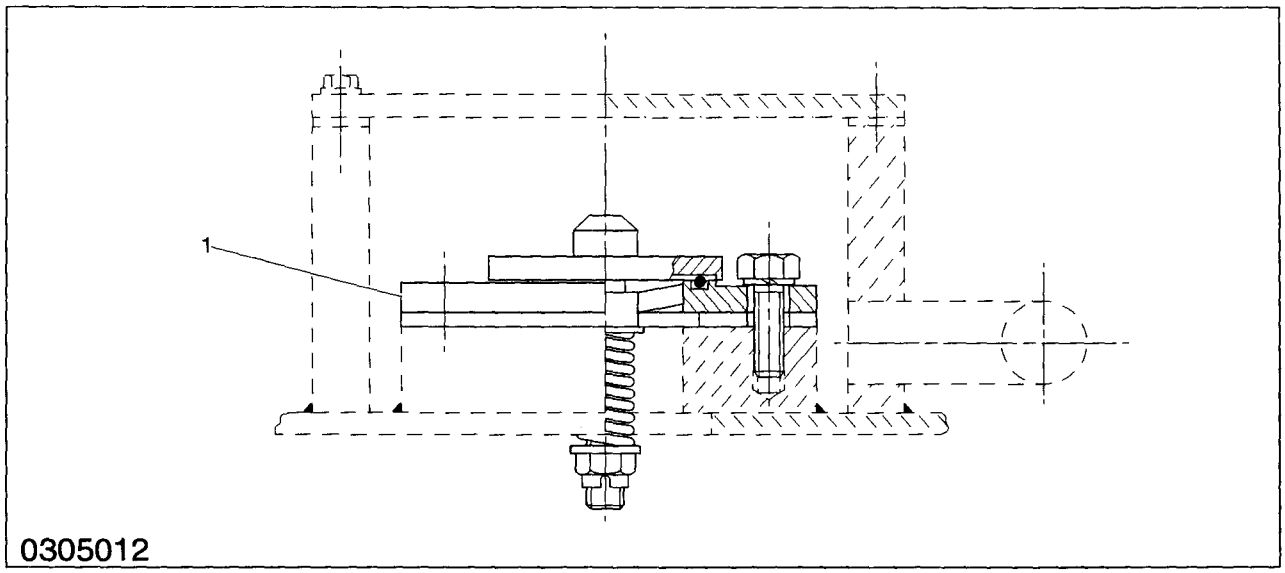
Safety equipment

Thermometer



The gas pressure thermometer (1) provides a local indication of the oil temperature. The sensor measures the oil temperature at the point of the highest value. There is a change in the pressure of the gas filling; this pressure is transmitted via the capillary tube to the pressure–gauge measuring spring in the indication instrument. Effects of the ambient temperature are compensated by a bimetallic element. The maximum allowable oil temperature is 150 °C.

Safety valve



The safety valve (1) or pressure–relief valve consists of a spring–loaded pressure plate above an outlet opening. It opens at a pressure of 0.8 bar and releases excess oil into a surrounding chamber with drain pipe. Its response time to the arrival of a wave of pressure is 3 msec. The pressure wave required for opening can be adjusted prior to installation by means of the spring preload.

Technical Data

@.1160

Transformer

– Type	LOT 6500
– Frequency	50 Hz
– Number per locomotive	1

Primary Winding

– Power	6531 kVA
– Voltage	25000 V
– Current	2261.25 A

Traction Winding

– Power	4 x 1449 kVA
– Voltage	4 x 1269 V
– Current	4 x 1142 A

Filter Winding

– Power	400 kVA
– Voltage	1154 V
– Current	347 A

BUR Winding

– Power	334 kVA
– Voltage	1000 V
– Current	334 A

Primary against

Traction

– Resistance	37 mΩ
– Inductance	2.10 mH
– Inductance tolerance	± 15%

Filter

– Resistance	19 mΩ
– Inductance	0.29 mH
– Inductance tolerance	–

BUR

– Resistance	60 mΩ
– Inductance	0.43 mH
– Inductance tolerance	–

Series Resonant Circuit Reactor

Type				2 SOD 240
Frequency				100 Hz
Number per unit				1
Current		2 x 984	A_{RMS}	
Inductance	until $\hat{I}$=2 x 1391 A	2 x 0.551 ± 15%	mH	
Phase–Phase voltage	max.	482	V_{AC}	
Phase–Ground voltage	max.	3471	V	
Power Losses	at 75 °C	12.5 + 15%	kW	

Auxiliary Converter DC–Link Reactor

Type				6 GOD 120
Frequency				100 Hz
Number per unit				1
Inductivity	at 0 A at 120 A at 155 A at 190 A	30 30 26 20	mH mH mH mH	
Current	nominal max.	155 190	A A	
Ripple	at 100 Hz	38.6	%	
Phase–Ground voltage	nominal max.	1153 2000	V V	
Power Losses		12 + 15%	kW	

Tank and lid

– Material	Aluminium
– Colour	RAL 7009 satin
– Weight	966 kg

Expansion tank

– Material	Aluminium
– Colour	RAL 7030 satin
– Volume	2 x 137 dm^3
– Weight	2 x 88 kg

Characteristics of the tansformer oil

Shell Diala DX	Unit	Test method	Requirements acc. to IEC 296 Class II (SEV 3163.72)	Expected values
Appearance			clear, free from suspended and collected impurities	must comply
Density 20 °C	g/cm^3	ISO 3675	max. 0.895	0.867–0.878
Flash point	°C	ISO 2719	min. 130	140
Pour point	°C	ISO 3016	max. –45	< –55
Cinematic viscosity 40 °C	mm^2/$_s$	ISO 3104	max. 11.0	8.5–9.5
Cinematic viscosity –30 °C	mm^2/$_s$	ISO 3104	max. 1800	800–1000
Neutralisation value	mgKOH/g	IEC Publ. 296	max. 0.03	must comply
Corrosive sulphur content		ISO 5662 SEV 3163	non-corrosive silver strips must not be blackened by silver sulphide	must comply
Break-down voltage	kV	IEC Publ. 156	min. 30	must comply
Dielectric loss factor 90 °C		IEC Publ. 247	max. 0.005	0.001
IEC Ageing process (164h/100 °C)		IEC Publ. 74		
Neutralisation value	mgKOH/g		max. 0.4	0.12
Impurities	g/100g		max. 0.1	0.05
Dielectric loss factor 90 °C			max. 0.15	0.045

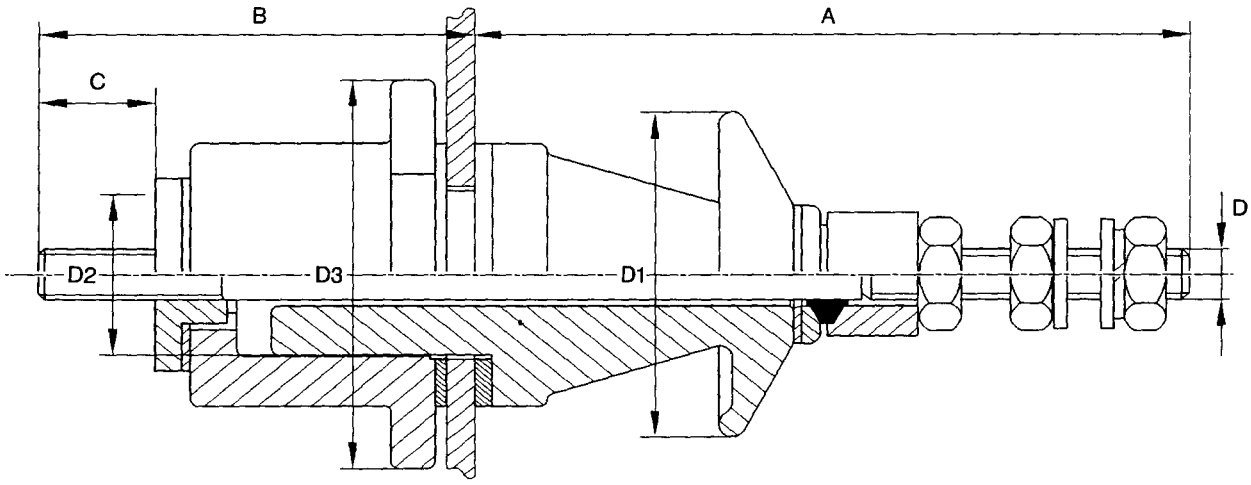
Insulation strength

Maximum operation voltage kV	New transformers			Transformers in operation		
	IEC 156	ASTM D-1816	ASTM D-877	IEC 156	ASTM D-1816	ASTM D-877
kV	kV/2.5 mm	kV/0.08"	kV/0.1"	kV/2.5 mm	kV/0.08"	kV/0.1"
up to 36	50	40	28	40	32	25

Oil specifications

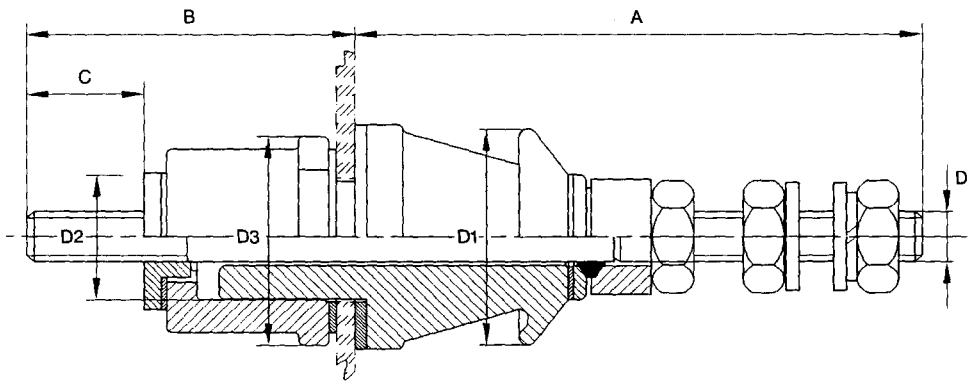
Ref. no.	Characteristic	Unit	Value	Test method
00001	Ident. text	–	Insulation oil T1	
00002	Ident. no.	–	NBT 402614P0201	
01000	Description	–	The insulation oil T1 is a pure mineral product without any additives; it is used in transformers and switch gear	
01120	Density at 20 °C	g/ml	≤ 0.895	ISO 3675 DIN 51757
01500	Delivery instructions	–	ZN 02125	
01800	Documentation	–	ZLC-documentation and QZ HSTC 419458	
05100	Colour	–	Pale yellow to yellow	
07900	Special properties	–	The oil is not cloudy and is free of solid particles and water	
26350	Pour point IEC class IA IEC class IIA	°C	 ≤ –30 ≤ –45	ISO 3016 ASTM D 97-66 DIN 51597
29300	Flash point in an enclosed crucible	°C	≥ 130	ISO 2719 ASTM D 93-66 DIN 51758
22500	Thermal expansion coefficient	K^{-1}	Standard NB 214200	
31300	Dielectric loss factor tan δ at 90 °C 50 Hz	–	≤ 0.005	IEC Publ. 247-1978 VDE 0370/12.78
35300	Break-down voltage	kV	≥ 50	IEC Publ. 156
43700	Interfacial tension	mN/m	≥ 40	ASTM D 971-50
45150	Cinematic viscosity at + 20 °C at + 40 °C at – 15 °C Class IEC IA at – 30 °C Class IEC IIA	$mm^2/_s$	 ≤ 25 ≤ 11 ≤ 800 ≤ 1800	ISO 3104
51370	Corrosive sulphur content	–	none	DIN 51353
55100	Neutralisation value	mgKOH/g	≤ 0.03	IEC Publ. 296-1978
55350	Aniline point	°C	≥ 80	ISO 2977 DIN 51775

Dimensions of DIN bushings



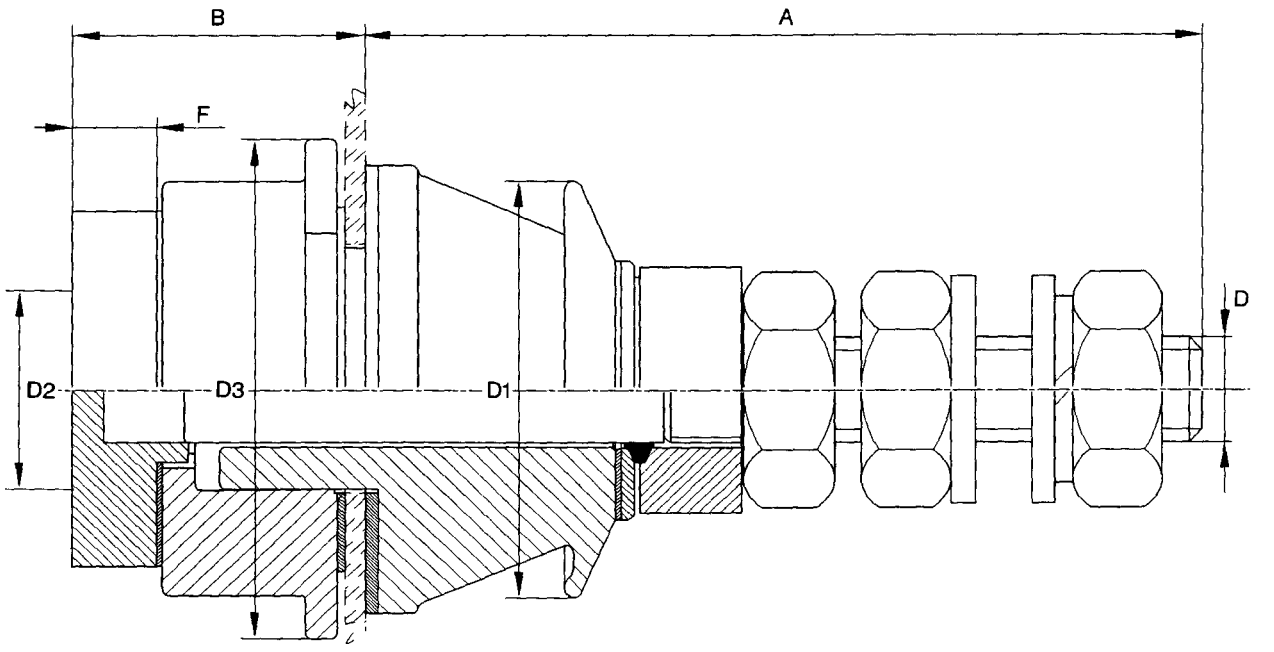
0305014

– Type	DT 1/250
– A	138
– B	67
– C	25
– D	M 12
– D1	50
– D2	28
– D3	60



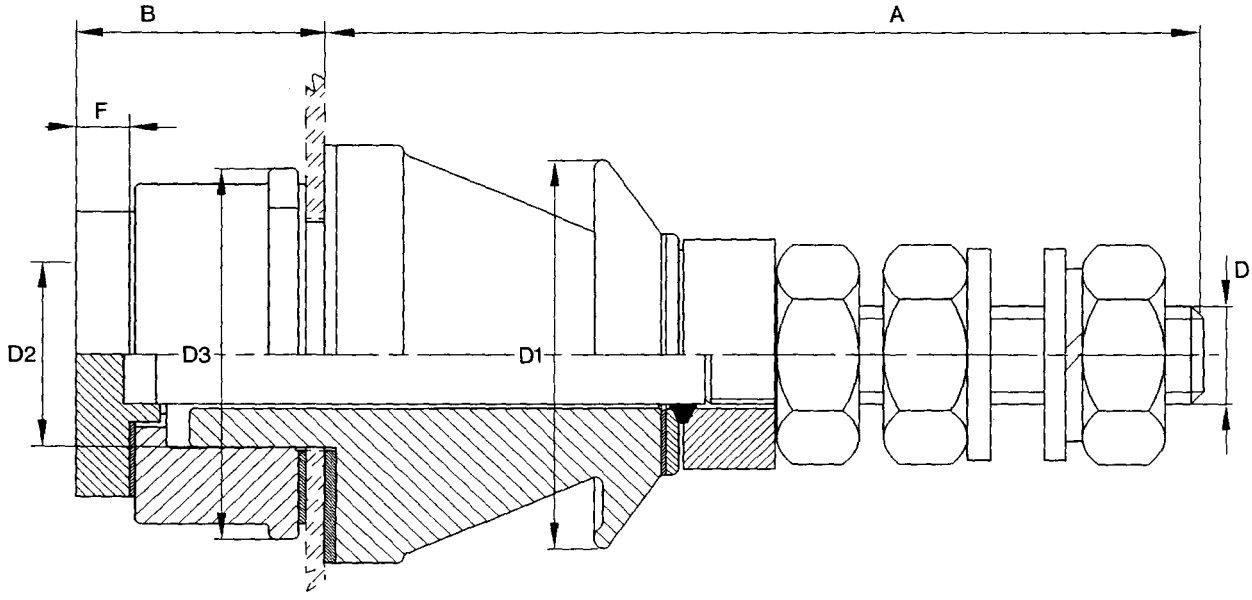
0305016

– Type	DT 3/630
– A	210
– B	108
– C	37
– D	M 20
– D1	90
– D2	45
– D3	85



0305015

– Type	DT 1/2000
– A	340
– B	71
– D	M 42 x 3
– D1	104
– D2	70
– D3	125
– F	22



0305017

– Type	DT 3/2000
– A	372
– B	91
– D	M 42 x 3
– D1	125
– D2	70
– D3	125
– F	22

Gaskets for DIN bushings

DT 1 / 250

– Drawing No.	HSTN 310 500
– 4	NBR–G70; Ø22/12x11
– 8	NBR–G80; Ø29/14x3
– 9	NBR–G70; Ø50/28x4
– 10	Presspan; Ø50/28x2
– 11	Presspan; Ø45/25x2

DT 1 / 2000

– Drawing No.	HSTN 310 503
– 4	NBR–G70; Ø59/42x18
– 8	NBR–G80; Ø76/44x3
– 9	NBR–G70; Ø104/70x4
– 10	Presspan; Ø104/70x3
– 11	Presspan; Ø90/63x3

DT 3 / 630

– Drawing No.	HSTN 310 506
– 4	NBR–G70; Ø32/20x13
– 8	NBR–G80; Ø41/22x3
– 9	NBR–G70; Ø70/45x4
– 10	Presspan; Ø70/45x2
– 11	Presspan; Ø63/40x2

DT 3 / 2000

– Drawing No.	HSTN 310 508
– 4	NBR–G70; Ø59/42x18
– 8	NBR–G80; Ø76/44x3
– 9	NBR–G70; Ø104/70x4
– 10	Presspan; Ø104/70x3
– 11	Presspan; Ø90/63x3

Weights

– Transformer active part LOT 6500	5380 kg
– Series resonant circuit reactor 2 SOD 240	590 kg
– Auxiliary Converter DC–Link Reactor 6 GOD 120	570 kg
– Tank and lid	900 kg
– Insulation oil	1780 kg
– Equipment	230 kg
– Total transformer unit	9450 kg
– Expansion tank (oil–level at 20 °C)	176 kg (2 x 88 kg)

Tolerances and Wear Limits

@.1170

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Tools and Special Tools

@.1180

In order to carry out work on the main transformer, the following special tools and equipment must be available:

– Application	Tool/Material
– Lifting equipment, roof, transformer unit	Crane > 10 t
– Lifting main transformer unit	Intermediate yoke
– Draining transformer oil	Oil vessels, total 2100 l
– Draining/pouring in transformer oil	Circulating pump, 2–direction (optional)
– Connection to drain cock	Flexible hose G1 1/4"
– Collecting spilled oil	Oil binding agent
– Pouring in oil, bleeding	Vacuum pump (optional)
– Insulation test	High–voltage tester 6/12 kV, 150 kV pulse
– Measuring no–load/operating currents	Clip–on Ammeter (battery–powered unit) 5/600 A
– Voltage check	Voltmeter (battery–powered unit) 2/30 kV
– Checking coil resistance	Ohmmeter
– Checking coil inductance	Inductance measuring bridge

Miscellaneous Materials

@.1200

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Before–Removal Operations

@.1220

Draining Oil

Drain the oil of the transformer oil cooling circuit by the draining valve of the transformer [ABB procedure to follow].

CAUTION:

Interventions on the main transformer unit, such as repairs or the replacement of individual components, may be carried out only by ABB specialists. The manufacturer's warranty on the unit will be voided if interventions are carried out by the customer. The only exemptions to this restriction are the local temperatur indicator, the primary current transformer and the roof bushing, which do not affect the oil filling.

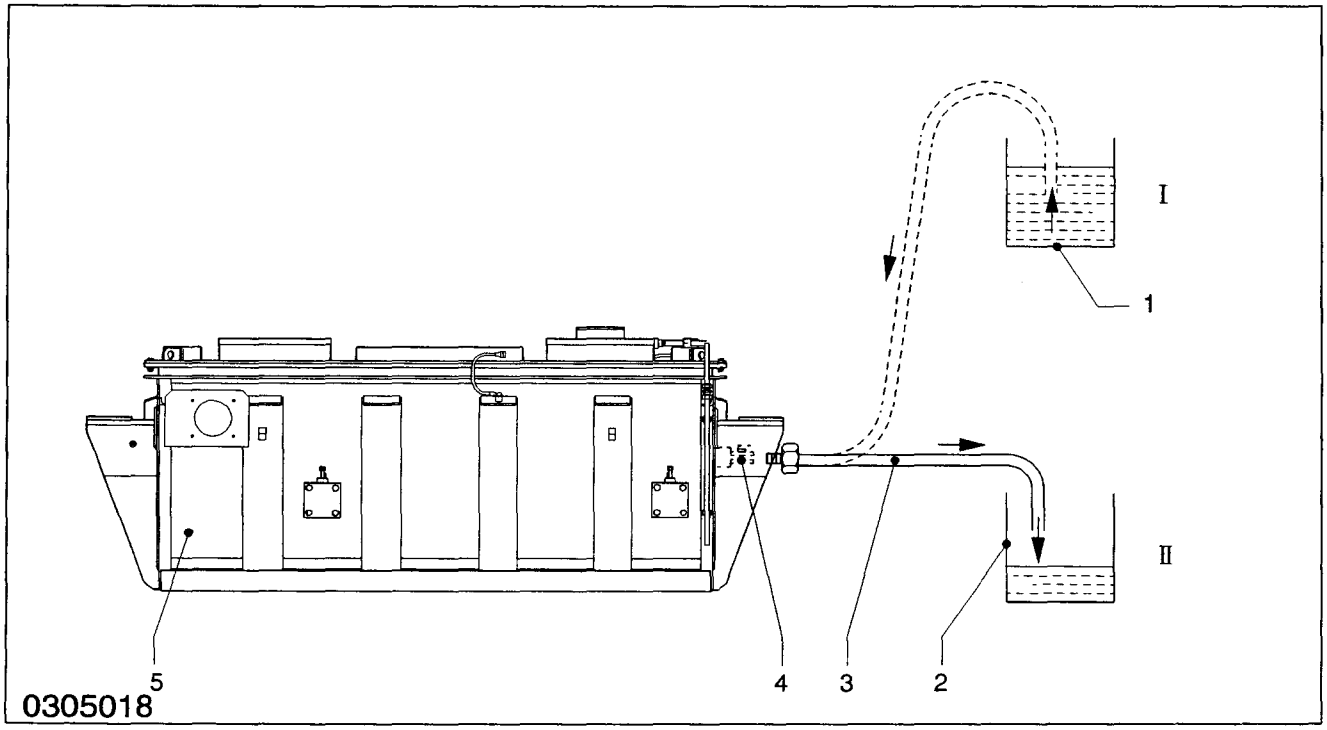
Certain operations may, after consultation with the ABB after–sales service, be carried out on site by an ABB service technician.

The transformer oil must be drained in order to replace wall–penetrating components.

CAUTION:

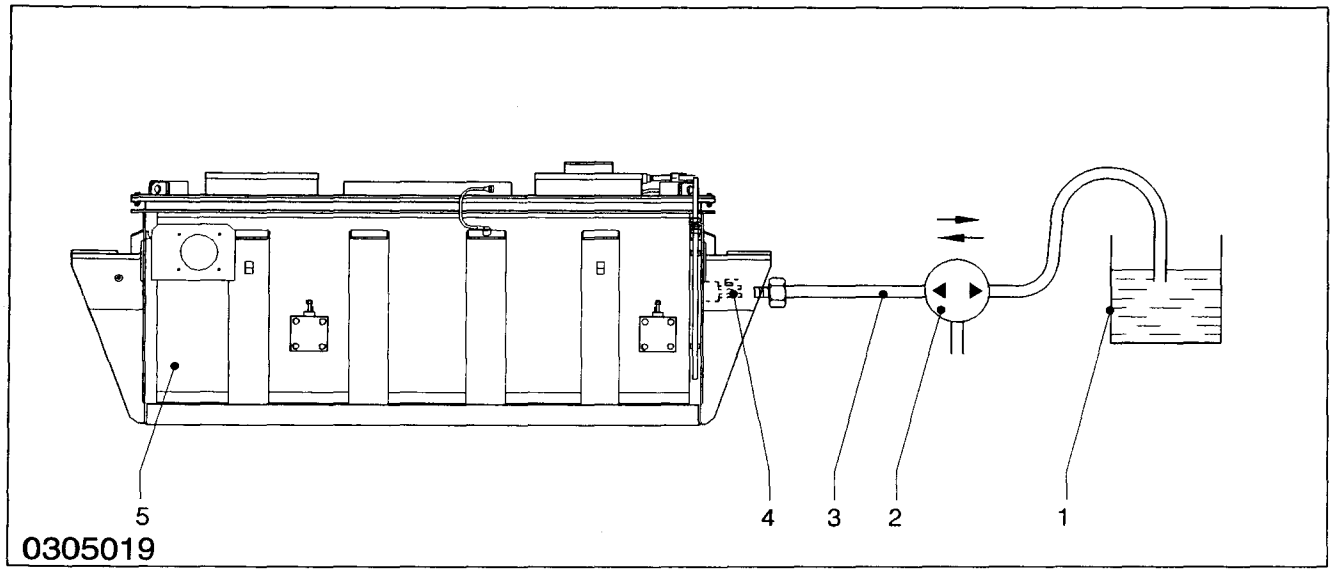
The handling of the transformer oil must be accompanied by utmost cleanliness. Solid impurities may result in short circuits in the tank. Use clean vessels.

Avoid air inclusions when filling in oil. These will have an adverse effect on electric strength and will impede the dissipation of heat loss. After filling in, leave air bubbles a few hours time to rise before energizing the transformer again.



The transformer oil can be drained or filled in two ways:

- Using the syphon principle: The oil flows under ist own weight off or to the tank, depending on the height of the end of the auxiliary hose in comparison with the level of the tank.



- Using an external circulating pump in the auxiliary hose line.

The two chambers of the tank are drained separately. This means that the oil draining procedure given below, must be performed separately for each of the two drain cocks.

NOTE:

To work in just one chamber, the other chamber can simply be partially drained to a level below the tank/cover flange. As there is no level indicator for the oil level in the lower region, the amount of oil to be drained must be calculated from the tank dimensions (standard rule: oil filling approx. 70% of the tank volume involved).

Procedure for draining transformer oil by syphon method

Close all cocks on the tank

Remove closing cover from one drain fitting

Connect hose; introduce other end into the storage vessel

Set up storage vessel below level of tank base

Open drain cock: oil flows out; air flows afterwards via air dryer. If necessary close drain cock, replace full storage vessel with empty one, then re–open drain cock.

Procedure for draining transformer oil by circulating pump

Close all cocks on the tank.

Remove closing cover from one drain fitting.

Connect hose; introduce other end into a storage vessel.

Open drain cock; switch on circulating pump: oil flows out; air flows afterwards via air dryer. If necessary: interrupt procedure; place empty supply vessel underneath.

Further operations

Disconnect the connetions machine room – roof. Remove the roof using suitable lifting equipment as described in Chapter 3.01.

Remove the traction converter as described in Chapter 4.01 Section Removal.

Disconnect the oil pipes of the transformer oil cooling from the flanges of the transformer as described in Chapter 3.06 Section Removal.

Removal

@.1230

Transformer

If the transformer needs to be removed because of a fault then the manufacturer have to be notified.

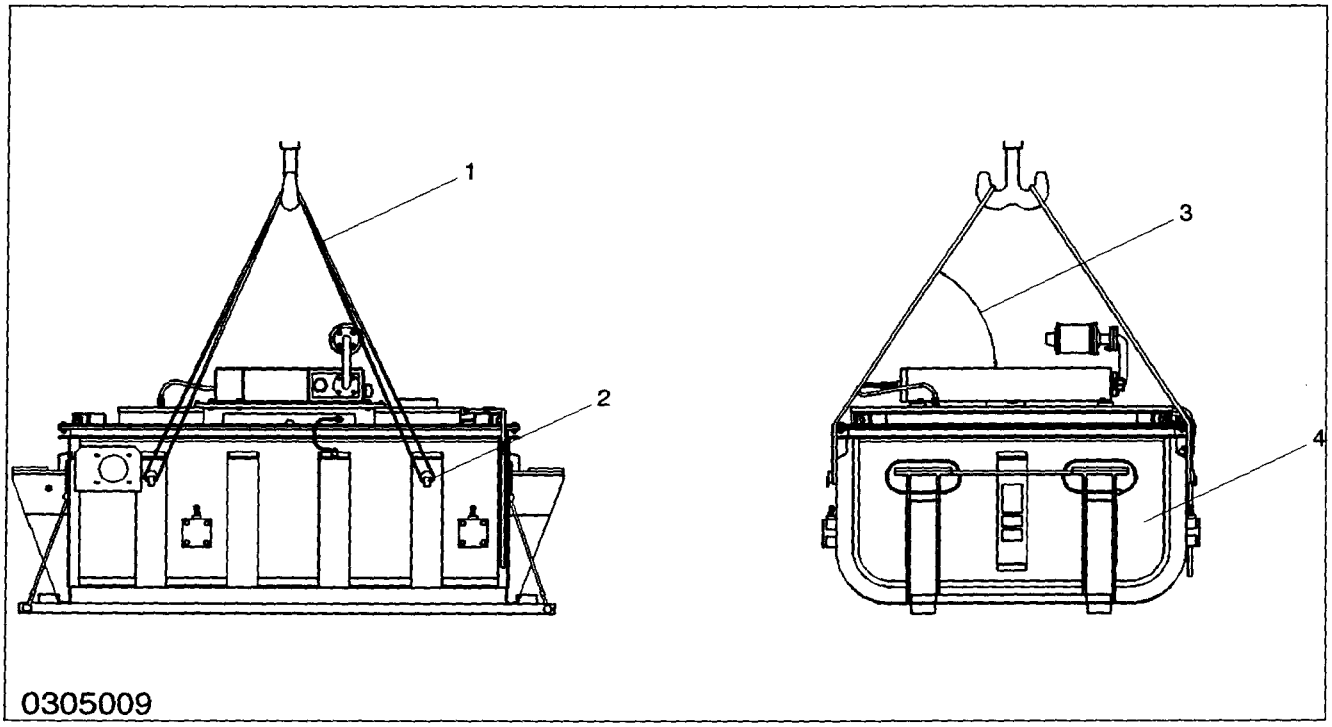
Transport

The transformer will be transported full with oil. Any oil volume changing (which is caused by temperature variations) during the transport or storage are taken up by the transport expansion tank which is mounted on the transformer lid.

The breather is connected to the transformer's expansion tank. The breather will only be removed during the installation of the transformer in the locomotive, and refitted as soon as possible. The breather must be filled with new or dried blue silica gel.

Lifting of the transformer

The transformer must never be lifted without its lid. Lifting points are welded to the side of the tank for this purpose. The rope should be attached on these lifting points as described. The ropes should never make a smaller angle than $\beta = 60°$ (3) with the horizontal, otherwise there is a danger that the tank will distort.



0305009

Setting down the transformer

The transformer should only be set down onto supporting blocks. These blocks protect the paint work as well as evenly distribute the load between the cross–members of the tank.

Supporting the transformer on a point.

f for any reason the transformer needs to be supported on a point, then it should only be supported on the indicated areas shown by arrows.

Disassembly

@.1240

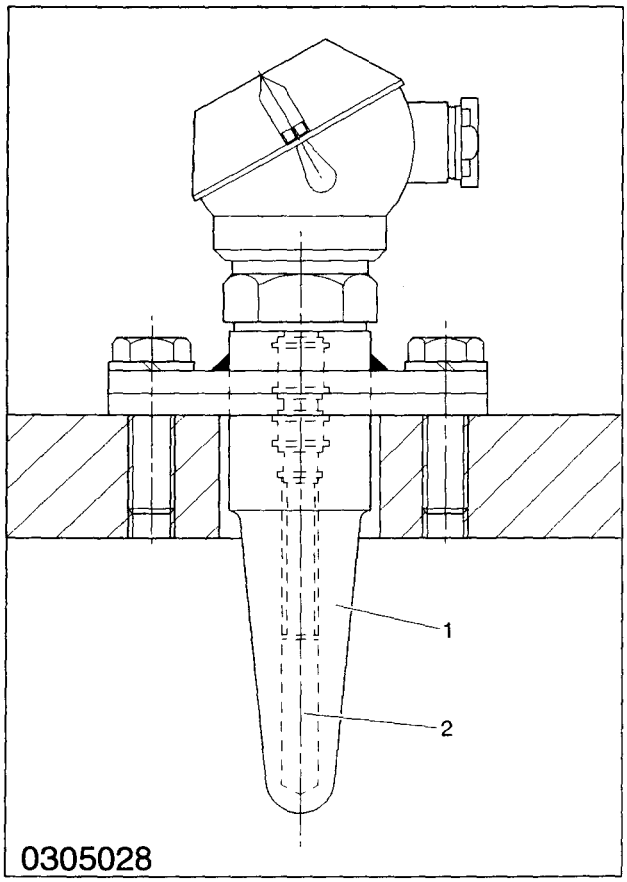
General

CAUTION:

Interventions on the main transformer unit, such as repairs or the replacement of individual components, may be carried out only by ABB specialists. The manufacturer's warranty on the unit will be voided if interventions are carried out by the customer. The only exemptions to this restriction are the local temperatur indicator, the primary current transformer and the roof bushing, which do not affect the oil filling.

