Securing hoses

Working Together for Safety Recommendation 039E/2022

SfS
Samarbeid for Sikkerhet

Prepared by the Working Together for Safety Working Group: **March 2022**	Version: **Rev 01**	Working Together for Safety Project Manager: Hugo Halvorsen Hugo Halvorsen (signature on file)
Applies from: **1 April 2022**	Version history: **Rev 00: March 2017**	Approved by the Working Together for Safety Board, Chairman: Hedyeh Malkamy Odd Rune Malterud (signature on file)

Contents

1. Introduction **3**

2. Purpose **3**

3. Target group **3**

4. Highlighting of changes **3**

5. Risk assessment **3**

6. Selection of securing devices **4**

7. Recommended practice **5**

7.1 Use of securing devices 5

7.2 Routing, suspension and protection of hoses 8

7.3 Hose inspection routines 9

8. References **9**

9. Attachment 1: Useful information **10**

1. Introduction

Hoses are used extensively within the Norwegian petroleum industry for the transport of hazardous fluids and gases at high pressure. The use of hoses involves risk to both safety and health, as well as the potential for pollution of the external environment. Ultimately, hose ruptures may result in serious injuries or a major accident, e.g. if inflammable chemicals/gases are released and ignited.

Hoses are subject to movement due to factors such as flow forces. It is therefore important that hoses are adequately secured in order to prevent inadvertent movement. It is often observed that hoses are secured incorrectly, providing a false sense of safety. The risk posed by a pressurised hose should never be underestimated, since extremely high forces may be released if the hose ruptures.

This recommendation describes good practice for securing hoses, and covers the following:

- Securing devices, such as whip-checks, splints and straps
- The correct routing, suspension and protection of hoses
- Hose inspection routines

2. Purpose

The purpose of this recommendation is to help to ensure that hoses are always secured correctly. It is a prerequisite that the correct hose for the task has been selected.

3. Target group

The target group for this recommendation includes mechanics, operators, deck personnel, riggers and others who work with hoses. The recommendation may also be useful for project engineers and those responsible for the procurement of securing devices.

4. Highlighting of changes

Only a few minor corrections have been made in this revision. Some extra bullet points have been added for "Chinese Fingers" and some language improvements and corrections have been made. Some photos have been removed and replaced with better examples.

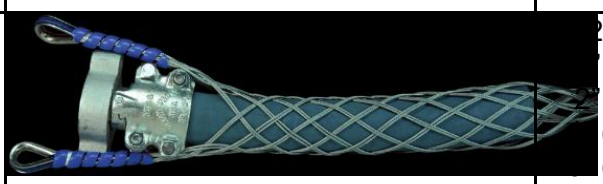
5. Risk assessment

A risk assessment should be carried out when selecting the hose securing device and other measures. This assessment should consider the pressure, temperature, medium and surroundings.

6. Selection of securing devices

Since hoses are available with various dimensions and pressure ratings, and for use with different mediums, there may be significant variation in the necessary strength of the securing device. The table below provides an overview of the most common types of securing device that may be used.

NB: There are many securing device manufacturers, and the same manufacturer may produce several variants. This means that in some cases there may be significant differences in the tensile strength of the available devices. The table below is intended as an aid for use in the selection of securing devices. The strength of the specific securing device one intends to use must always be verified.

Type of securing device	**Image**	**Hose dimensions[1]**	**Max. pressure[2]**	**Medium**
Safety cable (whip check, cable hose restraint)		Several dimensions – suitable for hoses from 0.5” to 4”	13.5 bar (all sizes)	All types excluding hydrojetting
Safety cable (cable choker)		From 1/4” to 1/2” From 1/2” to 1.5” From 1.5” to 3” From 3” to 6” From 6” to 12”	100 bar 60 bar 20 bar 10 bar 7 bar	
Nylon strap + If metal not desirable + Generally good labelling - Degrade with exposure to UV light and chemicals		1/4” (1,800 kg) 1/2” (1,800 kg) 1” (3,600 kg) 2” (3,600 kg) 3” (8,000 kg) 6” (8,000 kg) (Tensile strength in parentheses)	1,800 bar[3] 450 bar 230 bar 56 bar 85 bar 20 bar	
Safety sock[4] (Chinese fingers, finger grip, whip sock / whip stop)		” (1,200 kg) (2,400 kg) (9,000 kg) (15,000 kg) (15,000 kg) (Tensile strength in parentheses)	485 bar[3] 260 bar 220 bar 95 bar 40 bar	

Stopflex		Up to 2”	20 bar	Usually used for hydraulic hoses
Pyrojacket Pulled onto the outside of the hose for protection			Protects hoses against temperatures up to 1,650 °C	

1) When the diameter is doubled, the force for the same pressure will be quadrupled.
2) Max. pressure may be doubled for hoses with fluids (oil, water, hydraulics, etc.).
3) Applies to both gases and fluids (max. pressure for this diameter may not be doubled for fluids).
4) Safety socks/Chinese fingers are also available in versions with higher tensile strength that may be used for high pressure hoses.

