

SHOP MANUAL



GUIDANCE FOR REUSABLE PARTS

RUBBER HYDRAULIC HOSES



GUIDANCE FOR REUSABLE PARTS
KOMATSU

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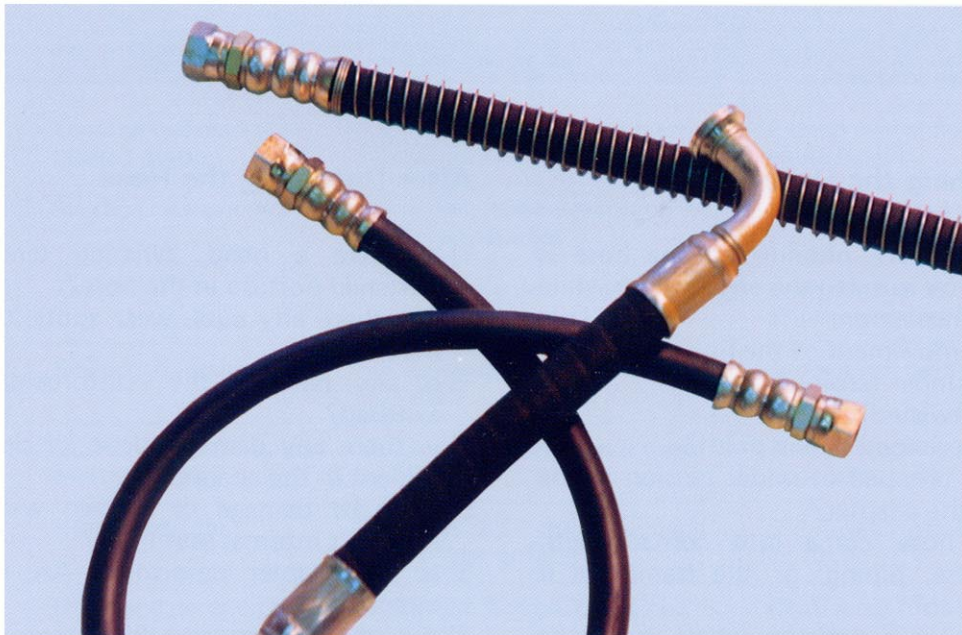
INTRODUCTION

This Guidance for Reusable Parts shows through illustrations how to decide whether or not to reuse the rubber hydraulic hoses in construction machines at the time of disassembly, repair, and reassembly. It also gives general information and describes the causes of defects in rubber hydraulic hoses.

Nowadays higher and higher pressures are being used in the hydraulic systems of construction machines. Therefore, a fault in the rubber hydraulic hoses which transmit this pressure between the various components will result in a lot more trouble than the mere loss of hydraulic fluid. The resultant loss of pressure will lead to a much lower operating ratio and—what is far worse—can even lead to serious accidents.

This manual is designed for everyone involved in fault diagnosis and repairs. It has two main aims:

- (1) to provide the mechanic with the technical means to accurately determine whether a hose can be reused—thus cutting down on the cost of repairs—or whether it must be replaced, and
- (2) to help him rapidly and accurately pinpoint the cause of the fault—knowledge which is essential to take the appropriate measures to prevent recurrence of the same problem.



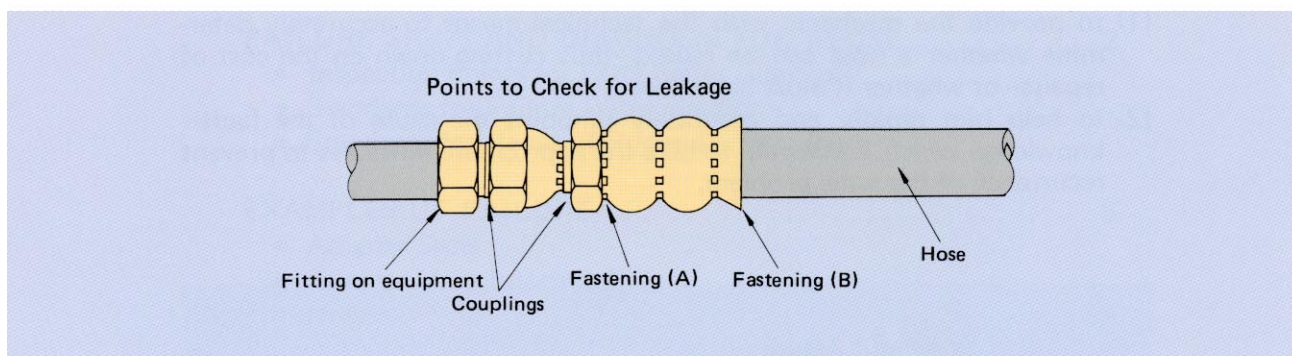
Note: This publication is intended for guidance only and KOMATSU LTD. hereby expressly denies and excludes any representation, warranty or implied warranty for the reuse of rubber hydraulic hoses.

FAILURE SIGNS AND DIAGNOSIS FOR REUSE

One important criterion in determining whether or not a part can be safely reused is, of course, the degree of damage. However, due consideration must also be given to the location of the damage and the risk which it poses to the machine as a whole. To make correct judgements, the machine must be given regularly scheduled maintenance, careful consideration must be given to the operating conditions to reveal why such faults occur, and the mechanic should have plenty of experience in order to relate actual phenomena to the photographs appearing in this manual.

Inspection Points for Parts Reuse Diagnosis

The first step in accurately judging whether or not to reuse a rubber hydraulic hose is to determine both the location and the extent of leakage. Pay special attention to the points in the accompanying diagram.



Before Detaching the Hose

Notes:

- * Better results are obtained if the hose is pressurized by running the engine for a while before the inspection.
- * Also check movement of the links.
 - 1) Is the hose under tension?
 - 2) Is the hose twisted?
 - 3) Is the hose crimped at any point?
 - 4) Is the hose crimped or under tension in the vicinity of the adapter?
 - 5) Does the hose come into contact with another hose, piping, or the frame? Is it likely to do so?
 - 6) Is the hose in a position where it can be constricted or compressed?
 - 7) Is the hose or adapter subject to external forces?
 - 8) Does the machine operate normally?
 - 9) Is the hydraulic fluid at a suitable temperature?
 - 10) Is the line pressure normal?

After Detaching the Hose

- 1) Is there a bend, twisting tendency, or flattened portion in the hose?
- 2) Are there any cuts, wear spots, or dents in the hose?
- 3) Is any part of the reinforcement layers exposed?
- 4) Is there any damage, dent, or deformation evident in the adapter?
- 5) Is there damage or uneven wear on the adapter's internal seat faces?
- 6) Is the adapter deformed? Are its threads intact?
- 7) Are the O-rings and their grooves free of damage?
- 8) Is any dirt or other foreign matter wedged into the mating parts?

Standards for Failure Determination

The standards for reuse for most parts are divided into three ranks (Use Again, Use After Reconditioning, Do Not Use Again). However, there are only two ranks for high-pressure rubber hydraulic hoses.

Rank	Failure Degree
Use again	Damage is not extensive enough to pose a risk of contributing to the malfunctioning of the related hydraulic equipment and devices.
Do not use again	Damage is so great that it prevents the proper functioning of the related hydraulic equipment and devices. If used, it would pose a risk of a major failure.

Standards for Reuse of Hydraulic Hose Parts

The following chart lists the basic standards which are used to determine whether or not hydraulic hose parts may be reused.

Part Name	Type of Failure	Failure Degree		
		Use again	Do not use again	
Adapter	Screw-in types	Longitudinal marks on tapered portion	Confined to an extremely limited area	Extend over almost the entire length
		Scuffing on taper faces	Small, shallow marks on circumference	Large, deep marks
		Taper fit	Slight dents or slightly elliptical contact mark	Deep dents or excessively elliptical contact mark
		Embedded foreign matter	Localized, shallow depressions	Widespread, deep depressions
		Nut deterioration due to overtightening	No deformation; nut turns readily	Bent self-locking portion impedes turning
		Rust on adapter	Only slight corrosion, none on seat surfaces	Significant rusting and corrosion
	Flanged types	Marks and dents on outer edge of O-ring groove	Slight damage, not joined	Continuous damage
		Crushing or deformation on rear surface of flange	None evident	In evidence
		Rust on adapter	Only slight corrosion; none on flange surfaces	Significant rusting and corrosion

Part Name	Type of Failure	Failure Degree	
		Use again	Do not use again
Adapter-hose interface	Separation of rubber cover near fastenings	Light separation due to wear	Reinforcing wire exposed (even for slight separation)
	Hose crushed near fastening		Crushing visible to the naked eye
	Hose bent near fastening		Obvious bending
	Seeping of hydraulic fluid at fastening	Operation produces no further seeping	Seeping continues
Hose	Damage to rubber cover	Slight damage; reinforcing wire not exposed	Reinforcing wire exposed
	Wear to rubber cover	Limited to light wear due to interference	Reinforcing wire exposed
	Cracking in rubber cover	Short, shallow cracks at intervals, but rubber still soft	Widespread cracking; rubber hardened
	Swelling in rubber cover	No signs of spreading and no seepage	Seepage of hydraulic fluid
	Hose crushed		Crushing visible to the naked eye
	Hose bent		Bend visible to the naked eye
	Hardening of the rubber		Hardening in evidence (that is, hose offers excessive resistance to bending)
	Damage to plastic cover	Does not extend to the hose itself	Rubber cover also damaged
	Protective springs crushed or deformed	Causes no wear or deformation to hose	Rubber cover damaged or hose or hose crushed

EXAMPLES OF FAILURES

Adapter Seals

1



DO NOT USE AGAIN

Failure Sign

- Crushing or deformation on rear surface of flange.