Certain operations may, after consultation with the ABB after–sales service, be carried out on site by an ABB service technician.

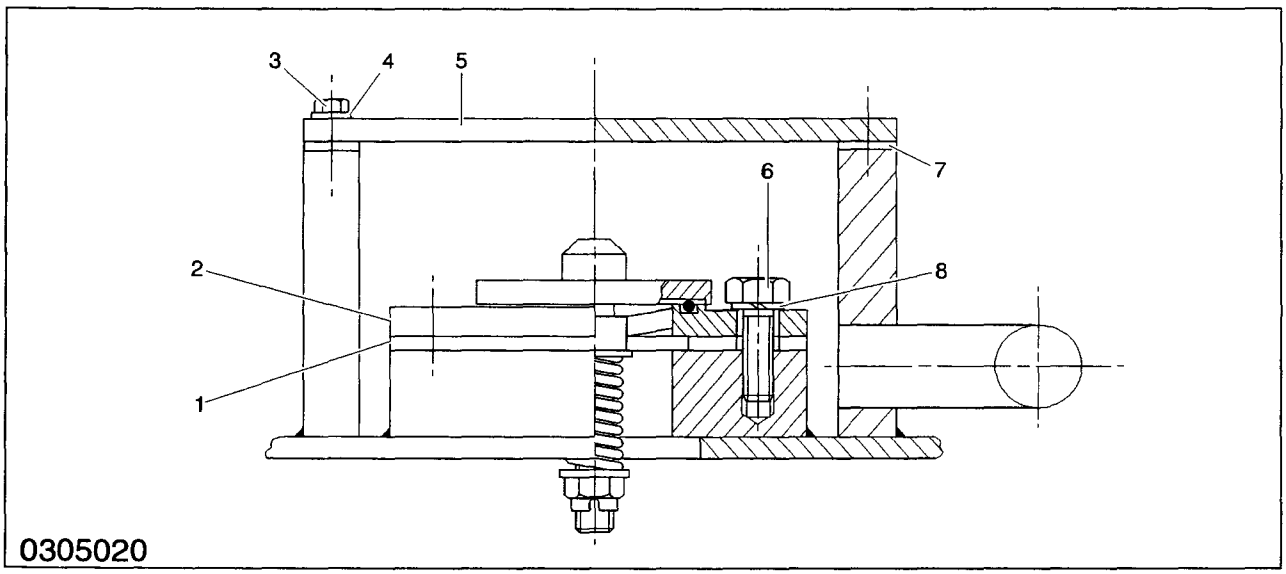
Thermometer



CAUTION:

Indication instrument, capillary tube and sensor (2) must not be separated from one another (gas pressure filling). Do not bend cappillary tube. Do not remove the immersion tube (1).

Safety valve



To remove or replace the safety valve, drain the transformer oil as described in Section Before Removal Operations. The tank cover remains closed.

Replace the pressure relief valve only as a complete unit. It cannot be dismantled, because auxiliary equipment is required for setting the pressure. The old valve should be sent to the manufacturer for inspection and resetting.

Close all tank cocks; drain oil as previously described.

Remove cover bolts (3), washers (4) and cover (5) with gasket (7).

Loosen valve flange bolts (6) with washers (8); remove valve (2) and gasket (1).

Bushings

The gaskets and the washers outside of the transformer can be replaced without removing the transformer lid. The oil level has to be decreased to 50 mm from the lower side of the lid. Once the electrical terminals have been removed, the fixing nut can be untightened.

Inspection and Repair

@.1250

WARNING:

Measurements and manipulations on the main transformer housing while live may be carried out only by trained specialists. Danger to life.

IMPORTANT:

Voltage flashovers constitute a danger to people, equipment and measuring devices. High–voltage measurements may be carried out only in the presence of a look–out man.

Measuring devices with an independent battery–operated power supply should be used for carrying out measurements while the system is live. The necessary insulation strength does not exist in the case of a mains power supply. The measuring devices should be set up on insulated auxiliary platforms:

The components of the main transformer unit cannot be repaired. In case of faults, replace the modules involved as complete units. Defective replaced parts should either be returned to the manufacturer for repair and re–testing or should be suitable disposed of.

If the annual oil test reveals irreversible contamination, ageing of the transformer oil or if the oil has already been in the tank for 15 years, it should be drained and replaced. The procedure is described under "Draining Oil" and "Filling Oil". At the same time, replace any bushing insulators with small chips that were still found to be just about usable at earlier inspections.

Any enquiries regarding repairs or orders for spare parts should always be directed to ABB Transportation Systems.

Storage of transformer

Duration of storage

The transformer can be stored as long as required, if the maintenance is carried out as required.

Storing place

The oil–filled transformer should not be stored outside. The storing place must be dry and the transformer must be covered with a lose taped plastic sheet.

Connecting flanges

All pipes, pumps and blocking valves should be closed off using blanking flanges.

Expansion tank

Fix the expansion tanks in vertical position on a higher level than the transformer's lid. Join them with flexible pipes with the transformer in the same way as they are installed in the locomotive. The oil level in the expansion tank should correspond with the temperature mark.

The breathers have to be mounted on the expansion tanks.

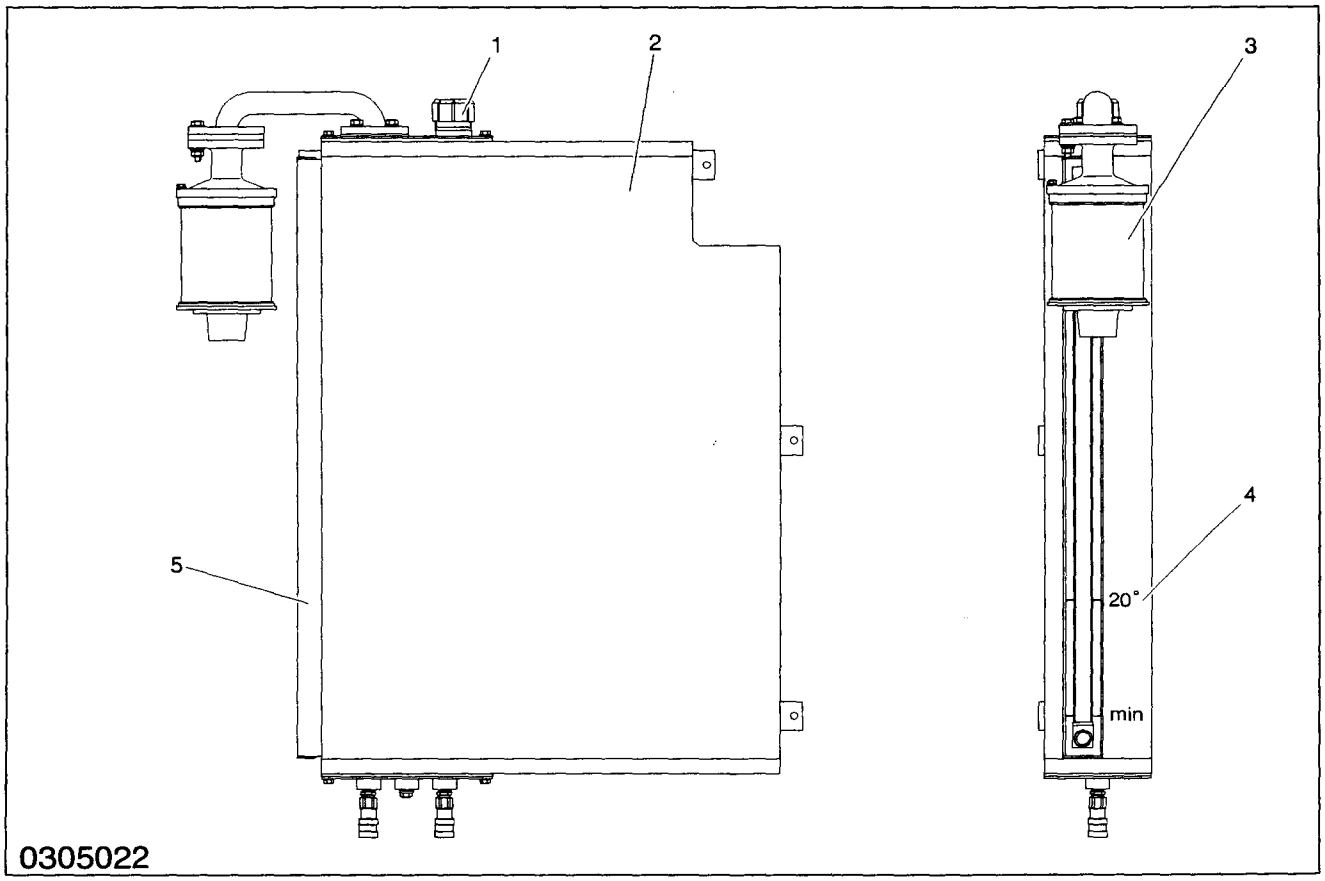
IMPORTANT:

Covering the transformer with stickers is forbidden. If stickers need to be added then they should be stuck on separate plates. The plates should then be tied to the transformer using strings (no wire).

NOTE:

After transport and installation at the storing place the transformer should be checked for any signs of oil leakage.

Oil level check



According to the atmospheric conditions the oil level (4) and the silica gel in the breather (3) should be checked every 6 months.

If the transformer has to be filled up, oil of the same quality must be used. Mixing with oils which have significantly different parameters should be avoided.

The oil level in the expansion tank (2) has to be checked each time before switching on the transformer and in case of non use at least every 6 months. The oil level in the expansion tank (2) must be equal to the corresponding temperature mark (3) on the sightglass (5).

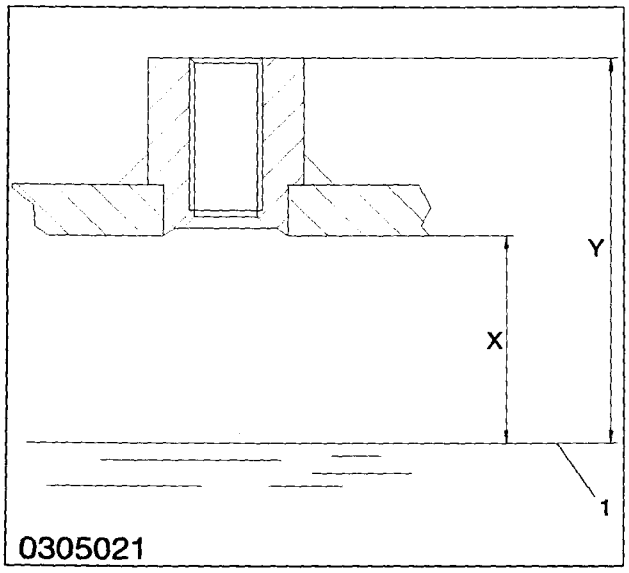
Oil level beneath the corresponding temperature mark

In case of the oil level is under the corresponding temperature mark, oil can be added directly by the filling plug (1) on the expansion tank. The oil used must comply with the relevant specifications.

Oil level not visible on the expansion tank

If the oil level is not visible at the expansion tank, the manufacturer has to be informed. The reason for the low oil level must be found. Oil should not be added by the filling gap of the expansion tank as long as the reason hasn't been found.

Oil level not visible on the sightglass



If the oil level (1) is not visible on the sightglass, the transformer must not be switched on. The oil must not be toped off by the filling plug on the expansion tank. One have to control the distance between the lid and the oil level (1) in the transformer. For this reason open one of the vent plugs on the transformer lid and measure the distance between the upper side of the plug and the oil level. If the distance (y) is lower than 100 mm the oil can be topped off by the draining valve of the transformer or the pipes between transformer and heat exchanger. The transformer has to be vented after.

If the distance (y) between upper side of the plug and the oil level is more than 100 mm then the level can only be topped off under vacuum conditions. For this reason the transformer must be removed from the locomotive and put in a vacuum oven.

Oil level above the corresponding temperature mark

If the oil level is above the corresponding temperature mark, oil can be drained by the draining valve on the transformer.

Taking oil samples

Only clean and dry sample containers should be used. These containers must not contain any traces of cleaning fluids. Before taking oil samples, clean the draining valve on the transformer; 5 litres of oil should then be drained off; after that the sample container should be rinsed using roughly 1/2 litre of oil. The oil sample must be protected from light.

The following are recommended as sample containers :

- glass bottles made out of dark–coloured glass, with a polished glass stopper
- tinned steel cans with a screw top
- clear glass bottle which should be covered with an opaque cover after the sample has been taken.

The oil sample should be at least 2 litres. For laboratory tests, 5 litres are required. If an oil sample is required to determine the amount of water gas or air content, then special vacuum bottles should be used. In such a case we recommend that we should be notified about the preparation of bottles and suction equipment.

Checking for any solid impurities in the oil

A test tube should be filled with the oil sample and held up against a light source. If there are any solid impurities in the oil, then the oil from which the sample comes should be filtered.

Simple test for water content

This is done using the so–called 'Spatter–test', i.e. the oil sample is heated in the test tube up to 105–110 °C. If there is any water in the oil then this will be noticeable if the oil crackles, snaps or bubbles. If the oil is overheated then the presence of water is falsely indicated; the upper temperature should therefore not be exceeded.

Dielectric strength (IEC test)

In accordance with the IEC Standard 156 (which also complies with the Swiss standard), this test should be performed using 12.5 mm ball electrodes with a diameter of 2.5 mm or with half–ball electrodes (so–called VDE –Kalloten) also with a diameter of 2.5 mm. The oil sample (temperature 15–25 °C) should be slowly poured (to avoid air bubbles) into the clean test container; the test should be carried out immediately. The voltage should be increased evenly up to break–down at a rate of 2 kV/second; this should be carried out 6 consecutive times. After each time the space between the electrodes must be free of traces of breakdown; use a clean and dry glass rod (diameter ≈ 2 mm) and move it slowly in–between the two electrodes. All six break–down voltages should be noted and the arithmetic average calculated (i.e. the sum of the individual values divided by six). None of the individual values should lie more than 15% below the average value, otherwise the test must be repeated using a new oil sample.

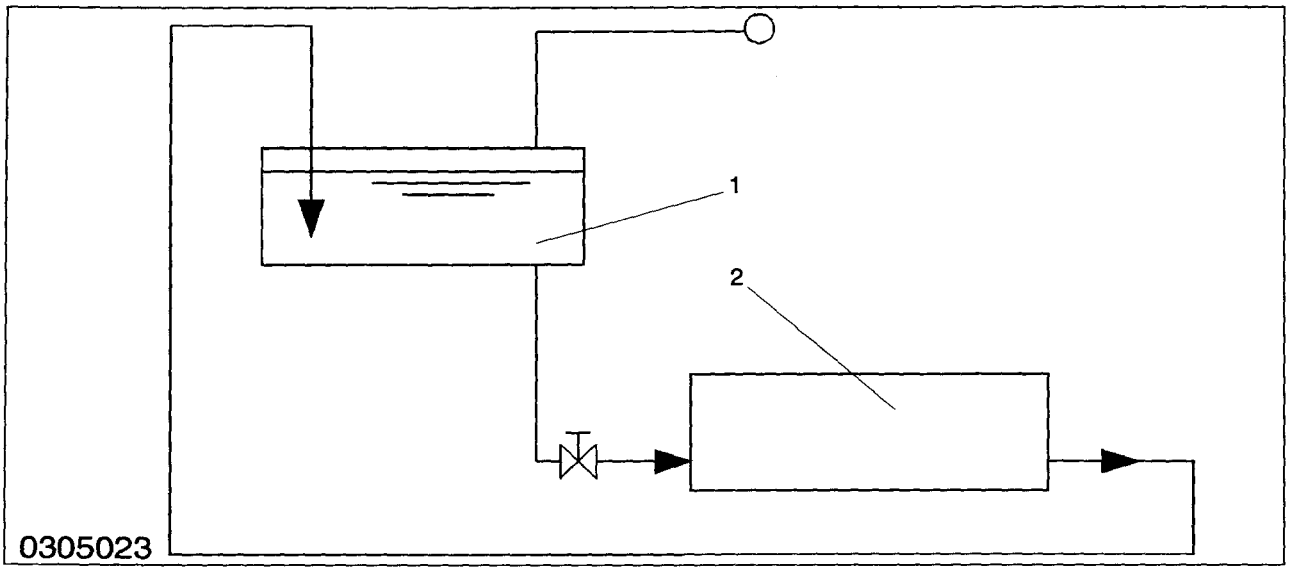
Reconditioning the oil

Drying

To carry out the drying process properly, a special drying apparatus is required. Simple drying equipment works without centrifugal vacuums or active filters. Such apparatus allows the removal of free water in the oil.

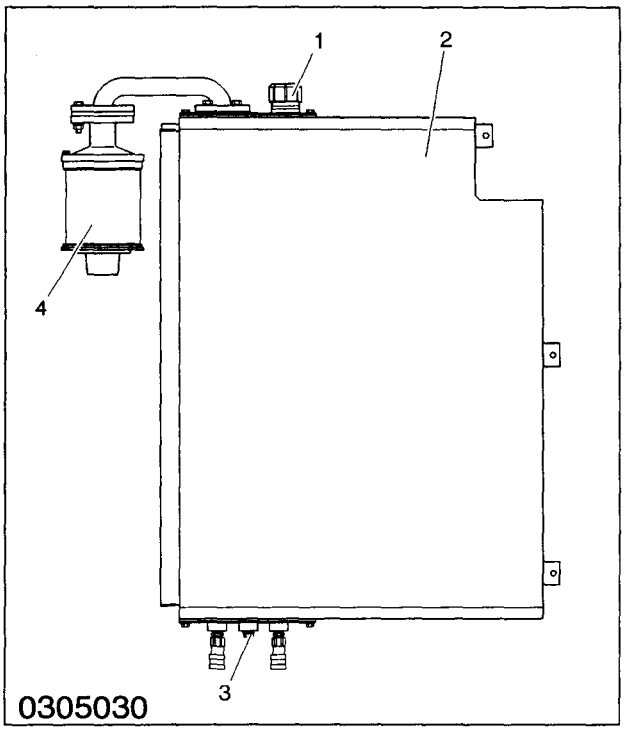
In the classical case the oil in the transformer / tank is directly fed into the drying apparatus. If this is not the case then the drying container must be capable of holding all the oil intended for use in the transformer. In order to prevent the stored oil re-absorbing water, an evacuated tank should be used (it should be continuously evacuated); this will prevent gas dissolving in the oil again. If an evacuated tank cannot be used, then a silica gel breather must be used so that the absorbed water content is kept to a minimum.The drying of the oil is complete when the required under–pressure in the vacuum cavity is reached at a constant oil flow rate, and when the purity of the oil fulfils the requirements (given by the break–down test).

Circulation reconditioning method



The transformer oil (1) is pumped through the reconditioning equipment (2). Depending on the state of the oil, the fuller's earth must be renewed periodically. If the measurement equipment (e.g. measurement cells to determine the DC resistance of the oil) which is built into the inlet and outlet pipes of the reconditioning equipment show roughly the same results, then the fuller's earth should be changed and the transformer oil filling procedure repeated twice more. During the last filling, the oil must be inhibited to decrease the negative effect of the ageing elements still present in small amounts in the fixed insulation within the transformer. The reconditioning can be considered as complete when the oil has reached the desired improvement in its chemical/physical and electrical properties and has also reached the required levels of dryness and purity.

Bleeding the expansion tank



As often as the breather has to be checked, the expansion tank (2) should be bleeded. For this reason crack open the bleeding plug (3). Let all the water run out. The oil level must be topped off by the filling plug (1) on the expansion tank (2).

Silica gel breather

According to the atmospheric conditions, the colour of the silica gel should be checked roughly every six months. When more than half of it is pink (saturated with water), then it should all be replaced. The saturated silica gel can then be dried out. Put it in an oven and increase the temperature slowly to max. 115 °C. Keep the temperature until the silica gel turns blue again.

However, this process should not be repeated too many times; after a while the silica gel appears to be not so effective, probably due to the ingress of dirt.

The transformer must not stay longer than 3 hours without a functional breather.

Angled connector

The angled connector requires no maintenance.

Repairing the paintwork

Cleaning the affected area

Using sand paper or a sander to smooth down and clean the affected area, a smooth transition to the intact paintwork must be made. Cover the area with primer by including the intact paintwork.

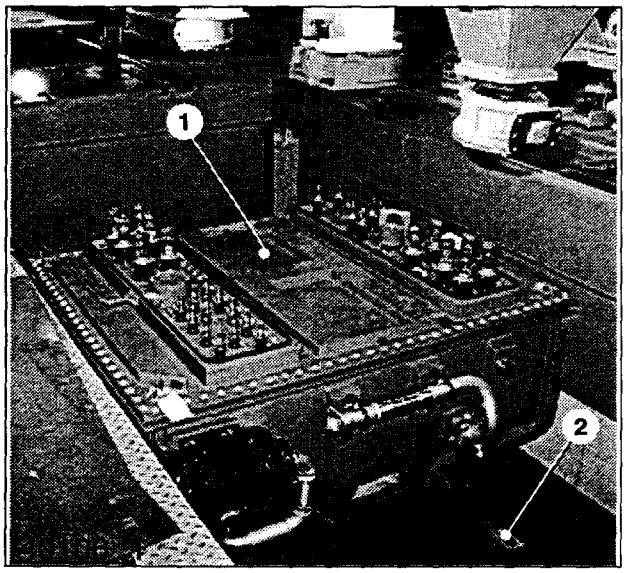
Top coating

Once the primer has been applied, wait at least 6 hours to apply the top coating. It can be applied by painting, rolling or spraying. The drying time at room temperature of about 20 °C is 6 hours; at temperature of 60 °C it is 1 hour.

– Primer	Two component epoxy resin
– Coating	Two component polyurethane paint

Gaskets of lid

In order to avoid leakages between the upper frame of the tank and the lid, the fixing bolts must be tightened with the following tightening torque. It has to be applied on the nut where accessible.



Lifting the tank

Use suitable lifting gear (2) for installing and removing the transformer tank (1). The housing cover is provided with four carrying bolts for the attachment of crane ropes. Use a lifting yoke in order to ensure that the four ropes pull vertically upwards.

Wall penetrations

All penetrations in the housing lead directly to the oil; only the gas pressure thermometer sensor is installed in an immersion tube. The oil must be drained before such parts are removed. Collection vessels for 2100 l of oil must be available for total drainage.

The main transformer unit is maintenance–free, with two exceptions:

Oil monitor

Periodically check the oil level as per maintenance schedule and top up if necessary.

Oil loss is possible as a result of leakages or through the pressure relief valve. The oil level can be read off on the level gauge of the expansion tank. It must always be visible throughout the entire temperature range from –10 to +105 °C. If necessary, the oil must be topped up as appropriate.

The ageing of the oil must be checked annually by means of an oil sample as per IEC–156. The water content must be measured as well as the degree of solid impurities. If necessary, a drying and filtering treatment must be carried out. The silica gel in the breather/filter must likewise be dried or renewed.

A change of oil must be carried out in any case after approx. 15 years.

Bushings

Check periodically for accumulation of dirt as per maintenance schedule and clean if necessary.

Heavily soiled ceramic insulators on the bushings will lose their insulation strength and resistance to tracking. The frequency of regular inspection and cleaning is laid down in the maintenance schedule. Do not use any metal brushes. Grease–dissolving solvents or detergents are allowable.

WARNING:

Measurements and manipulations on the main transformer housing while live may be carried out only by trained specialists. Danger to life.

Voltage flashovers constitute a danger to people, equipment and measuring devices. High–voltage measurements may be carried out only in the presence of a look–out man.

Tank

Oil level and oil leaks:

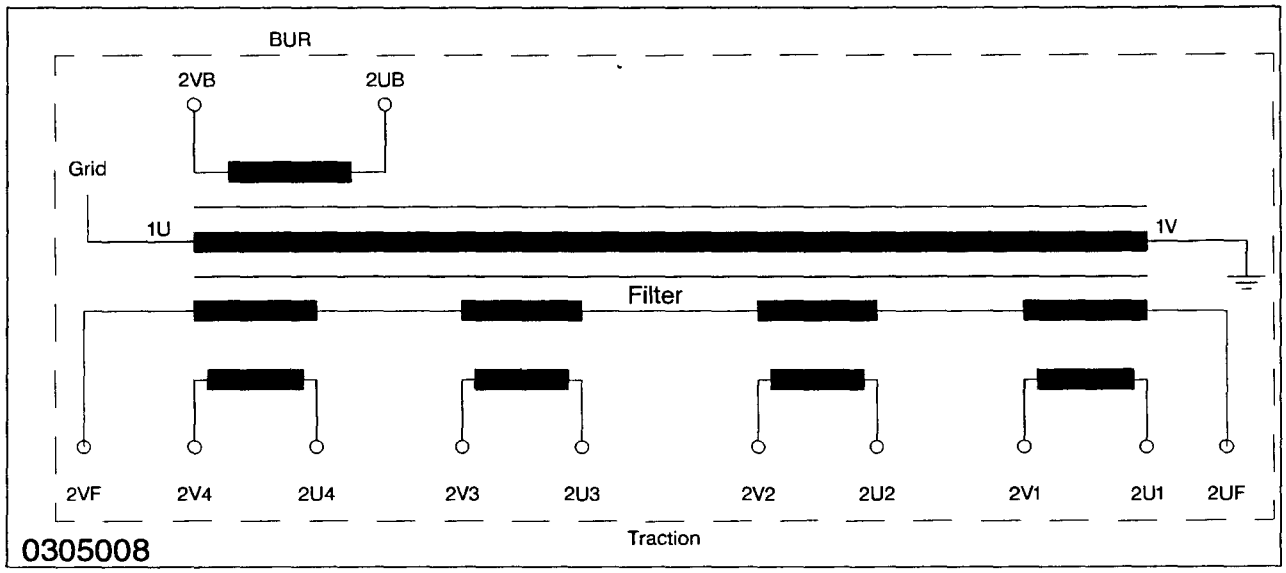
The oil level is checked at the level gauge on the conservator. The oil level must always be visible throughout the entire range from ambient temperature to maximum operating temperature.

Seals and joints should be checked at normal operating temperature. In case of oil loss, examine all the oil circuits. In case of leaks with flat gaskets, the situation can be remedied by tightening the fastening screws. If this is not sufficient, replace the gasket and other parts involved.

If oil level is insufficient, top up with oil.

Main transformer

The position of the windings and the terminal designations (bushings) are given in the following figure:



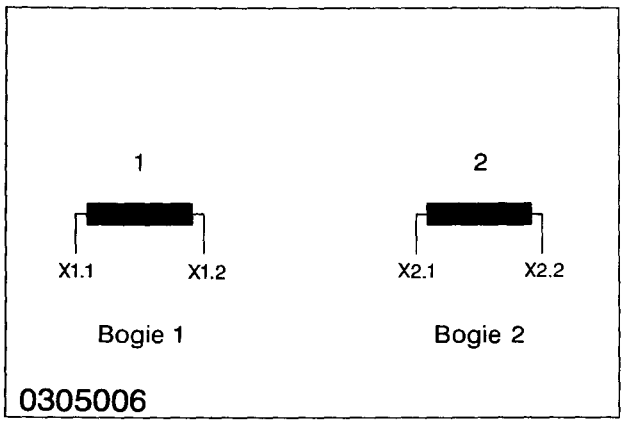
Primary	1U – 1V	Traction 1	2U1 – 2V1
Auxiliary circuits	2UB – 2VB	Traction 2	2U2 – 2V2
Filter	2UF – 2VF	Traction 3	2U3 – 2V3
		Traction 4	2U4 – 2V4

Correct operating values and proper working order of the main transformer can be checked by live measurements or in the de–energized insulated (terminals open) state. The full operating currents are reached only in full–load operation. The demand values are compiled in the following Table

Connections	Nominal voltage	Operating current	Impedance Resistance	Inductance	Inductance tolerance
1U – 1V	25 KV	261.25 A	–	–	–
2 UB – 2VB	1000 V	334 A	60 mΩ	0.43 mH	–
2UF – 2VF	1154 V	347 A	19 mΩ	2.10 mH	–
2U1 – 2V1	1269 V	1142 A	37 mΩ	2.10 mH	± 15%
2U2 – 2V2	1269 V	1142 A	37 mΩ	2.10 mH	± 15%
2U3 – 2V3	1269 V	1142 A	37 mΩ	2.10 mH	± 15%
2U4 – 2V4	1269 V	1142 A	37 mΩ	2.10 mH	± 15%

Voltage test for all windings as per IEC Publication No. 310–26.3 with a surge voltage of 150 kV.

Series Resonant Chokes



1 to traction converter 1
2 to traction converter 2

The following values should be checked in normal operation:

– Nominal current	2 x 984 A_{rms}

These values are reached only with the traction converters at full load:

– Phase-Phase voltage	max. 482 V_{AC}
– Phase-Ground voltage	max. 3471 V

Sanitation Parts/Operating Material

@.1260

Ensure that transformer oil which is no longer to be used is disposed of in an environmentally compatible manner.

Assembly

@1270

Bushings

Clean the contact surfaces before assembling. No oil or glue must be applied on the gaskets. Fit the gaskets with the insulator and the corresponding washers on the bolt. Before tightening the fixing nut make sure that the inner insulator mates on the positioning wedge.

Once the bushing has been assembled, tighten the fixing nut with a dynamometer (tightening torque see table below). To ensure the tightness of the gasket, retighten the nut a few hours later.

The oil level must be topped off to normal level. Use the filling system for this reason. The transformer has to be vented after.

Tightening torque M and max. horizontal load F for DIN bushings

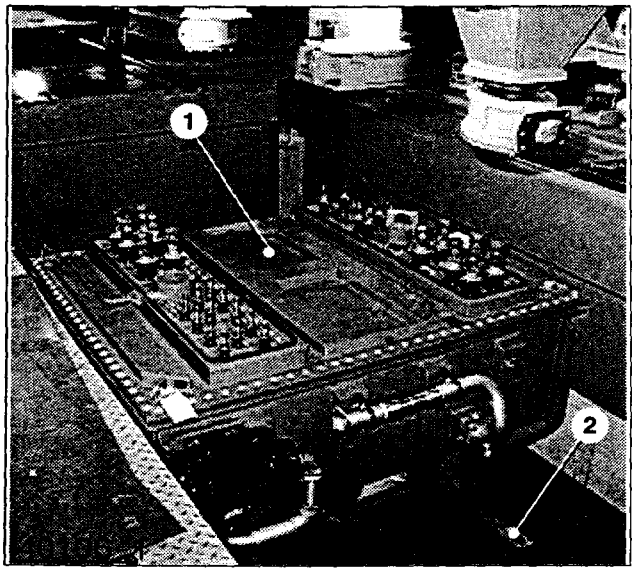
DIN type	Drawing No.	D	Section [mm^2]		M [Nm]	F [N]
			bolt	extern		
DT 1 / 250	HSTN 310 500	M 12	74.3	84.3	10	50
DT 1 / 630	HSTN 310 501	M 20	220	245	30	60
DT 1 / 1000	HSTN 310 502	M 30x2	596	621	65	80
DT 1 / 2000	HSTN 310 503	M 42x3	1150	1210	150	100
DT 1 / 3150	HSTN 310 504	M 48x3	1540	1600	230	100
DT 3 / 250	HSTN 310 505	M 12	74.3	84.3	10	30
DT 3 / 630	HSTN 310 506	M 20	220	245	30	40
DT 3 / 1000	HSTN 310 507	M 30x2	596	621	65	50
DT 3 / 2000	HSTN 310 508	M 42x3	1150	1210	150	60
DT 3 / 3150	HSTN 310 509	M 48x3	1540	1600	230	60

Installation

©.1280

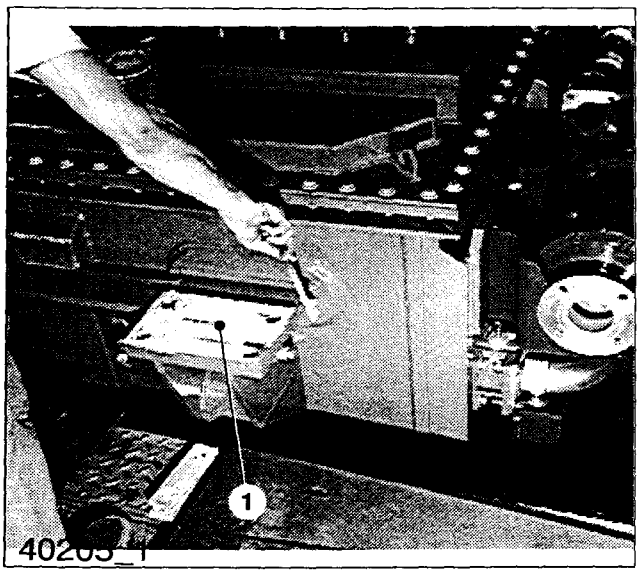
Transformer

During the assembly in the locomotive, the main valves of the transformer stay closed.

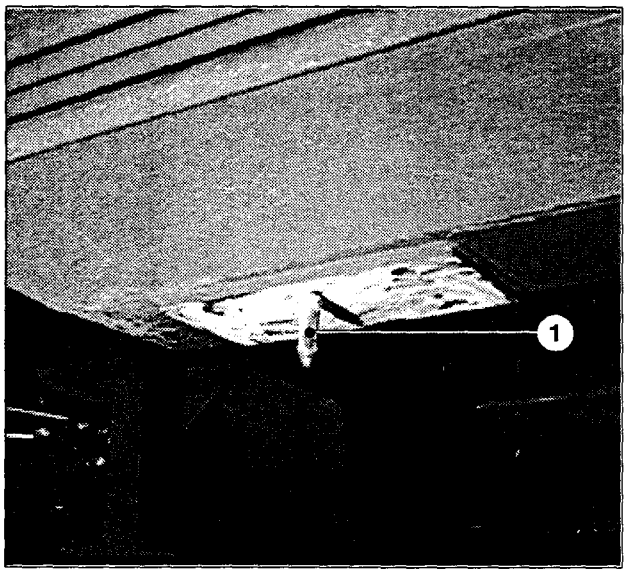


Prepare the inspected or repaired transformer (1) on the lifting equipment (2).

