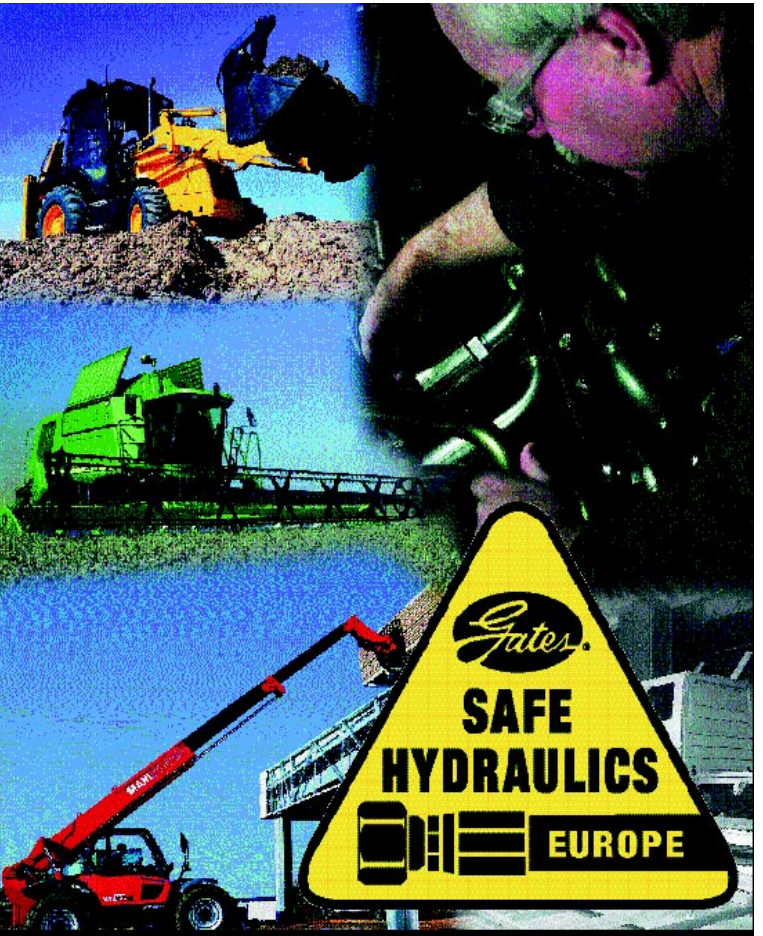


Preventive maintenance for safe, reliable and productive machines.

E2/500093

CONTENTS

WHY PREVENTIVE MAINTENANCE?

There are several good reasons to begin a preventive maintenance programme. Costly repairs, production downtime and worker safety to name a few.

The main objective of a preventive maintenance programme is to identify component weaknesses before failure and loss of production. Some people believe that PM actually should mean “predictive maintenance” rather than “preventive maintenance.”

Preventive maintenance is especially important with hydraulic products. The high pressures and temperatures associated with hydraulics make hose and fitting maintenance and selection critical. If done correctly, the risk of injury and/or excessive costly downtime decreases significantly. In addition, there is a growing awareness regarding costs associated with cleaning up a hydraulic spill. Combining top-quality Gates products with a regular preventive maintenance programme will keep your equipment at maximum efficiency.

- Efficient production
- Better use of in-shop maintenance personnel
- Improved control
- Reduction of equipment downtime
- Safety hazards minimised
- Increased life expectancy
- Fewer capital outlays for new equipment
- Reduced repair costs
- Prevention of equipment deterioration

AVOID FLUID INJECTION INJURIES

Prevent fluid injuries - Fluids under pressure, even in small amounts, can cause serious injuries. Pressurised fluid escaping from even a small pin-sized hole can easily puncture the skin. To prevent injuries, never touch a pressurised hydraulic hose assembly with any part of your body.

If injury occurs - Pressurised fluid injuries are a serious matter. If fluid happens to puncture the skin, even if no pain is felt, get medical help immediately! Failure to obtain prompt medical help can result in the loss of the injured body part or death.

Testing precautions - Pressurised hose assemblies can burst unexpectedly during testing. For this reason stay out of hazardous areas during hose assembly tests. And always follow proper safety precautions.

