snowy hydro Limited renewable energy	
Snowy Technical Standards	
SHL-MEC-116	***Flexible Hose Management***
Subject Matter Expert *Duncan Murdoch* *Mechanical Engineer*	Version Date: 7 February 2018 Revision: *Original*

1. Executive Summary

This standard sets out the structure for the management of flexible hoses throughout their lifecycle. Proper management of flexible hose assemblies leads to a reduction in the risk associated with their implementation.

2. Scope

This document outlines the control measures necessary for the design, installation and maintenance controls to ensure the technical integrity of flexible hose assemblies.

As a guide this procedure is applicable to flexible hoses:

Service Type	Construction
• Hydraulic • Chemical • Pressurised fluids • Pneumatics • Steam • Inert gases • Hydrocarbon process	• Rubber construction • Textile braid • Wire reinforced • Thermoplastic • Stainless braid • Convoluted • Code hose

This document shall **not** be used for the management of:

- Breathing apparatus
- Fire hoses
- Mobile plant
- Open ended hose installations
- Portable greasing equipment
- Grease lines
- Workshop equipment

2.1. Applicable Standards

AS 3791-1991	Hydraulic Hose
AS 1180	Method of Test for Hose made from Elastomeric Materials
AS 1179-1972	Glossary of Terms for Rubber Hose
AS 1257-1973	Bore Sizes, Test Pressures and Tolerances on Length of Elastomeric Hose

AS/NZS 1869:2012	Hose and Hose Assemblies for Liquefied Petroleum Gases (LP Gas), Natural Gas and Town Gas
AS/NZS 2554:1998	Hosen and Hose Assemblies for Air
AS/NZS 3499:2006	Water Supply - Flexible Hose Assemblies

3. Definitions

Word and/or picture	*Definition*

4. Technical Requirements

4.1. General

Flexible hose assemblies are used in a vast array of applications and industry types. Flexible hose failure can create hazards including:

- Operational unavailability - wiped bearings, pressure loss
- Injury to personnel - fluid injection, chemical burns, whipping
- Environmental damage - oil spills, hydrocarbon pollution
- Equipment damage - fluid contamination, electrical faults, mechanical damage

Due to this fact, it is paramount that a flexible hose management program is implemented to mitigate the risks associated with flexible hose assemblies

4.2. Regulatory Considerations

This document does not replace specific requirements of Australian and International standards that apply to specific installation and design requirements.

4.3. Lifecycle Management

The lifecycle of a flexible hose is managed and governed by phases outlined in this document. Lifecycle management is applicable to both new and existing installations.

Flexible Hose Lifecycle Activities

Phase	**Deliverable**	**Activity**
Conceptual Design	Assess whether a hose is the only viable	Risk Assessment

	alternative – *is a hose the best solution for the application?*	Technical evaluation Life Cycle Cost Alternative Methods
Risk Analysis	Risk reduction analysis – *how can we reduce the risk?*	Identify all opportunities to reduce risk
Detail Design	Detail design, check specification of hose against the actual operating conditions.	Hose performance compatibility to be identified Further Risk assessment Operating Parameters Procurement criteria Certification Change Management
Construction, Installation, Commissioning	To ensure the hoses are transported and stored properly, and to ensure the hose is proven to meet the design requirements.	Installation Routing Risk Assessment Test Commissioning Storage and transportation
Maintenance and Inspection	The integrity of the hose is maintained throughout its operational life.	Tagging and logging of data Inspection strategy Rejection criteria
Decommissioning	The integrity of the flexible hose is retained during decommissioning.	Risk Assessment Decommissioning/removal Change Management Documentation and closeout

4.4. Conceptual Design

4.4.1. Objective

To ensure that there is an understanding in the processes required before a flexible hose is used in an application. These factors need to be considered when reviewing existing installations under a flexible hose management program.

4.4.2. Design for Application

A number of considerations must be made when incorporating flexible hoses into any assembly. An extensive list of design considerations and technical requirements has been included in Appendix A - Design.

4.4.3. Design for Installation

When designing an application, the installation requirements must also be considered. Appendix B - Installation must be consulted during the conceptual design stage.

4.5. Risk Analysis

4.5.1. Objective

To review specific applications, both conceptual and existing, and identify any risk posed by flexible hose assemblies. Applications shall be analysed to ensure that all risk reduction measures are considered. **Hard piping** is the preferred risk reduction measure.