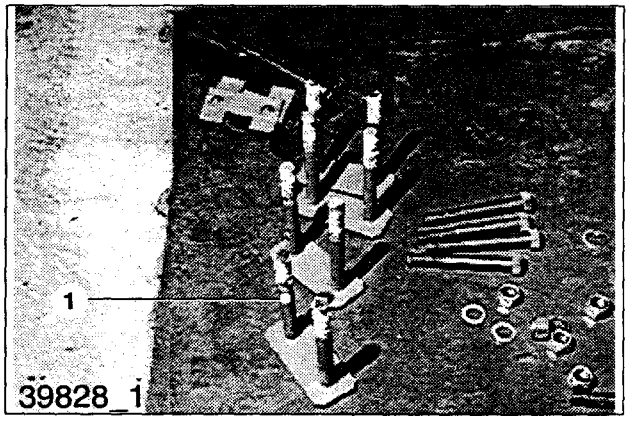
Position the prepared loco over the lifting equipment (2) which will lift the transformer (1).



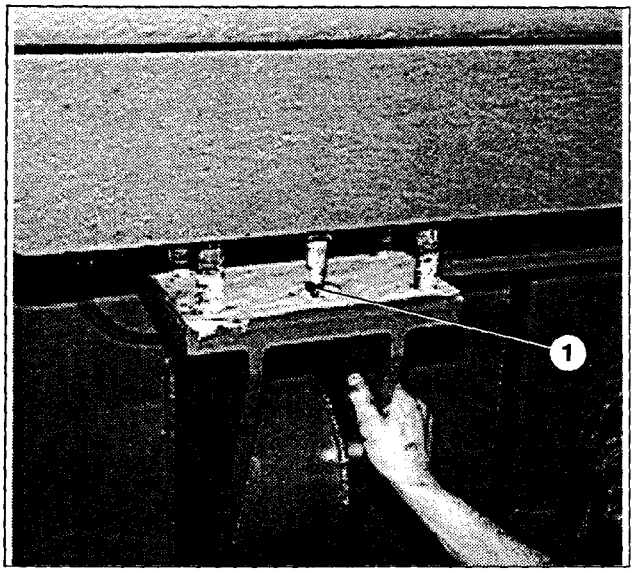
Clean the contact faces of the transformer. Apply a film of Molikote Longtherm W3 to the four contact faces (1) of the transformer.



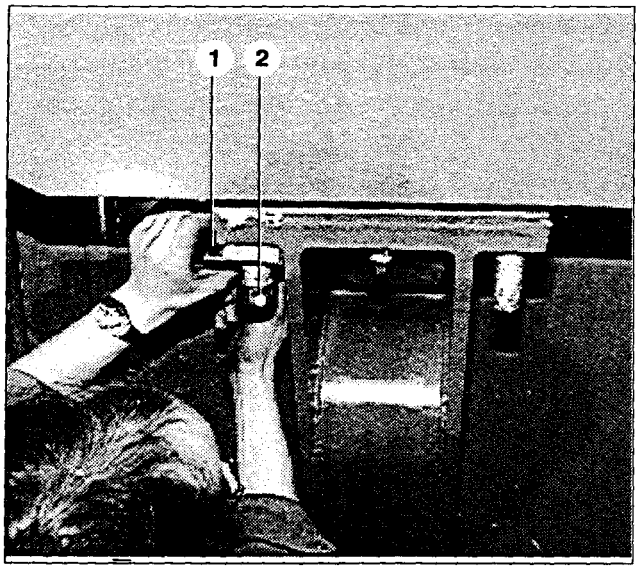
Clean the contact faces of the loco body. Apply a film of Molikote Longtherm W3 to the four contact faces of the loco body and the two centring pins (1).



Apply a film of Molikote Longtherm W3 to all the twin screws (1). Mount the twin bolts into the holes in the underframe of the locomotive.



Lift the transformer slowly under the underframe of the locomotive. Make sure that the two centring pins (1) fit in the corresponding hole.



Assemble the hot dip galvanised washers (1) under the supports when assembling the nuts (2). Tighten the fixing nuts to the bolts with 675 Nm.

After–Installation Operations

@.1290

Oil–piping

Before removing the blanking flanges make sure that all blocking valves are closed. They stay closed during the whole installation.

Special care must be taken to ensure that all pipes, pumps and coolers have been thoroughly cleaned and flushed with insulation oil before one proceeds with assembling.

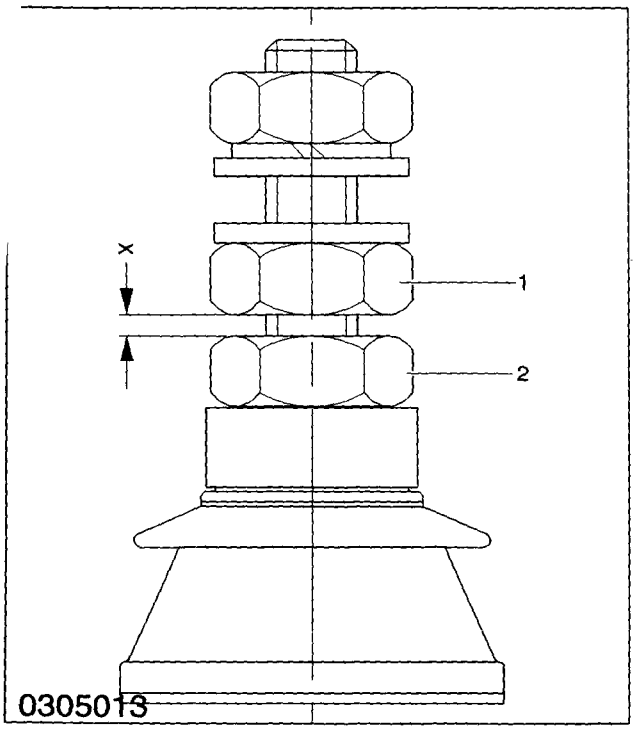
Fitting of the angled connector

Before the angled connector can be fitted onto the bushing, the bushing must be properly cleaned. No dirt should be trapped in the connection. To allow easy fitting, the bushing should be slightly greased with silicon. When mounting the angled connector care should be taken that no air is trapped inside. The connector can be vented using a nylon thread on the bushing, which is pulled out when the angled connector is fitted.

NOTE:

The angled connector is not oil resistant.

lectrical Connections



The electrical terminations of the bushings have to be carried out in a way, that the nut (2) stay accessible to be re tightened.

Electrical connections must not be numb. They should be made flexible so that the bushing isn't stained. Cable connections should be made with a loop, for bars use flexible ribbon to connect them on the bushing.

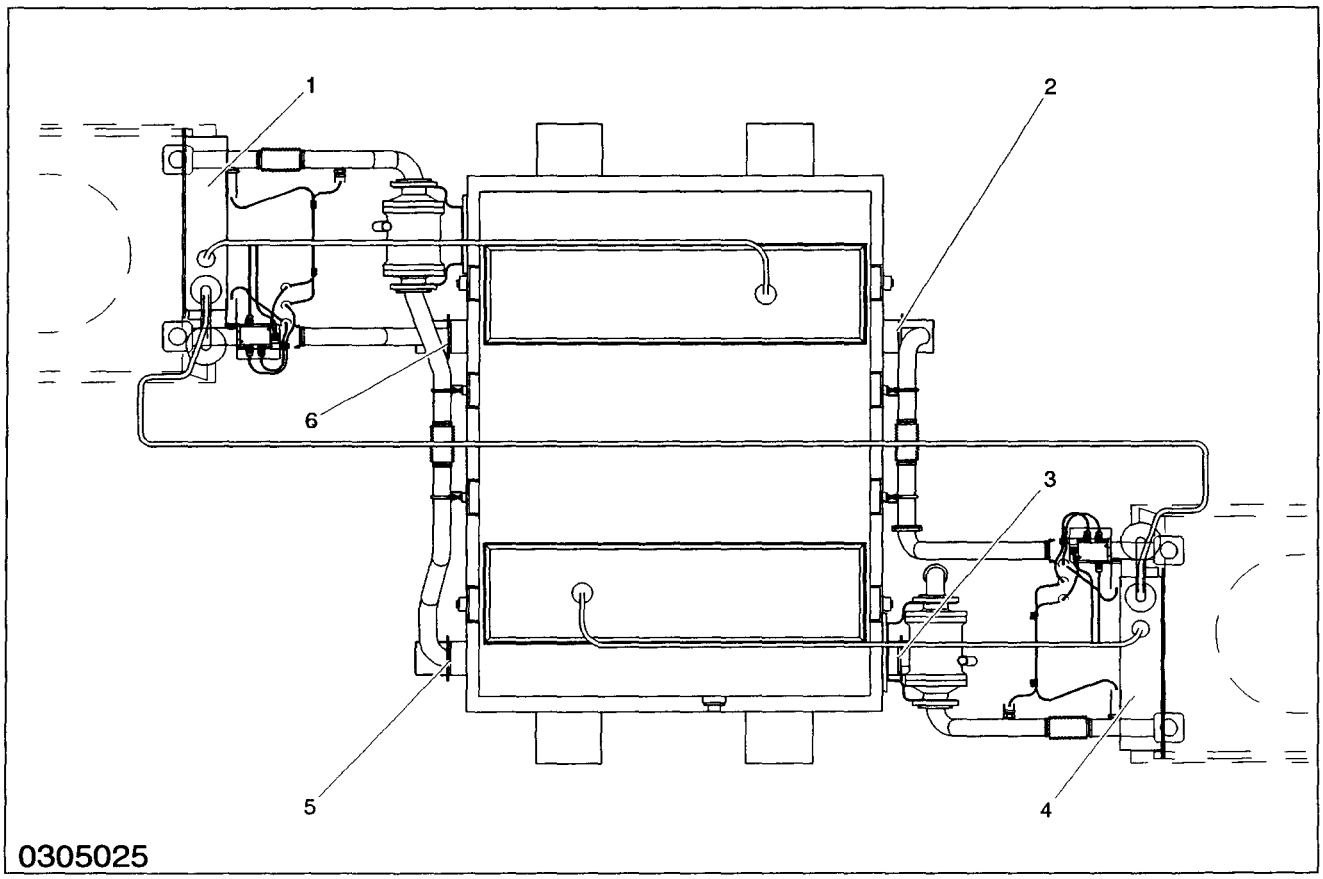
When assembling the electrical connections, make sure that the nut (2) does not become loose. Keep a distance (x) of min. 3 mm between the 2 nuts (1) and (2). After assembling of the connection re-tighten the nut (2).

Earthing terminal

In order to avoid discharges and unwanted failures, all metallic parts inside and outside the transformer are earthed. The earthings of the transformer active part and the reactors are connected with each other via the tank.

The marked earthing terminals have to be connected to the locomotive's earthing terminal.

Filling the remaining oil



Once the transformer has been installed in the locomotive and all piping connections to the heat exchanger and the pump have been made, it is necessary to fill the remainder of the cooling system with oil. The oil used must comply with the relevant specifications. Casting doubt on, an oil test has to be carried out.

The transformer main valves should only be opened when all pipes and the heat exchanger have been filled with oil and vented. No air should enter the transformer assembly from the piping or the heat exchanger.

Draining/Filling Transformer Oil by Syphon Method

Draining

- Close all cocks on the tank.
- Remove closing cover on one drain fitting.
- Connect hose; introduce other end into storage vessel.
- Set up storage vessel below level of tank base.
- Open drain cock: oil flows out; air flows afterwards via air dryer. If necessary: close drain clock; replace full storage vessel with empty one; re-open drain cock.

Filling

- Remove closing cover on one drain fitting.
- Connect hose; introduce other end into storage vessel and immerse.
- Set up storage vessel below level of tank cover.
- Open drain cock and allow oil to flow from tank until air has been forced out of hose; then close drain cock.
- Raise storage vessel above level of tank and open drain cock; oil flows into tank; oil level must be continuously monitored at the level gage on the expansion tank. If necessary: before air is drawn in, close drain cook, replace empty storage vessel with full one, re–open drain cock.
- Open all tank cocks to pipe connections; continue filling until level at expansion tank is OK.
- Close drain cock.
- Wait several hours in order to give air bubbles time to rise; check level and top up if necessary.
- Close drain cock; lower storage vessel below level of tank base.
- Unscrew hose from drain fitting and allow to drain into storage vessel.
- Fit closing cover to drain fitting.

Draining/Filling Transformer Oil by Circulating Pump

Draining

- Close all cocks on the tank.
- Remove closing cover on one drain fitting.
- Connect hose; introduce other end into storage vessel.
- Open drain cock; switch on circulating pump: oil flows out; air flows afterwards via air dryer. If necessary: interrupt procedure; place empty supply vessel underneath.

Filling

- Remove closing cover on one drain fitting.
- Fill hose with oil from storage vessel by briefly switching on the circulating pump.
- Connect hose to drain fitting.
- Open drain cock; switch on circulating pump: oil flows into tank; oil level must be continuously monitored at the level gauge on the expansion tank. If necessary: before air is drawn in: switch off circulating pump; close drain cock; have full storage vessel ready.
- Open all tank cocks to pipe connections; continue filling until level on conservator is OK.
- Switch off circulating pump; close drain cock.
- Wait several hours to give air bubbles time to rise; check level and top up if necessary.
- Close drain cock; unscrew hose from drain fitting and empty back into storage vessel with circulating pump.
- Fit closing cover on drain fitting.

Stopcocks

The procedure is the same for all cocks: the transformer oil must be drained; the tank cover remains closed.

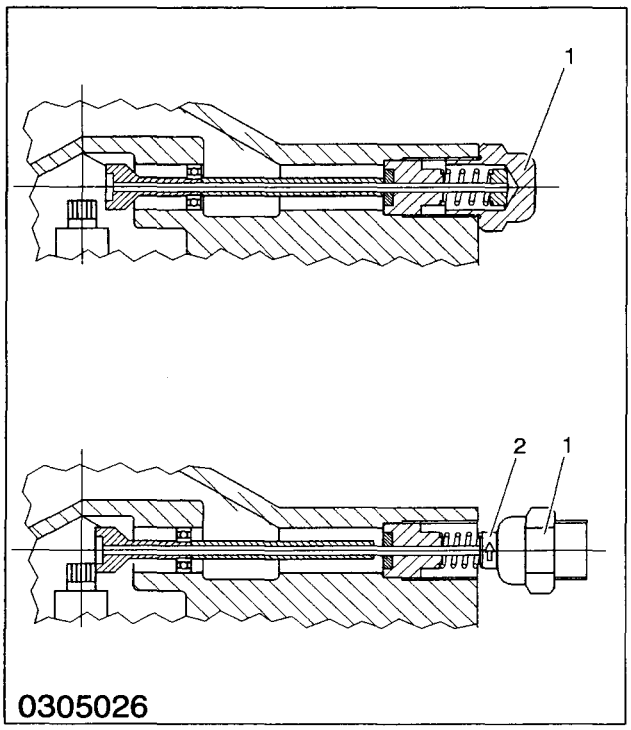
Procedure for Replacing Cocks

- Close all cocks on the tank.
- Place collection vessel under the cock to be replaced.
- Unscrew pipe flange; oil flows out of pipe.
- Drain oil as described on Page 49.
- Clean surroundings of cock on tank.
- Loosen screws on tank flange of old cock and remove cock together with seal.
- Insert new cock with new seal and screw down,
- Screw pipe with new seal onto cock flange.
- Fill oil as described on Page 49.

Oil pump

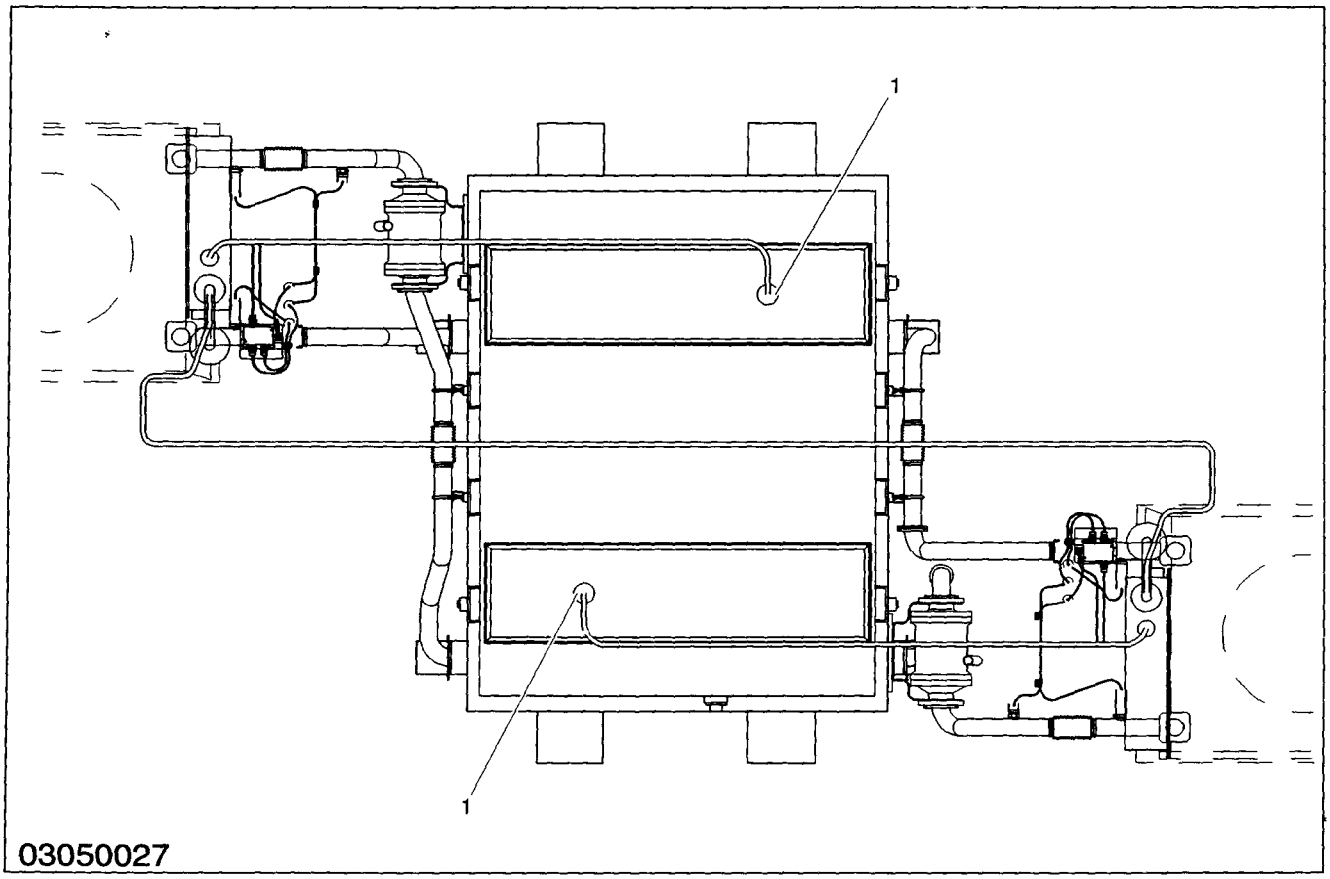
Before the pump is put into action, make sure that the pumps, piping and heat exchanger are filled with oil. Never start the pump without oil.

Checking the direction of rotation



Remove the screw plug (1) and push the headface on the shaft of the rotation indicator (2). The rotation direction of the pump is correct when the rotation indicator turns in the same direction as the arrow. After completing the check, refit the screw plug (1).

Venting



Once all pumps, pipes and heat exchangers are filled up with oil, the transformer main valves can be opened. Secure the valves in open position. To drive any remaining air out of the system, put the two oil pumps in operation for 30 seconds. Let the whole system resting during 30 minutes. Connect the filling system (see chapter 6.1) to one of the draining taps, put it into action and crack open all vent plugs (1) on the transformers lid until oil leaks out. Repeat this procedure until the total breathing of the system. Adjust the oil level in the expansion tank after.

Adjustements

@.1310

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3.6 Transformer Oil Cooling

General Notes On Hazards in the Work Area

@.0104

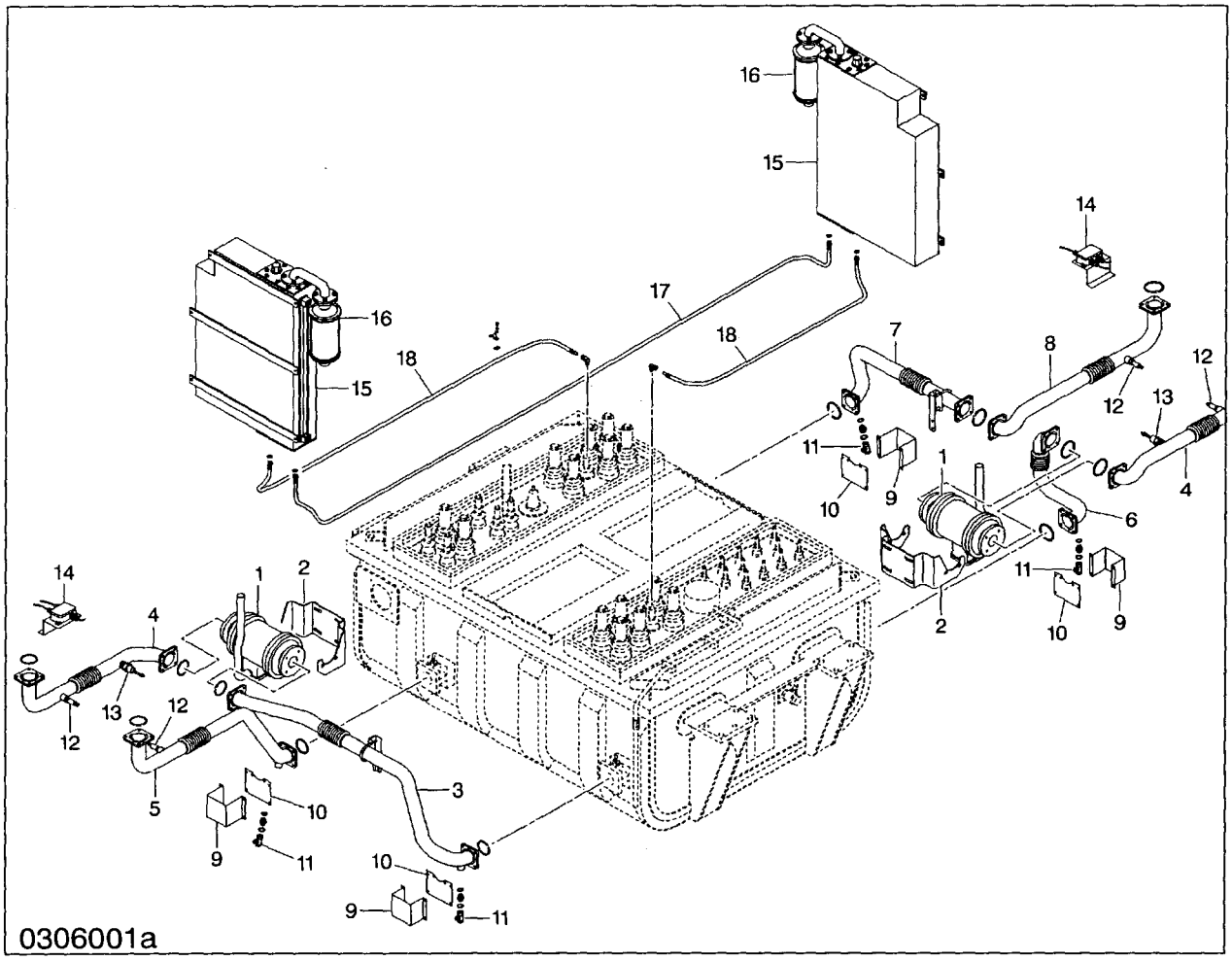
WARNING:

The oil in the transformer cooling system can operate at high temperatures. Ensure the system has cooled to ambient temperature prior to undertaking any maintenance on the oil cooling system.

Group Summary

@.1120

This chapter contains information on the transformer cooling system, which includes the transformer oil pump, oil piping and expansion tank.



1	Oil pump (62)	10	Plate
2	Oil pump bracket	11	Drain cock
3	Pipe A	12	Pressure transducer (213.5)
4	Pipe B	13	Temperature probe (210.5)
5	Pipe C	14	Pressure differential amplifier (214)
6	Pipe D	15	Expansion tank
7	Pipe F	16	Silica gel breather
8	Pipe G	17	Equalisation hose
9	Cover	18	Expansion hose

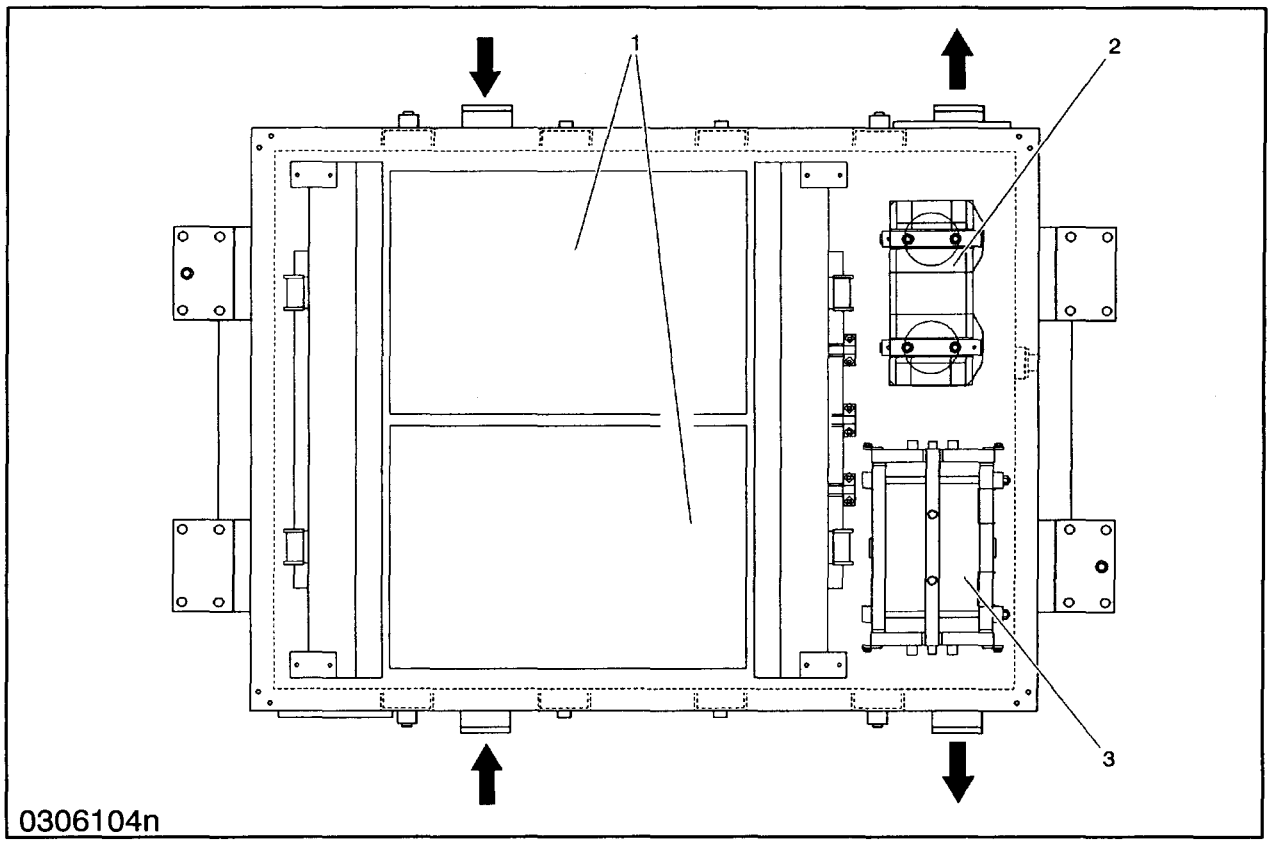
Numbers in brackets () denote the electrical equipment apparatus item number used in the locomotive schematics, refer to Volume G, Cabling Documentation.

Functional Description

@.1140

The transformer oil cooling system circulates cooling oil through the transformer to the oil blower unit. Heat generated in the transformer is absorbed into the cooling oil. This heat is then removed from the oil in the oil blower.

The cooling oil is pumped through the oil cooling system by the transformer oil pumps, which are bolted to the transformer. Oil pipes have flexible compensators to allow for movement and expansion between the transformer and oil blower units.



The cooling oil flows into the transformer tank through the ports near the centre of the transformer windings (1). The oil circulates through the transformer windings (1), then through the reactors (2, 3) then out of the transformer tank through the ports near the end wall of the tank.

Expansion tanks are fitted to the oil system to accommodate the volume increase that occurs when the cooling oil is heated. Piping from the bleed valves located in the transformer tank lid connects to the expansion tanks. As the oil in the transformer expands, the oil level in the expansion tank rises. An equalisation pipe connects the two expansion tanks together, ensuring an even level in both expansion tanks.

Silica gel breathers fitted to the expansion tanks remove moisture from the air drawn into the expansion tanks as the cooling oil contracts. Silica gel can absorb up to one third its own weight in water. When the silica gel is dry, it is blue in colour. As the silica gel absorbs water, it turns from blue to pink. Any moisture that does enter the system condenses in the expansion tank. This water can be drained from the expansion tank at the drain valve.

A level gauge is mounted on the side of the transformer oil expansion tank. It is a glass tube for measuring the level of the transformer oil in the transformer expansion tank. Oil enters the gauge through a hole in the bottom, whilst expelling air through a hole in the top (back into the expansion tank).

To compensate for temperature expansion effects, a temperature scale is alongside the gauge. To establish the correct oil level, the temperature must be read off the main transformer thermometer. The correct oil level can then be determined.

For further information regarding the transformer, refer to Chapter 3.5, Transformer.

For further information regarding the oil blower, refer to Chapter 5.5, Oil Blowers.

Technical Data

@.1160

Oil Cooling System

- Cooling oil type	Shell Diala DX
- Cooling system oil volume	2,800 litres
- Nominal oil flow rate	90 l/min.
- Maximum allowable oil temperature	65 °C
- Minimum allowable oil temperature	0 °C
- Oil system pressure drop	2.7 bar

Oil Pump

- Model	Plummet TA 8-2174/15
- Weight	51 kg
- Motor	3 phase, 2 pole, 415 Volt
- Power consumption	5.6 kW @ 60 °C

Expansion Tank

- Expansion tank volume	2 x 137 litres
- Weight (empty)	60 kg
- Oil weight at 20 °C	88 kg

Tolerances and Wear Limits List

@.1170

Oil Specifications

The cooling oil must meet the specifications given in Chapter 5, Main Transformer of Volume F3, Suppliers Documentation.

- Recommended oil	Shell Diala DX
- Breakdown voltage	30 kV
- Water content	50 ppm
- Dielectric loss factor, tan δ at 90 °C	1.0
- Neutralisation number (acid number)	0.5 mg KOH/g

Tools and Special Tools

@.1180

In addition to conventional railways workshop tools and equipment, the following tools and equipment is also required for the procedures described in this chapter:

- Oil vessels, total 2,100 litres
- Circulating pump, 2-direction (optional)
- Flexible hose G1 1/4 inch
- Vacuum pump (optional)

Miscellaneous Materials

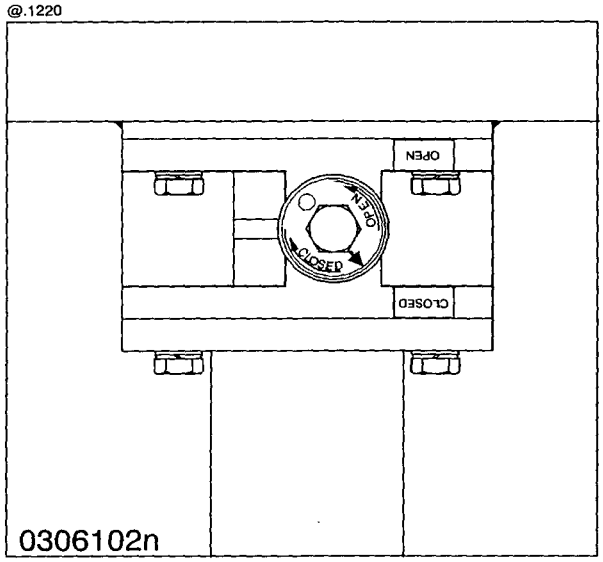
@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Molycote is required for sealing o-rings
- Oil binding agent is required for collecting any spilled oil
- Blanking plates and gaskets are required for covering oil port flanges on main transformer
- Shell Diala DX Mineral oil is required to refill the oil cooling circuit

Before-Removal Operations

@.1220



Close the valves on the main transformer oil inlet and outlet ports. Using a suitable spanner, rotate the valve to the CLOSED position, as indicated by the arrow. Repeat the procedure for all four valves on the transformer.

Steam clean the transformer, oil pumps and piping, and surrounding area. Remove all traces of dirt, debris and build-up of grease. Pay particular attention to the oil piping flanges, inlet and outlet valves and associated connections. Refer to Steam Cleaning in the Preface of this Volume.

Lower the pantograph and isolate the locomotive from the overhead catenary. Earth the locomotive at the vacuum circuit breaker. Refer to the Preface of this Volume.

Set the "Oil Pump, Transformer" circuit breaker (62.1) to the Off position. Circuit breaker 62.1/1 for the No. 1 End is situated in auxiliary circuits cubicle-1 (HB1) and circuit breaker 62.1/2 for the No. 2 End is situated in auxiliary circuits cubicle-2 (HB2). For more information on circuit breakers, refer to Chapter 5.2, Auxiliary Converter Control.

Earth the traction converter as described in Chapter 4.1, Traction Converter. Operation of the key interlocking system is described in the Preface of this Volume.

Draining Oil

NOTE:

Before removing any parts of the transformer oil cooling circuit, the oil of the oil cooling circuit has to be drained at the draining valves.

The transformer cooling oil must not be hot when draining. Ensure that the cooling oil is at ambient temperature.

Draining the oil from the main transformer should only be performed when necessary. The main transformer, oil cooling pumps and piping, and the oil cooling radiator can all be removed and replaced without draining the main transformer. Shut-off valves located in the main transformer oil ports can be used to retain oil in the main transformer while draining oil from the oil cooling pipes and oil cooling radiators.