CHOOSING THE RIGHT COMPONENTS

Safe, long-lasting hydraulic assemblies begin by choosing the right components. The “right” components are couplings and hoses designed to work together. Most manufacturers offer safe, high-quality components. But mixing and matching couplings from one manufacturer with hoses from another manufacturer can lead to premature assembly failure.

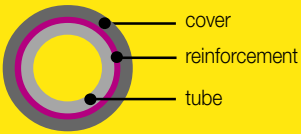
That’s because hoses, couplings, assemby equipment and crimping tolerances vary from one manufacturer to another and are not interchangeable. When components from different manufacturers are mixed, coupling retention can be adversely affected. Mixing components can not only cause unnecessary downtime, it can result in personal injury as well.

Gates offers a complete line of couplings, hoses and related equipment, all designed to work together as a system. Gates components meet stringent test requirements and are engineered to provide the highest quality and long service life.

CHOOSING THE RIGHT HOSE

Choosing the right hose is the first step to long and safe assembly service life.

Hose construction



Hydraulic hoses have three parts: the cover, tube and reinforcement.

The cover protects the reinforcement and tube from environmental conditions such as:

- weather
- ozone
- abrasion
- temperature
- chemicals, etc.

Choose a hose with a cover that can meet the demands of your system, especially in abrasive situations or if the hose will be exposed to chemicals or extreme temperatures.

The purpose of the tube is to allow the fluid to pass with as little resistance as possible.

The reinforcement is the hose's muscle. It provides the necessary strength to resist internal pressure (or external pressure in the case of suction/vacuum).
The three basic types of reinforcement are braided, spiralled or helical. The type of reinforcement is dependent on the intended use of the hose.
When choosing a hose, it's crucial the cover, tube and reinforcement are all compatible with the type of fluid used in the system.

Other variables, such as elevated temperatures, fluid contamination and fluid concentration, will also affect compatibility. If in doubt, consult your hose distributor or the hose manufacturer.

CHOOSING THE RIGHT HOSE

The "STAMPED" method

S
Size

T
Temperature

A
Application

M
Material

P
Pressure

E
Ends/Couplings

D
Delivery

Studies conducted by fluid power parts manufacturers indicate that the three most common causes of hydraulic hose failure are abuse, misapplication and improper routing. Equipment operators and technicians can reduce, if not eliminate, premature hydraulic hose failure by giving maximum consideration to hose assembly selection and installation.

Gates suggests using the "**STAMPED**" method to be sure you get the right hose assembly for the job. "STAMPED" stands for Size, Temperature, Application, Material to be conveyed, Pressure, Ends or couplings and Delivery. Here's how it works:

Size
The inside diameter of the hose must be adequate to keep pressure loss to a minimum and avoid damage to the hose due to heat generation or excessive turbulence.

CHOOSING THE RIGHT HOSE

Temperature
The hose selected must be capable of withstanding the minimum and maximum temperature seen by the system.

Application
Determine where or how the replacement hose or assembly is to be used. You'll need to know the equipment type, working and surge pressures, fluid to be used, bend radius, electrical conductivity, etc.

Material to be conveyed
Product selection must assure compatibility of the hose tube, cover, couplings and O-rings with the fluid used.

Pressure
A crucial aspect in the hose selection process is knowing the system pressure, including pressure spikes. Working pressures as published in the Gates Hydraulic hose, couplings & equipment catalogue must be equal to or greater than the system pressure.

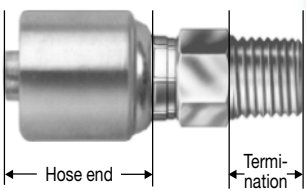
Ends or couplings
Identify the type of threads the system uses and select a coupling that is compatible with that thread type.

Delivery
Make sure the hose is properly sized to efficiently transport fluid.

CHOOSING THE RIGHT COUPLING

Coupling selection

A hydraulic coupling consists of two functional ends:
1. The hose end for hose attachment.
2. The termination end for port or adaptor attachment.



The hose end is identified by the hose size and type to which it is attached. Coupling design is specified by the hose manufacturer to meet hose performance.

The termination or thread end of a coupling can be identified by comparing it with the coupling being replaced or by measuring the port or termination end to which it will be attached.