4.5.2. Risk Assessment

New Flexible Hose Assemblies

A formal risk assessment shall be made for all conceptual designs which will:

- Identify whether hoses are the only viable method
- Identify unacceptable hazards
- Remove uncertainties regarding safety and cost effectiveness
- Ensure that designs are to suitable technical standards
- Inform maintenance strategies

Should a flexible hose be deemed the most viable option for the application, the criticality of the parent system shall be assessed and recorded in section 4.9.3 Maintenance Frequency Guidelines if it has not already been done so.

Existing Flexible Hose Assemblies

Flexible hoses that are currently in service shall be identified by the maintenance team and the criticality of their parent system shall be assessed and recorded in section 4.9.3 Maintenance Frequency Guidelines if it has not already been done so.

4.6. Detailed Design

Detailed design or arrangement of a hose is covered by SHL procedures, manufacturer catalogues and relevant standards. These standards shall not be departed from under any circumstance.

Appendix A - Design shall be consulted.

4.7. Installation

Hoses are to be installed using an end fitting suitable for the style of hose and system application. Under no circumstance is a flexible hose to be installed using generic hose clamps.

Appendix B - Installation shall be consulted.

4.8. Tagging and Documentation

All hoses must be located and physically tagged, and have their data and location recorded in the SHL ERP system. It is the responsibility of the Regional Planning and Scheduling Team to update the SHL ERP system with all new hoses or changes made to the specification of existing hoses. Hose tags shall carry the following information as a minimum:

- Hose supplier
- Hose number (ID)
- Date of installation
- Rated hose pressure
- Max system pressure

All history, documentation and data required for replacement shall be stored in the SHL ERP system:

- Design standard
- Construction type
- Hose inside diameter

- Overall assembly length
- Protective cover material
- End connection details
    - Male or female
    - Thread type
    - Diameter
    - Etc.

4.9. Maintenance and Inspection

4.9.1. Objective

The objective of this section is to provide a structured framework for the development and application of maintenance and inspection strategies for flexible hose assemblies.

4.9.2. Inspection Criteria and Frequency

All systems where flexible hose assemblies are implemented must be assessed for criticality and included in section 4.9.3 Maintenance Frequency Guidelines. The formulated criticality shall govern the frequency of inspection and replacement.

Note: Maintenance teams may inspect and replace flexible hoses more or less frequently based on condition assessment and historical evidence. A formal risk assessment must be made, incorporating evidence for the change. All changes must be made in accordance with SHL change management procedures. The new Inspection or Replacement Interval and note of the change must be recorded in the SHL ERP system.

4.9.3. Maintenance Frequency Guidelines

System	Failure Effect	Inspection Interval	Replacement Interval
Bearings and Lubrication (inclusive of Thrust Bearing HP Oil System)	Unit OOS	2 years	10 years
Compressed Air	Loss of redundancy	2 years	10 years
Cooling Water System	Unit OOS	2 years	10 years
Coolant Systems (Gas and Diesel)	Unit OOS	2 years	10 years
Cranes and Lifts	Aux. System OOS	2 years	10 years
Demineralised Water	Station OOS	1 year	5 years
Diesel Generators	Loss of Vis./Unit OOS	2 years	10 years
Domestic Water	Aux. System OOS	2 years	10 years
Drainage Systems	Station Flood	2 years	10 years
Evaporative Coolers	Unit OOS	2 years	10 years
Fire Protection Systems	Station Fire	1 year	5 years
Fuel, Oil and Purge Water System	Environmental Damage	2 years	10 Years

Fuel Supply and Storage	Environmental Damage	1 year	5 years
Gates and Valves (River outlet, intake, tunnel regulating etc.)	Aux. System Failure	2 years	10 years
Governor	Unit OOS	2 years	10 years
Lifting and Station Hydraulics	Aux. System Failure	2 years	10 years
Lubrication (Gas)	Unit OOS	2 years	10 years
MIV and DV	Unit OOS	2 years	10 years
Oil Filtration Systems (Fixed and Portable)	Aux. System OOS	2 years	10 years
Oil Water Separators	Aux. System OOS	2 years	10 years
Outlying Works	Aux. System OOS	N/A	10 years
Pipeline Protection	Aux. System Failure	2 years	10 years
Sewerage Systems	Aux. System OOS	2 years	10 years
Spillway Gates	Safety System Failure	1 year	5 years
Station Drainage	Station OOS	1 year	5 years
Transformers	Group OOS	2 years	10 years
Turbine (Gas and Hydro)	Unit OOS	2 years	10 years
Urea System	Group OOS	2 years	10 years
Ventilation (HVAC)	Aux. System OOS	2 years	10 years

Systems not identified in the above table shall have their flexible hose installations inspected on a 2 yearly cycle and replaced every 10 years.