If necessary, oil samples should be taken during the oil draining procedure. Further information regarding taking oil samples is given in Chapter 5, Main Transformer of Volume F3, Suppliers Documentation.

Oil from the transformer cooling system should be drained into a suitably sized, clean container that is evacuated prior to filling with oil. Once the oil has been drained, appropriate tests may be performed on the oil. Some reconditioning of the oil may be required prior to the oil re-entering service.

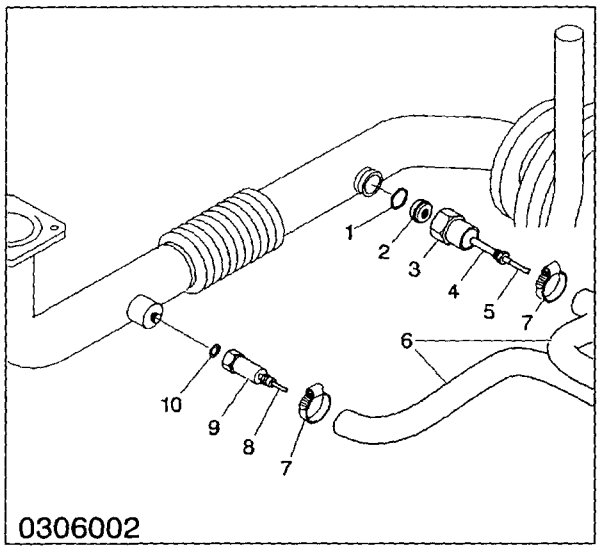
To drain the oil from the piping only and not the main transformer, the shut-off valves on the transformer oil ports should be closed. The transformer cooling system bleed valve on the oil cooling radiator and the drain valves located in the oil piping adjacent to the main transformer oil ports can then be opened. The oil will now empty from the transformer cooling system piping and the oil cooling radiator.

Once the oil has been completely drained, all piping valves must be closed.

Removal

@.1230

Oil Piping



0306002

NOTE:

Do not remove the cables from the bushing tubes in the floor.

Loosen the hose clamp (7) at the pressure transducer (9) conduit. Slide the conduit (6) back to expose the sensor electrical connections.

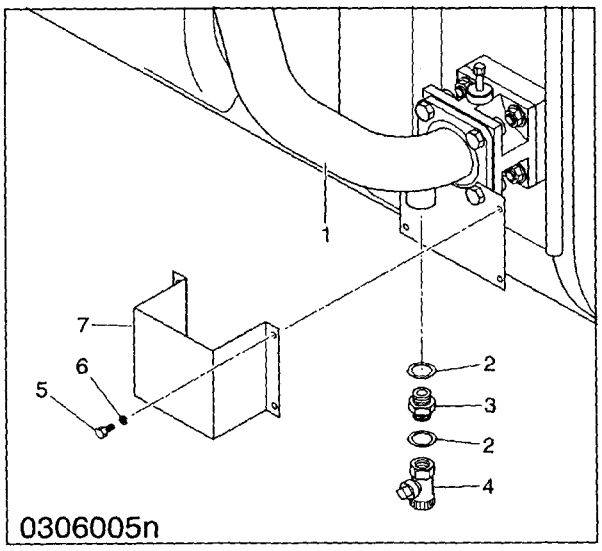
Tag and disconnect the cable (8) from the pressure transducer (9) terminal.

Unscrew the pressure transducer (9) from the pipe. Remove and discard the o-ring (10).

Loosen the hose clamp (7) at the temperature probe (4) conduit. Slide the conduit (6) back to expose the sensor electrical connections.

Tag and disconnect the cable (5) from the temperature probe (4) terminal.

Loosen the nut (3). Unscrew the nut (3) and the temperature probe (4). Remove the temperature probe (4) from the fixing cone (2). Remove and discard the o-ring (1).



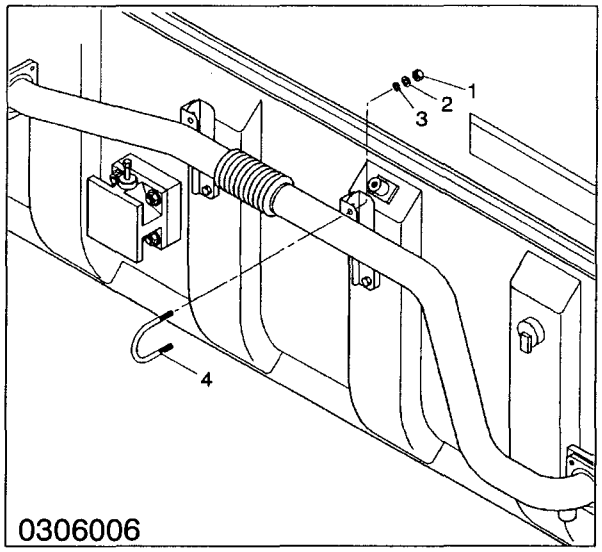
0306005n

NOTE:

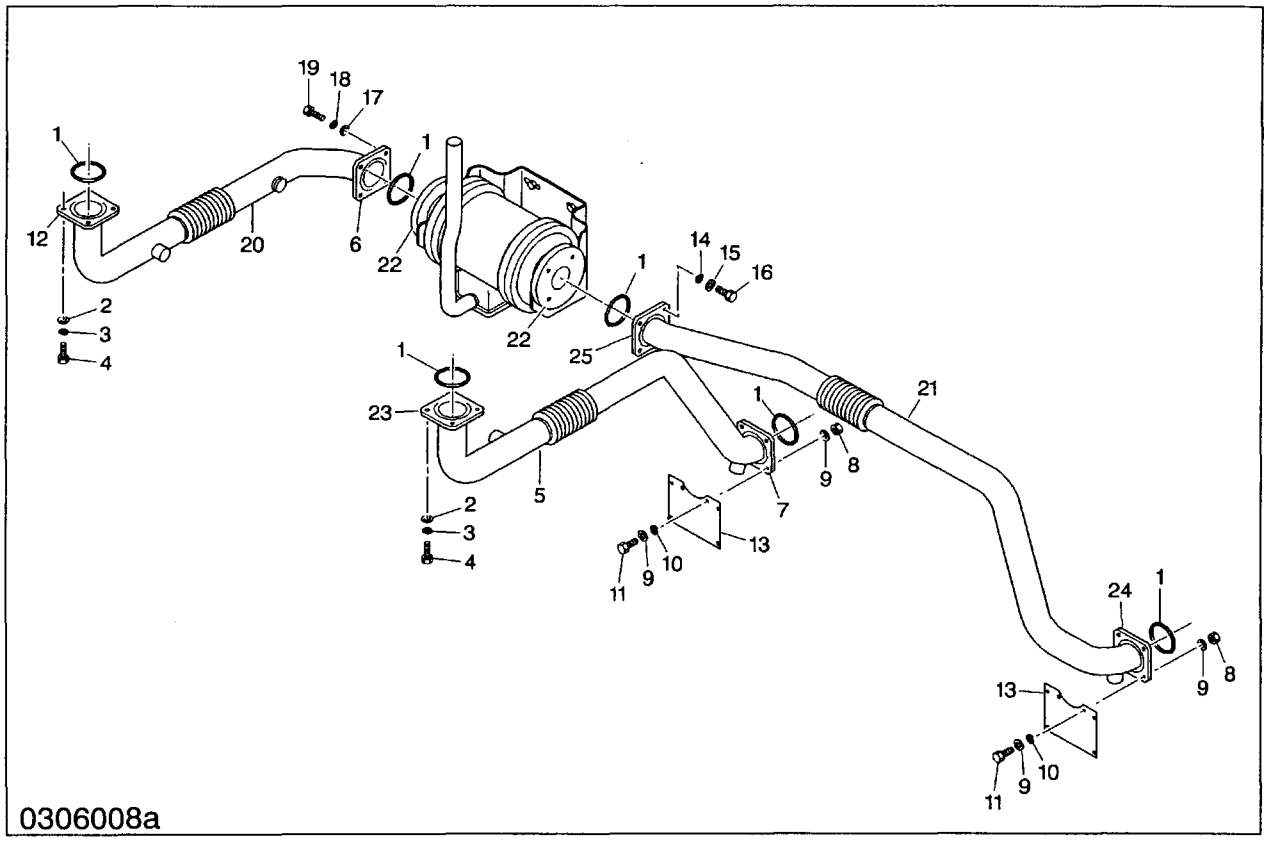
There are four transformer shut off valves in total, two on each side of the main transformer.

Remove the screws (5) securing the drain cocks (4) cover plate (7) of the ball valve (4).

If necessary, remove the threaded adaptor (3), drain cocks (4) and o-rings (2) from the pipe (1).



Remove nuts (1), washer (2), spring washer (3) and U-bolt (4).



Support the pipes (5, 20, 21) to prevent them falling when disconnected.

Remove the bolts (4), spring and plain washers (2, 3) securing the pipe (5) flange (23) to the oil blower radiator.

Remove the bolts (11), spring and plain washers (9, 10) and nuts (8) securing the pipe (5) flange (7) to the transformer shut off valve. Remove the plate (13).

Remove the pipe (5) and o-rings (1). Discard the o-rings (1).

Remove the bolts (4), spring and plain washers (2, 3) securing the pipe (20) flange (12) to the oil blower radiator.

Remove the bolts (19), spring and plain washers (18, 17) securing the pipe (20) flange (6) to the oil pump flange (22).

Remove the pipe (20) and o-rings (1). Discard the o-rings (1).

Remove the bolts (16), spring and plain washers (15, 14) securing the pipe (21) flange (25) to the oil pump flange (22).

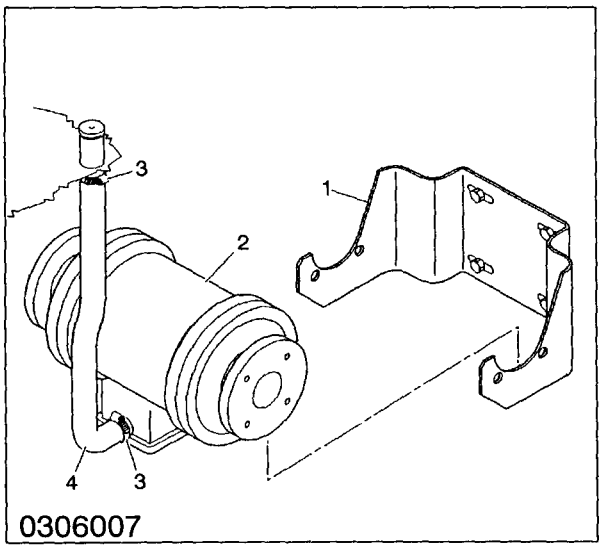
Remove the bolts (11), spring and plain washers (9, 10) and nuts (8) securing the pipe (21) flange (24) to the transformer shut off valve. Remove the plate (13).

Remove the pipe (21) and o-rings (1).

Discard the o-rings (1).

Once the pipes have been removed, cover the transformer shut off valves flanges with blanking plates and gaskets to prevent the ingress of moisture and foreign material. Seal the both ends of the pipes (5, 20, 21) and the oil blower radiator to prevent the ingress of moisture and debris.

Oil Pump



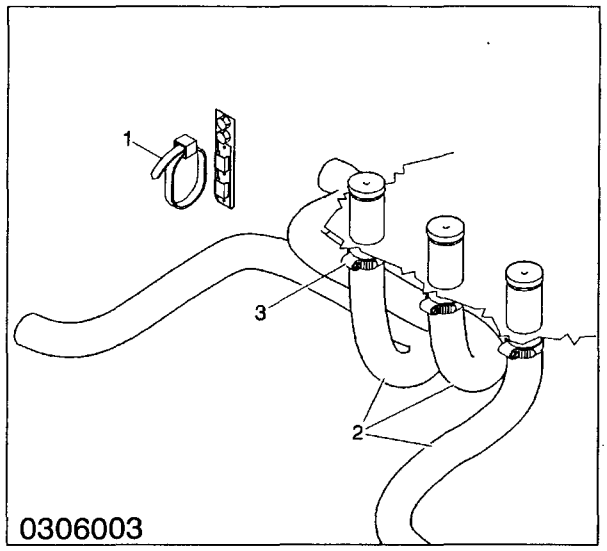
0306007

Remove the oil pump (2) terminal box cover, then tag and disconnect the cables from the oil pump (2).

Loosen the hose clamp (3) securing the conduit (4) to the oil pump (2) terminal box, then slide the conduit (4) from the oil pump (2). Withdraw the electrical cables from the oil pump (2).

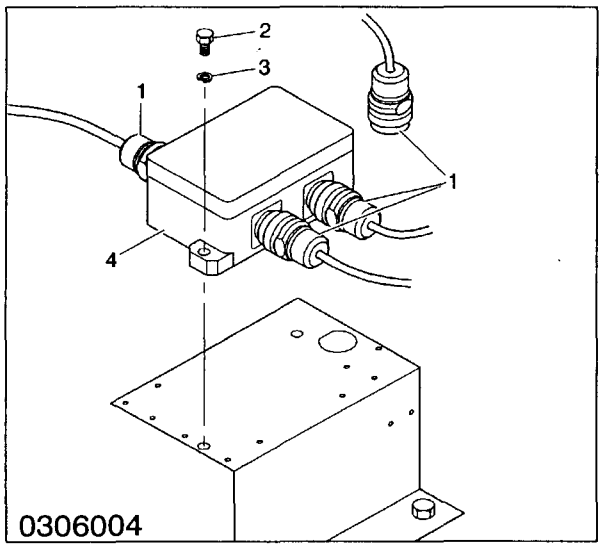
Remove the bolts securing the oil pump (2) to the bracket (1), then remove the oil pump (2) from the bracket (1) using suitable lifting equipment.

Signal Differential Amplifier



Remove the cable tie (1) securing the conduit.

Loosen the hose clamps (3). Remove the conduit (2).



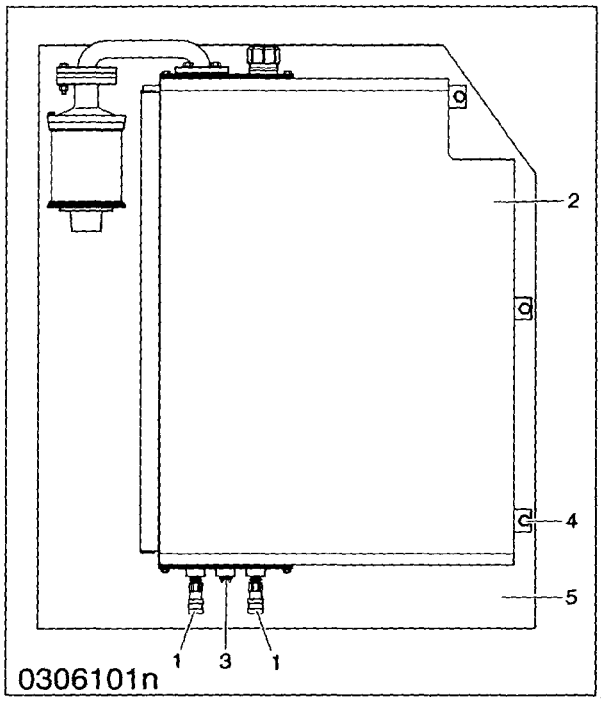
The signal differential amplifier (4) is located within an air duct, adjacent to the oil blower, in the machine room floor. Remove the screws securing the cover plate over the air duct.

Tag and disconnect the 5-pole connectors (1) from the signal differential amplifier (4).

Remove the bolt (2) and spring washer (3) securing the signal differential amplifier (4).

Remove the signal differential amplifier (4).

Expansion Tanks



Drain the oil from the expansion tank (2) at the drain valve (3).

Disconnect the quick connect fittings for the expansion and equalisation hoses (1) from the bottom of the expansion tank (2).

NOTE:

Some oil may leak from the piping. To prevent oil leakage, raise the end of the piping to a level above the oil in the expansion tank and seal the piping with suitable plugs.

Attach suitable lifting equipment to the expansion tank (2), then loosen and remove the bolts (4) securing the expansion tank (2) to the oil cooling unit (5).

Remove the expansion tank (2) from the oil blower unit (5).

Disassembly

@.1240

Oil Pump

For further information regarding the oil pumps, refer to Chapter 6, Transformer Oil Cooling of Volume F3, Suppliers Documentation.

Signal Differential Amplifier

There is no disassembly applicable to the signal differential amplifier.

Inspection and Repair

@.1250

Oil Circuit

Clean the cooling circuit components by flushing with clean oil.

Check the condition of the flanges. Replace if cracked or damaged.

Inspect the pipe expansion joints for damage or cracking. Replace any pipe with damaged or cracked expansion joints.

Check the expansion tank for damage, cracking or corrosion. Rectify any faults found or replace the expansion tank as necessary.

Inspect the condition of the oil pump. Replace the pump if worn or damaged.

WARNING:

Do not pressurise the oil cooling system when testing for leakages. Check for leaks at normal operating pressure.

Check the oil cooling system for leakages. Rectify any leakages found.

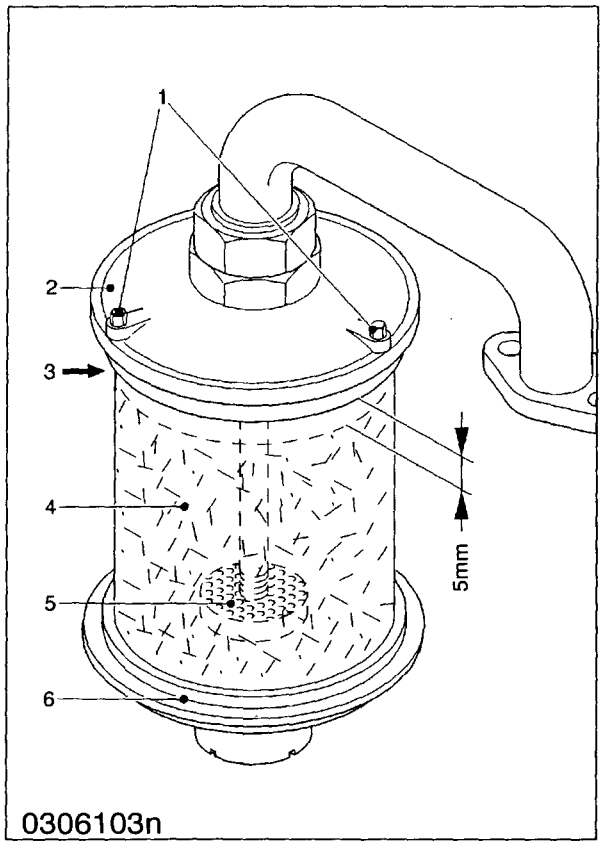
Silica Gel Breather

NOTE:

The transformer must not stay longer than 3 hours without a functional breather.

The colour of the silica gel in the breather will change from blue to pink as the silica gel absorbs moisture. The rate of water absorption is dependent on atmospheric conditions. The silica gel should be replaced when more than half of it is a pink colour, saturated with moisture. The saturated silica gel can be dried out by placing it in an oven and increasing the temperature slowly to a maximum of 150-180 °C. Maintain the temperature until the silica gel turns blue again. The silica gel must be replaced if it becomes a brownish colour. Only silica gel that is a clear blue colour after treatment may be re-used.

Silica Gel Replacement



Remove breather bottom part (6) by loosening the three bolts (1) on the cover (2).

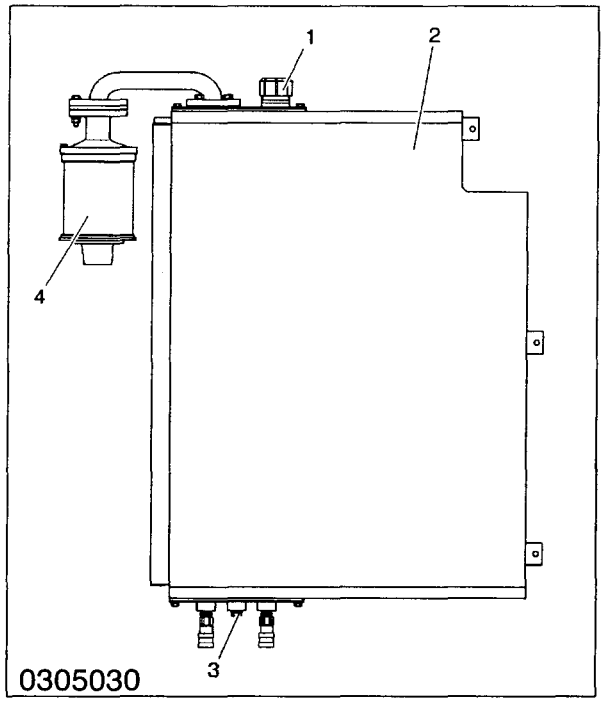
Turn breather bottom part (6) upside down and drain silica gel through openings in top part.

Inspect filter plate (5) through glass cylinder (4). The filter openings must be largely clear and not clogged by grains of silica gel. If the grains cannot be removed by light tapping, blow out the filter or clean with a bristle brush.

Fill the breather with regenerated or new silica gel through the opening in top part to approximately 5 mm below the cover flange.

Check gasket (3) for damage; if necessary, use new gasket and install breather bottom part (6) on cover (2) with the cover bolts (1).

Bleeding the Expansion Tank



To purge water from the expansion tank, place a suitable receptacle below the drain cock (3) on the expansion tank (2), then crack open the drain cock (3). Once all the water has been purged from the expansion tank, the oil level in the tank must be topped up at the filling plug (1).

Waste Disposal

@.1260

Silica gel is non-poisonous (silica) and can be disposed of as normal refuse.

Cooling oil must be disposed of in accordance with prevailing environmental regulations.

Assembly

@.1270

Oil Pump

For further information regarding the oil pumps, refer to Chapter 6, Transformer Oil Cooling of Volume F3, Suppliers Documentation.

Signal Differential Amplifier

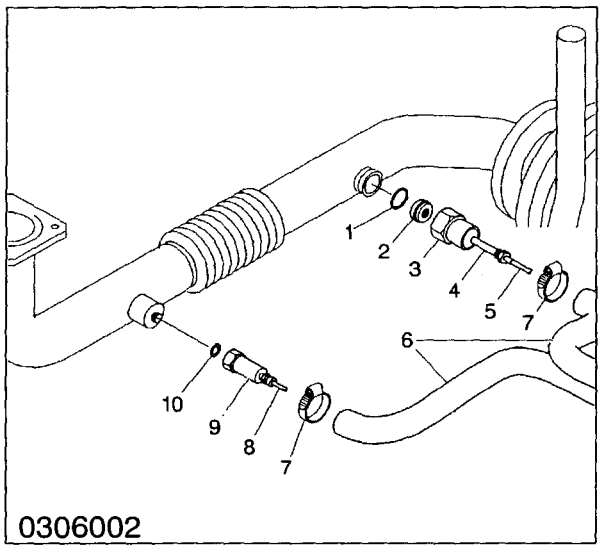
There is no assembly applicable to the signal differential amplifier.

Installation

@.1280

Oil Piping

Refer to Section 13, Actual Value Detection, Sheets 12E & 12I, Oil Circuit Monitoring of Volume G1, Cabling Documentation for sensor and amplifier electrical connections.



0306002

Remove any protective material from the pipe apertures or sensors.

Apply a film of Molycote to a new o-ring (10), then install the o-ring (10) on the pressure transducer (9).

Secure the pressure transducer (9) into the pipe.

Connect the cable (8) to the pressure transducer (9) terminal as tagged during removal.

Slide the conduit (6) over the sensor electrical connections. Secure the conduit using the clamp (7).

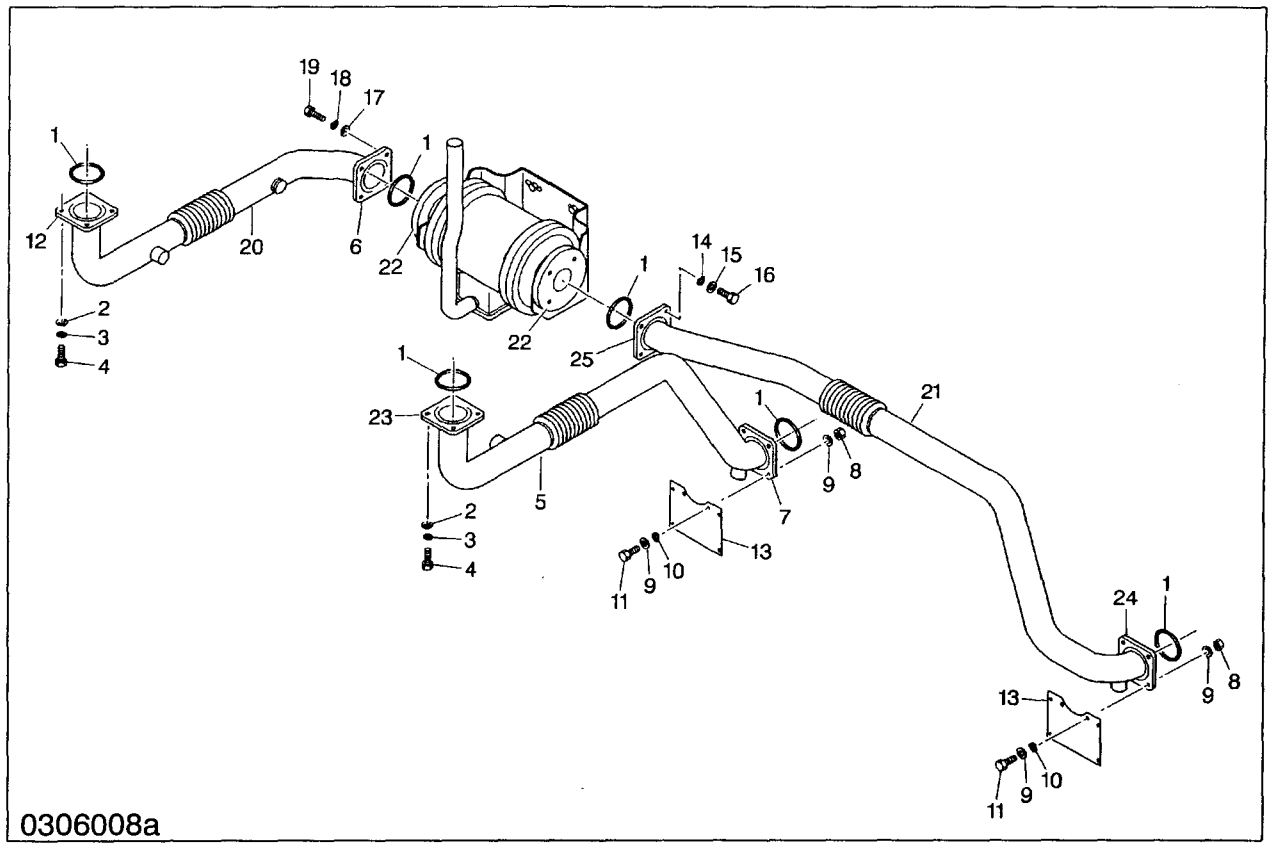
Assemble the fixing cone (2) to the temperature probe (4).

Apply a film of Molycote to a new o-ring (1), then install the o-ring (1) in the groove of the fixing cone (2).

Install the temperature probe (4) into the pipe, then tighten the nut (3).

Connect the cable (5) to the temperature probe (3) terminal as tagged during removal.

Slide the conduit (6) over the sensor electrical connections. Secure the conduit using the clamp (7).



Remove any protective material from the pipe and oil blower radiator flanges.

Remove the blanking plates and gaskets from the transformer shut off valves.

Apply a film of Molycote to new o-rings (1), then place the o-rings (1) in the grooves of the pipe (5) flanges (23, 24).

Position and support the pipe (5) to prevent it falling during assembly.

Align the holes in the flange (23) with the holes in the oil blower radiator.

Install the bolts (4), spring and plain washers (2, 3) to secure the pipe (5) flange (23) to the oil blower radiator. Tighten the bolts (4).

Position the plate (13) over the pipe (5) flange (7).

Align the holes in the flange (7) with the holes in the plate (13) and transformer shut off valve.

Install the bolts (11), spring and plain washers (9, 10) and nuts (8) secure the pipe (5) flange (7) to the transformer shut off valve. Tighten the nuts (8).

Apply a film of Molycote to new o-rings (1), then place the o-rings (1) in the grooves of the pipe (20) flanges (12, 6).

Position and support the pipe (20) to prevent it falling during assembly.

Align the holes in the flange (12) with the holes in the oil blower radiator.

Install the bolts (4), spring and plain washers (2, 3) to secure the pipe (20) flange (12) to the oil blower radiator. Tighten the bolts (4).

Align the holes in the flange (6) with the holes in the oil pump flange (22).

Install the bolts (19), spring and plain washers (18, 17) to secure the pipe (20) flange (6) to the oil pump flange (22). Tighten the bolts (19).

Apply a film of Molycote to new o-rings (1), then place the o-rings (1) in the grooves of the pipe (21) flanges (24, 25).

Position and support the pipe (21) to prevent it falling during assembly.

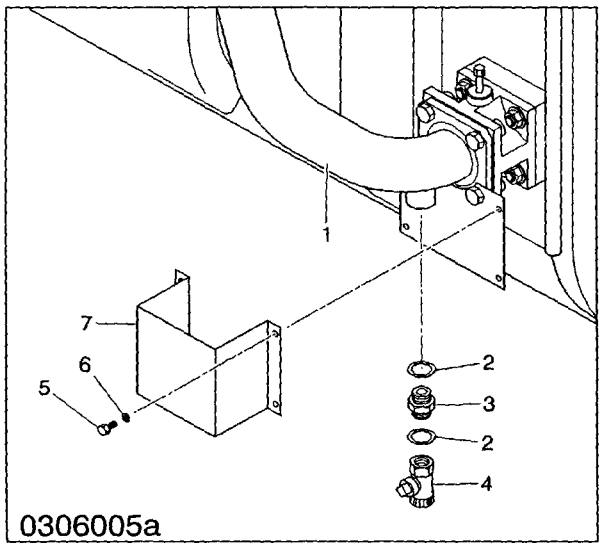
Align the holes in the flange (25) with the holes in the oil pump flange (22).

Install the bolts (16), spring and plain washers (15, 14) to secure the pipe (21) flange (25) to the oil pump. Tighten the bolts (16).

Position the plate (13) over the pipe (21) flange (24).

Align the holes in the flange (24) with the holes in the plate (13) and transformer shut off valve.

Install the bolts (11), spring and plain washers (9, 10) and nuts (8) securing the pipe (21) flange (24) to the transformer shut off valve. Tighten the bolts (11).



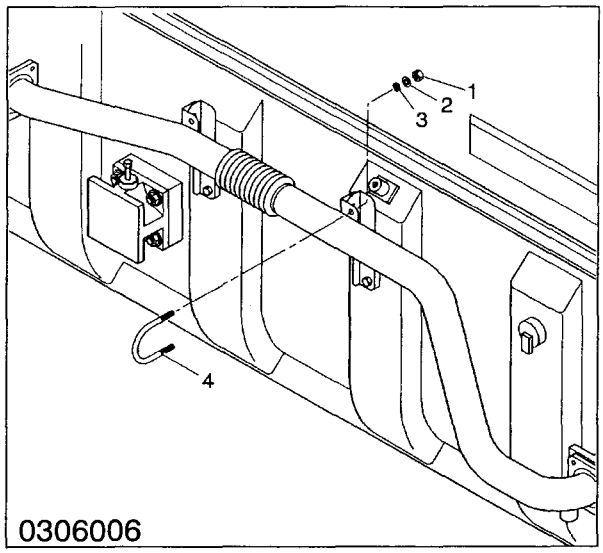
0306005a

NOTE:

There are four transformer shut off valves in total, two on each side of the main transformer.

If necessary, apply a film of Molycote to new o-rings (2). Install and secure the threaded adaptor (3), drain cocks (4) and o-rings (2) to the pipe (1).

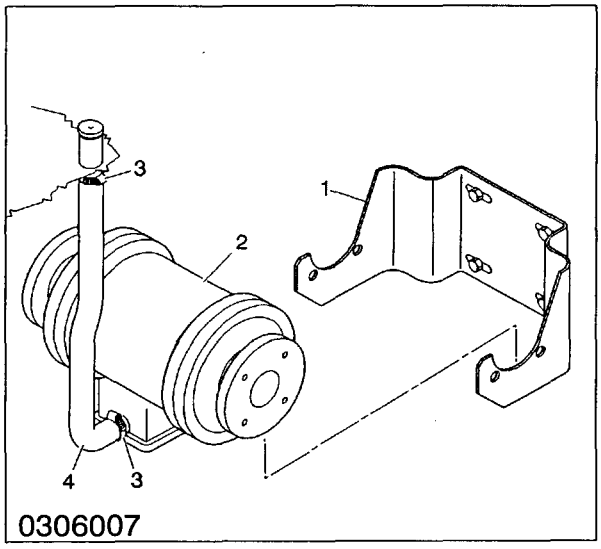
Position the cover plate (7) over the drain cocks, then install and tighten the screws (5) and washers (6) to secure the cover plate (7).



Position the U-bolts (4) over the pipe into the bracket.

Install and tighten the spring and plain washers (2, 3), and nuts (1).

Oil Pump



Lift the oil pump (2) onto bracket (1) using suitable lifting equipment.

Align the holes in the oil pump (2) with the holes in the support (1), then install and tighten the bolts to secure the oil pump in position.

If necessary, slide the conduit (4) and the hose clamp (3) over the cable.

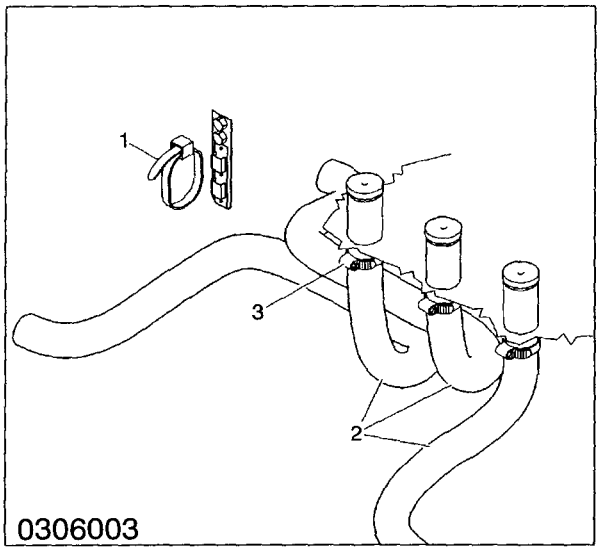
Connect the cables to the oil pump (2) electrical terminals as tagged during disassembly.