CHOOSING THE RIGHT COUPLING

Thread size identification guide

MALE THREAD DIAMETERS

Ø mm	Tapered thread (largest dimension) 30° female seat: NPTF Flat face: BSPT		Cylindrical thread MALE SEAT 37° seat: JIC 45° seat: SAE 45°		Cylindrical thread FLAT FACE O-ring located outside: SAE / Boss O-ring located at nose seat: ORFS		Cylindrical thread FEMALE SEAT 24° cone / metric tube: DIN 24° universal cone / "Gaz" Tube: French Gaz 60° cone: BSP		Ø mm
10.1	1/8"-28 BSP	**2MBSPT**					1/8"-28 BSP	**2MBSPP**	10.1
10.3	1/8"-27 NPT	**2MP**							10.3
11.0			7/16"-20 7/16"-20	**4MJ** **4MS**	7/16"-20	**4MB**			11.0
12.0							M12 x 1.5	**6MDL**	12.0
12.5			1/2"-20	**5MJ**	1/2"-20	**5MB**			12.5
13.0									13.0
13.6	1/4"-19 BSP	**4MBSPT**					1/4"-19 BSP	**4MBSPP**	13.5
13.9	1/4"-18 NPT	**4MP**							13.9
14.0							M14 x 1.5 M14 x 1.5	**6MDH** **8MDL**	14.0
14.1			9/16"-18	**6MJ**	9/16"-18 9/16"-18	**6MB** **4MFFOR**			14.1
15.9			5/8"-18	**6MS**					15.7
16.0							M16 x 1.5 M16 x 1.5	**8MDH** **10MDL**	16.0
16.5									16.5
17.1	3/8"-19 BSP	**6MBSPT**					3/8"-19 BSP	**6MBSPP**	17.1
17.3	3/8"-18 NPT	**6MP**			11/16"-16	**6MFFOR**			17.3
18.0							M18 x 1.5 M18 x 1.5	**10MDH** **12MDL**	18.0
18.9			3/4"-16	**8MJ**	3/4"-16	**8MB**			18.9
19.1			3/4"-16	**8MS**					19.1
20.0							M20 x 1.5 M20 x 1.5	**12MDH** **13MFG**	20.0
20.6									20.6
20.9									20.9
21.5	1/2"-14 BSP	**8MBSPT**					1/2"-14 BSP	**8MBSPP**	21.5
21.6	1/2"-14 NPT	**8MP**							21.6
22.0					13/16"-16	**8MFFOR**	M22 x 1.5 M22 x 1.5	**14MDH** **15MDL**	22.0
22.1			7/8"-14 7/8"-14	**10MJ** **10MS**	7/8"-14	**10MB**			22.1
22.9									22.9
23.4	5/8"-14 BSP	**10MBSPT**					5/8"-14 BSP	**10MBSPP**	23.4
24.0							M24 x 1.5 M24 x 1.5	**16MDH** **17MFG**	24.0
25.3					1"-14	**10MFFOR**			25.3