Cause

- Faulty alignment during installation has produced uneven tightening.

2



DO NOT USE AGAIN

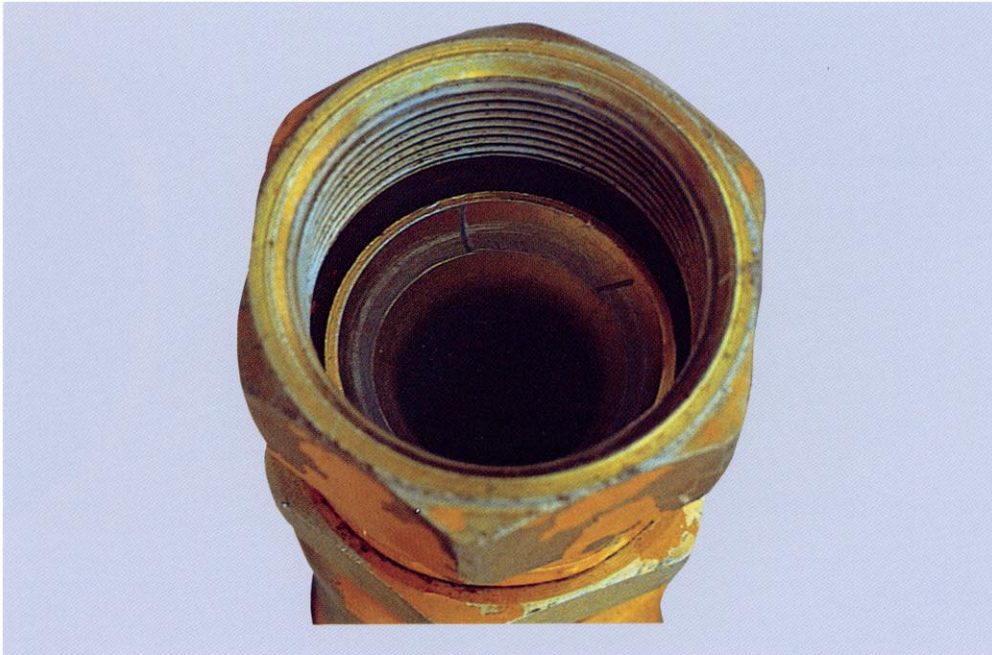
Failure Sign

- Split flange crushed.

Cause

- Faulty alignment during installation has produced uneven tightening. Note that the O-ring has also been damaged so must be replaced.

3



DO NOT USE AGAIN

(Unless longitudinal marks are confined to an extremely limited area)

Failure Sign

- Longitudinal marks extend over almost the entire length.

Cause

- Foreign matter wedged inside.

4



USE AGAIN

(but remove foreign matter)

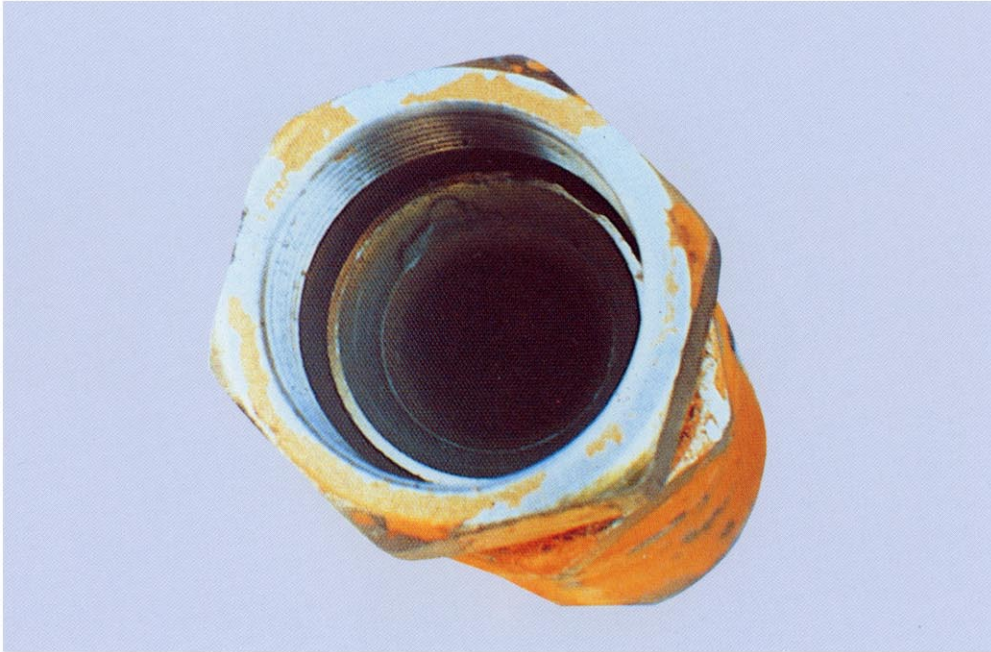
Failure Sign

- Foreign matter adhering to seat surfaces, contact of the seat is not strong enough.
- Foreign matter wedged inside.

Note:

If there is leakage from an adapter seal, disconnect the hose, wipe all hydraulic fluid off the male and female mating parts and the seat, and reconnect the hose with the specified tightening torque. Except in extreme cases (large or deep marks), this procedure should stop the leakage.

5



DO NOT USE AGAIN

(unless the damage is confined to an extremely limited area of the seat)

Failure Sign

- Sludge and scratch marks on seat surface.

Cause

- Abrasion by foreign matter.

6



DO NOT USE AGAIN

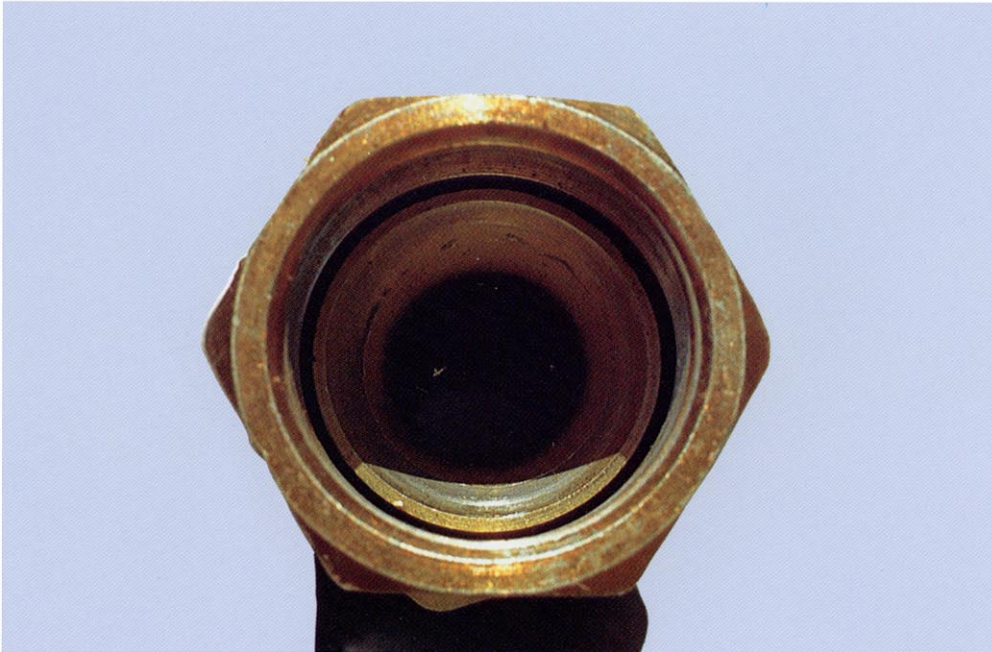
Failure Sign

- Large, deep scuffing marks around the circumference of the tip near the seat surface.

Cause

- Abnormalities in the shape (for example, dents) of the matching nipple.

7



USE AGAIN

Failure Sign

- Slight scuffing marks around the circumference of the tip near the seat surface.

Cause

- Abnormalities in the shape (for example, dents or flash) or the matching nipple.

8



USE AGAIN

(but remove all rust from mating parts)

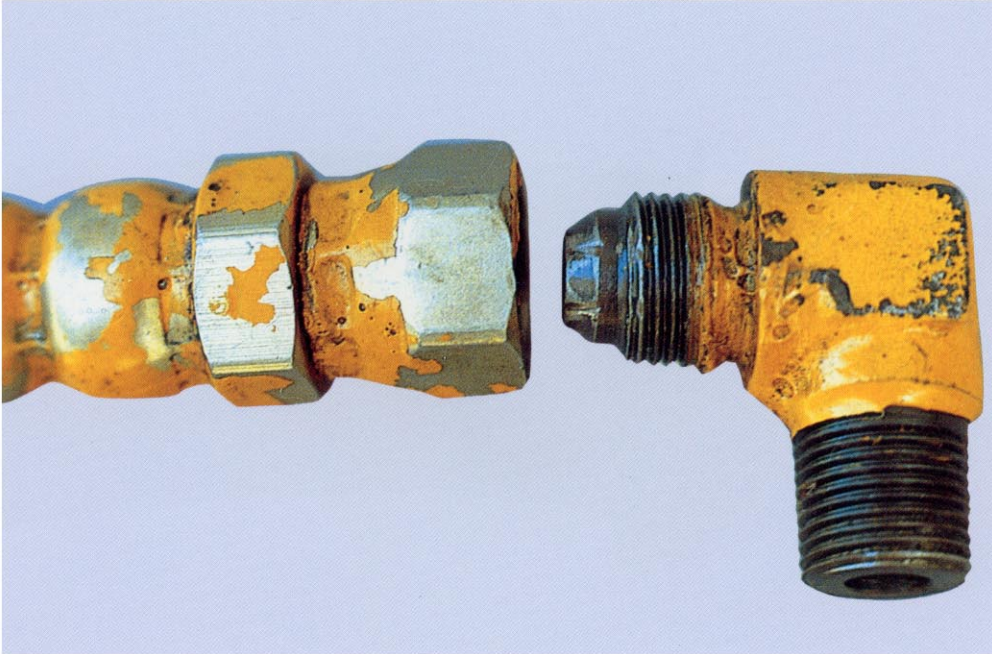
Failure Sign

- Lots of rust on the contact surfaces, but only slight contact marks.