Fix the conduit (4) to the oil pump (2), and if necessary the locomotive underframe, using the clamp (3).

Install the oil pump (2) terminal box cover and secure the screws.

Refer to Section 3, Auxiliary Circuits 3 Phase, Sheet 02I, Oil Pumps and Compressors of Volume G1, Cabling Documentation for oil pump electrical connections.

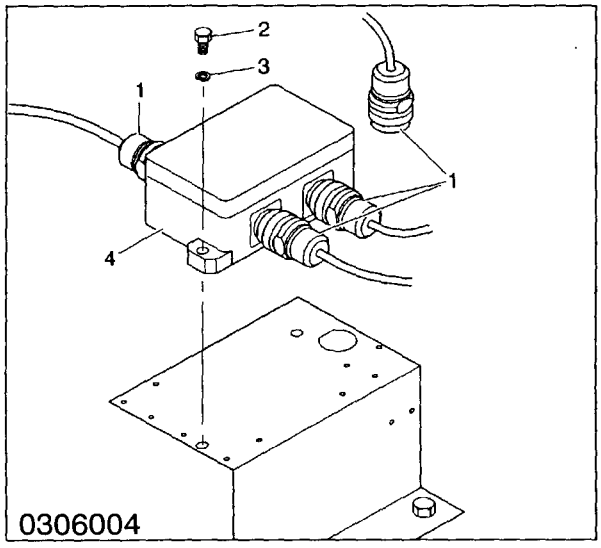
Signal Differential Amplifier



Slide the conduit (2) and the hose clamps (3) over the cables.

Secure the conduit (2) to the locomotive underframe using the hose clamps (3).

Secure the conduits (3) to the support using new cable ties (1).



The signal differential amplifier (4) is located within an air duct, adjacent to the oil blower, in the machine room floor.

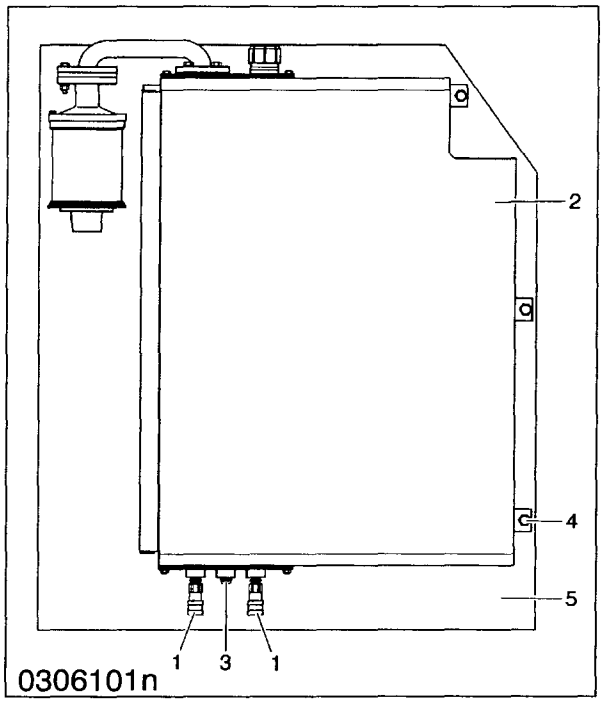
Position the signal differential amplifier (4) onto the bracket.

Install the bolts (2) and spring washers (3), then tighten the bolts (2).

Connect the 5-pole plugs (1) to the signal differential amplifier (4) as tagged during disassembly.

Install the cover plate and gasket over the air duct and secure the screws.

Expansion Tanks



Remove any protective material or plugs from the pipes, expansion tank or transformer apertures.

Attach suitable lifting equipment to the expansion tank (2), then position the expansion tank (2) on the oil blower unit (5). Install the bolts (4) to secure the expansion tank (4). Tighten the bolts (4).

Connect the expansion and equalisation hoses (1) to the transformer and expansion tank (2).

After-Installations Operations

@.1290

Refill the expansion tanks, transformer, oil blower unit and oil circuit with clean oil, meeting the specification in Section Technical Data.

Filling The Cooling System With Oil

Once all piping connections to the heat exchanger and the pump have been made, it is necessary to fill the remainder of the cooling system with oil. The oil used must comply with the relevant specifications. If necessary, an oil test should be carried out to ensure the oil to be used meets the required specification. The oil cooling circuit should be flushed with clean oil prior to refilling the system.

The transformer main valves should only be opened when all pipes and the heat exchanger have been filled with oil and vented. No air should enter the transformer assembly from the piping or the heat exchanger.

Refer to Chapter 5, Main Transformer of Volume F3, Suppliers Documentation for further details regarding refilling the oil cooling system.

Test the oil cooling system for leakage. Refer to Section Inspection and repair.

Oil Pump

WARNING:

Ensure the oil cooling system, the pump and the transformer are filled with oil prior to operating the pumps. Running the pumps when the cooling system is empty can damage the pumps.

Check the direction of rotation of the pump, as described in Chapter 6, Transformer Oil Cooling of Volume F3, Suppliers Documentation. Ensure the oil pump is connected correctly prior to activating the oil cooling system.

Refer to Section 3, Auxiliary Circuits 3 Phase, Sheet 021, Oil Pumps and Compressors of Volume G1, Cabling Documentation for oil pump connections.

Adjustments

@.1310

Oil Level of the Transformer Expansion Tank

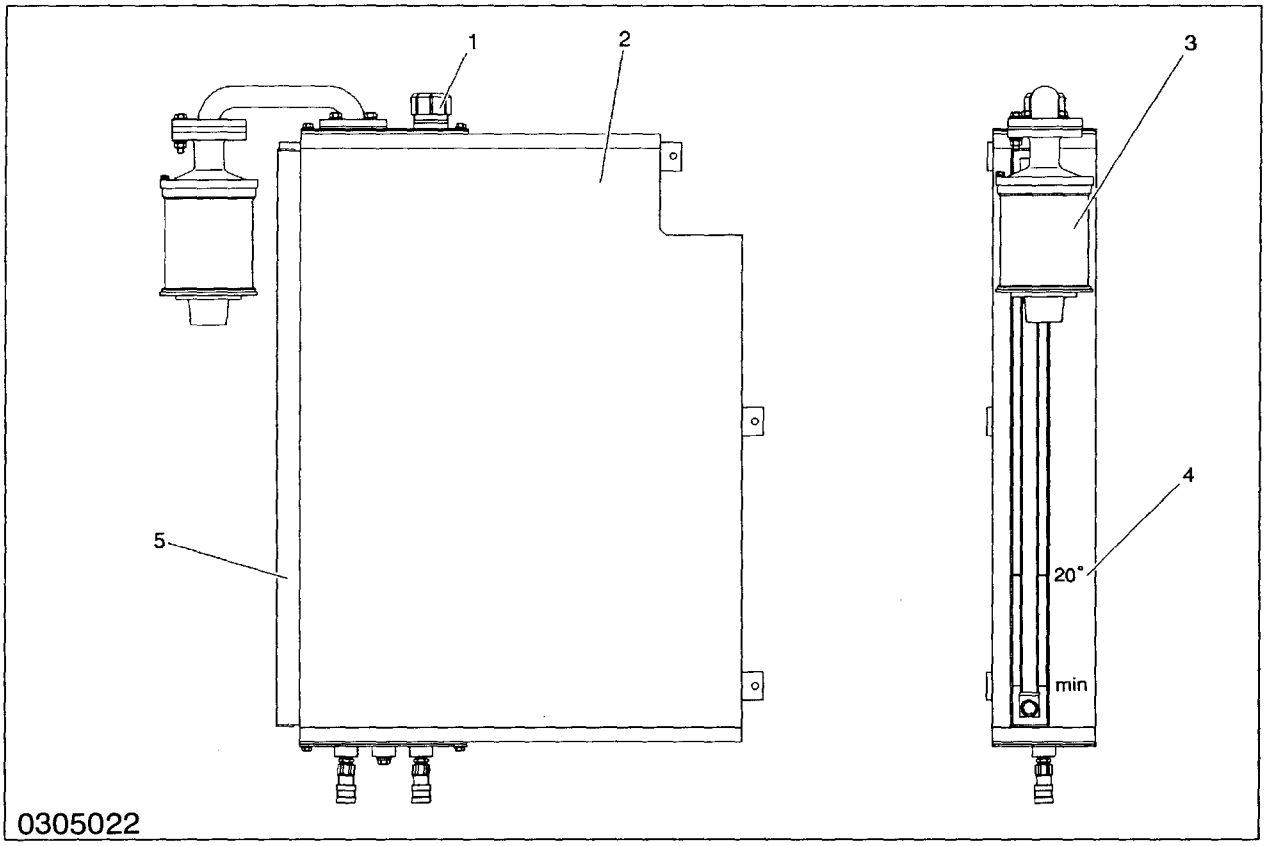
The oil level should lie within the marks on the oil level gauge.

The oil level of relatively new vehicles may drop considerably for some time after commissioning. This is due to the expulsion of residual air pockets.

In such cases, check the security of the pipes (rubber and steel), flanges and fittings.

Slight oil films, recognisable by dust adhering to the surface, are acceptable if there is no dripping leak. Replace any components as required to rectify any leakage found.

Oil Level Check



The oil level in the expansion tank must be checked each time before operating the locomotive. For transformers/locomotives in storage, the oil level must be checked at least every 6 months. The oil level in the expansion tank must be equal to the corresponding temperature mark on the sightglass.

If the transformer has to be filled up, oil of the same quality must be used. Do not mix oils that have different properties.

3.7 Transducers

General Notes on Hazards in the Work Area

@.1040

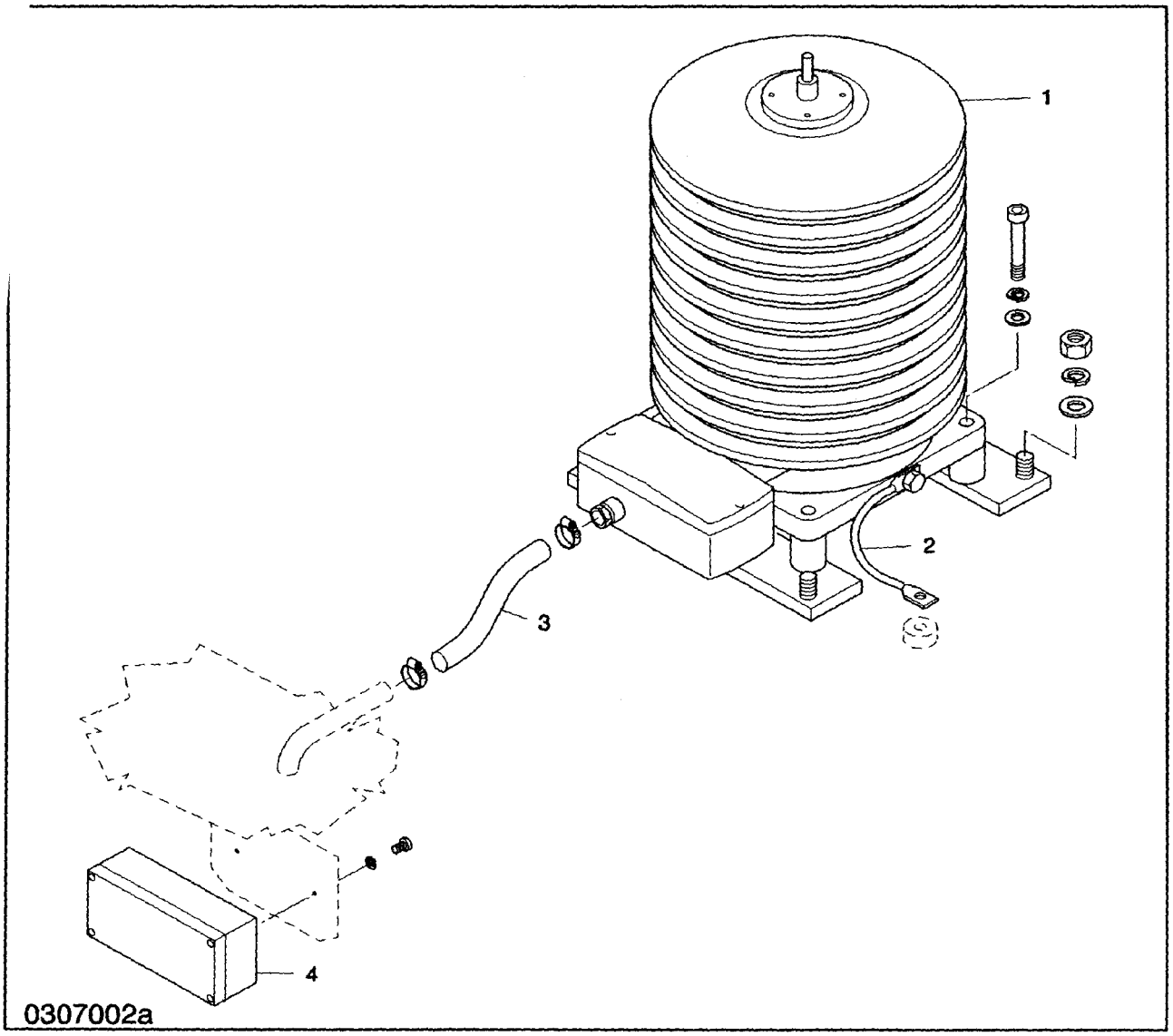
WARNING:

HIGH VOLTAGE! DANGER OF ELECTROCUTION. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVER-HEAD.
Lower the pantograph and isolate the overhead catenary power whenever working on the roof.

iroup Summary

1120

his chapter contains information on the primary voltage transformer.



1	Primary voltage transformer (3)	3	Conduit
2	Earthing cable	4	Load resistor (74.2)

Numbers in brackets () denote the electrical equipment apparatus item number used in the locomotive schematics, refer to Volume G, Cabling Documentation.

Functional Description

@.1140

The primary voltage transformer is situated on the converter roof hatch and attached to the pantograph voltage via the roof line. The primary voltage transformer reduces the catenary voltage, approximately 25 kVa, to 200 volts AC. A resistor is placed across the primary voltage transformer to provide a reference load. The output signal is used in three ways; main converter electronics, catenary voltmeters on the driver's console and for the minimum voltage relay.

Primary voltage transformer module (224.2) reduces and rectifies the 200 volt signal from the primary voltage transformer (3) to 10 volt DC for the catenary voltmeters (UBA) on the driver's console.

Another primary voltage transformer module (224.1) reduces the 200 volt signal to 4 volt AC for the control electronics (415). The control electronics monitor the catenary voltage amplitude for phase generating the thyristor firing pulses.

The 200 volt signal from the primary voltage transformer (3) is fed to the minimum voltage relay (86) which de-energises when the catenary voltage falls below 17.6 kV.

Numbers in brackets () used in this Functional Description relate to the electrical equipment apparatus item number used in the locomotive schematics, refer to Volume G, Cabling Documentation.

Technical Data

@.1160

Primary Voltage Transformer

- Type	MWB Mittelspannungstechnic VGF 36
- Weight (nominal)	50 kg
- Voltage	36 kV
- Weight (wet total)	495 mm
- Diameter	310 mm
- Transformer winding ratio	25,000:200

Load Resistor

- Type	GRF
- Resistance	3.3 Ω
- Nominal load	300 Watt

Tolerances and Wear Limits

@.1170

Load Resistor

· Resistance	2.97 - 3.63 Ω

Tools and Special Tools

@.1180

Conventional railway workshop tools are required for the procedures described in this chapter.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Dow Corning 5 S sprayable silicone compound or Goldschmitt "ISL" silicone grease is required as a protective coating on the primary voltage transformer insulator. Refer to Chapter 7, Transducers of Volume F3, Suppliers Documentation
- Clean paper towelling or tissues are required to remove the silicone coating from the transformer
- Clean, dry lint free cloth is required to polish the transformer insulator
- Paper towelling

Before-Removal Operations

@.1220

Lower the pantograph and isolate the overhead catenary. Earth the locomotive at the vacuum circuit breaker. Refer to the Preface of this Volume.

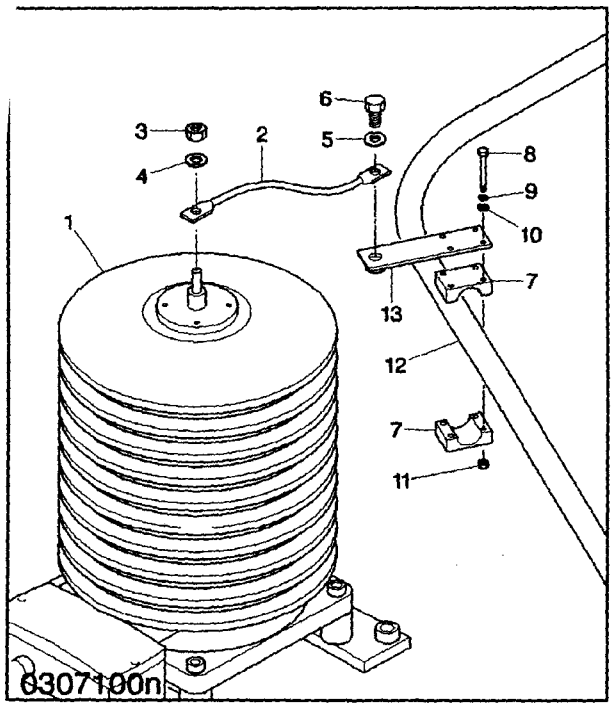
Earth the traction converter as described in Chapter 4.1, Traction Converter. Operation of the key interlocking system is described in Chapter 3.11, Protection Concept of Volume A, Driver's Manual.

Steam clean the primary voltage transformer, remove all traces of dirt and debris. Refer to Steam Cleaning in the Preface of this Volume.

lemoval

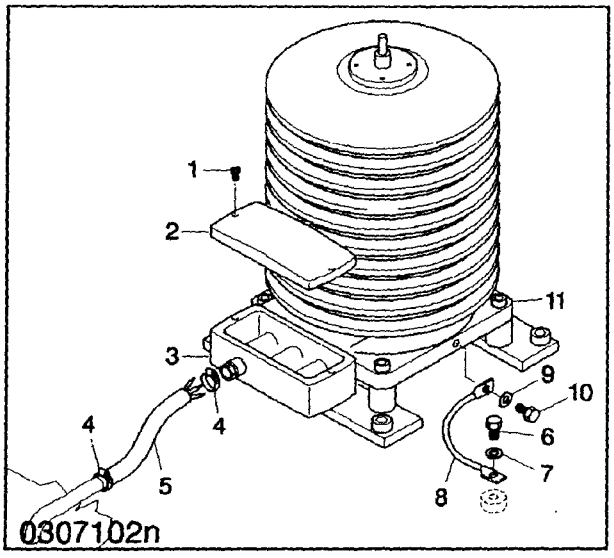
.1230

rimary Voltage Transformer



Disconnect the high voltage cable (2) between the primary voltage transformer (1) and the roof line (12). Remove the nut (3) and washer (4) at the transformer (1). Remove the bolt (6) and washer (5) securing the cable (2) to the plate (13).

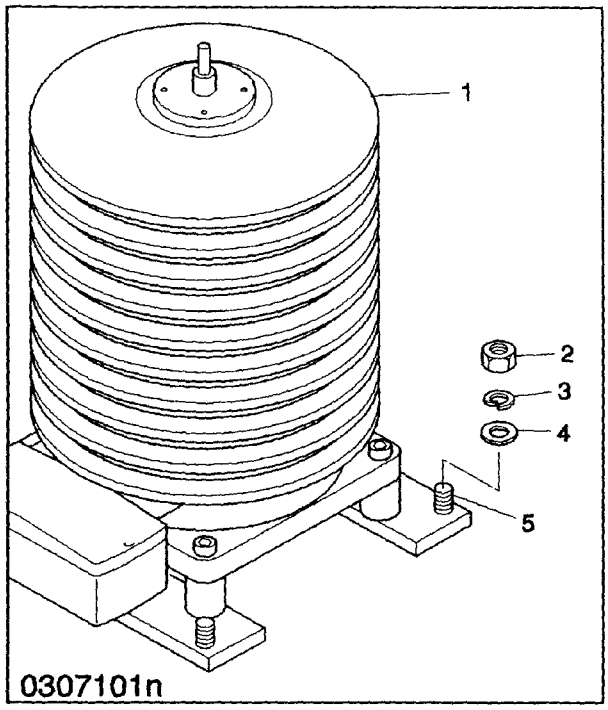
If necessary, remove the bolts (8), washers (9, 10) and nuts (11) securing the plate (13) and clamps (7) to the roof line (12).



Undo the screws (1) and remove the cover (2) from the terminal box (3).

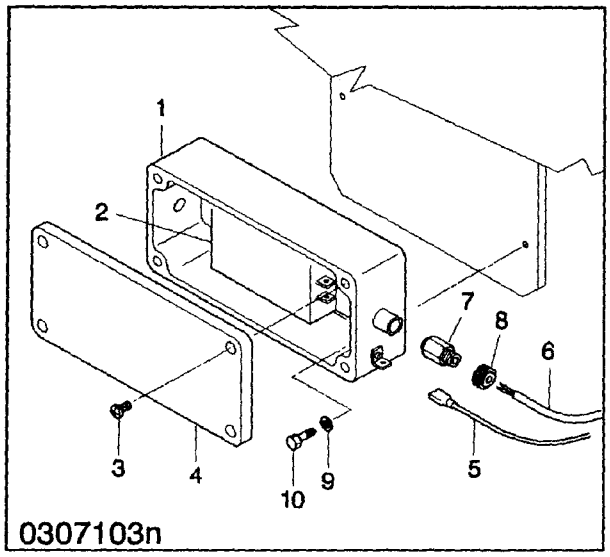
Loosen the clamps (4), then slide the conduit (5) from the terminal box (3). Tag and disconnect the electrical harness from the terminals.

Remove the screw (10) and washer (8) securing the earthing cable (8) to the transformer (11). If necessary, remove the screw (6) and washer (7) securing the cable (8) to the converter roof hatch.



Remove the nuts (2), spring and plain washers (3, 4) securing the transformer (1) to the converter roof hatch. Lift the transformer (1) from the locomotive using suitable lifting equipment

Load Resistor



Disconnect the earth wire (5) from the terminal on the terminal box (1).

Remove the screws (3) securing the terminal box cover (4).

Tag and disconnect the electrical harness (6) from the terminals.

Remove the screws securing the resistor to the terminal box (1).

If necessary, unscrew the conduit unions (7, 8) from the terminal box (1), then withdraw the harnesses (6). Remove the screws (9) and washers (10) securing the housing (1) to the converter roof hatch.

Disassembly

.1240

The primary voltage transformer cannot be disassembled. The unit must be replaced if damaged or faulty.

The load resistor or terminal box cannot be disassembled. Either unit must be replaced if damaged or faulty.

Inspection and Repair

@.1250

Inspect the insulator of primary voltage transformer for cracks, chips or damage.

Check the condition of the seal on the terminal box. Replace the seal if worn or damaged.

Check the condition of the thread for the high voltage connection. Minor damage can be repaired using an M10 thread chaser.

Check the condition of the high voltage and earthing cables. Replace the cables if worn, damaged or frayed.

Replace the primary voltage transformer if damaged.

Check the load resistor for damage.
Measure the resistance of the load resistor using a suitable multi-meter.

Replace the resistor if damage or not within the range specified in Section Tolerances and Wear Limits.

Inspect the condition of the silicon coating on the insulator of the primary voltage transformer. Contaminants in the silicon coating reduce the insulating effect of the insulator. Water applied to the surface of the primary voltage transformer should bead and not wet the surface. If the coating is contaminated or is wetted by water, the coating must be renewed. Audible discharges or flashovers that are visible in the dark are an indication that the primary voltage transformer needs to be re-coated.

Remove the contaminated silicon coating using paper towelling. Wipe any remaining silicon coating from the primary voltage transformer using a clean, dry, lint free cloth. Clean the surface of the insulator thoroughly using a cloth soaked in alcohol.

Ensure the glazed surface of the primary voltage transformer is clean, dry and shiny. The silicon grease described in Section Miscellaneous Materials should be applied evenly to the entire glazed surface of the primary voltage transformer to a thickness of 0.2 to 1 mm.

Take care when handling the primary voltage transformer after coating to avoid contamination of the silicon grease.

Waste Disposal

@.1260

Dispose of waste parts, materials and fluids according to the prevailing environmental standards or workplace practices.

Assembly

@.1270

The primary voltage transformer is replaced as a unit; no assembly is necessary.

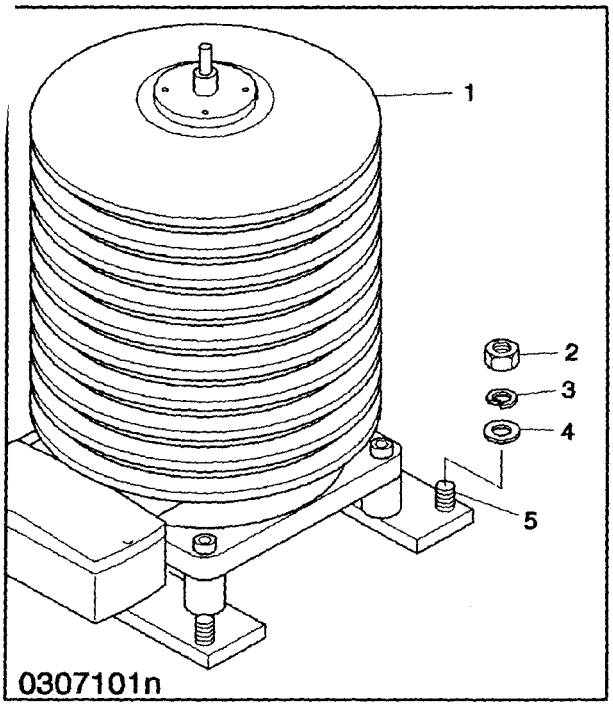
The load resistor is replaced as a unit; no assembly is necessary.

ıstallation

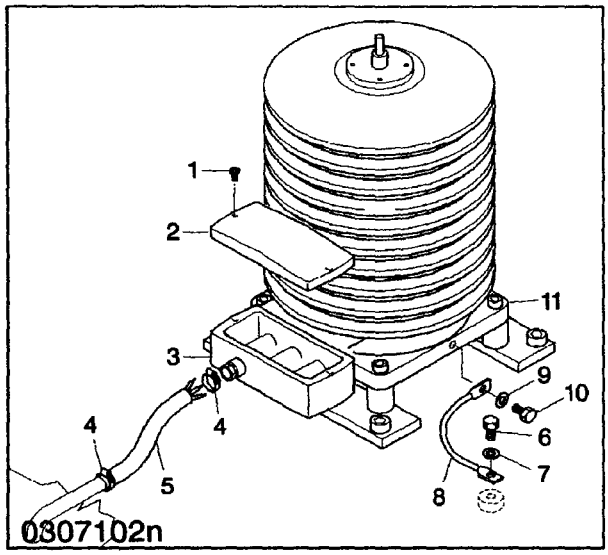
1260

rimary Voltage Transformer

ake care when handling the primary voltage transformer to avoid contamination of the silicon rease.



Position the transformer (1) onto the studs on the converter roof hatch. The terminal box faces the longitudinal centre line of the locomotive. Install the nuts (2), spring and plain washers (3, 4) to secure the transformer (1) to the converter roof hatch, then tighten the nuts.

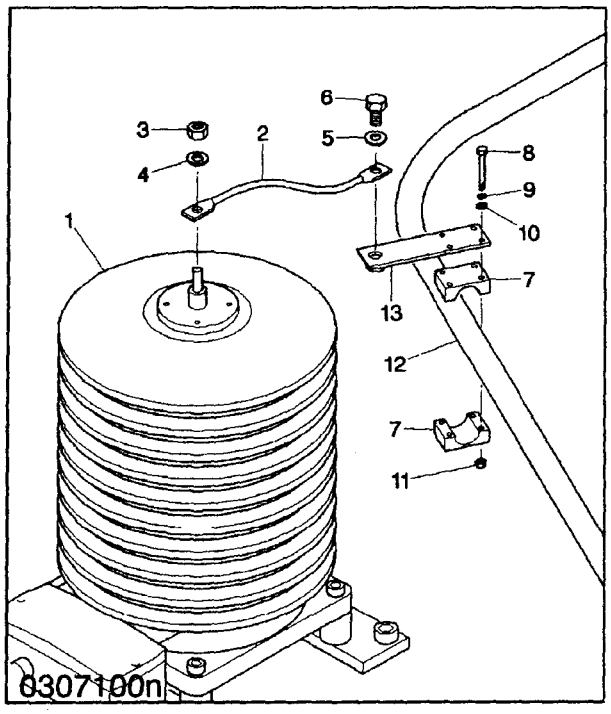


If necessary, install the screw (6) and washer (7) to secure the earthing cable (8) to the converter roof hatch. Install the screw (10) and washer (8) to secure the earthing cable (8) to the transformer (11).

Place the conduit (5) and clamps (4) over the electrical harness. Insert the electrical harness into the terminal box (3) opening.

Re-connect the electrical cables to the terminals of the transformer (11) as tagged during removal. Refer to Section 2, Sheet 01A, Main Power Circuit of Volume G1, Cabling Documentation.

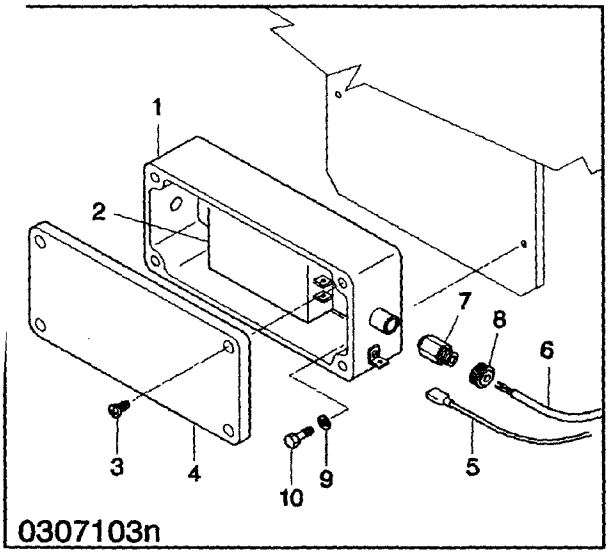
Place the cover (2) and seal on the terminal box (3), then install and tighten the screws (1).



If necessary, install the plate (13) and clamps (7) to the roof line (12), then install the bolts (8), washers (9, 10) and nuts (11).

Connect the high voltage cable (2) between the primary voltage transformer (1) and the roof line (12). Install and tighten the nut (3) and washer (4) at the transformer (1). Install and tighten the bolt (6) and washer (5) at the plate (13) on the roof line.

oad Resistor



Position the terminal box (1) on the converter roof hatch. Install the screws (10) and washers (9) to secure the box (1).

Install the resistor (2) into the terminal box and secure the screws.

Place the unions (7, 8) over the cable conduit. Insert the electrical cables (6) into the terminal box (1).

Re-connect the electrical cables to the resistor terminals as tagged during removal. Refer to Section 2, Sheet 01A, Main Power Circuit of Volume G1, Cabling Documentation.

Connect the earth wire (5) to the terminal on the box (1).

Tighten the unions around the conduit (7, 8).

Place the cover (4) and seal on the terminal box (1), then install and tighten the screws (3).

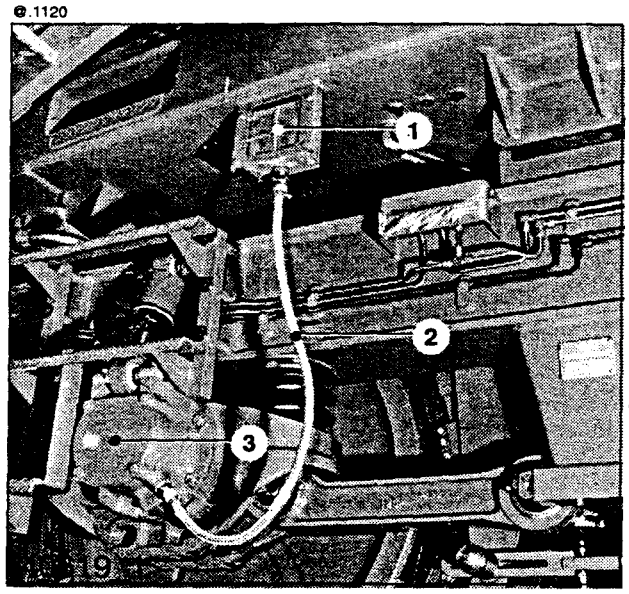
Adjustments

@.1310

There are no adjustments applicable to the primary voltage transformer.