4.9.4. Maintenance Methods

The following detail the methods available to verify and assure the integrity of the flexible hose assembly.

Visual Inspection

Visual inspection must be carried out on all hoses and hose connections. A list of common signs of deterioration has been included in Appendix C - Inspection Guidelines and Rejection Criteria. The observations shall be logged in the work order history.

Replacement

Hoses are to be replaced on a “hard time” basis in accordance with Section 4.9.3 Maintenance Frequency Guidelines. Reasoning for any deviation in frequency must have historical evidence and be noted in the SHL ERP system.

4.9.5. Replacements and Spares

It is the responsibility of the regional maintenance team to manage the supply and storage of flexible hoses for all plant under their jurisdiction. To reduce the risks associated with failure and long lead times, spare flexible hoses may be kept for critical systems. Flexible hoses may be kept as spares in accordance with the following criteria:

- Hoses shall be tagged to identify their properties and in-service location
- Spare hoses are not to be kept for a period longer than the replacement period of their in-service equivalent
- Hoses shall be stored between 0-40 degrees Celsius and not subject to direct heat
- Hoses shall be stored away from direct sunlight
- Hoses shall not come into contact with any substance that may reduce the integrity of the hose
- Hoses shall not be stored as a coil with a diameter less than that specified by the manufacturer
- Hoses shall be stored on a flat, dry surface (not slung over a pole or hook)
- Hoses shall be capped to prevent ingress from contamination during storage

4.9.6. Personnel Competency

The following strategies shall be applied to ensure the continuing integrity of flexible hose installations:

- All personnel required to install, inspect and maintain flexible hose lines shall be fully conversant with the appropriate installation and maintenance procedures.
- All personnel required to test flexible hose lines shall be fully conversant with the relevant test procedure.
- Installation or maintenance shall normally be performed by instrument or mechanical discipline technicians.

4.10. Removal and Disposal

4.10.1. Objective

The objective of this section is to ensure that flexible hoses are disposed of correctly and that any change to their duty is managed accordingly. In the event that a flexible hose is removed from the system, the system is either partially or fully decommissioned, or the system is modified, SP09-78 Asset Change Management Procedure must be abided by.

4.10.2. Removal

A system must be fully de-energised before the removal of any components. Once de-energized, the flexible hose may be removed and disposed of in accordance with the procedure outlined in this document.

4.10.3. Disposal

Flexible hoses that have been permanently removed from service must:

- have the end fittings removed and the main carcass of the hose marked as “scrap”
- be cleaned/decontaminated prior to transportation and labeled if they contained any substance which could be considered hazardous to health
- disposed of in line with local disposal segregation procedures

4.10.4. Partial Decommissioning

Where flexible hoses form part of systems that are only being partially decommissioned, care is required to assess the impact of the decommissioning on the retained plant. Suitable risk assessment shall be conducted as appropriate and recorded as part of the change procedure.

4.10.5. Management Responsibilities

Role	Responsibility
Regional Technical Team	Record hose failures and defects against applicable hose. Notify Regional Planning and Scheduling Team of changes made with regard to flexible hoses. Make suggestions for the removal of flexible hoses and replace with hard piping.
Regional Planning and Scheduling Team	Update SHL ERP system with changes to hose specification, replacement or removal. Plan and procure components for the replacement of flexible hose assemblies.
Asset Engineer	Update and implement changes to the flexible hose management standard.

5. References

- Information for this Document was collected from:

- Pirtek Consultation
- Flexible Hose Management Guidelines by Health and Safety Executive (HSE) and Institute of Petroleum (IP)
- AS 3791-1991 – Hydraulic Hose
- AS 1180 – Method of Test for Hose made from Elastomeric Materials
- AS 1179-1972 – Glossary of Terms for Rubber Hose
- AS 1257-1973 – Bore Sizes, Test Pressures and Tolerances on Length of Elastomeric Hose
- AS/NZS 1869:2012 – Hose and Hose Assemblies for Liquefied Petroleum Gases (LP Gas), Natural Gas and Town Gas
- AS/NZS 2554:1998 – Hosen and Hose Assemblies for Air
- AS/NZS 3499:2006 – Water Supply - Flexible Hose Assemblies

APPENDIX A - DESIGN

A1 Safety

- permanent piping is the preferred option
- hose length to be kept to a minimum - while also considering flexibility, manual handling, minimum bend radius etc.
- The flexible hose assembly must:
    - meet the required piping class of the installation
    - withstand environmental conditions associated with the installation
    - be securely fitted to their end fitting by the hose manufacturer/supplier
    - be supplied assembled and tested with supporting documentation
    - have “whip” prevention devices installed where risk of damage or injury is present
    - have the appropriate fire rating for the installation
    - be compatible with the installation - media, environment, pressure (+ve or -ve)
    - have adequate support consistent with manufacturer and “best practice” guidelines
    - have replacement specifications recorded in the SHL ERP system
- Depending on the application, all metallic or conductive components may be required to be electrically continuous and in some cases bonded to earth.