7. Recommended practice

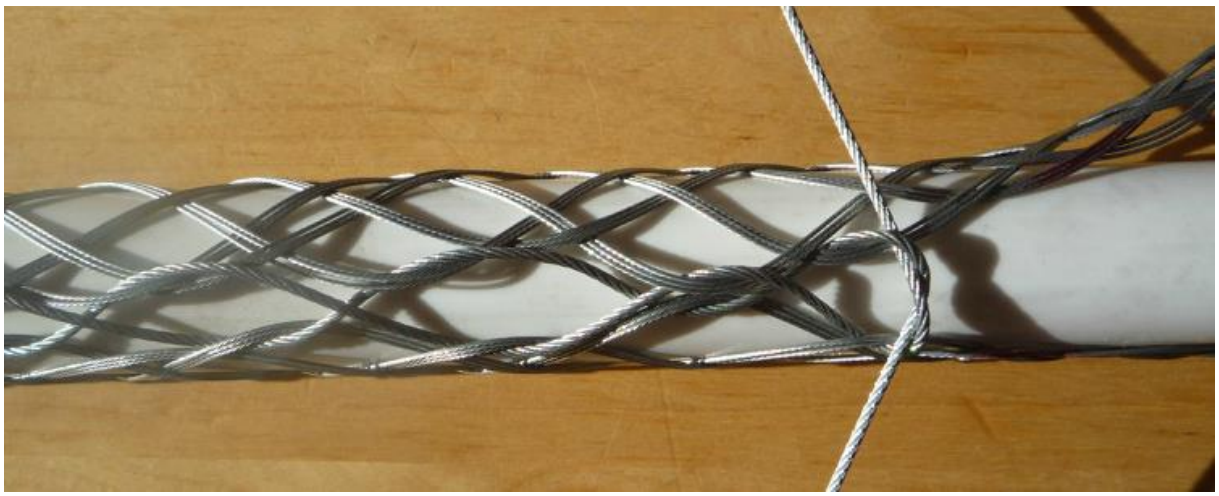
7.1 Use of securing devices

- All securing devices must be installed tightly. A slack safety cable will be exposed to significant dynamic forces if the hose ruptures. “Chinese fingers” must also sit tightly around the hose.
- To ensure that "Chinese fingers" fit tightly (are the right size), they should be ordered with the hose.
- Retrofitting «Chinese fingers» can be difficult if the coupling has a much larger diameter than the hose - but there are solutions (open solution with «zipper» - see picture page 6) that can be used for retrofitting. You can also choose to disassemble the coupling temporarily to have "Chinese fingers" with the correct diameter fitted.
- “Chinese fingers” must be connected using a shackle or the equivalent of sufficient quality and strength.
- Follow the usage instructions and guidance from the manufacturer to ensure that the device is used correctly.
- All hose ends should be secured before the hose is pressurised.
- A safety splint should be used wherever possible.
- Securing devices that have been subjected to stresses should not be used, as the strength of the device will then be uncertain.

Example of good securing using «Chinese fingers», clamps and shackles:

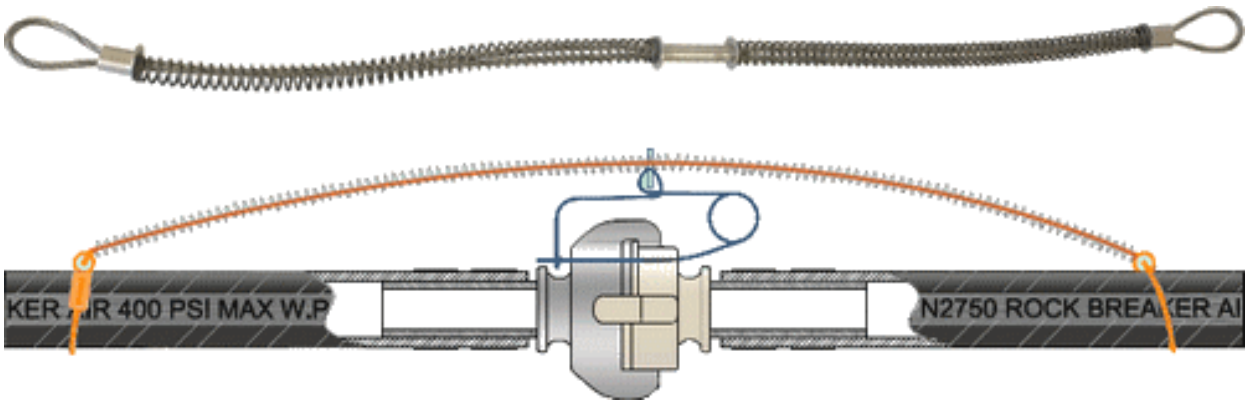
Example of good securing using «Chinese fingers» and shackles:

Example of «Chinese Fingers» with «zipper» (wire that can be tightened after assembly). Suitable for use when retrofitting hose securing:



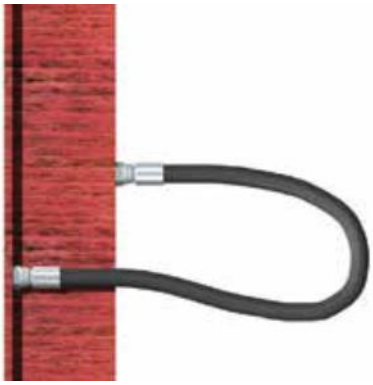
Correct	Incorrect
	
	

Example of good securing using tight safety cable and safety pin:



7.2 Routing, suspension and protection of hoses

- External mechanical stresses must be taken into account during installation.
- Consider using extra external protection against wear (e.g. due to vibration/friction).
- Hoses must be routed so that they do not come into direct contact with sharp edges.
- Use hose-in-hose or other forms of temperature protection as necessary.
- Hoses must not be fed through fire doors without the necessary safety clearance.
- High-pressure hoses should be secured to the structure a minimum of every ten metres.
- The load on vertically suspended hoses should be relieved using straps or cables.
- Avoid twisting or kinking the hose when pulling it.
- Avoid bending the hose near the connection, as this may weaken the integrity of the hose and connection during use.[2]
- When routing hoses in the field, the hose's bend radius must not be less than the specified minimum bend radius.[2]
- When routing, walkways / escape routes should be avoided wherever possible.
- Hoses must be shielded (e.g. by using a hose bridge) wherever necessary.
- In areas where an explosive atmosphere may be present, only hoses with sufficient electrical conductivity shall be used if their use may generate static electricity.

Correct	Incorrect
	
	
	

7.3 Hose inspection routines

- Always check all hoses, couplings and securing devices before use.
- The couplings, sealing surfaces and threads must be cleaned and free from damage prior to installation.
- Hoses must be free from damage. To prevent damage, hoses should be stored in a cool, dry, dark place.[1]
- Hose clamps/connections must be of an approved type and interface with each other correctly.
- Remember that some hose connections should be retightened if necessary

8. References

1. NS-EN ISO 8331:2014 “Rubber and plastics hoses and hose assemblies. Guidelines for selection, storage, use and maintenance”

2. ISO/TR 17784 “Rubber and plastics hoses and hose assemblies. Guide for use by purchasers, assemblers, installers and operating personnel”

9. Attachment 1: Useful information

Pressure and energy formulae

1. Kinetic energy: $E = 1/2\ mv^2$ (joules)
2. Gravitational potential energy: $E = mgh$ (joules)
3. Force from pressure in hose: $F = PA$ (newtons)
4. Newton's second law: $F = ma$

m = mass, v = speed, g = gravitational constant, a = acceleration, h = height, P = pressure, A = area

Units/designations (note that here m = metres and s = seconds)
Force is measured in newtons (N), kg m s^{-2}
Energy is measured in joules (J), kg m^2 s^{-2} (=Nm)
Pressure is measured in pascals (Pa), kg m^{-1} s^{-2} (= Nm^{-2})

Since hose diameters are often given in inches and pressures in psi (pounds per square inch), it is beneficial to also perform calculations in these units. Force can therefore be calculated in lbf (pound-force), where 1 lbf is equal to 4.448 newtons.

Example calculation:
Hose diameter (internal): 4''
Pressure: 1,500 psi
Force: (Area x Pressure) = (4/2)2*3.14 x 1,500 = 18,840 lbf = 83,800 N
This is equivalent to the force exerted by a mass of 8,542 kg (83,800 / 9.81).
It is important that the hose is stopped as quickly as possible. If it is allowed to accelerate over a longer distance, the force when it finally stops will be greater.

Calculators that can be used to calculate the forces involved in hose ruptures are available online. Manufacturers of hose securing device also provide tables that indicate the strength of the various securing methods.

Some manufacturers have also produced YouTube films presenting tests of various types of hose securing devices.