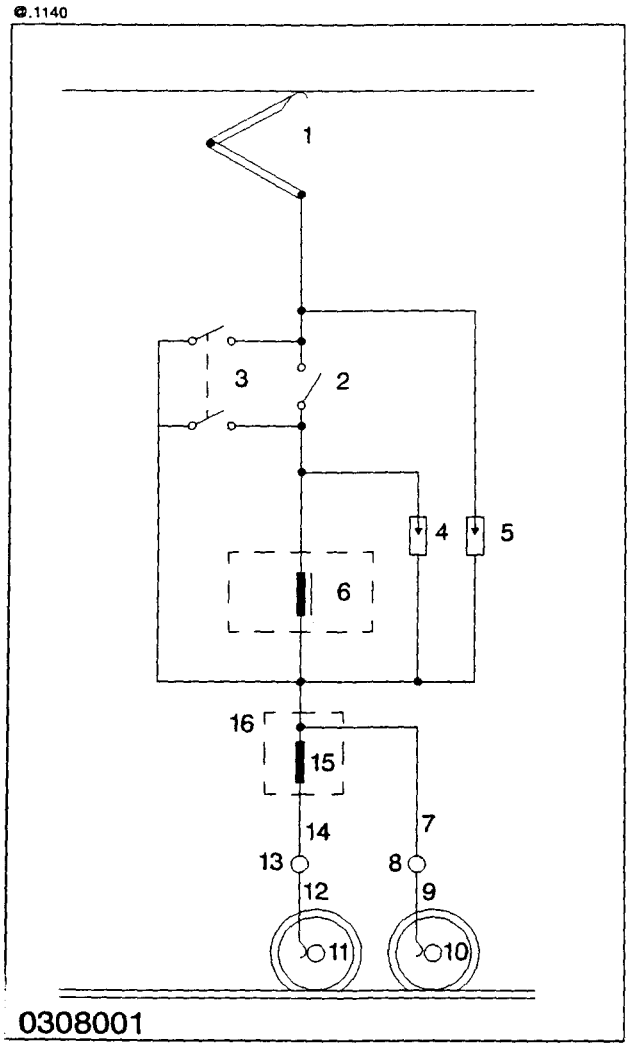
3.8 Primary Earth

Overview



1	Terminal box
2	Cable to earthing brush
3	Journal bearing

Functional Description



1	Pantograph
2	Vacuum circuit breaker
3	Primary earthing switch
4	Surge arrester
5	Surge arrester
6	Main transformer
7	Stranded earthing conductor, 3 times
8	Terminal box, 3 times
9	Cable to earthing brush, 3 times
10	Earthing brush, 3 times
11	Earthing brush
12	Cable to earthing brush
13	Terminal box
14	Stranded earthing conductor
15	Earthing coil
16	Filter block

For the locomotive to be able to move, it must be part of a closed electrical circuit. This is achieved in the following way:

The pantograph (1) diverts current from the high voltage line into the locomotive. The transformer (6) is the part that strictly speaking uses the energy. It feeds the drive motors, the auxiliary converter and the train heating secondarily. In filter block (16) the cable separates into the cables (7) and (14) to direct current via the four axles and wheels to the track. Cables (9, 12) discharges the primary current of the transformer to the earthing brushes (10, 11). Because the axles have an electrical connection with the wheels and the tracks, the electrical circuit is thus closed.

Various elements perform safety functions:

Surge arrester (5) protects the electrical circuit in the primary circuit of the transformer against overload. Surge arrester (4) protects the transformer itself against overload. The switch (2) cuts off the electrical circuit in case of emergency. Primary earthing switch (3) earths the locomotive.

In filter block (16) the cable separates to direct current via the four axles and wheels to the track. Cables (7, 9) and (12, 14) respectively discharges the primary current of the transformer via the journal bearings.

This chapter describes how to check and replace the movable cables (9, 12) that lead from the terminal boxes (8, 13) to the earthing brushes (10, 11) in the journal bearings. Terminal boxes (8, 13) are located beneath the loco body.

Look up the functional description of the earthing coil (15) in documentation G2.

Technical Data

.1160

[Not applicable]

Tolerances and Wear Limits List

.1170

[Not applicable]

Tools and Special Tools

.1180

Normal workshop equipment is required.

Miscellaneous Materials

.1200

[Not applicable]

Before–Removal Operations

.1220

[Not applicable]

Removal

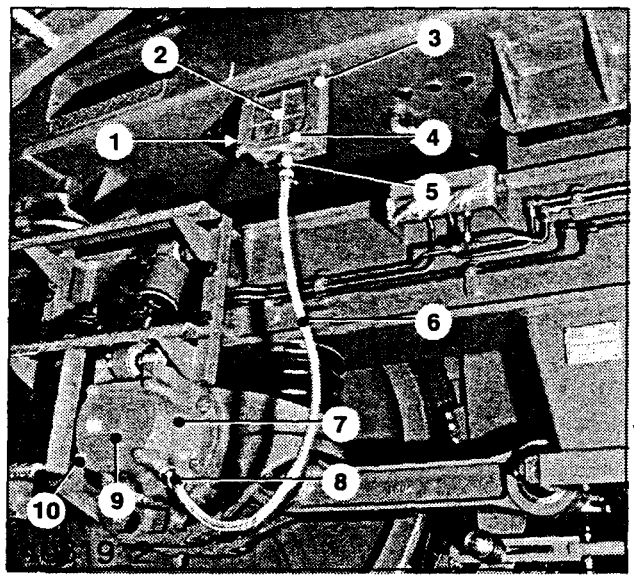
.1230

[Not applicable]

Disassembly

©.1240

Journal bearings and terminal boxes

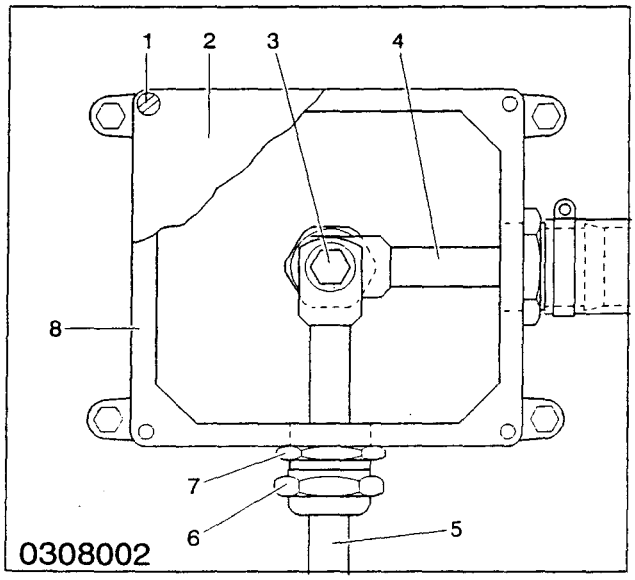


The electrical cable in tube (1) connects the earthing coil in the filter block with the terminal box (2). This cable is neither checked nor replaced.

Unscrew cable screw joints (5) and (8) of the cable to earthing brush (6) from the housings. Loosen four M6 hexagonal head bolts (3) with spring washer and washer from the rear of the terminal box and remove. Press terminal box (2) out of holder (4), tilt slightly and twist back (with cover) forwards.

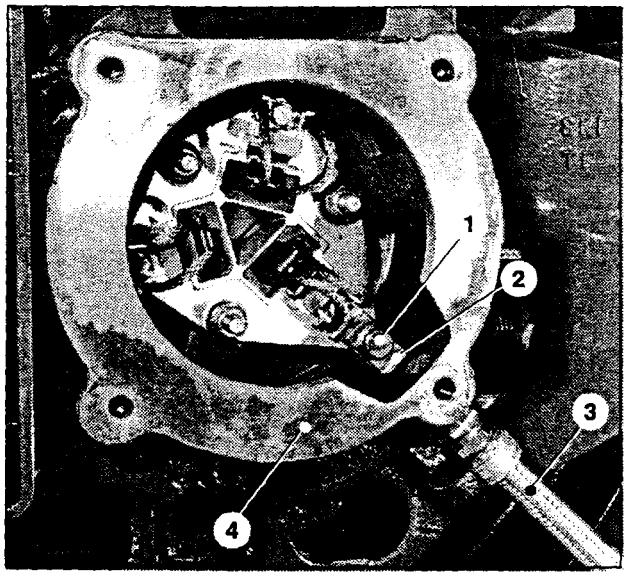
Loosen four M12 bolts (10) with washers. Remove cover (9) with the associated seal from journal bearing (7).

Terminal box



Loosen four screws (1) with spring washer and washer and lift off cover (2). Loosen M8 hexagonal head bolt (3) with spring washer and washer. Simultaneously lift cable lug (4) and cable to earthing brush (5) slightly so that the load is taken off the bolt (3). Bolt (3) can be removed more easily in this way. Pull the cable to earthing brush (5) out of the terminal box (6).

Journal bearing



Loosen screw (1) and remove together with clamping plate (2). The cable lug of cable (3) is now exposed. Pull the cable to earthing brush (3) out of the axle box (4).

Inspection and Repair

⊕.1250

Check the cable to the earthing brush for loosed contact. Replace the cable if it is defective.

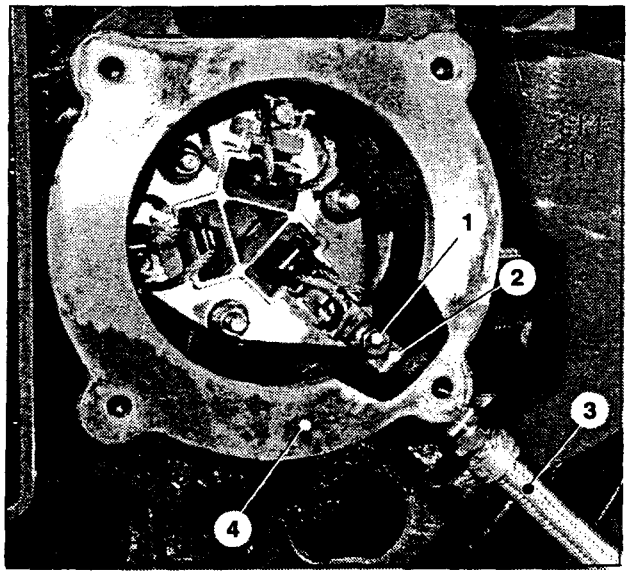
Sanitation Parts/Operating Material

⊕.1260

Assembly

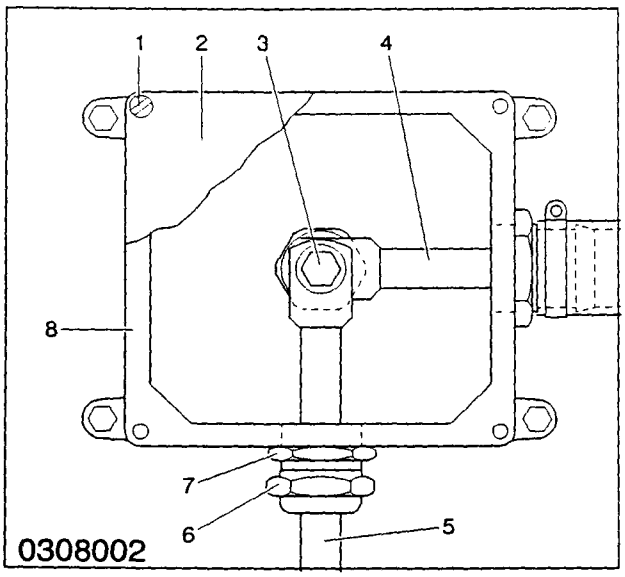
⊕.1270

Journal bearing



Push the cable to the earthing brush (3) through the eye into the journal bearing (4). Hold the cable lug of cable (3) and clamping plate (2) in position and tighten with screw (1).

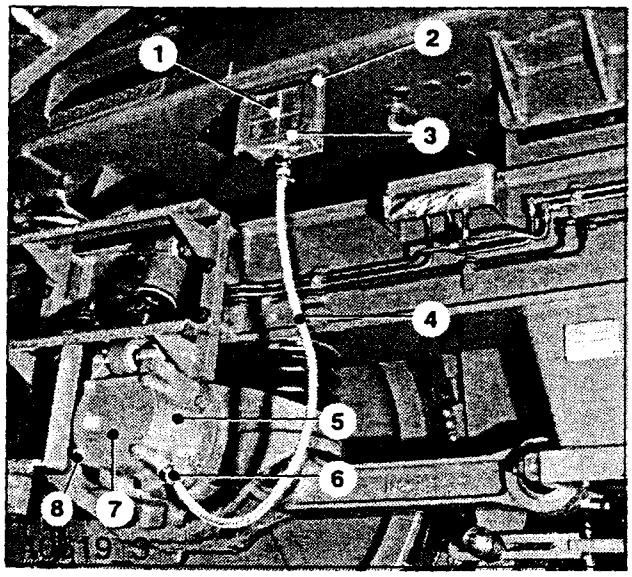
Terminal box



Push the cable to earthing brush (5) into the terminal box (8). Hold the cable lug of stranded earthing conductor (4) and the cable lug of the cable to earthing brush (5) in position. Fasten cable lugs with M8 hexagonal head bolt (3), spring washer and washer. Screw cable (5) with hexagonal head screw connector (6) onto terminal box (8) and secure with lock–nut (7).

Fasten cover (2) with screws (1), spring washers and washers.

Journal bearings and terminal boxes



Turn back terminal box (1) (cover on the back) and push from the back into the holder (3). Fasten terminal box with M6–hexagonal head screws (2), high tension spring lock washers and washers.

Screw on cable screw joint (6) of the cable to earthing brush (4) and secure with lock–nut.

Fasten cover (7) and seal with M12–hexagonal head bolts (8) and associated washers onto journal bearing (5).

Installation

@.1280

[Not applicable]

After–Installation Operations

@.1290

[Not applicable]

Adjustments

@.1310

[Not applicable]

empty page

3.9 Filter

General Notes on Hazards in the Work Area

@.1040

WARNING:

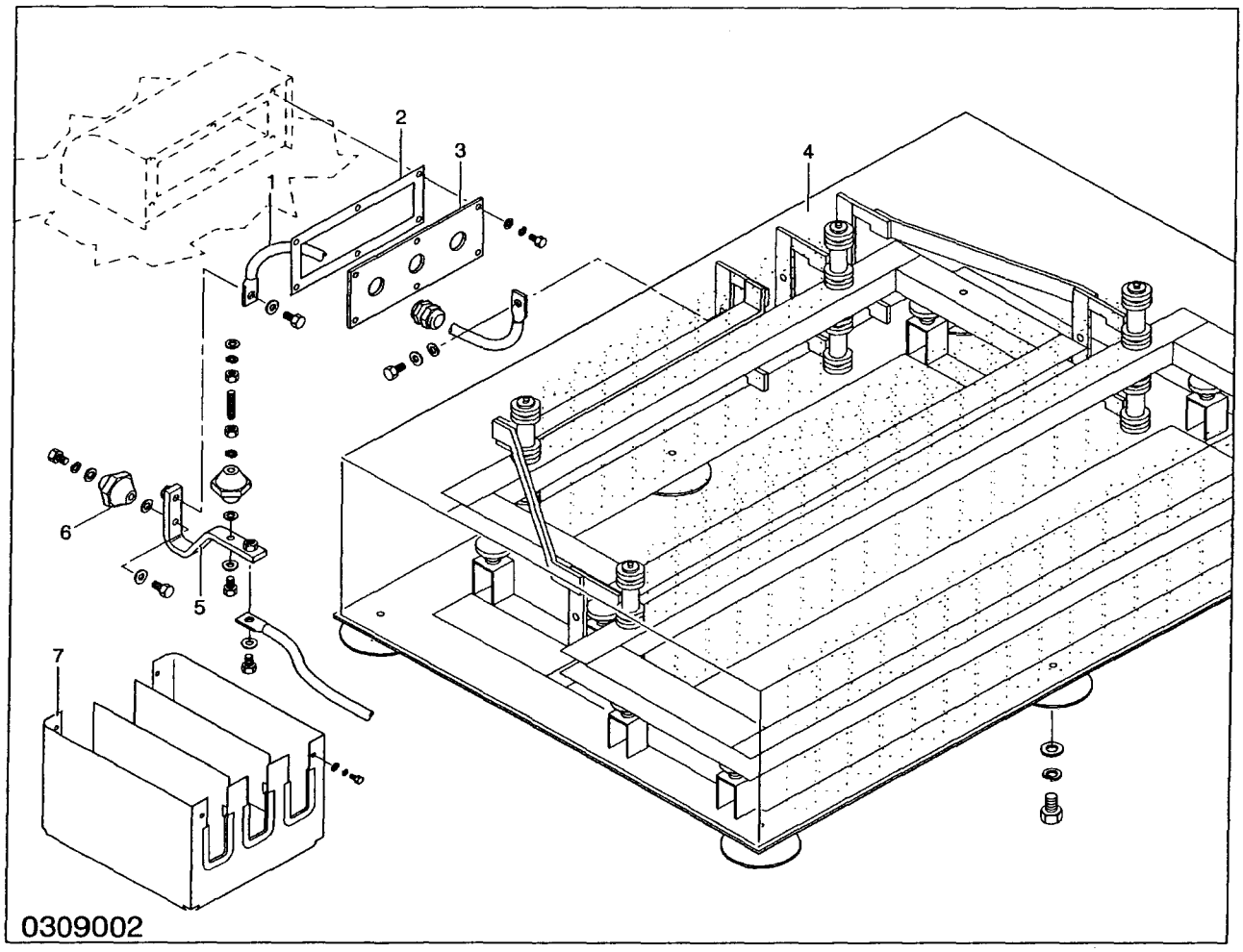
HIGH VOLTAGE! DANGER OF ELECTROCUTION. NEVER WORK ON THE ROOF AREA WHILE THE LOCOMOTIVE IS UNDER A LIVE OVERHEAD.
Lower the pantograph and isolate the overhead catenary power whenever working on the roof.

Group Summary

@.1120

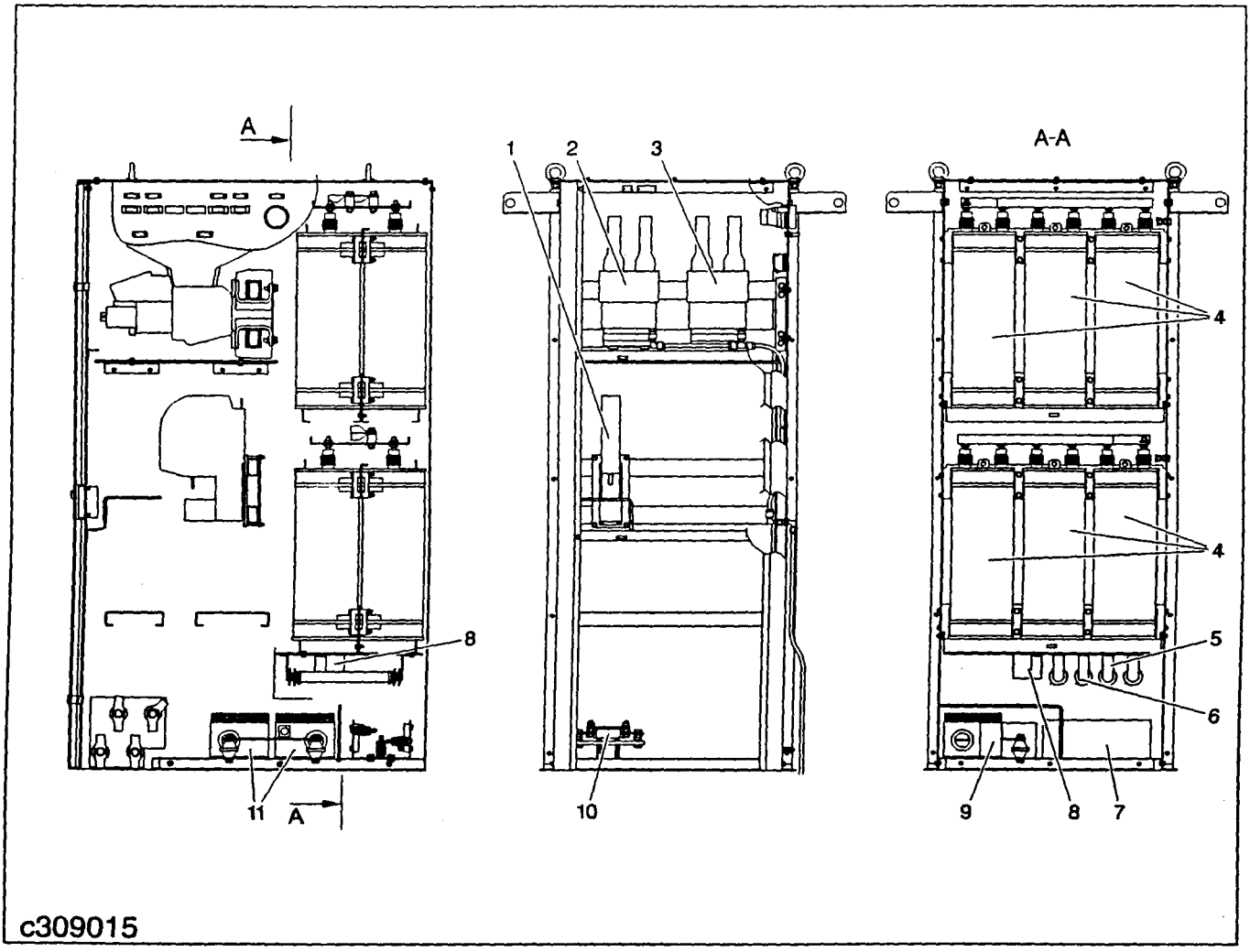
This chapter contains information on the line harmonic filter which consists of: filter resistor, filter cubicle, filter windings and primary earth choke coil (resistor). The filter windings are described in Chapter 3.5, Transformer.

Filter Resistor



1	Cable	5	Connecting angle
2	Gasket plate	6	Insulator
3	Plate	7	Cover
4	Resistor, filter block		

Overview Filter cubicle



1	Contactor for discharching resistor (8.41)	7	Discharging resistor for capacitor bank (8.42)
2	Contactor filter on/off (8.1)	8	Earth fault relay harmonic filter (89.6)
3	Contactor filter adaptation (8.2)	9	Primary current sensor (6.2)
4	Capacitor bank harmonic filter (8.4)	10	Surge arrestor for primary current sensor (6.21)
5	Earthing resistor earth fault detection harm. filter (8.62)	11	Current sensor harmonic filter (8.5)
6	Earthing resistor earth fault detection harm. filter (8.61)		

Numbers in brackets denote the electrical equipment apparatus item number used in the locomotive schematics, refer to Volume G, Cabling Documentation.

Functional Description

@.1140

A filter is connected across the main transformer windings to limit line harmonics:-reducing critical interference levels of the locomotive. In general, the harmonic filter is a Resistor Inductor Capacitor (RLC) circuit providing a low pass filter.

When the VCB (vacuum circuit breaker) is closed, the filter On/Off contactor will close whenever the TE/BE controller is moved from the zero position to any driving position. Whenever the TE/BE controller is returned to zero with the VCB remaining closed, the filter contactor remains closed for 5 minutes and then opens. The discharge contactor is then closed for 500 milliseconds to discharge the capacitors. Whenever the TE/BE is moved again, the filter contact closes.

Current sensor (8.5) measures the harmonic current and sends the feedback to the control electronics.

The earth fault relay (89.6) is provided to detect an earth fault in the circuit. Two series of resistors (8.61/1, 8.62/1; 8.61/2, 8.62/2) are connected across the filter winding. Earth fault relay is connected in between the resistors 8.62/1 and 8.61/2, with its other terminal grounded. The principle of operation is the same as the DC link earth fault relay described in Chapter 4.1, Traction Converter.

The locomotive primary earth is connected to the main transformer via a junction at the filter cubicle. Axles 3, 4 and 6are a direct path to earth. Axle 1 is separated from earth by an earthing coil (11):- a resistor. Should axles 3, 4 and 6 become detached from the earthing circuit, the choke (11) limits the voltage through axle 1 to prevent excessive current damaging the tapered roller bearing. The earthing coil (11) is situated on the side of the filter cubicle.

Technical Data

@.1160

Filter Resistor

- Manufacturer	Sécheron
- Type	BW
- Weight	100 kg
- Height	375 mm
- Length	1,245 mm
- Width	915 mm
- Power dissipation (maximum)	20 kW

Contactor for Discharging Resistor (8.41)

- Manufacturer	Sécheron
- Type	HSm
- Weight	5.8 kg
- Rated current	50 Amp
- Rated voltage	3,000 Volt
- Power consumption	20 Watt

Contactor, Filter (8.1, 8.2)

- Manufacturer	Sécheron
- Type	BPS 30.06S
- Weight	20.5 kg
- Rated current	600 Amp
- Rated voltage	3,000 Volt
- Power consumption	8 - 14 Watt

Tolerances and Wear Limits List

@.1170

Contactor

- Permissible erosion on contacts 3 mm deep, no more than 15 mm high

Tools and Special Tools

@.1180

Conventional railway workshop tools are required for the procedures described in this chapter.

Miscellaneous Materials

@.1200

Miscellaneous materials required for the procedures described in this chapter include:

- Plastic plugs or alike to seal pneumatic unions against the ingress of dirt and foreign material.
- Sikalastomer 710 sealant.

Before-Removal Operations

@.1220

Lower the pantograph and isolate the overhead catenary. Earth the locomotive at the vacuum circuit breaker. Refer to the Preface of this Volume.

Earth the traction converter as described in Chapter 4.1, Traction Converter. Operation of the key interlocking system is described in the Preface of this Volume.

Steam clean the filter block and surrounding area, remove all traces of dirt, debris and build-up of grease. Refer to Steam Cleaning in the Preface of this Volume.

Filter Cubicle

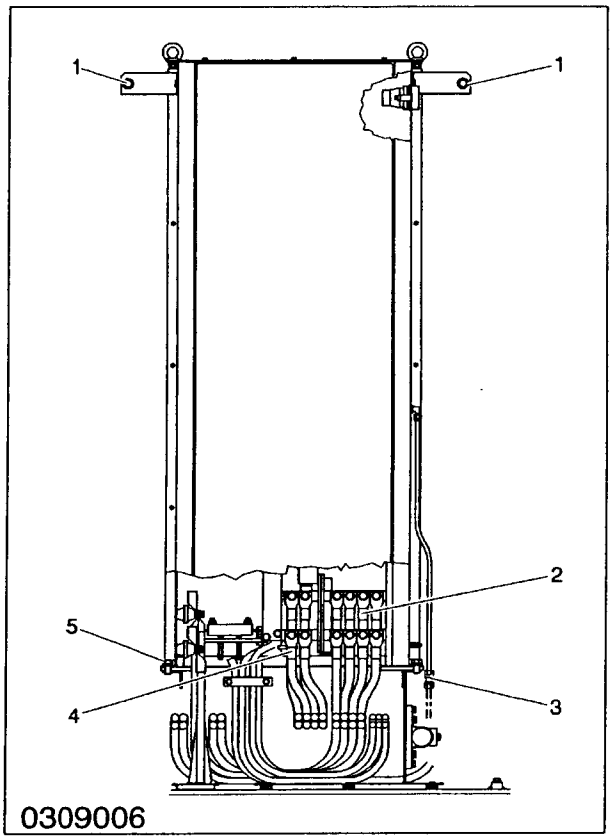
Unlock the FB cabinet (filter cubicle) using a green key. Operation of the key interlocking system is described in the Preface of this Volume.

When removing the filter cubicle as a unit from the machine room, remove the No. 1 End pantograph roof hatch as described in Chapter 1.1, Structure.

Removal

@.1230

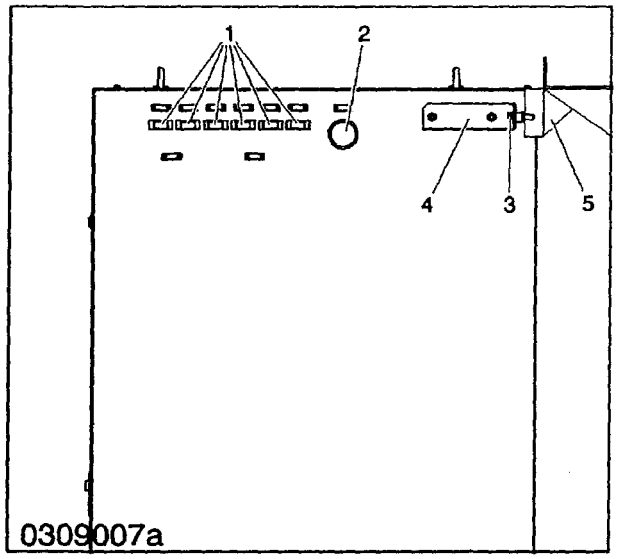
Filter Cubicle



Open the filter cabinet doors using a square key.

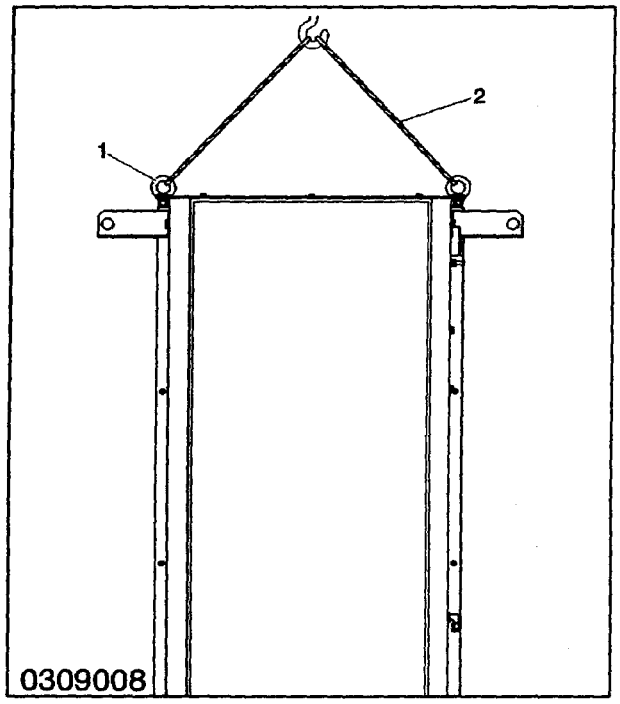
Disconnect the contactor pneumatic supply pipe at the union (3). Seal the pipes with suitable plastic plugs.

Tag and disconnect the electrical cables from the terminals (2, 4).



Tag and disconnect the seven electronic control cables from the sockets (1, 2) at the side of the cubicle.

Remove the bolts, spring and plain washers (3) securing angle brackets (4) at the top of the cabinet to the bracket on the machine room wall (5).

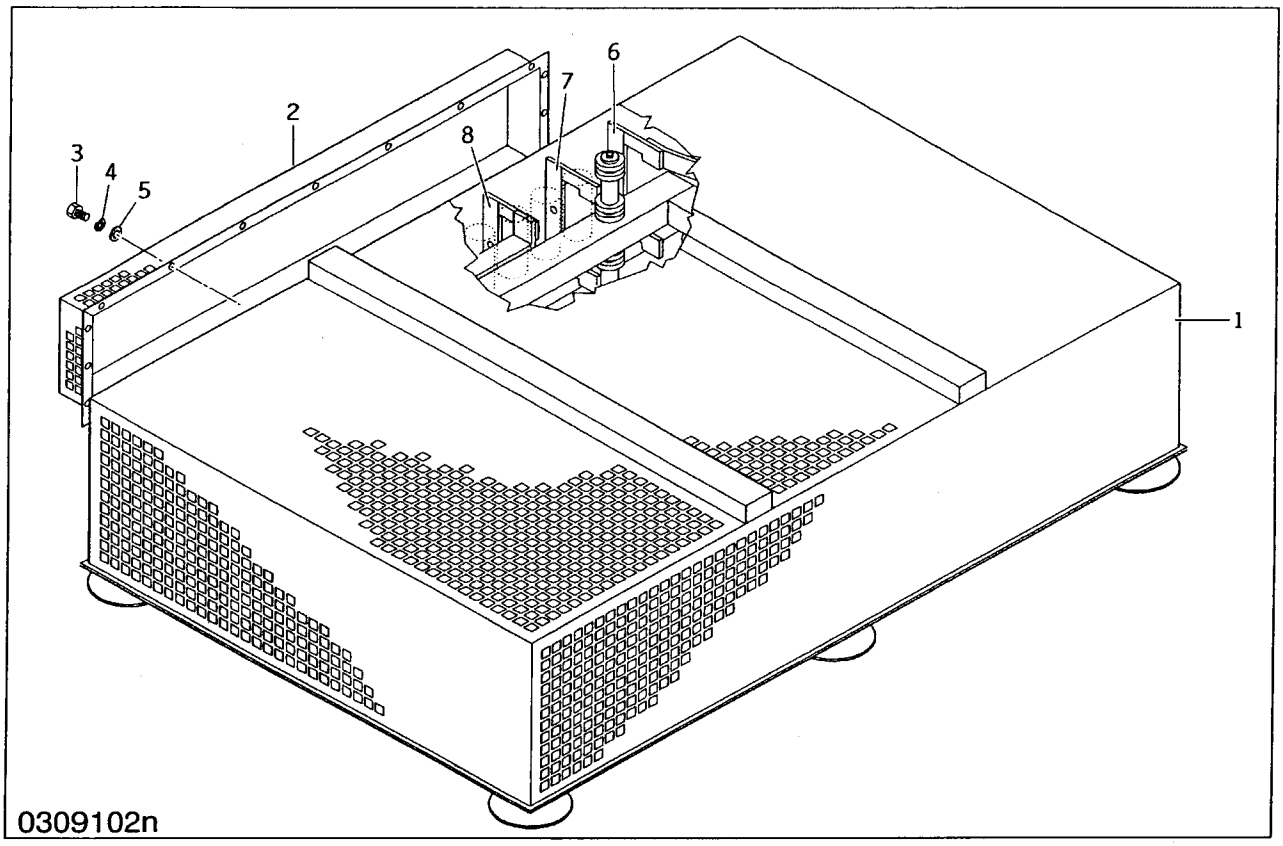


Attach suitable lifting equipment (2) to the eye hooks (1) on the top of the filter cubicle.

Remove the bolts and washers securing the filter cubicle flange to the machine room floor.

Slightly lift the cubicle and ensure that nothing is entangled, then carefully lift the filter cubicle from the machine room.