CHOOSING THE RIGHT COUPLING

Thread size identification guide

MALE THREAD DIAMETERS

Ø mm	Tapered thread (largest dimension)	Cylindrical thread			Ø mm
		MALE SEAT	FLAT FACE	FEMALE SEAT	
	30° female seat: NPTF Flat face: BSPT	37° seat: JIC 45° seat: SAE 45°	O-ring located outside: SAE / Boss O-ring located at nose seat: ORFS	24° cone / metric tube: DIN 24° universal cone / "Gaz" Tube: French Gaz 60° cone: BSP	
26.0				M26 x 1.5 **18MDL**	26.0
26.9		1.1/16"-12 **12MJ** 1.1/16"-14 **12MS**	1.1/16"-12 **12MB**		26.9
27.0	3/4"-14 NPT **12MP** 3/4"-14 BSP **12MBSPT**			3/4"-14 BSP **12MBSPT**	27.0
30.0		1.3/16"-12 **14MJ**	1.3/16"-14 **12MFFOR** 1.3/16"-12 **14MB**	M30 x 1.5 **21MFG** M30 x 2.0 **20MDH** M30 x 2.0 **22MDL**	30.0
32.0				M32 x 2.0	32,0
33.2		1.5/16"-12 **16MJ**	1.5/16"-12 **16MB**		33.2
33.7	1"-11.5 NPT **16MP**				33.7
33.9	1"-11 BSP **16MBSPT**			1"-11 BSP **16MBSPP**	33.9
36.0				M36 x 1.5 **27MFG** M36 x 2.0 **25MDH** M36 x 2.0 **28MDL**	36.0
36.3			1.7/16"-12 **16MFFOR**		36.3
38.0				M38 x 1.5	38.0
41.2		1.5/8"-12 **20MJ**	1.5/8"-12 **20MB**		41.2
42.0				M42 x 2.0 **30MDH**	42.0
42.5	1.1/4"-11.5 NPT **20MP**				42.5
42.6	1.1/4"-11 BSP **20MBSPT**		1.11/16"-12 **20MFFOR**	1.1/4"-11 BSP **20MBSPP**	42.6
45.0				M45 x 1.5 **33MFG** M45 x 2.0 **35MDL**	45.0
47.6		1.7/8"-12 **24MJ**			47.5
48.5	1.1/2"-11 BSP **24MBSPT**			1.1/2"-11 BSP **24MBSPP**	48.5
48.6	1.1/2"-11.5 NPT **24MP**				48.6
50.6			2"-12 **24MFFOR**		50.6
52.0				M52 x 1.5 **42MFG** M52 x 2.0 **38MDH** M52 x 2.0 **42MDL**	52.0
59.5					59.5
60.5	2"-11 BSP **32MBSPT**			2"-11 BSP **32MBSPP**	60.5
60.7	2"-11.5 NPT **32MP**				60.7
63.3		2.1/2"-12 **32MJ**			63.3

Male: *refers to the external thread or part which enters into the female to provide connection (source: BFPA/P47-1999)*

All dimensions are nominal. Actual dimensions may differ slightly due to production tolerances.

CHOOSING THE RIGHT COUPLING

Thread size identification guide

FEMALE THREAD DIAMETERS

Ø mm	MALE SEAT 60° cone BSP 24° cone + O-ring / metric tube: DIN 24° universal cone / "Gaz" tube: French Gaz 60° universal cone / metric tube: DIN		FLAT FACE O-ring located at nose seat male: ORFS sealed through copper washer / bonded seal: BSP		FEMALE SEAT 37° seat: JIC 45° seat: SAE 45° 30° seat: JIS		Ø mm
9.9					7/16"-20	**4FJX**	9.9
					7/16"-20	**4FSX**	
10.5	M12 x 1.5	**6FDLORX**					10.5
11.5					1/2"-20	**5FJX**	11.5
					1/2"-20	**5FSX**	
11.7	1/4"-19 BSP	**4FBSPORX**	1/4"-19 BSP	**4FBFFX**	1/4"-19 BSP	**4FJISX**	11.7
12.5	M14 x 1.5	**8FDLORX**			M14 x 1.5	**4FKX**	12.5
12.9			9/16"-18	**4FFORX**	9/16"-18	**6FJX**	12.9
14.3					5/8"-18	**6FSX**	14.3
14.5	M16 x 1.5	**8FDHORX**					14.5
	M16 x 1.5	**10FDLORX**					
15.2	3/8"-19 BSP	**6FBSPORX**	3/8"-19 BSP	**6FBFFX**	3/8"-19 BSP	**6FJISX**	15.2
15.9			11/16"-16	**6FFORX**			15.9
16.5	M18 x 1.5	**10FDHORX**			M18 x 1.5	**6FKX**	16.5
	M18 x 1.5	**12FDLORX**					
17.5					3/4"-16	**8FJX**	17.5
					3/4"-16	**8FSX**	
18.5	M20 x 1.5	**12FDHORX**					18.5
	M20 x 1.5	**13FFGX**					
	M20 x 1.5	**14FDLORX**					
18.9	1/2"-14 BSP	**8FBSPORX**	1/2"-14 BSP	**8FBFFX**	1/2"-14 BSP	**8FJISX**	18.9
19.1			13/16"-16	**8FFORX**			19.1
20.5	M22 x 1.5	**14FDHORX**			7/8"-14	**10FJX**	20.5
	M22 x 1.5	**15FDLORX**			M22 x 1.5	**8FKX**	
					7/8"-14	**10FSX**	
20.9	5/8"-14 BSP	**10FBSPORX**	5/8"-14 BSP	**10FBFFX**			20.9
22.5	M24 x 1.5	**16FDHORX**			M24 x 1.5	**10FKX**	22.5
	M24 x 1.5	**17FFGX**					
23.6			1"-14	**10FFORX**			23.6
24.4	3/4"-14 BSP	**12FBSPORX**	3/4"-14 BSP	**12FBFFX**	3/4"-14 BSP	**12FJISX**	24.4
24.5	M26 x 1.5	**18FDLORX**					24.5
25.0					1.1/16"-12	**12FJX**	25.0