A2 Temporary Application

For use in a temporary application, flexible hoses must be:

- specified and tested for the application
- have a pre-defined period of installation
- be included in the risk assessment for the task
- be regularly monitored during service

Examples of such tasks: sampling, diversion to closed drain or vent, temporary method to transport fluid etc.

Note: Use of temporary flexible hoses for longer periods shall be subjected to a risk review and a suitable permanent solution sought which demonstrates risks are as low as practicable.

A3 Selection Guidelines

In order to optimise the service life of a hose it is important that all the interested parties: user, manufacturer, buyer and distributor, agree on the full specification, expected life and working conditions of any hose being considered.

The initial parameters for the flexible hose assembly selection are illustrated on the table below:

	Customer Responsibility	**Manufacturer / Vendor Responsibility**
Media to be carried	Defines fluid composition and phase for all foreseeable operating modes	Ensures compatibility of all components
Working Environment	Defines expected minimum and maximum environmental conditions including process or environmental contaminants if relevant	Ensure compatibility of all components with all specified fluids

Flow Requirements	Defines full range of flow conditions (including pulsating flow, multiphase flow, limiting pressure drop requirements)	Defines construction requirements and hose bore size
Pressure Range	Defines maximum and minimum pressures (including vacuum) for all foreseeable operating modes	Ensures compatibility of all components with specified range
Temperature Range	Defines maximum and minimum operating temperatures for all foreseeable operating modes	Ensures compatibility of all components with specified range
Installation Geometry	Provide details of the proposed geometry	Assess geometry and advise customer on feasibility, including lengthening, torsion, etc.
Flexibility	Ensures the flexibility of the hose assembly is suitable for the proposed geometry	Advises minimum bend radius and other installation limitations
Weight	Ensures the hose assembly is suitably supported along its length	Define weight and supports requirements.
Volumetric Expansion	Ensures the proposed geometry and support allows for any foreseeable hose expansion	Advises expansion performance and installation requirements based on specified function and hose properties
Earth Bonding	Defines requirements	Ensure electrical continuity of all components
Fire Rating	Defines requirements	Ensures compatibility of all components or advises on fire resistance
Piping Class	Defines materials and pipe rating of connecting pipework or equipment	Ensures compatibility of all components with connected system
Erosion and Abrasion Requirements	Ensures the hose assembly is suitable for foreseeable interior and exterior environments	Ensures compatibility of all components meets or exceeds system requirements.
End Fittings	Defines requirements, including materials, end fitting type and orientation	Ensures compatibility of all components meets or exceeds system requirements.
Other Requirements	Specify any other relevant information, which could affect lifecycle performance. If in doubt consult manufacturer / vendor.	Ensures other measures are compatible or advises use of consequences

A4 Hose Length Calculation

In the majority of installations a hose is required to have at least one bend in its length. It is essential that to obtain maximum expected life from a hose assembly, undue tension at the end fittings must be avoided. The

following information is intended to provide a guide to ensure that the correct hose length is calculated for both static and flexing conditions.

To avoid tension on end fittings a short length of straight hose is required at each end of the unit so that the bend starts away from the end fitting.

When establishing optimum Flexible Hoses length, the following factors shall be considered:

- Motion absorption;
- Flexible hose length due to pressure;
- Hose and machining tolerances.

The following figures explain how the optimal hose length shall be calculated.

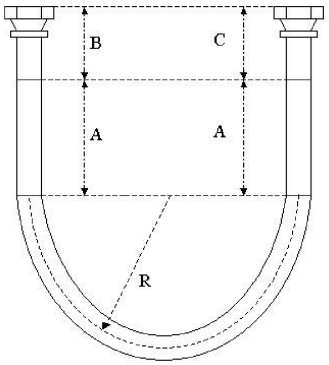


Figure 1 - Effective length of the hose assembly

The hose immediately adjoining the coupling shall remain un-flexed for a length at each side of not less than six (6) times the outside diameter (O.D.) of the hose.