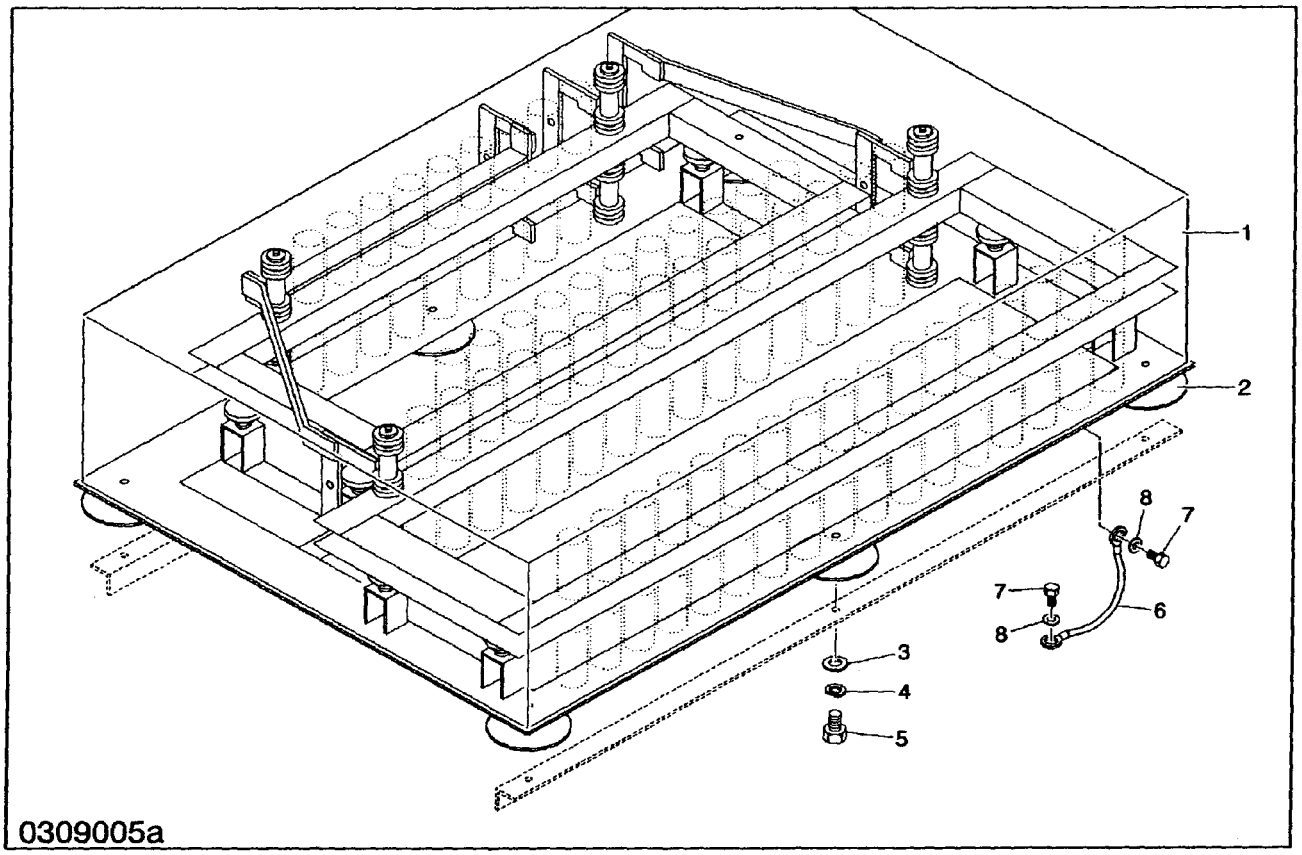
Filter Resistor



Remove the screws (3), spring and plain washers (5, 4) securing the protective cover (2) to the filter resistor (1). Remove the cover (2).

Tag and disconnect the cables from the terminals (6, 7, 8) on the filter resistor (1).

Secure the cables clear of the filter resistor (1).



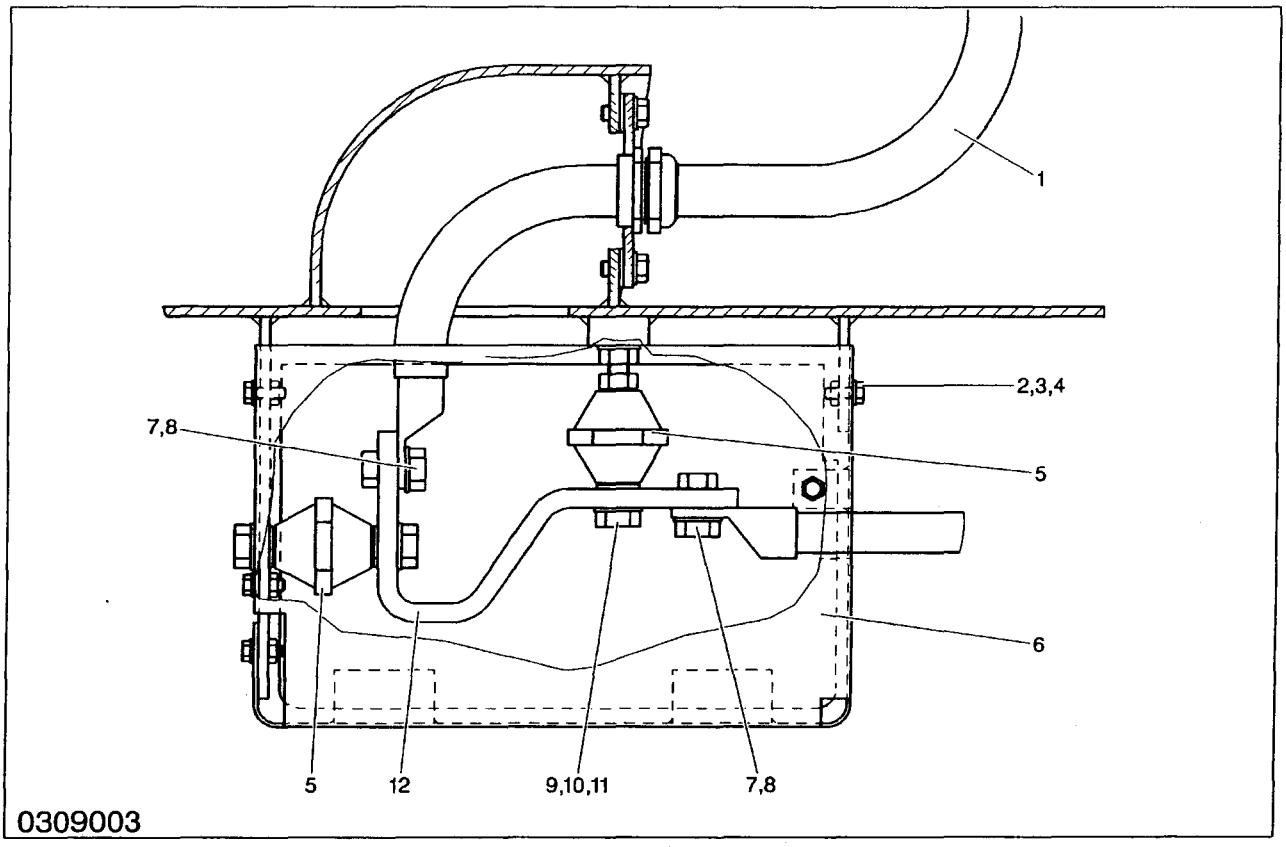
Remove the bolts (7) and spring washers (8) securing the earthing cable (6) to the filter resistor housing (1) and roof hatch.

Attach suitable lifting equipment to the filter resistor (1).

From beneath the angle bracket, remove the bolts (5), spring and plain washers (4, 3) securing the filter resistor (1).

Ensure nothing is entangled, then lift the filter resistor from the locomotive roof.

Junction Box



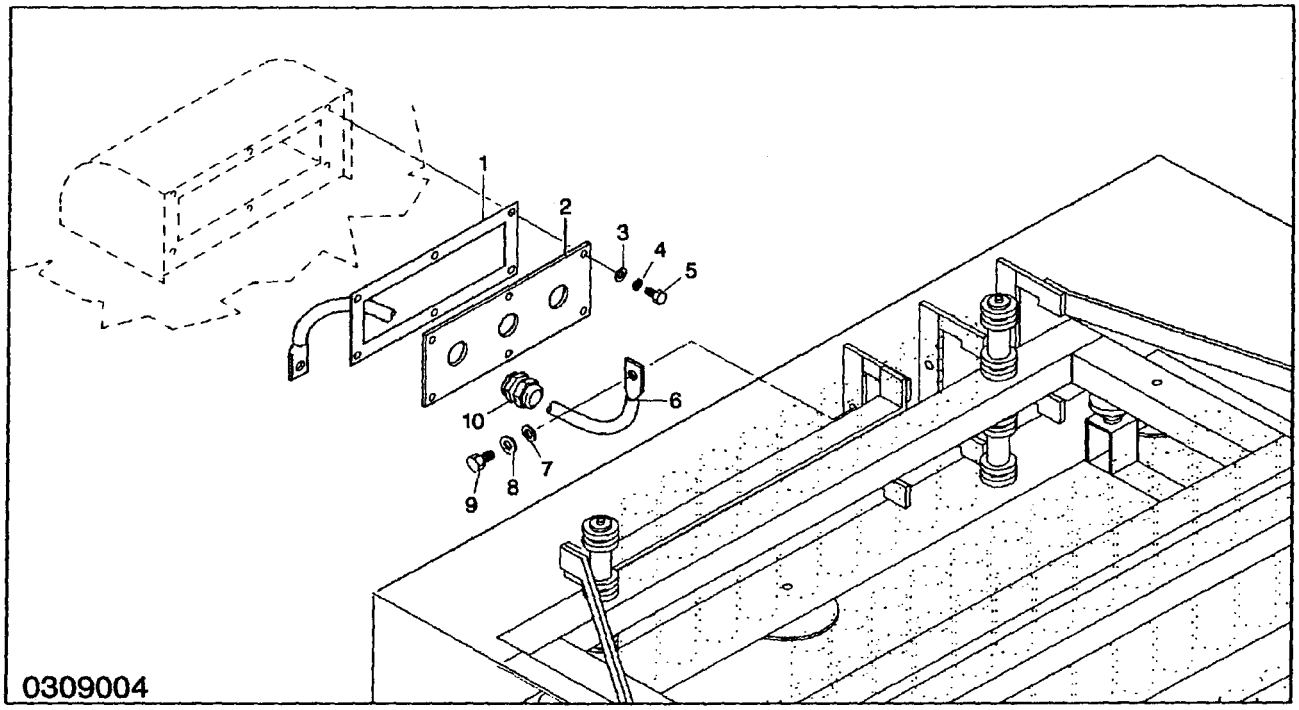
From within the machine room, remove the bolts (4), spring and plain washers (2, 3) securing the terminal housing cover (6).

Separate the cover (6) from the terminal housing.

Tag and disconnect the cables (1) from the terminal bars (12). Remove the bolts (8) and washers (7) securing the cables (1) to the terminal bars (12).

If necessary, remove the bolts and washers (7, 8) securing cable to the terminal bars (12).

If necessary, remove the bolts (11), spring and plain washers (9, 10) securing the terminal bars (12) to the insulators (5), then remove the terminal bars (12).

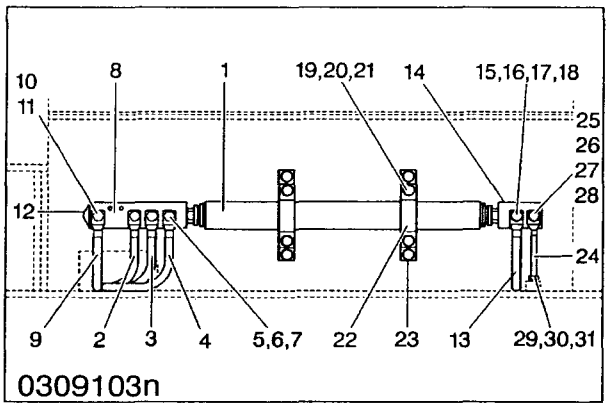


Loosen cable gland (10), then screw the gland (10) from the plate (2).

Remove the screws (9), washers (8, 7) and nuts, then disconnect the electrical cables (6) from the filter resistor terminals as described in Filter Resistor in this Section.

Remove the bolts (5), spring and plain washers (4, 3) securing the cover plate (2) to the roof junction box. Slide the cover plate (2) over the cables, then remove the gasket (1).

Earthing Coil (11)



From within the machine room, tag and disconnect the earthing cables (2, 3, 4) from the terminal bar (8). Remove the bolts (5), washers and nuts (6, 7) securing the cables to the terminal bar (8).

Tag and disconnect the earth cable (9) from the terminal bar (8). Remove the bolt (10), washer (11) securing the cable and terminal bar (8) to the insulator (12).

Tag and disconnect the earthing cable (13) from the bracket (14). Remove the bolts (15), spring and plain washers and nuts (16, 17, 18) securing the cable (13) to the bracket (14).

Tag and disconnect the locomotive earth cable (13) from the bracket (14). Remove the bolt (25), spring and plain washers and nut (26, 27, 28) securing the cable (25) to the bracket (14).

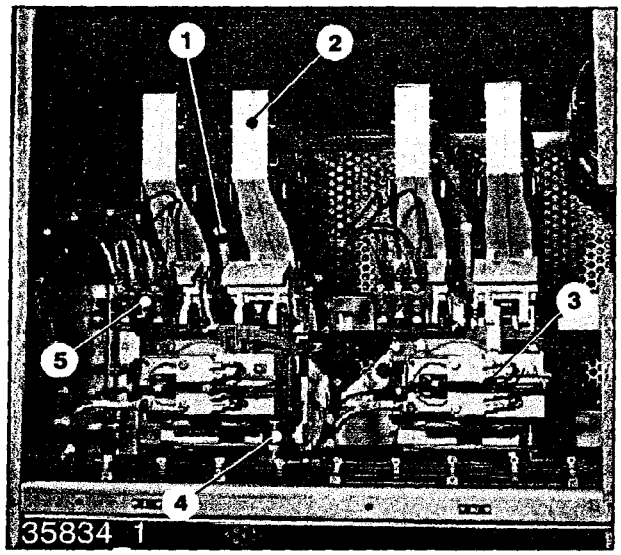
If necessary, disconnect the locomotive earth cable (24) from the filter cubicle earthing stud. Remove the bolt (29), spring and plain washers (30, 31) securing the cable (25) to the stud.

Support the earthing coil (1), then remove the bolts (19), spring and plain washers (20, 21) securing the coil brackets (22) to the holder (23). Remove the coil (1) from the cabinet.

Disassembly

@.1240

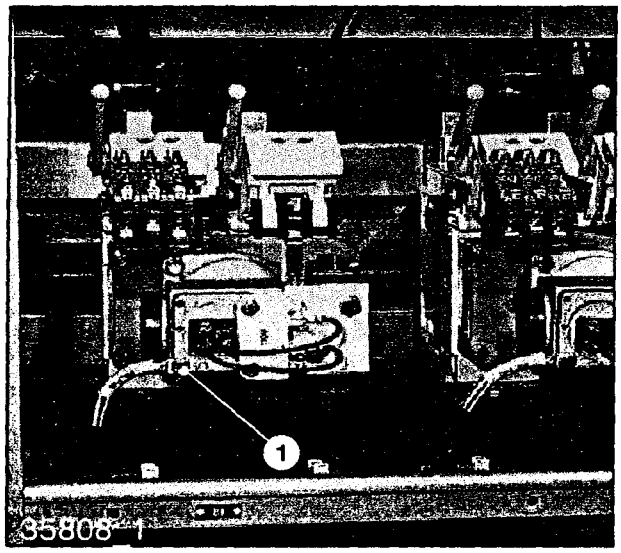
Contactor, Filter (8.1, 8.2)



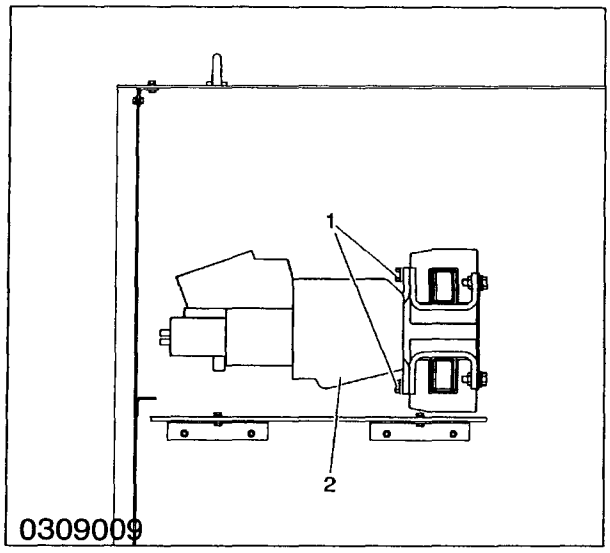
Push the lever (1) towards the back of the cubicle and simultaneously tilt the front of the arc chute (2), then lift the chute (2) from the socket.

Tag and disconnect the electrical cables (3, 5) from the terminals.

Tag and disconnect the pneumatic line (4) from the union on the valve housing.

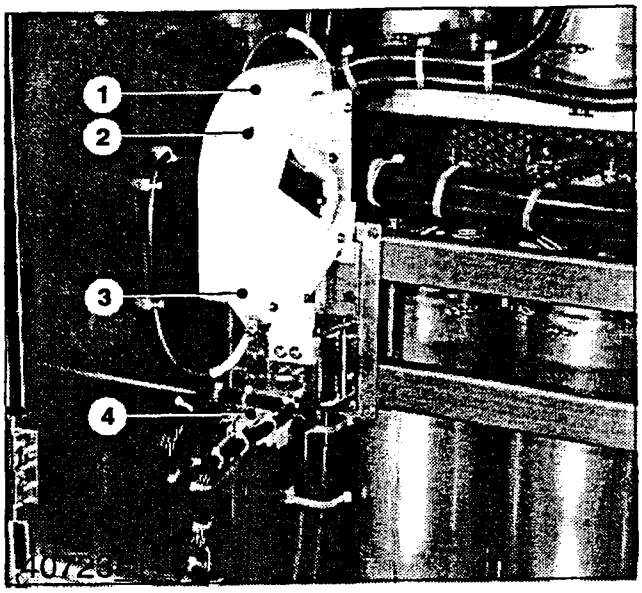


Tag and disconnect the earthing cable (1) from the valve housing.



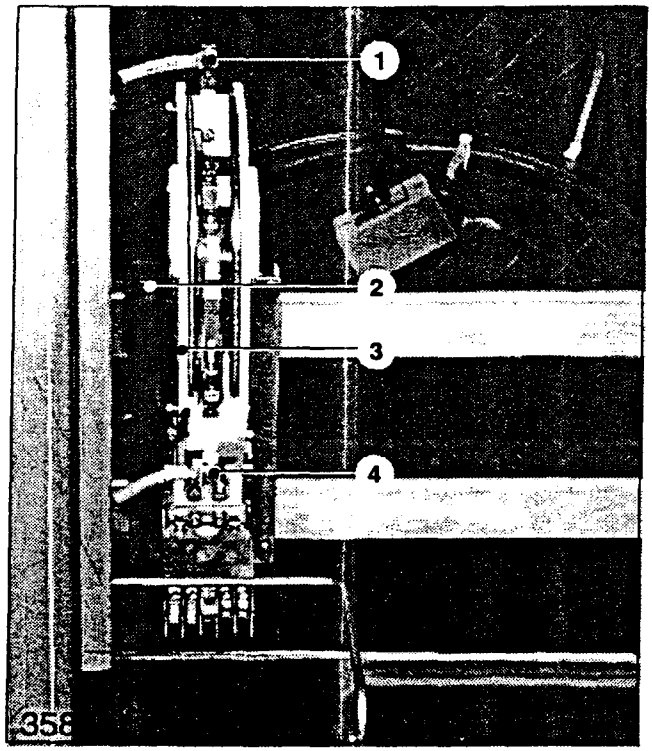
Remove the bolts (1), spring and plain washers securing the contactor (2), then remove the contactor.

Contactor for discharging resistor (8.41)



Loosen bolts (2,3). Lift arc chute (1).

Loosen electrical cable (4).

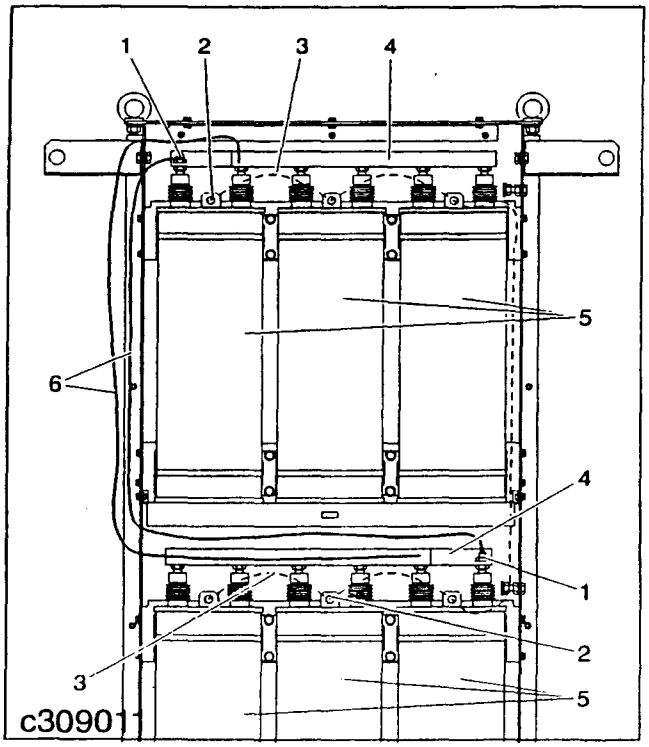


Loosen high voltage connections (1,4).

Loosen all 4 M6 bolts (2) and remove together with washers, spring washers and nuts.

Remove contactor (3).

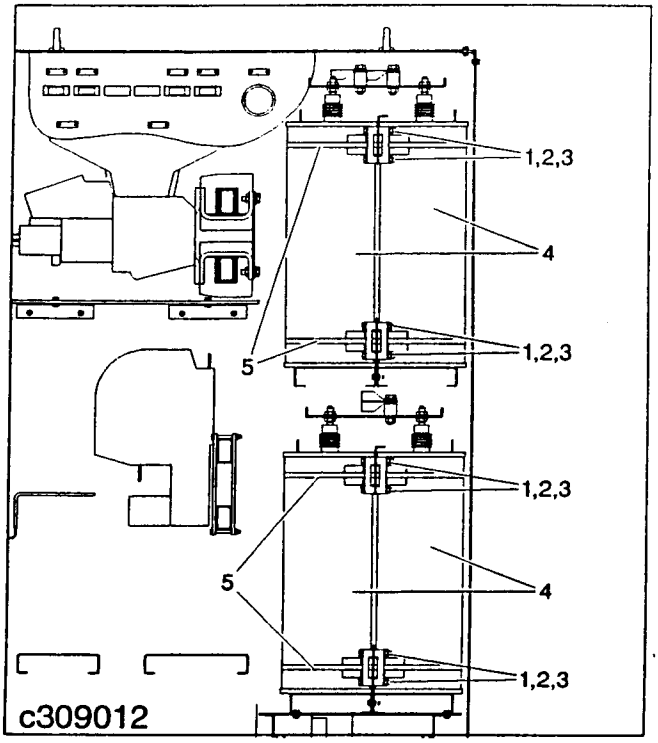
Capacitor bank (8.4)



Loosen M10 nuts (1) at the upper end of all capacitors (5) and remove together with serrated washers and spring washers.

Remove copper rails (4) together with cable (6).

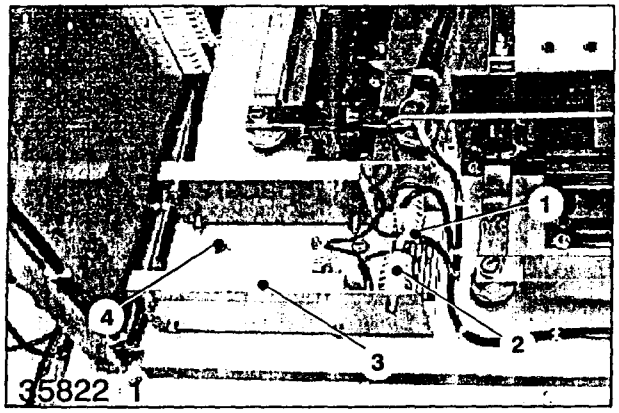
Loosen M10 bolts (2) and remove together with washers, spring washers and nuts. Remove earthing cable (3).



Loosen M6 bolts top and bottom (1) and remove together with the spring washers (2) and washers (3).

Remove tension clips (5). Remove capacitors (4).

Discharging Resistor, Capacitor Bank (8.42)

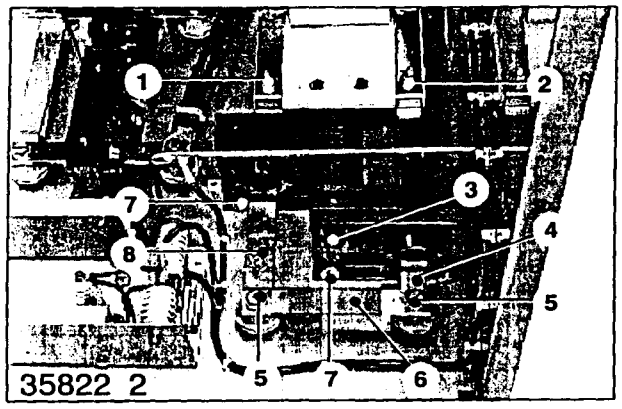


Tag and disconnect the electrical cable (1) from the terminal.

Remove the bolts (4), spring and plain washers securing the resistor bracket.

Remove the complete discharging resistor unit: - resistors (3) and insulator (2) assembly.

Primary Current Sensor (6.2)



Remove the primary current sensor surge arrester, electrical equipment apparatus number 6.21, as described in this Section.

Tag and disconnect the plug from the sensor (3).

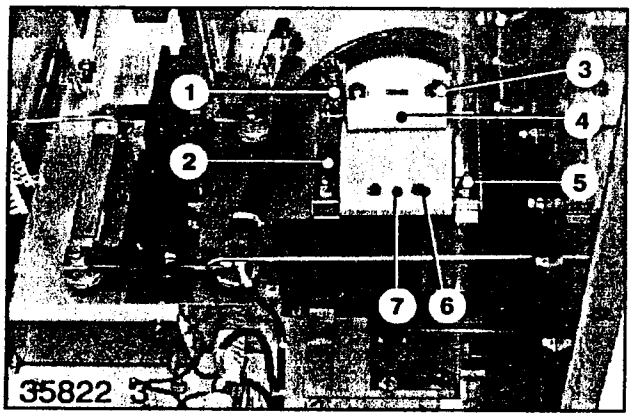
Remove the bolts (5), spring and plain washers securing the bus bar to the insulators.

Remove the copper rails (6).

Remove bolts (7), spring and plain washers securing the current sensors.

Remove current sensors and copper rails (4,8).

Surge Arrester, Primary Current Sensor (6.21)



Remove nuts (3) and washers securing the cover (4), then remove the cover (4).

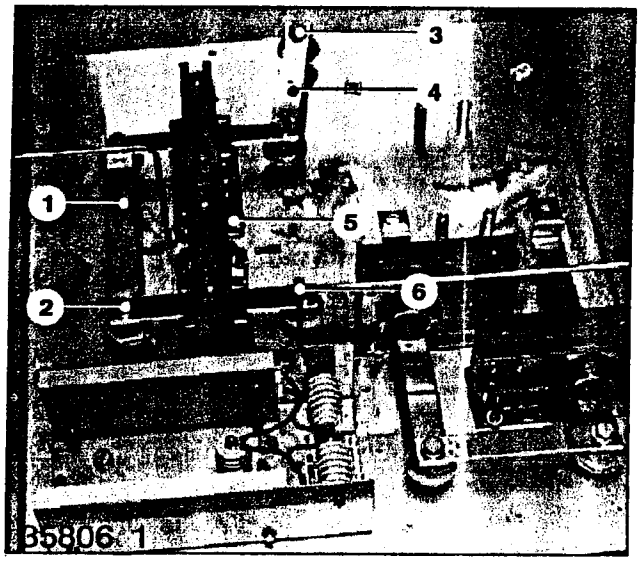
Remove bolts (1) and spring washers securing the terminals to the bus bar (2).

Remove nuts (5), spring and plain washers securing the bus bars (2).

Remove the nuts (6), spring and plain washers securing the base plate (7).

Remove surge arrester, base plate (7) and bus bars (2).

Current Sensor, Harmonic Filter (8.5)



Tag and disconnect the cables from the terminals (3, 6).

Remove the bolts (2), spring and plain washers securing the current sensor and bus bar (1) to the insulators.

Remove the bolts (5), spring and plain washers securing the current sensor.

Remove current sensor and bus bars (1, 4).

Inspection and Repair

@.1250

Inspect the condition of the contact points in all contactors. Ensure contactor wear and erosion does not exceed the maximum permissible level.

Waste Disposal

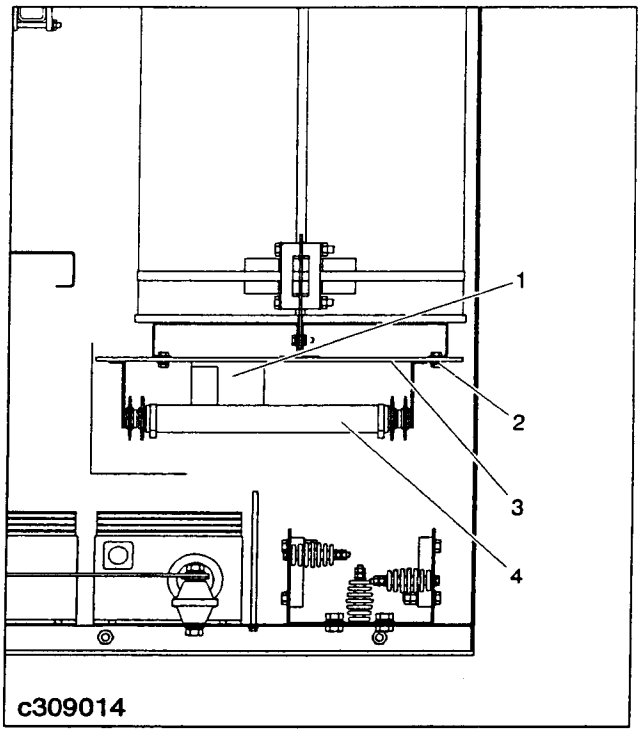
@.1260

Dispose of waste parts, materials and fluids according to the prevailing environmental standards or workplace practices.

Assembly

.1270

Earthing resistors, relay (8.61/8.62/89.6)

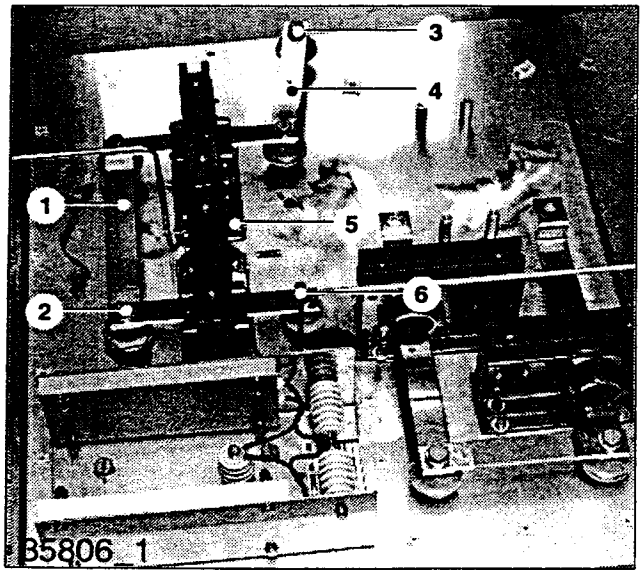


Push in cover (3) complete with relay (1) and resistors (4).

Screw in M6 bolts (2) together with washers and spring washers and tighten.

Fasten electrical cables.

Current sensor harmonic filter (8.5)



Mount units.

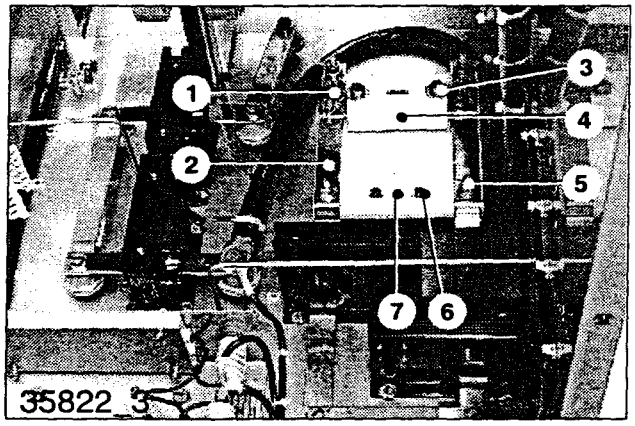
Mount copper rails (1,4).

Screw in M6 bolts (5) together with washers and spring washers and tighten.

Screw in M10 bolts (2) together with washers and spring washers and tighten.

Connect electrical cables (3,6).

Surge arrestor for primary current sensor (6.21)



Mount unit with base plate (7).

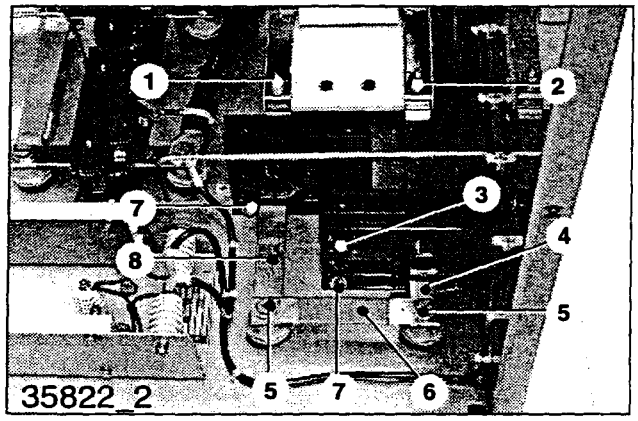
Screw in M6 bolts (5) together with washers and spring washers and tighten.

Screw in M10 bolts (1) with spring washers and tighten.

Replace cover (4).

Screw on M10 nuts (3) with washers and tighten.

Primary current sensor (6.2)



Mount both units together with the copper rails (4,8).

Screw in M6 bolts (7) together with washers and spring washers and tighten.

Screw in M10 bolts.