CHOOSING THE RIGHT COUPLING

Thread size identification guide

FEMALE THREAD DIAMETERS

Ø mm	MALE SEAT 60° cone BSP 24° cone + O-ring / metric tube: DIN 24° universal cone / "Gaz" tube: French Gaz 60° universal cone / metric tube: DIN		FLAT FACE O-ring located at nose seat male: ORFS sealed through copper washer / bonded seal: BSP		FEMALE SEAT 37° seat: JIC 45° seat: SAE 45° 30° seat: JIS		Ø mm
25.4							25.4
28.0	M30 x 2.0	**20FDHORX**	1.3/16"-16	**12FFORX**			28.0
	M30 x 2.0	**22FDLORX**					
28.2					1.3/16"-12	**14FJX**	28.2
28.5	M30 x 1.5	**21FFGX**			M30 x 1.5	**12FKX**	28.5
30.6	1"-11 BSP	**16FBSPORX**	1"-11 BSP	**16FBFFX**	1"-11 BSP	**16FJISX**	30.6
31.3					1.5/16"-12	**16FJX**	31.3
31.5					M33 x 1.5	**16FKX**	31.5
34.0	M36 x 2.0	**25FDHORX**					34.0
	M36 x 2.0	**28FDLORX**					
34.4			1.7/16"-12	**16FFORX**			34.4
34.5	M36 x 1.5	**27FFGX**			M36 x 1.5	**20FKX**	34.5
39.2					1.5/8"-12	**20FJX**	39.2
39.3	1.1/4" -11 BSP	**20FBSPORX**					39.3
40.0	M42 x 2.0	**30FDHORX**					40.0
40.5					M42 x 1.5	**24FKX**	40.5
40.5			1.11/16"-12	**20FFORX**			40.5
43.0	M45 x 2.0	**35FDLORX**					43.0
43.5	M45 x 1.5	**34FFGX**					43.5
45.2	1.1/2" -11 BSP	**24FBSPORX**					45.2
45.5					1.7/8"-12	**24FJX**	45.5
46.4							46.4
48.5			2"-12	**24FFORX**			48.5
50.0	M52 x 2.0	**38FDHORX**					50.0
	M52 x 2.0	**42FDLORX**					
50.5	M52 x 1.5	**42FFGX**					50.5
59.5	2" -11 BSP	**32FBSPORX**					59.5
61.4					2.1/2"-12	**32FJX**	61.4

Female: *refers to the internal thread or recess, may be of a fixed part or a swivel nut to hold mating parts together (source: BFPA/P47-1999)*

All dimensions are nominal. Actual dimensions may differ slightly due to production tolerances.

PERIODIC INSPECTIONS

Prior to conducting any inspection of your hydraulic system, it is important that you know how the equipment sounds, looks and feels during normal operation. Any noticeable difference in its daily operation may indicate a problem. Take time to check it out thoroughly. Always review specific precautions outlined by your equipment's manufacturer first.

When to inspect and how often

Because this varies by type of equipment, refer to your equipment manual for recommendations. Always follow the manufacturers' inspection recommendations. If they are not available, a good rule of thumb is:

- For mobile equipment: every 400- 600 hours or three months, whichever occurs first.
- For stationary equipment: every three months.

The following factors influence how often you need to inspect your hose:

- critical nature of equipment
- operating temperatures
- operating pressures
- environmental factors
- type of usage (rugged, abusive, shock, vibration, operating time, etc.)
- accessibility of equipment

EUROPEAN LEGISLATION

As safety is of utmost importance when designing hydraulic circuits, in Europe this evidence has been translated into legislation in the European Machinery Directive 98/37/CE. The Machinery Directive provides the regulatory basis for the harmonisation of the essential health and safety requirements for machinery at European Union level.
The text of the Machinery Directive is very limited and restricted only to the essential safety and performance requirements in the general public interest.