Cause

- Abnormality on the matching nipple (rust).

9



Reference:

Example of dents on matching nipple and seat surface.

10



USE AGAIN

Failure Sign

- Slight elliptical contact mark.

Cause

- Installation off-center.

Adapter-Hose Interface

11



DO NOT USE AGAIN

Failure Sign

- Collapsed hose or damaged rubber cover near fastening.

Cause

- Hose bent near fastening.

12



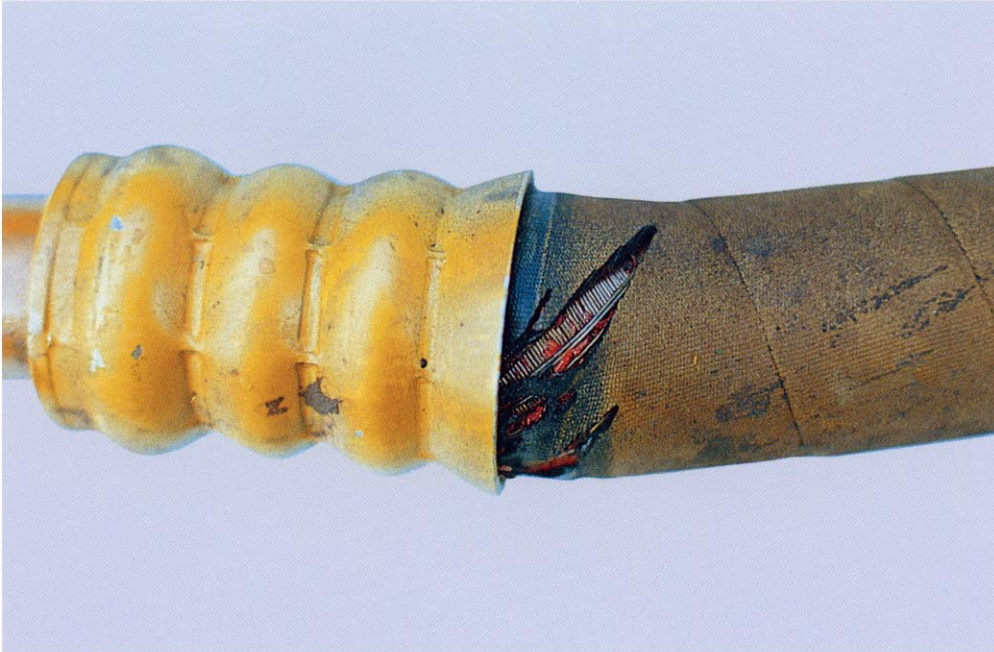
Reference:

Disassembled view.

Note:

A crushed hose will, to a certain extent, revert to its original form so as not to be visible to the naked eye. Measure the diameter with calipers at several points around the circumference.

13



DO NOT USE AGAIN

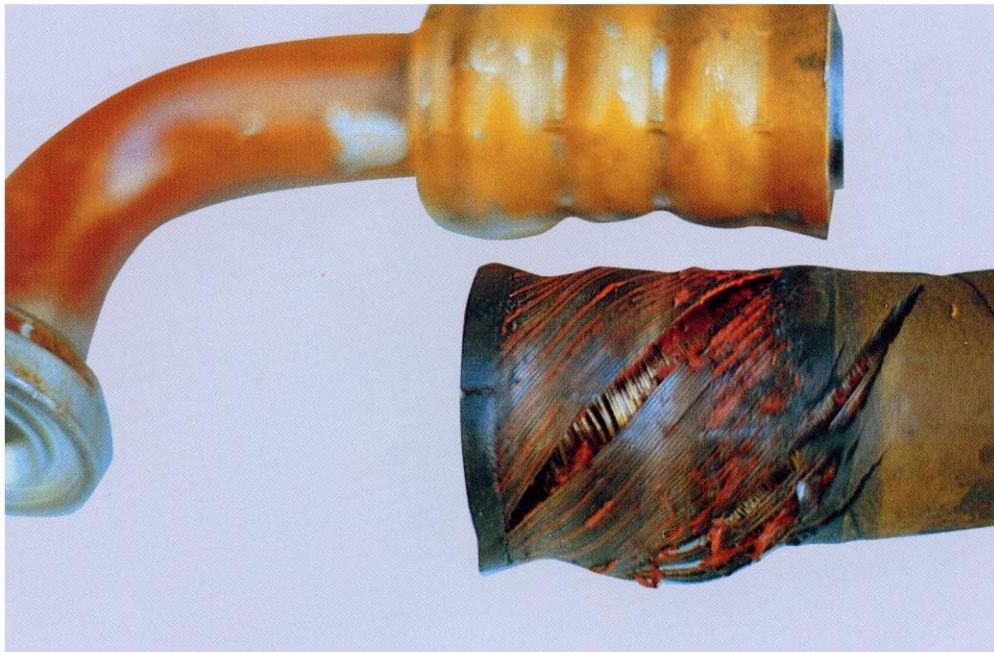
Failure Sign

- The adapter is bent at the tip so it is beginning to slip off.

Cause

- Hose was installed in twisted condition; sudden sharp increase in pressure while a wire rope is being used has produced crumpling.

14



Reference:

Disassembled view.

15

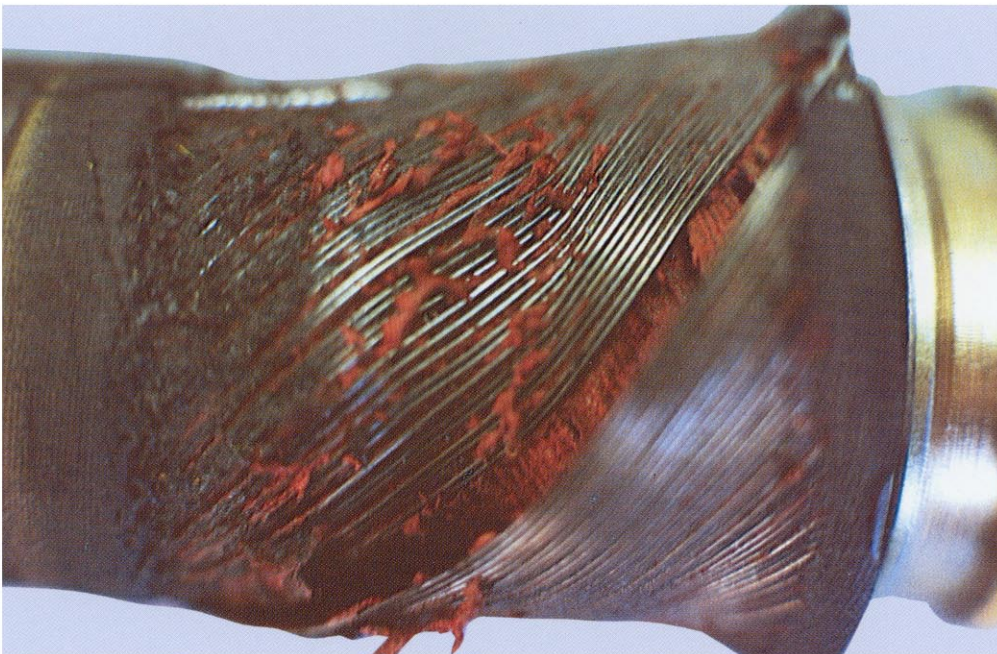


DO NOT USE AGAIN

Failure Sign

- The adapter is slightly bent at the junction with the hose and the rubber cover is broken.

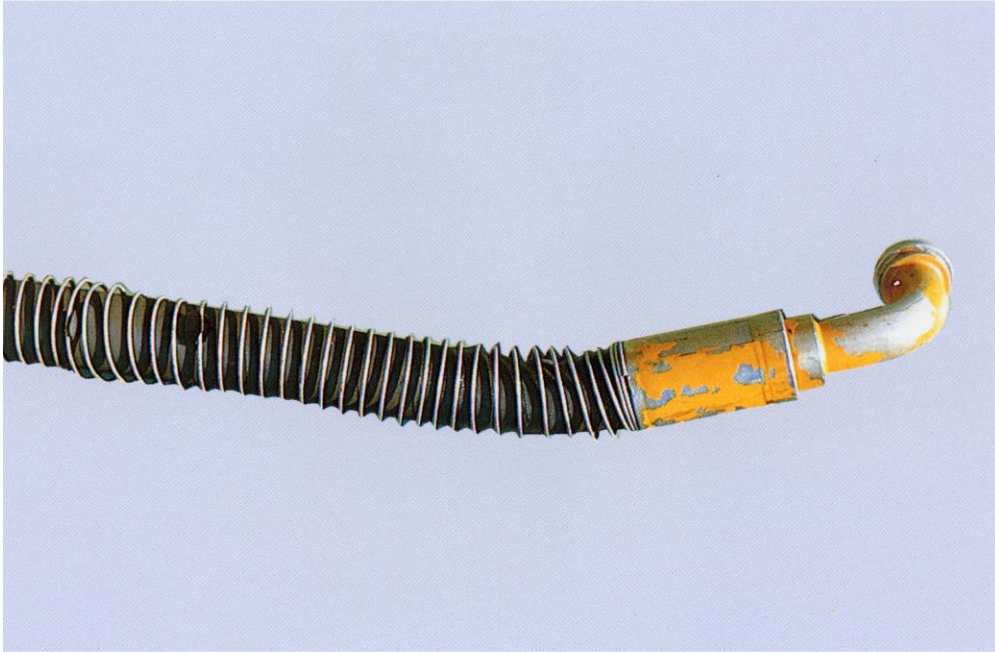
16



Reference:

Disassembled view.