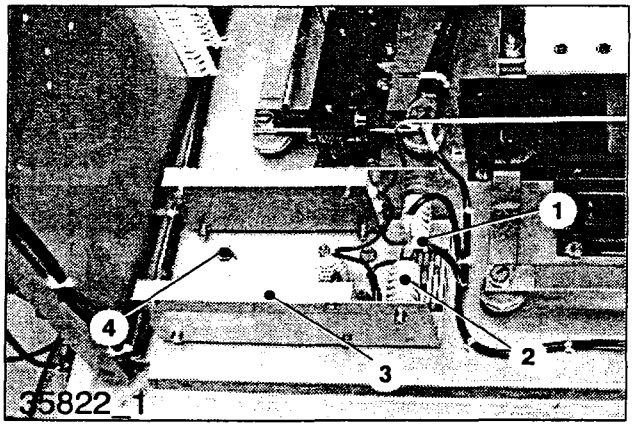
Screw on hexagonal nuts M10 (1,2) together with washers and spring washers and tighten.

Mount copper rail (6).

Screw in M10 bolts (5) together with spring washers and tighten.

Fasten cable with plug (3).

Discharging resistor for capacitor bank (8.42)

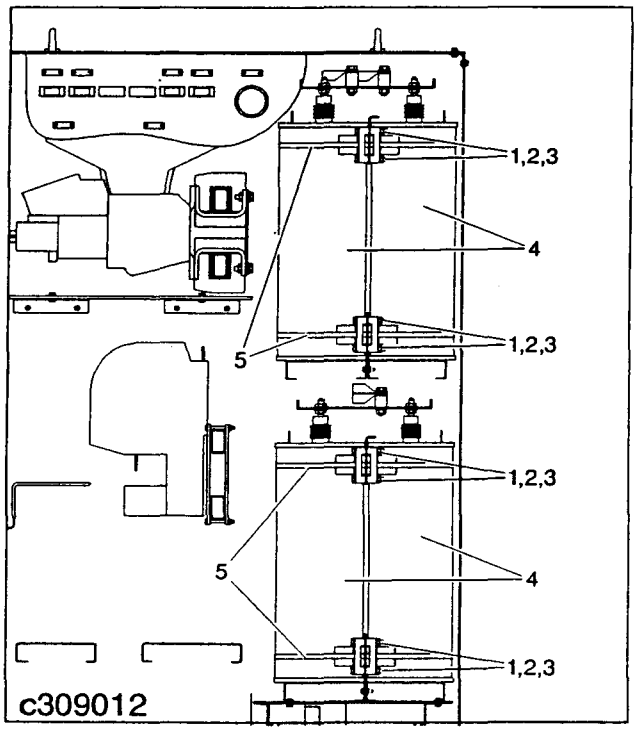


Mount complete unit with resistors (3) and insulators (1,2).

Screw in the four M10 hexagonal bolts (4) together with washers and spring washers and tighten.

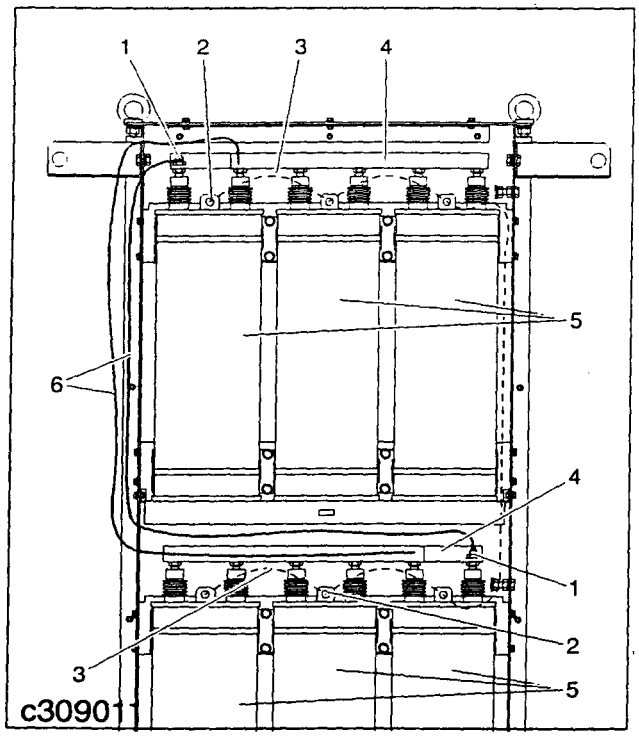
Fit electrical cable (1).

Capacitor bank (8.4)



Fit capacitors (4).

Fasten tension clips (5) with M6 bolts top and bottom (1), spring washers (2) and washers (3). Tighten bolts.

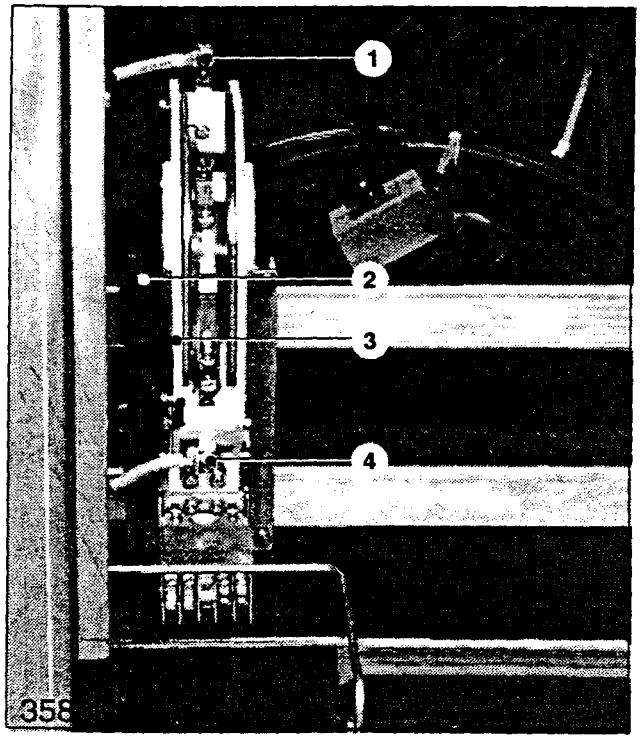


Connect earth cable (3) with M10 nut (2) and washer. Tighten nut (2).

Fit copper rails (4) with cable (6).

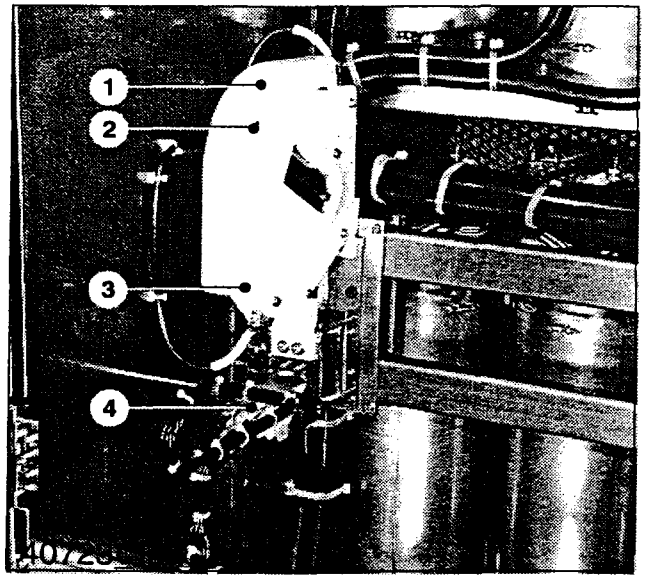
Fasten copper rails (4) at the top end of all capacitors (5) with M10 nuts (1), serrated washers and spring washers. Tighten nuts (1).

Contactor for discharging resistor (8.41)



Fit contactor (3) and fasten with 4 M6 bolts (2), washers, spring washers and nuts. Tighten bolts (2).

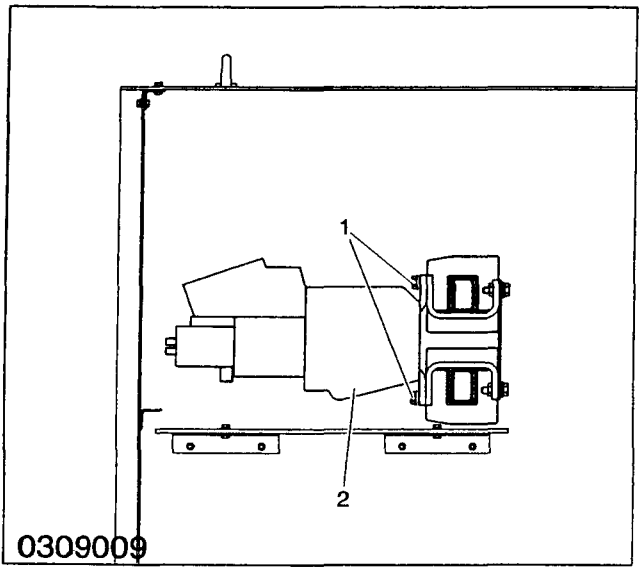
Make high voltage connections (1,4).



Fit arc chute (1). Fasten with bolts (2, 3).

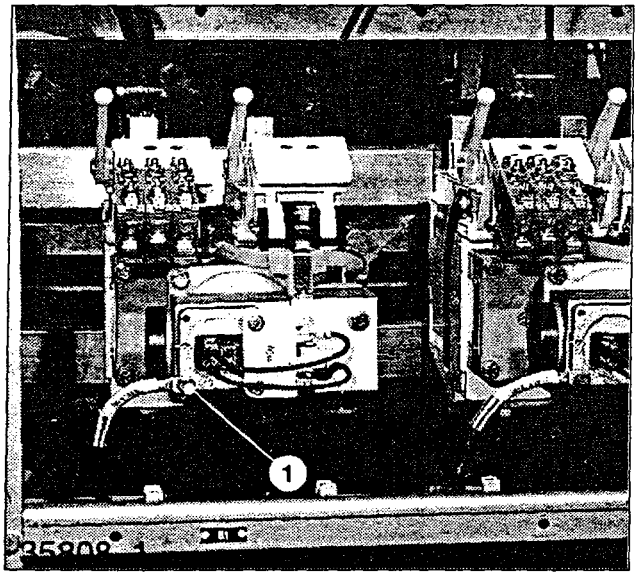
Connect electrical cable (4).

Contactor filter (8.1/8.2)

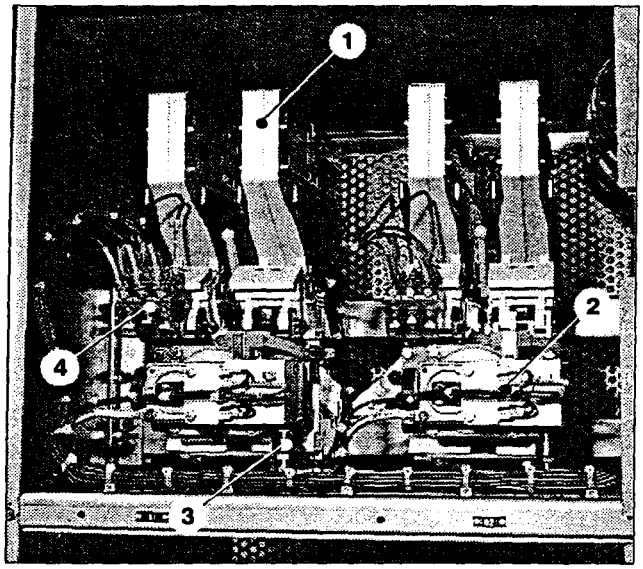


Fit both contactors (2).

Screw in bolts (1) together with washers and spring washers and tighten.



Connect the earthing cable (1).



Connect the air line (3) to the valve cylinder cover.

Fit the electric cables (2, 4).

Fitting the arc chute.

Fit the arc chute (1) from above, front slightly raised.

Press the front of the arc chute downwards until it locks into place.

After fitting the arc chute check by hand that it fits tightly.

NOTE:

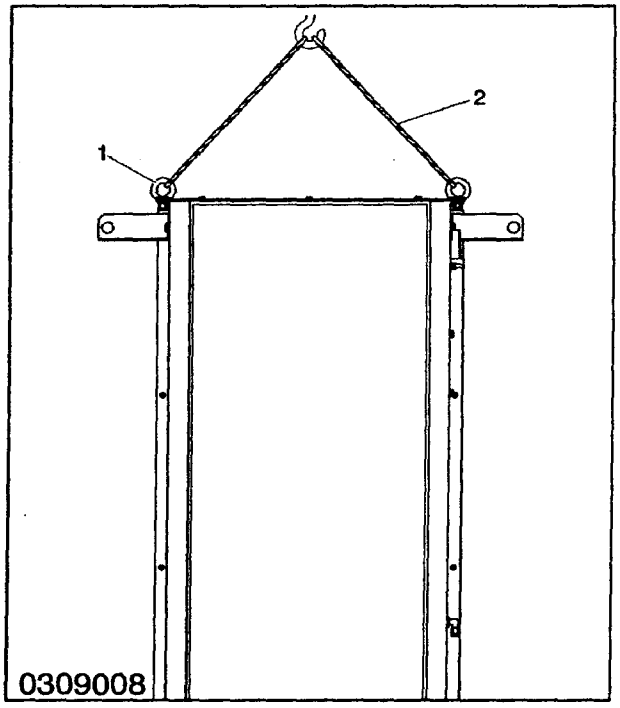
Repeat this procedure for the other contactor (8.2)

Empty Page

Installation

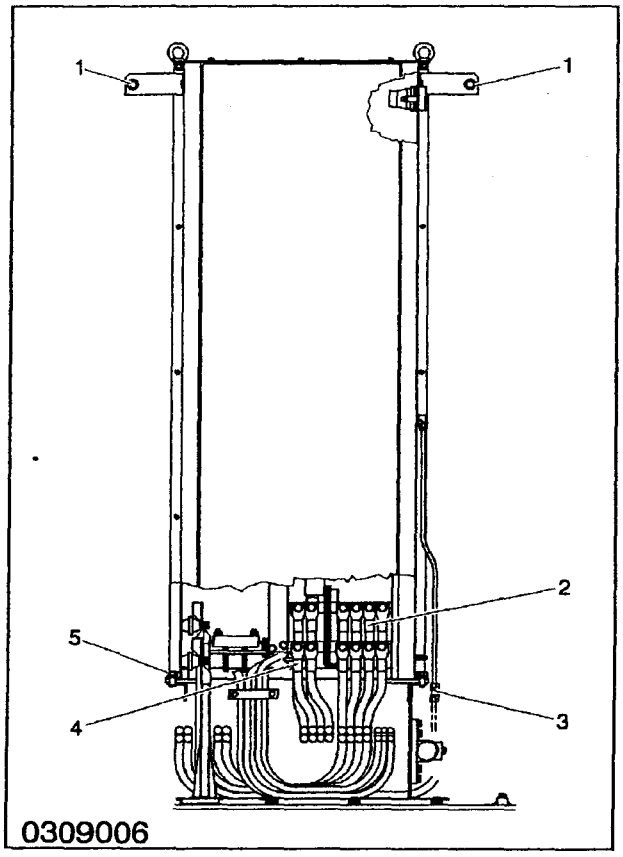
@.1280

Filter Cubicle



Attach suitable lifting equipment to the lifting eyes (1) on the filter cubicle.

Lift the filter cubicle and carefully position the cubicle into the machine room.

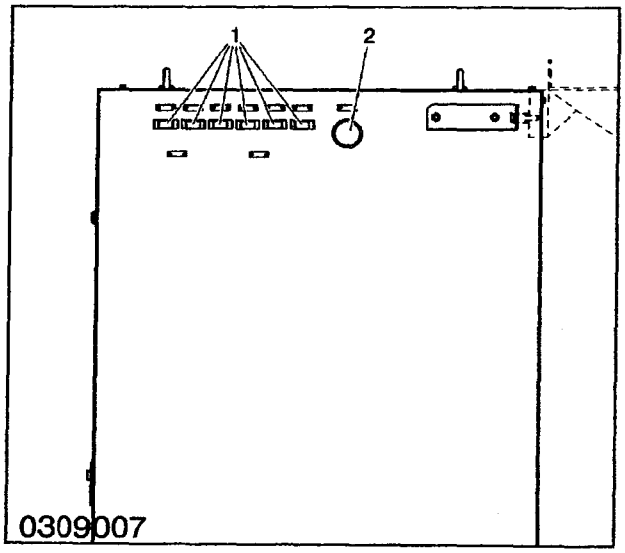


Install and tighten the bolts (5), with spring and plain washers to secure the cubicle to the pedestal.

Install and tighten the bolts (1), spring and plain washers securing the upper mounting brackets to the machine room wall.

Connect the pneumatic line (3) as tagged during disassembly.

Connect the electrical cables (2, 4) to the terminals as tagged during disassembly.

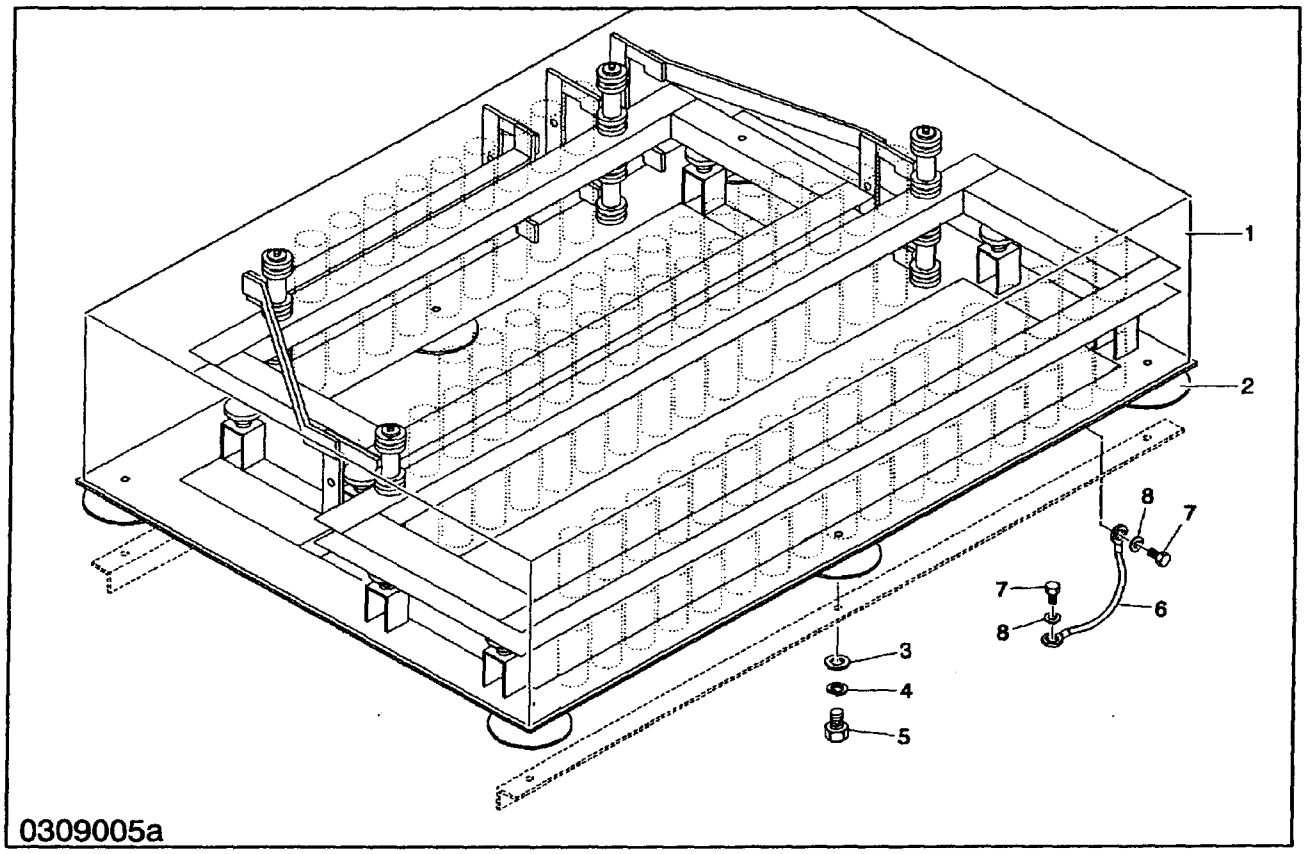


Connect plugs to the sockets (1) and (2) as tagged during disassembly.

Filter Resistor

NOTE:

Use three ropes of synthetic material and minimum diameter of 16 mm to lift the filter resistor.

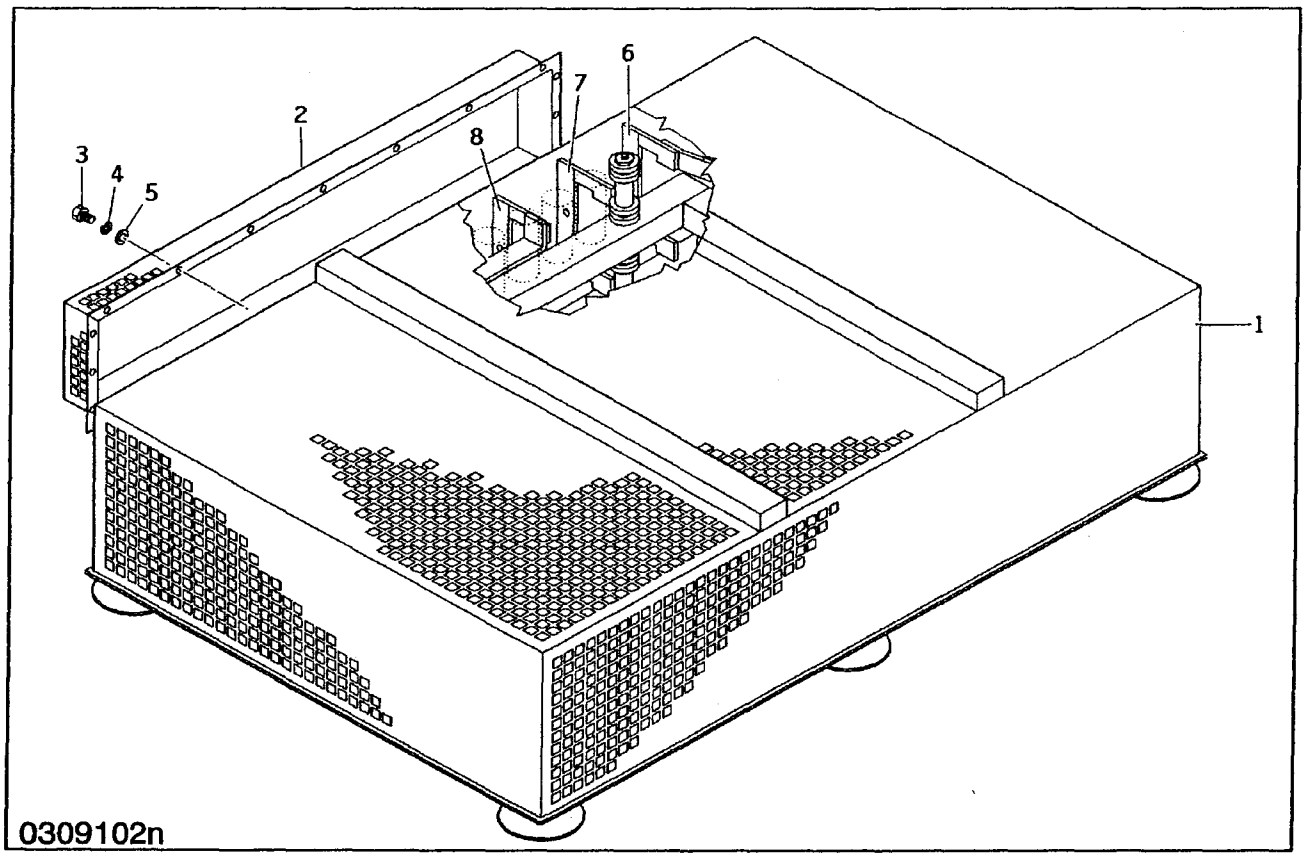


Attach suitable lifting equipment to the filter resistor.

Position the resistor (1) on the converter roof hatch. Ensure that the cable connections face towards the junction box on the roof.

From beneath the angle bracket, install the bolts (5), spring and plain washers (4, 3) to secure the filter resistor to the converter roof hatch. Tighten the bolts (5).

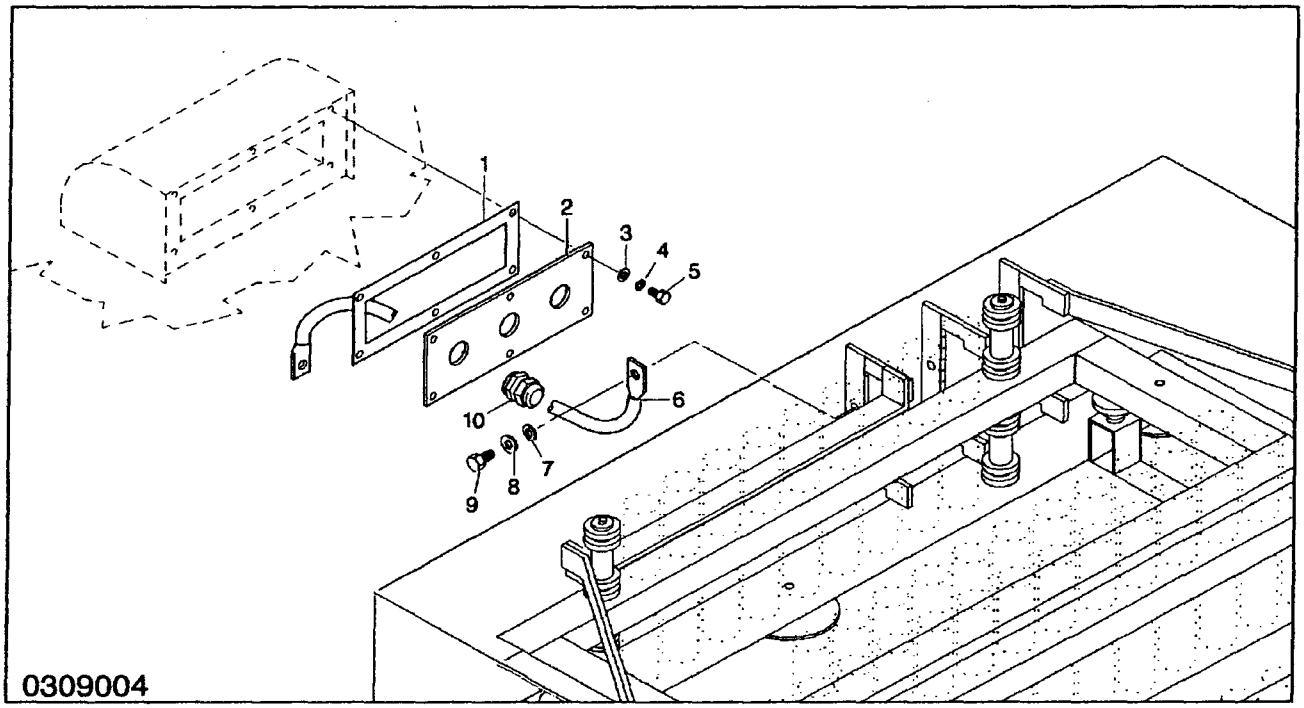
Install the earthing cable (6) between the filter resistor (1) and roof hatch. Install the bolts (7) and spring washers (8) securing the earthing cable (6), then tighten the bolts (7).



Connect the cables to the filter resistor terminals (6, 7, 8) as tagged during disassembly.

Position the protective cover (2) on the filter resistor (1), then install the screws (3), spring and plain washers (5, 4) to secure the cover (2). Tighten the screws (3).

Junction Box



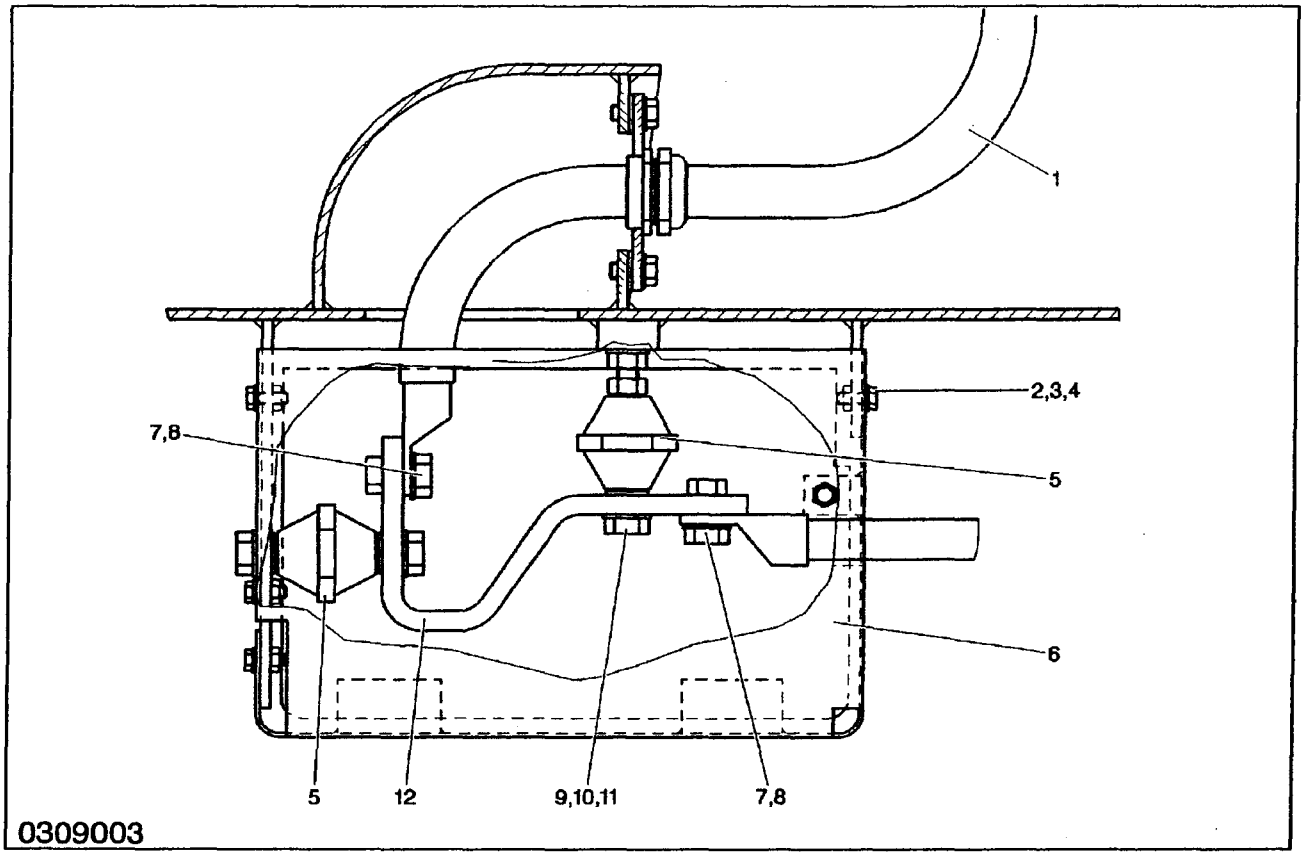
Apply a continuous 7 mm diameter bead of Sikalastomer 710 to both sides of the gasket (1). Ensure all surfaces have been correctly prepared prior to application of the sealant, as described in the Preface of this Volume.

Place the cable gland (10), cover plate (2) and gasket (1) over the cables (6).

If necessary, connect the electrical cables (6) to the filter resistor terminals as described in Filter Resistor in this Section. Install the screws (9), washers (8, 7) and nuts, then tighten the nuts (7).

Secure the cover plate (2) to the roof junction box with bolts (5), spring and plain washers (4, 3).

Screw the gland (10) into the plate (2), then tighten the cable gland (10).



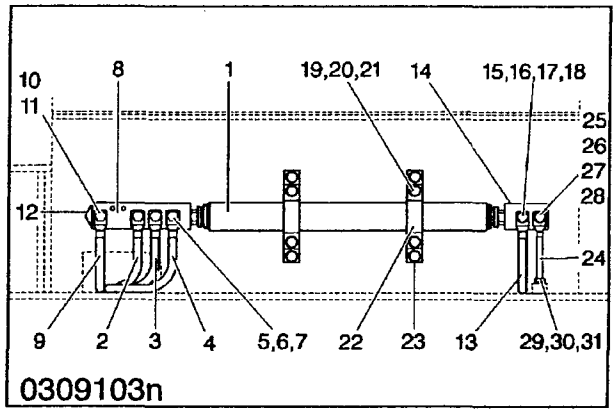
If necessary, install the terminal bars, then install the bolts and washers and secure the terminal bars to the insulators.

Install the connecting angles and secure with bolts (9), spring washers (10) and washers (11).

Install the cover (6) to the terminal housing.

Install the bolts (4), spring and plain washers (2, 3) to the terminal housing cover (6).

Earthing Coil (11)



Install the earthing coil (1) into the cabinet. Support the coil (1), then install the bolts (19), spring and plain washers (20, 21) securing the coil brackets (22) to the holder (23).

Connect the earth cable (9) to the terminal bar (8) as tagged during disassembly. Install the bolt (10), washer (11) to secure the cable and terminal bar (8) to the insulator (12). Tighten the bolt (10).

Connect the earthing cables (2, 3, 4) to the terminal bar (8) as tagged during disassembly. Install the bolts (5), washers and nuts (6, 7) to secure the cables to the terminal bar (8). Tighten the nuts (7).

Connect the earthing cable (13) to the bracket (14) as tagged during disassembly. Install the bolts (15), spring and plain washers and nuts (16, 17, 18) to secure the cable (13) to the bracket (14). Tighten the nuts (18).

Connect the locomotive earth cable (13) to the bracket (14) as tagged during disassembly. Install the bolt (25), spring and plain washers and nut (26, 27, 28) to secure the cable (25) to the bracket (14). Tighten the nut (28).

If necessary, connect the locomotive earth cable (24) to the filter cubicle earthing stud as tagged during disassembly. Install the bolt (29), spring and plain washers (30, 31) securing the cable (25) to the stud. Tighten the bolt (29).

Refer to Section Main Power Circuit, Sheet 01A, Primary Current of Volume G1, Cabling Documentation for earthing coil electrical connections.

After-Installations Operations

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Reinstall the converter roof hatch, as described in Chapter 1.1, Structure.

Conduct a water test around the junction box and check for leakage. Refer to Water Test in the Preface of this Volume. Rectify any faults found.