The easiest route to demonstrate compliance with the Directive is to comply with Harmonised Standards. The Harmonised European Standards (better known as EN standards) are tools to help manufacturers and users comply with the Directive by providing practical guidance on meeting its requirements.
The two most important EN standards on safety requirements in the domain of hydraulic hose assemblies are ISO EN 12100 (previously EN 292) and EN 982.

- ISO 12100 / EN 292: 'Safety of machinery: Basic concepts, general principles for design'.
- EN 982 'Safety of machinery - Safety requirements for fluid power systems and their components - Hydraulics'.

Basic requirements of EN 982:

1. **Replacement of a hose assembly**
   The EN 982 standard forbids the use of hoses that have previously been used as part of an assembly. Only new hose is to be used.

2. **Performance requirements**
   All hose assemblies must fulfill all performance requirements specified in the appropriate European and/or international standards (SAE J517 or EN 853, 854, 856 and 857 standards).
   The most important performance requirement for hose assemblies is passing impulse testing. This is a cyclic endurance test every hose/coupling combination has to be qualified to, during which it has to withstand the number of cycles specified in the relevant hose specification.

In practice this means that every manufacturer of hose assemblies must be able to show evidence that the hose/coupling combination used for any assembly has been tested to the impulse requirements specified in the above standards.

The Gates integrated approach of hoses, couplings, machines, dies and crimp data allow its users to fully rely on Gates for all evidence of continuous testing that meets or even EXCEEDS the requirements of the various international standards.

3. Storage and service time

The recommendations of the hose manufacturer on storage time and service time for hose assemblies shall be respected.

4. Fitting onto the machine

EN 982 requires a safe fitting of the hose assembly onto the machine, taking into account possible risks of whiplash and fluid injection.

5. Marking

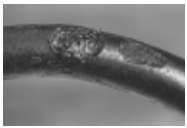
The EN 982 explicitly requires the following data to be shown in a visible and permanent way on all components:

- Identification of the manufacturer of the assembly
- Date of manufacture of the assembly

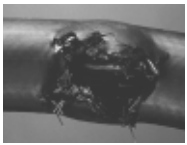
The Gates integrated system of hoses, couplings, self assemby machines and crimp data is the perfect solution to allow you to fully comply to the European Machinery directive.

HOSE TROUBLESHOOTING

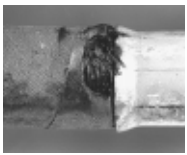
Hose failures can be caused by conditions such as excessive pressures, non-compatible fluids, extreme temperatures, etc. Your goal in troubleshooting is to identify the cause(s), then take appropriate corrective action.
The information in this chapter provides you with examples of the most common hose failures, as well as solutions on ways to correct or prevent them.



Abrasion
Solution - Reroute the hose to keep it away from abrasive sources and exposure to noncompatible fluids or guard the hose with a protective sleeve.



Hose burst at body
Solution - Check the pressure output of the system. It may be necessary to use a pressure transducer to measure the magnitude of any pressure surges. Select a hose that has the proper working pressure rating to handle the maximum pressure
(including surges) of your application.
Reroute hose to eliminate excessive flexing and/or exceeding the minimum recommended bend radius for the hose in use.

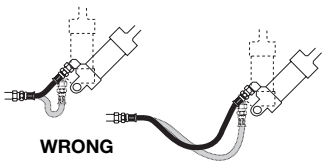


Hose burst at coupling
Solution - Increase assembly length to accommodate contraction of the hose under pressure. Increase actual bend radius as the hose exits the coupling. Bend restrictors can also be used to reduce bending stress at the coupling. Replace hose assembly with properly crimped assembly.

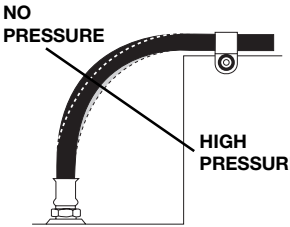
HOSE ASSEMBLY ROUTING TIPS

Proper hose installation is essential for satisfactory performance. If hose length is excessive, the installation's appearance will be unsatisfactory, and unnecessary equipment costs will be incurred. If hose assemblies are too short to permit adequate flexing and allow for length changes due to expansion or contraction, service life will be reduced.