17



DO NOT USE AGAIN

Failure Sign

- Protective spring crushed or deformed with the rubber cover broken.

Cause

- An external force has twisted and crushed the hose and disrupted the reinforcement wire layer.

18

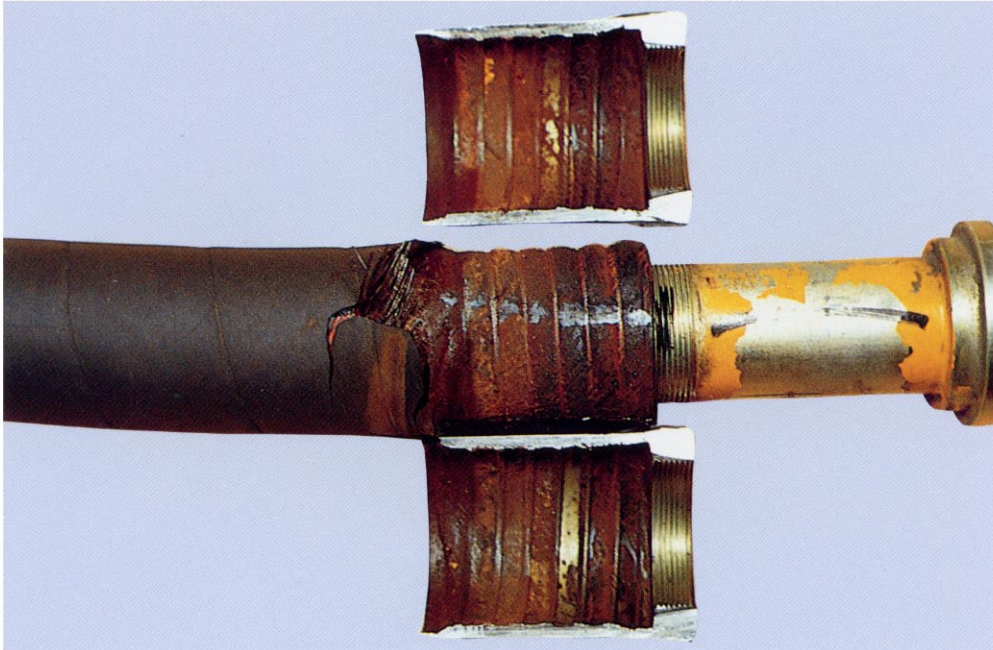


Reference:

Disassembled view.

Reference (Disassembled view)

19



DO NOT USE AGAIN

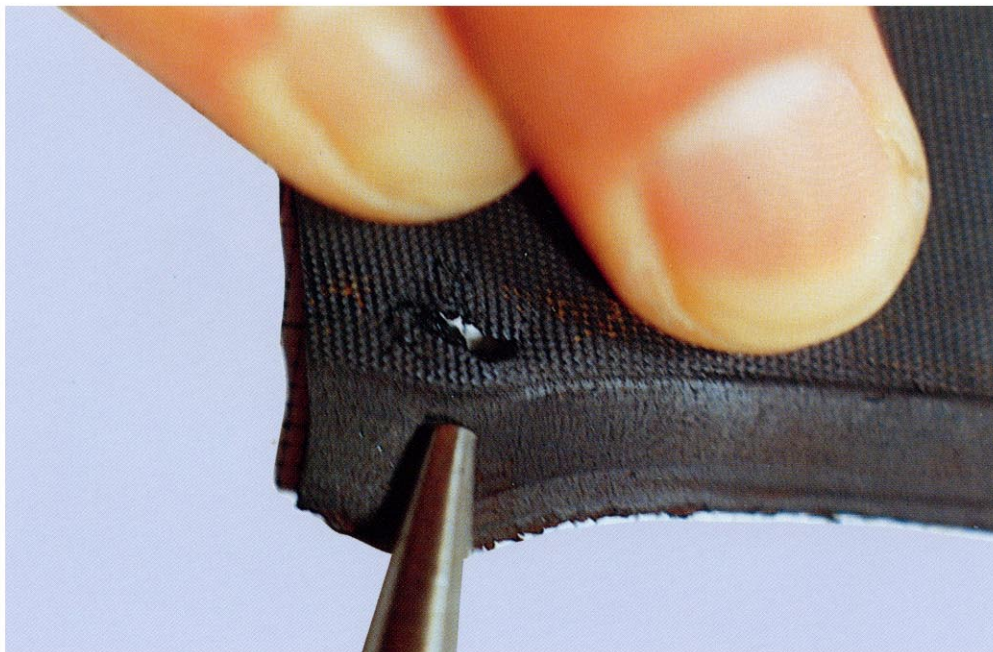
Failure Sign

- Hose broken at the fastening with reinforcing wires broken and sticking out.

Cause

- Rust in the reinforcing wires has led them to break under the pressure.

20

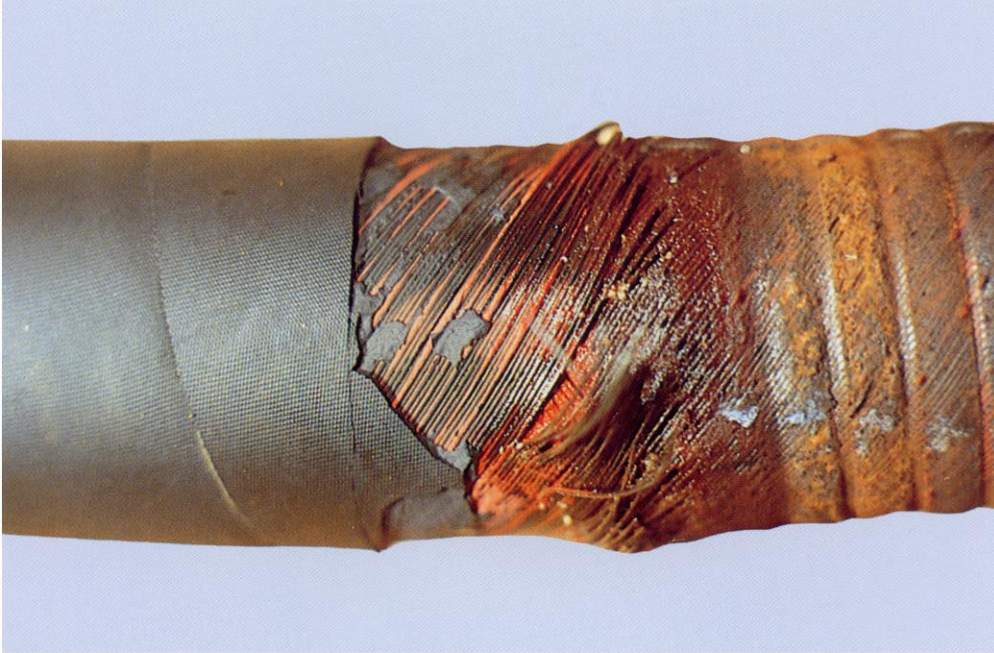


Reference:

Disassembled view.

Puncture holes visible in the rubber cover near the site of damage and the fastening.

21



Reference:

Disassembled view.

As rusting proceeds, the outermost, reinforcing layer of wire weakens and breaks.

Process Leading to Breakage

- (1) A stone hits the rubber cover and damages it.
- (2) Moisture entering through the damaged rubber leads to rusting of the outermost wire layer.
- (3) As rusting proceeds, the reinforcing wire weakens and breaks.
- (4) Deprived of the reinforcement provided by the outermost layer, the inner layer is more subject to metal fatigue, so it rapidly deteriorates.

The rubber cover is provided to protect both the reinforcement layer and the rubber tube inside. Replace a hose as soon as possible if it has been damaged and the wire is exposed.

22



DO NOT USE AGAIN

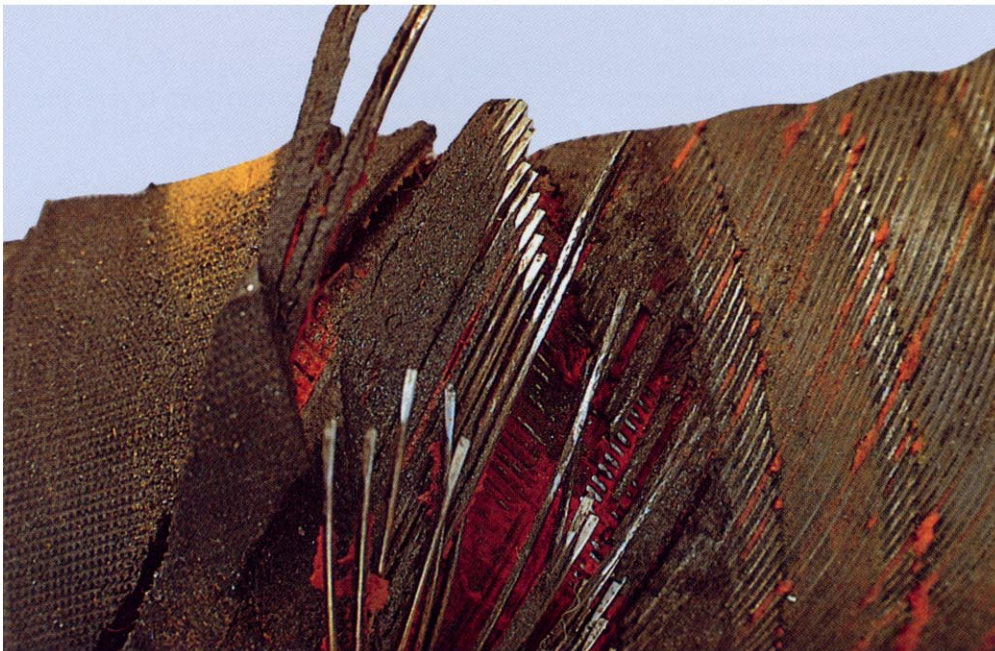
Failure Sign

- Longitudinal wear marks on the hose with breakage near the fastening.

Cause

- An external force has twisted, bent, or stretched the hose, weakening the wire layers.

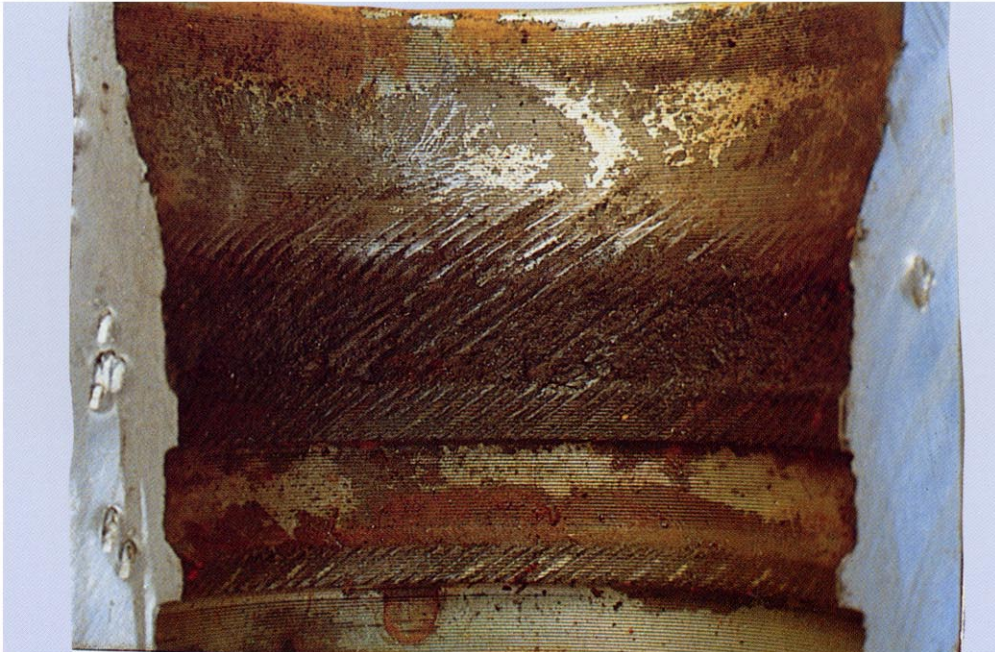
23



Reference:

Disassembled view of worn wires.

24



Reference:

Disassembled view.

Contact with the reinforcing wire has produced rapid wear on the inside of the adapter socket.

An external force which twists, bends, or stretches the hose can, in certain cases, lead to this sort of damage. Therefore make sure that all hoses lie in their proper arrangement at all times.

25



DO NOT USE AGAIN

Failure Sign

- Rust or corrosion on metal parts.

Cause

- Site conditions conducive to rusting and corrosion have made this part unusable.

26



DO NOT USE AGAIN

Failure Sign

- Rust or corrosion on metal parts.

Cause

- Site conditions conducive to rusting and corrosion have made this part unusable.

Hoses

27



USE AGAIN

Failure Sign

- Cuts in the rubber cover are shallow and do not reach the reinforcing wire layer.

Cause

- Interference with a sharp edge.

Note:

As these cuts grow, they eventually let in moisture which can foster rusting which will weaken the reinforcing wire layer. It is therefore advisable to watch them closely and to replace the hose before cuts get too big.

28



USE AGAIN

Failure Sign

- Cracking in the painted surface of the hose and in the rubber cover beneath.

Cause

- Repeated flexing of the hose.

29



USE AGAIN

Failure Sign

- Slight splitting of the rubber.

Cause

- Blows to the rubber or interference.

30



USE AGAIN

Failure Sign

- Depression evident in rubber cover, but hose not crushed and reinforcing wire layer not exposed.

Cause

- Blows to the rubber or interference.

31



USE AGAIN

Failure Sign

- Wear evident in rubber cover, but hose not crushed and reinforcing wire layer not exposed.

Cause

- Interference.

32



USE AGAIN

Failure Sign

- Hose slightly crushed.
- Clamping too tight.

33



USE AGAIN

Failure Sign

- Outer protective spring crushed or deformed, but not enough to bite into the hose; hose not crushed.

Cause

- External force.

34



USE AGAIN

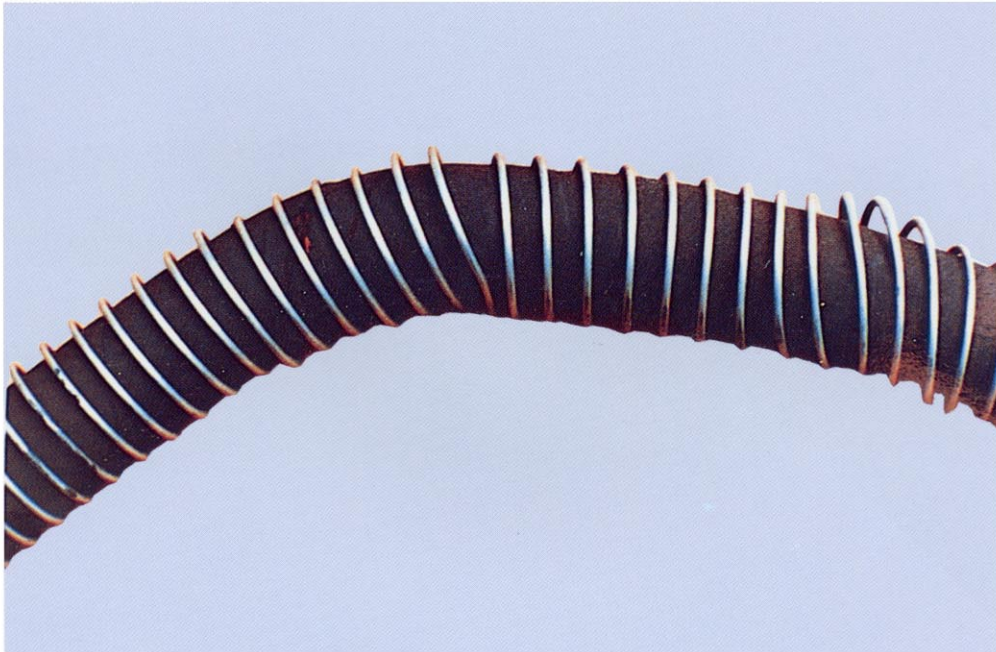
Failure Sign

- Plastic protective cover damaged, but not the rubber beneath.

Cause

- Interference.

35



DO NOT USE AGAIN

Failure Sign

- Protective spring crushed, deformed, and biting into the rubber.

Cause

- Excessive bending under an external force.

36



Reference:

Disassembled view.

37



DO NOT USE AGAIN

Failure Sign

- Hose bent with the rubber cover split.

Cause

- Hose crushed under external force.

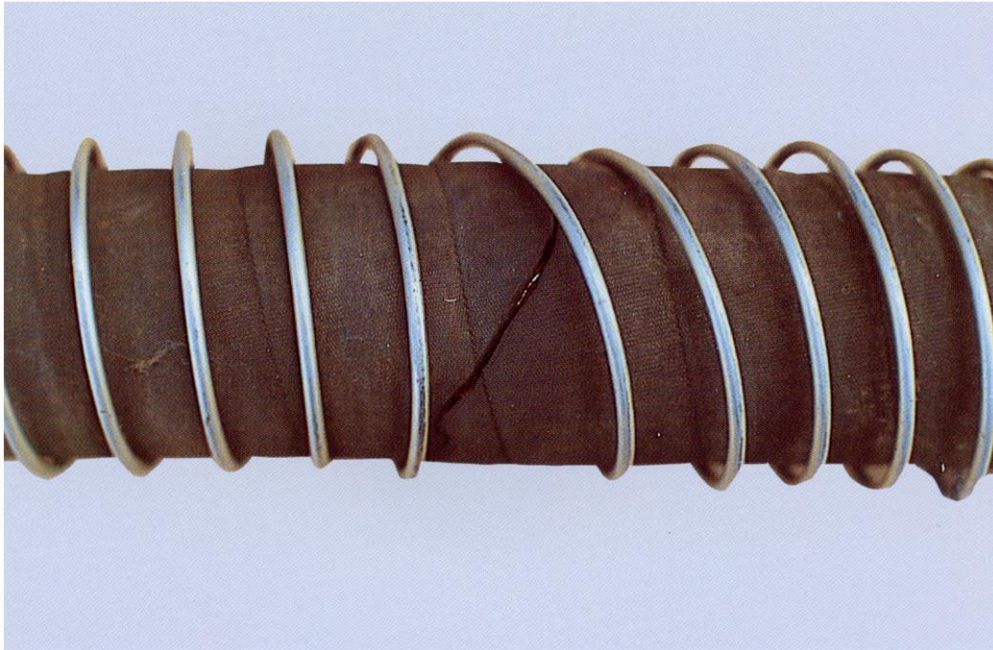
38



Reference:

Disassembled view.