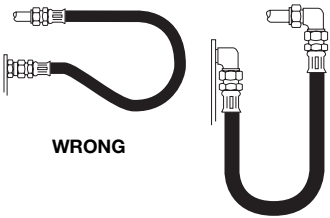
When hose installation is straight, allow enough slack in hose line to provide for length changes which will occur when pressure is applied.



Adequate hose length is necessary to distribute movement on flexing applications and to avoid abrasion.



To allow for length changes when hose is pressurised, do not clamp at bends so that curves will absorb changes. Do not clamp high and low pressure lines together.



When radius is below the required minimum, use an angled adaptor to avoid sharp bends.

HOSE CLEANLINESS

As your customers become more dependent on ISO standards, your overall strategy must reflect a dedication to system cleanliness.

What is hydraulic system cleanliness? "Cleanliness" is a term used to describe the level of solid and liquid contamination found in hydraulic systems. "Contamination" may be defined as any substance that is not part of the hydraulic system's working fluid.

Why is cleanliness important to your customers?

- **Efficient production** because clean systems provide for maximum productivity
- **Improved control** of spare parts through preventive maintenance and monitoring contamination
- **Reduced equipment downtime** through scheduled inspections
- **Safety hazards minimised** through preventing contamination related failure and increased life expectancy of components on equipment
- **Reduced repair cost** due to fewer breakdowns

Several reputable sources have claimed that 70% to 80% of hydraulic system failures are due to contamination. By establishing a contamination control programme, costly repairs and downtime may be minimised. A contamination control programme can be as simple as establishing an allowable level of contamination within a hydraulic system, supplying cleaned components for the system, and monitoring levels of contamination as part of a preventive maintenance promotion.

SEVEN EASY STEPS TO INSTALL A HOSE ASSEMBLY

1. Clean the surrounding area where connections are to be made. Make sure no dirt or contamination gets into hydraulic openings.

2. Install adaptors into ports (if used). Tighten to manufacturer's recommended torque settings.

3. Lay the hose assembly into routing position to verify length and correct routing.

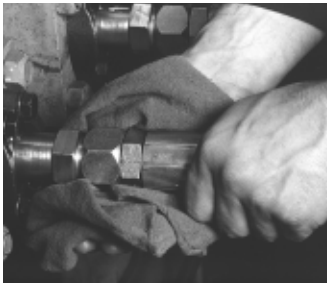
4. Screw one end of hose assembly onto port (or adaptor). If the hose assembly uses an angled fitting, always install it first to ensure proper positioning.

SEVEN EASY STEPS TO INSTALL A HOSE ASSEMBLY

5. Screw other end of the assembly without twisting the hose. Use a spanner on the backup hex on the fitting while tightening.

6. Properly tighten both ends.

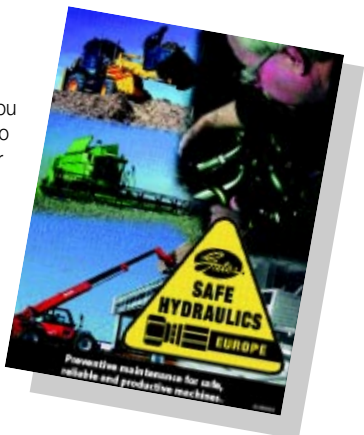
7. Run the hydraulic system to circulate oil under low pressure and reinspect for leaks and potentially damaging contact. Circulating also purges air (bleed) from the system that can cause sluggish performance and possible damage to pumps and other components.



SAFE HYDRAULICS

There you have it, an overview of hydraulic safety and preventive maintenance. There is much more to this topic than can be covered in this booklet, including fitting orientation, coupling identification, agency specifications, hydraulic fluids, hose storage life, proper installation torque values, crimper preventive maintenance, and in-depth information on troubleshooting and hose assemblies.

Gates has developed an in-depth hydraulic preventive maintenance training programme, called "Safe Hydraulics" that can provide you with all of the information you need to properly maintain your equipment for safe operation.



For more information contact your local Gates hydraulic distributor or call Gates at + 44 (0) 1480 22 50 00. You can also visit us online at www.gates.com/europe.

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