39



DO NOT USE AGAIN

Failure Sign

- Protective spring deformed, hose crushed, hose crushed, and rubber cover split.

Cause

- Hose crushed by external force against sharp corner.

40



Reference:

Disassembled view.

This photograph shows how the wires in the outermost protective layer (the fourth layer) have been pushed out of alignment with some of them actually bent, but with none of them broken. Note that the second layer, which has the same orientation, is in the same state.

41



DO NOT USE AGAIN

Failure Sign

- External marks on adapter and hose with hose crushed and rubber cover broken.

Cause

- Hose crushed under external force.

42



Reference:

Disassembled view.

The wires in the intermediate reinforcement layers are broken at an angle to the spiral formed by the wires in the outermost layer—with the rubber tube split at the same angle.

43



DO NOT USE AGAIN

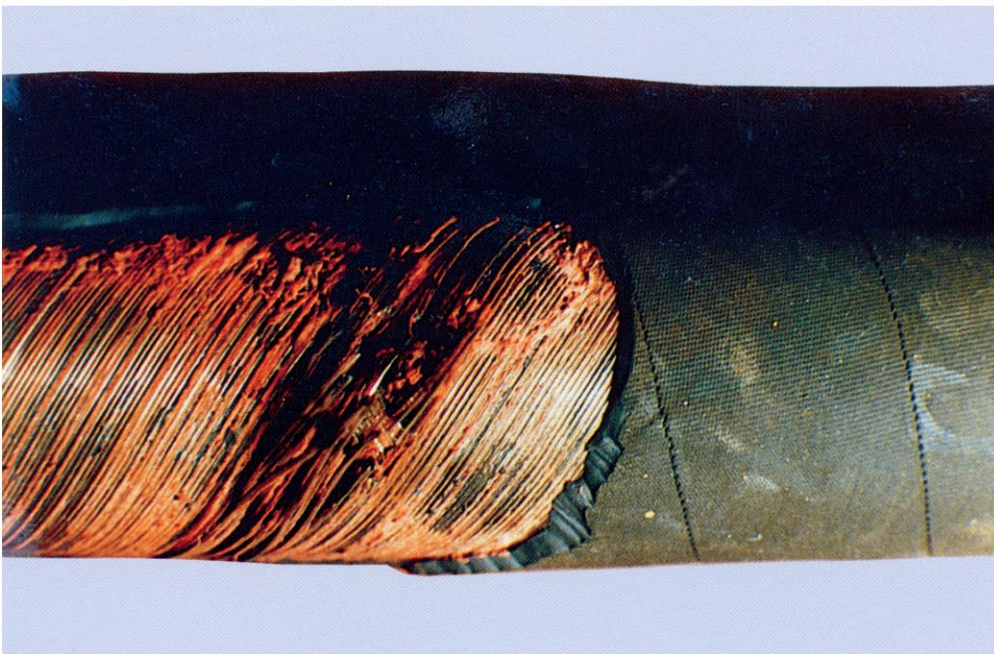
Failure Sign

- Rubber cover broken and separated from the layers underneath.

Cause

- Protruding object has struck the hose and deformed the reinforcing wire layer.

44



Reference:

Disassembled view.

The portion of the wire layer exposed by the separation of the rubber cover is crushed with some of the wire twisted or broken.

45



DO NOT USE AGAIN

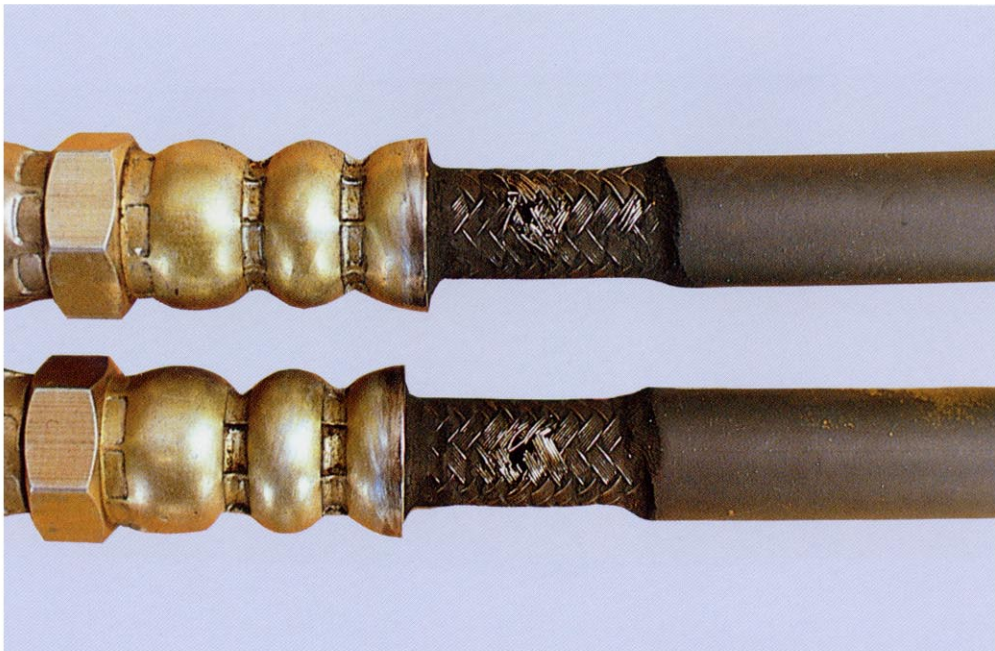
Failure Sign

- Rubber cover gouged with the reinforcing wire exposed.

Cause

- Replacement with a hose of the wrong length has led to interference of the hose with the machine.

46



Reference:

Disassembled view.

Note:

When replacing hoses, always be sure to use the ones with the specified Parts Numbers and the specified lengths.

47



DO NOT USE AGAIN

Failure Sign

- Many fine cracks in the rubber cover.

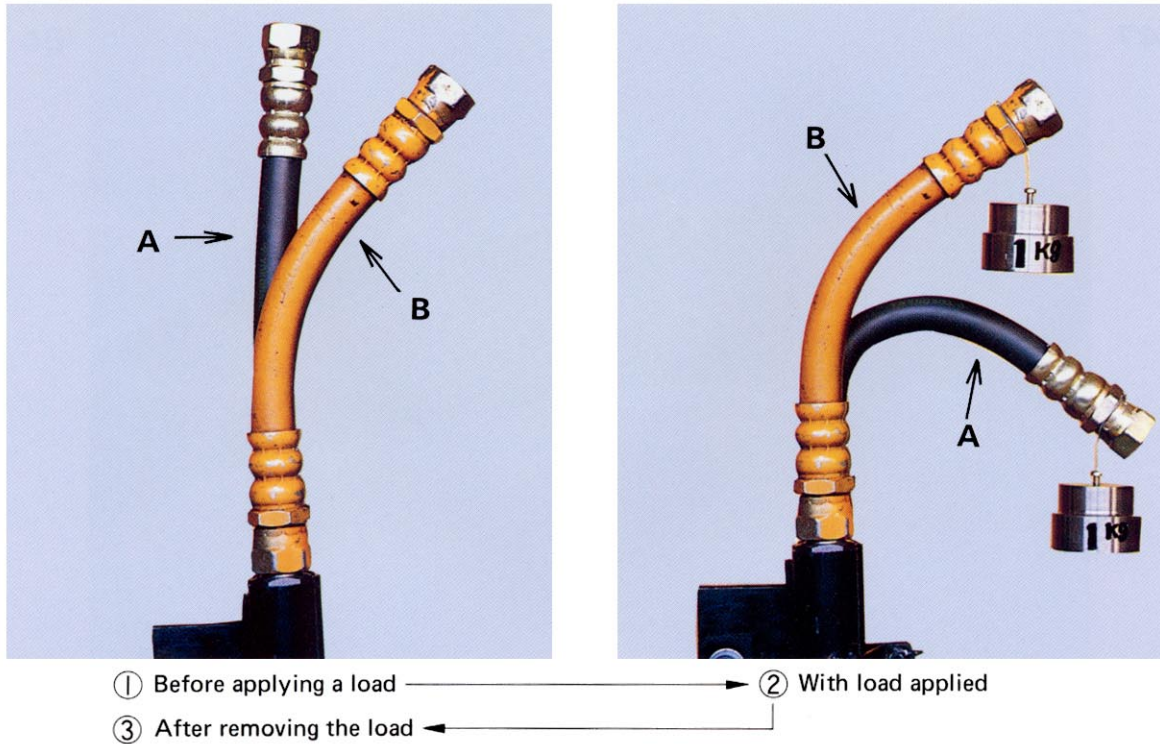
Cause

- Deterioration due to excessively high temperatures or the presence of ozone.

This type of failure is generally very difficult to detect especially when the hose is dirty. To check the hose, remove the dirt with cleaning oil and then bend the hose. Note that if the hose is not exposed, this type of failure is not likely to occur in a short time.

Hardening of the Hose

An example of judging hose flexibility



Ⓐ : Use again

Put a load on the hose. If the hose sags, then springs back when the load is removed, the hose can be reused.

Ⓑ : Do not use again

Put a load on the hose. If the hose is in such bad condition that it does not sag, replace the hose.

Failure Sign

- Excessive resistance to bending.

Cause

- Deterioration due to excessively high temperatures or the presence of ozone.

STRUCTURE AND FUNCTION

Functions

If the pump is the heart of the hydraulic system, the piping forms its arteries. Both pipes and hose are used, but rubber hoses offer certain advantages over metal pipes:

- (1) being more flexible, they bend, and
- (2) they soften and absorb vibrations.

Because of these special properties, hoses are usually used at piping joints—especially at those which must move or at which there is a great deal of vibration.

Note: Bending a hose beyond its limits or twisting it leads to crushing and crimping, two effects that shorten the hose's service life. Another effect that shortens service life is interference between the hose and other piping or the machine frame at links.

Hose Structure

The hose is made up of a rubber tube covered with layers of braided wire and enclosed in a rubber cover.

The rubber tube, which forms the innermost part of the hose, has the function of keeping the hydraulic fluid from leaking out of the hydraulic system. It is made of a synthetic rubber which is highly resistant to mineral oils and high temperatures.

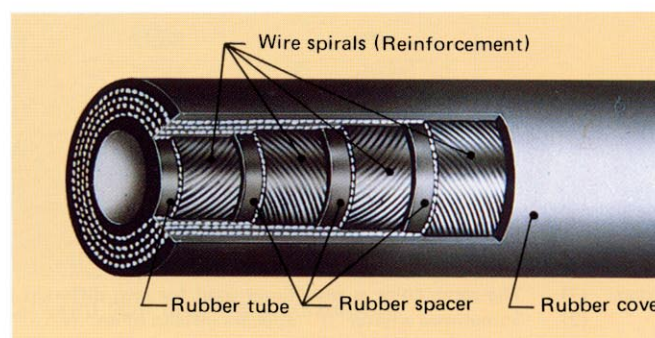
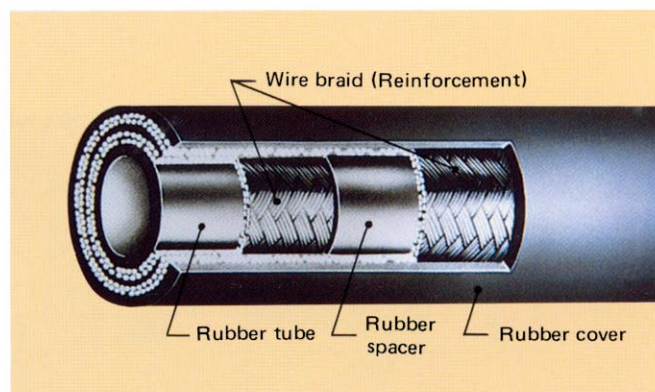
The wire layers are made up of tough wires 0.3 to 0.6 mm in diameter braided into a mesh which keeps the rubber tube from bursting under the hydraulic pressure inside and from collapsing under pressure from the outside. These layers are numbered from the inside—No. 1 wire layer, No. 2 wire layer, etc. The greater the number of layers, the greater the hose's ability to withstand pressure.

The wire layers are the life of the hose. They are carefully braided at the angle best suited to withstanding high pressures. Excessive bending or twisting, however, changes the angle of the braiding, lowering the hose's ability to withstand pressure and increasing the risk of hose damage.

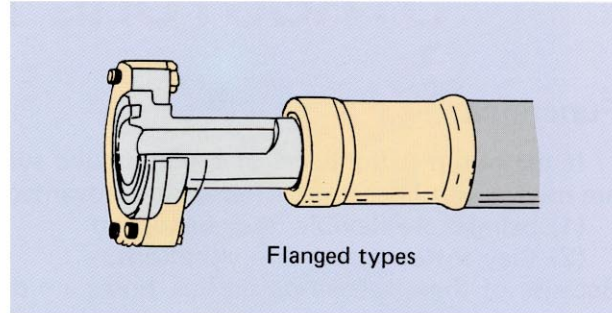
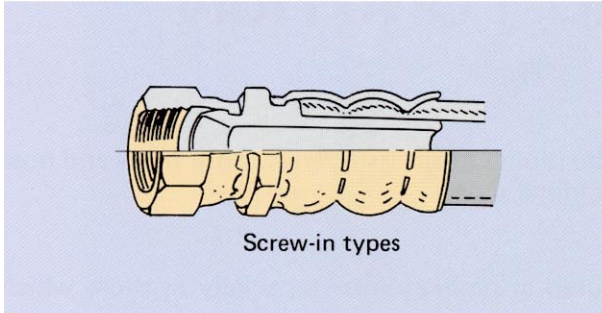
The rubber cover on the outside of the hose protects both the rubber tube and the wire layers. It is made of a synthetic rubber highly resistant to heat, weathering (especially that due to the presence of ozone in the atmosphere), and wear.

If there is a risk that stones or other objects will come into contact with the rubber cover during operation, resulting in damage to the rubber cover and exposure of the wire layers underneath, the hose is further wrapped with a protective coil of wire. Similarly, if there is a risk that vibration will cause interference with other parts, the hose is wrapped with a plastic coating. Also available are asbestos-wrapped hoses for machines used in slag-handling or other high-temperature environments.

In addition to the wire braid hoses just discussed, there are also hoses which use wire spirals for reinforcement. Since the wires are not braided together, they are much more resistant to metal fatigue. Such hoses also have great resistance to pressure, so they are ideal for lines subject to sudden pressure changes.



Adapter Structure

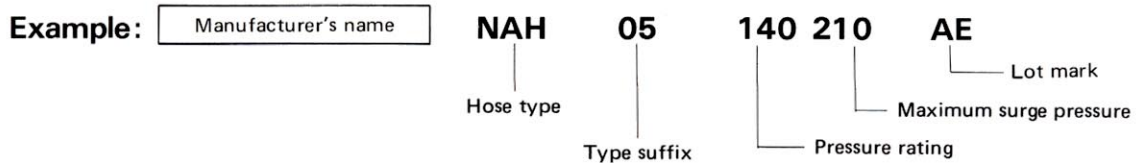


Hoses are fitted with adapters at the ends so that they may be attached to other piping. The accompanying illustrations show the two types of adapters used: flanged and screw-in types.

Similarly, there are many different ways of attaching an adapter to a hose. Improper attachment allows the hose to slip out of the adapter, leading to leakage. Komatsu hoses use the method shown in the illustrations: the adapter is clamped onto the hose with a cylindrical press. This method is, however, quite delicate: insufficient clamping pressure allows the hydraulic pressure to force the hose out of the adapter, while too much pressure splits the rubber. Attachment is therefore entrusted to the hose manufacturer.

Hose Brands

Each hose manufacturer stamps a brand onto the surface of the hose. This can be used to indicate which Komatsu specifications it conforms to.



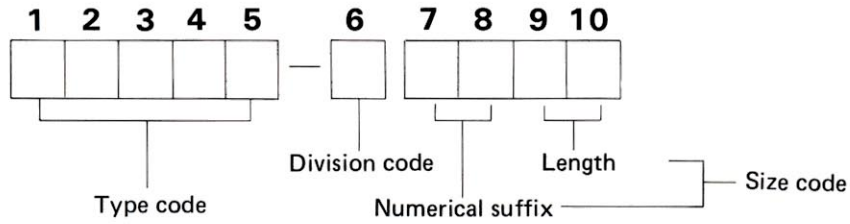
Colors: Each brand is color-coded in accordance with the pressure ratings.

Hose type		Color	Pressure rating x Maximum surge pressure (kg/cm ²)
Standard version	Special cold wether version		
LHH	LHC	Green	30 x 45
MHS	—	White	70 x 105
HHS	—	Red	100 x 150
NAH	NAC	Yellow	140 x 210
NBH	NBC	Pink	175 x 260
NCH	NCC	Orange	210 x 315
NDH	NDC	Blue	250 x 375
NFH	NFC	White	280 x 420
NJH	NJC	Red	350 x 525

- Notes: (1) The same color is sometimes used for two different hose types: for example, MHS and NFH, HHS and NJH.
 (2) Sometimes a letter "F" appears instead of an "N".
 Examples: NAH → FAH
 NAC → FAC

Hose Parts Number

Parts Numbers are assigned in accordance with the following format:



Size of Hoses

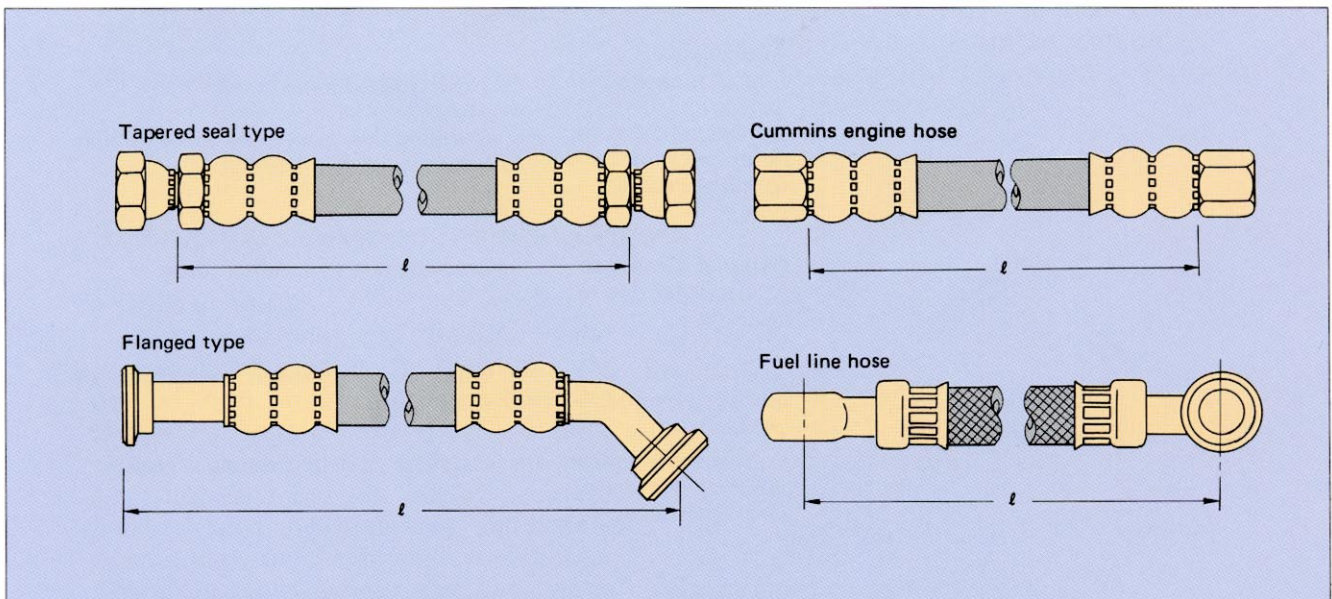
Size code

The four digit size code is made up of the hose's numerical suffix (two digits) followed by its length (in units of 10 cm). The numerical suffix is related to the hose's inner diameter.

Numerical suffix	02	03	04	05	06	10	12	14	20
Hose's inner diameter (mm)	6.3	9.5	12.7	15.9	19.1	25.4	31.8	38.1	50.8

Examples: Size code 0203 Inner diameter = 6.3 mm Length = 300 mm
 Size code 0308 Inner diameter = 9.5 mm Length = 800 mm
 Size code 0415 Inner diameter = 12.7 mm Length = 1500 mm

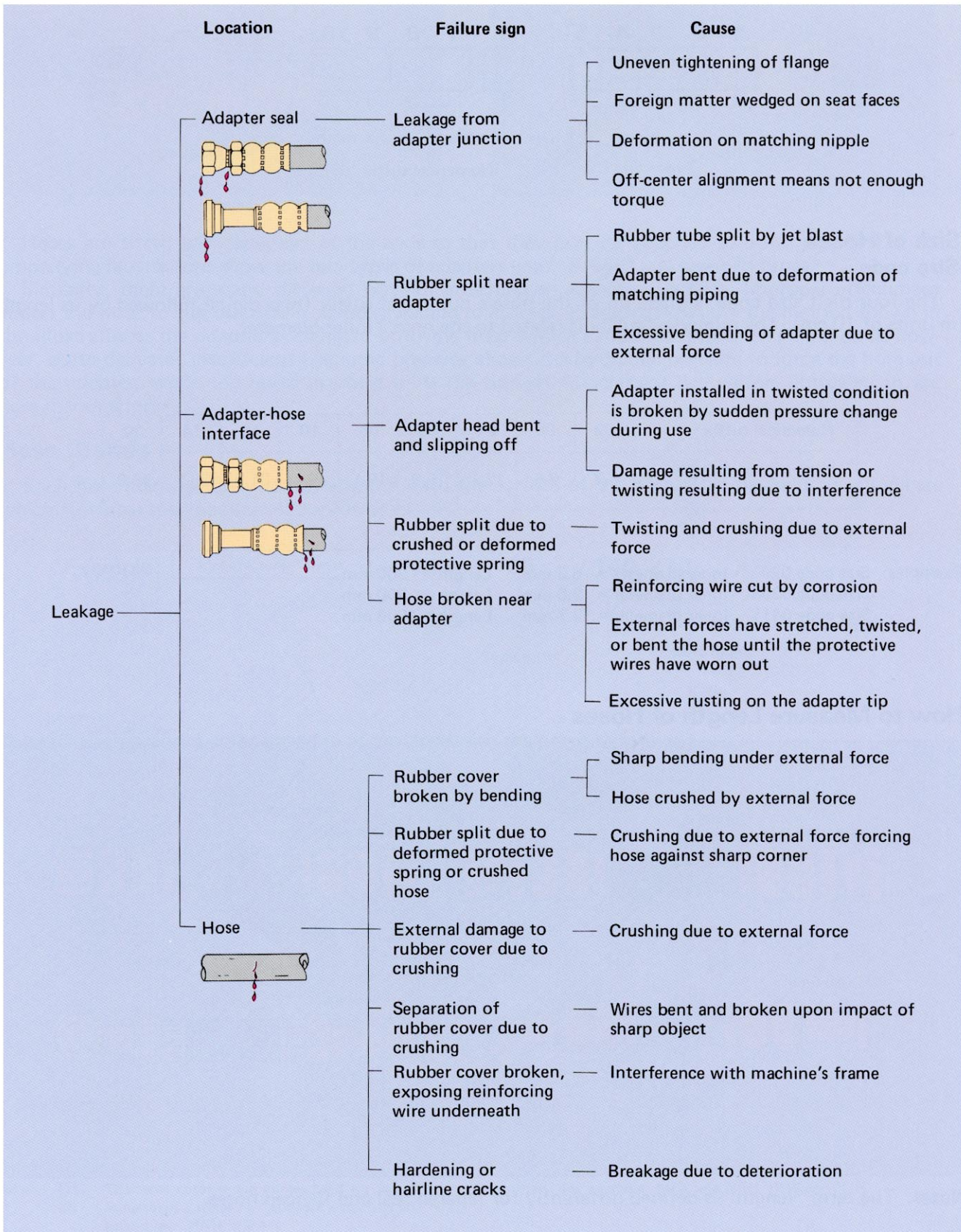
How to Measure Length of Hoses



Notes: The term "length" is defined differently for tapered seal and flanged hoses.

FAILURES AND THEIR CAUSES

Leakage from high-pressure rubber hoses can be due to any number of causes: for example, marks on the adapter seat surfaces, breakage near the hose-adapter interface, damage to the hose's surface. The following chart outlines the more common failures and their causes.



PREVENTIVE MAINTENANCE

1. Maintenance

To prevent machine breakdowns before they have a chance to happen and to keep the machine operating at 100% of its capacity, it is necessary to be constantly aware of the state of the hoses—in particular, to be on the lookout for leakage and excessive heating.

If diligently followed, the maintenance procedures outlined in the machine's Operation and Maintenance Manual are sufficient to prevent damage. In addition, you should strictly observe the following two rules:

- During the check-before-starting, check for any signs of leakage.
- Always use genuine Komatsu hydraulic fluid and oil filter elements. Replace them at the specified intervals.

2. Precautions when Storing Hoses

Since these hoses are made of rubber, they must be stored in an area free from any of the things that can damage rubber: high temperatures, high humidity, ozone, direct sunlight, chemical solvents, corrosive liquids, and smoke.

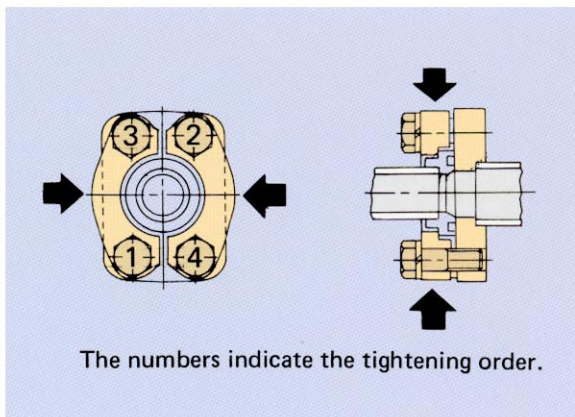
Always observe the following rules:

- (1) Store hoses in a cool place, away from direct sunlight, and in an atmosphere free of damaging gases and humidity;
- (2) Do not place hoses directly on the floor; put them on stands or shelves. Do not pile them too high or place heavy objects on them: the excess weight may crush the hoses on the bottom.
- (3) Do not store hoses on spikes or other forms of hooks that can allow the hoses to bend.
- (4) Do not allow grease or mineral oils to come into contact with the hoses.
- (5) Do not remove the protective caps on the ends. Otherwise, dust, dirt, and other foreign matter will enter the hose and cause trouble in the hydraulic components.
- (6) All metal parts (couplings, adapters, etc.) have been plated to retard rusting. However, if they will be stored for a long time, we recommend that you give them additional protection with rust-preventing paper or another suitable rust prevention method.
- (7) Arrange the hoses so that the length of storage can be readily determined. Always use the oldest hose first—that is, on a "first in, first out" inventory system.

3. Precautions when Installing Hoses

• Split flanges

When installing split flanges, make sure that the gaps in the bolt holes are pushed into the center and that the tightening torques are equal on both sides. If these gaps are left on the outside, the head can slip out of position, making the flange unevenly tightened—a situation that can lead to leakage. Therefore, always press the two halves inward (in the direction of the arrows in the accompanying diagram) when tightening the bolts.



- **Flanged adapters**

Make sure that the hose is not twisted. Temporarily tightening the elbow side first before tightening the straight side and the elbow side reduces the amount of constriction imposed on the hose and gives better results.

- **Screw-in adapters**

To keep a hose with screw-in adapters from twisting, make sure that the hose adapter and the matching nipple are in a straight line and first tighten by hand. Tightening with a wrench after the nipple, socket, and seats are in contact helps ensure that the connection will not be off-center.

When tightening the nuts, make sure that they do not go in at an angle.

4. Physical Effects of Long-Term Storage

Even when hoses are stored under ideal conditions—with both ends capped and completely sealed from the outside air in plastic wrapping—rubber hoses lose their pliability and hardness after about three years and their resistance to tension after seven years.

The same applies to the rubber inside the hose; over time, it gradually loses its pliability, hardness, and resistance to tension.

We therefore advise the user against using rubber hoses which have been in storage too long.