The formula for calculating the effective length of the hose assembly is:

$L = 2A + B + C + \pi R$

Where:

L: Overall Length
A: 6 x O.D.
B: Effective length of attached coupling
C: Effective length of attached coupling
R: minimum bend radius
π: Mathematical constant ~3.14

Extra length needs to be added to the hose to allow for the flexing operation; therefore, the extra length of the hose to be allowed in assembly is represented by M.

The formula for calculating the assembly length is:

$L = 2A + B + C + \pi R + M$

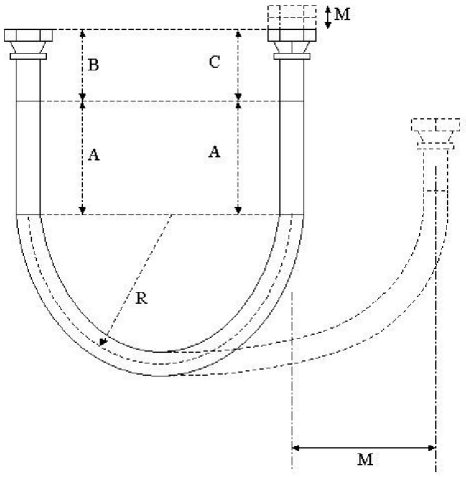


Figure 2 - Extra length for flexing operation

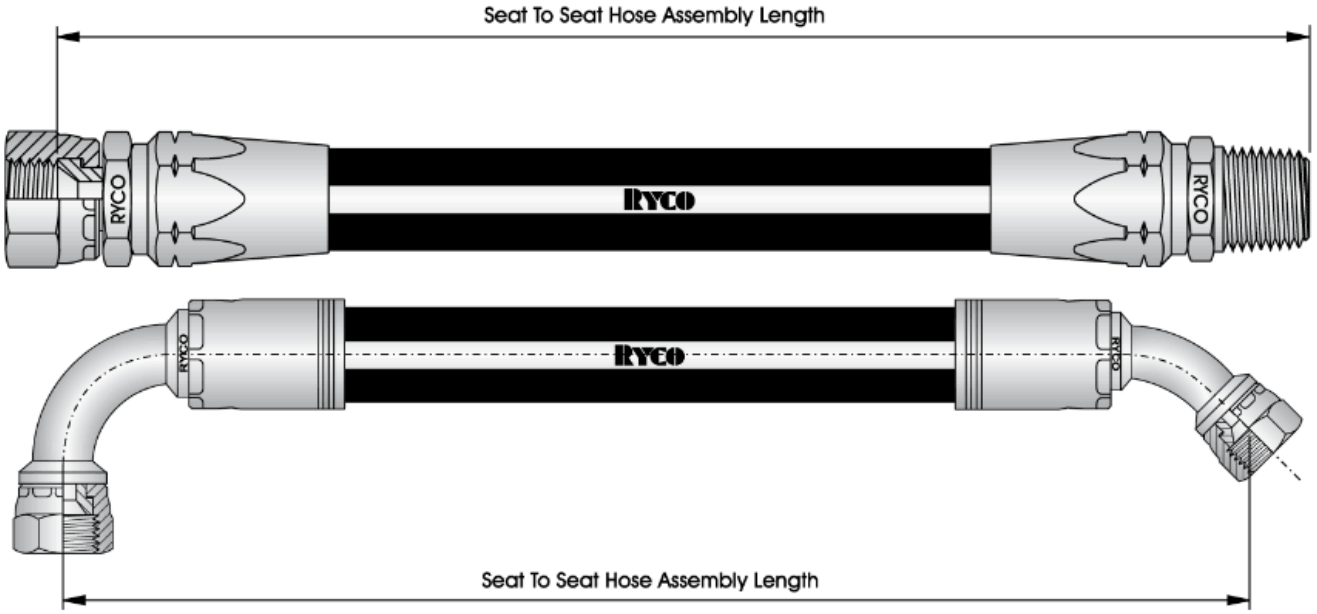
A5 Certification

The Flexible Hose shall be supplied with a certificate, which includes the following as a minimum:

- Manufacturers name
- Manufacturers hose batch number
- Manufacturing standard
- Nominal size
- Unique serial number
- Actual inside and outside diameters
- Materials of construction
- Test pressure
- Proof and burst pressure
- Electrical continuity tests (if applicable)
- Year and month of manufacture
- Fire rating

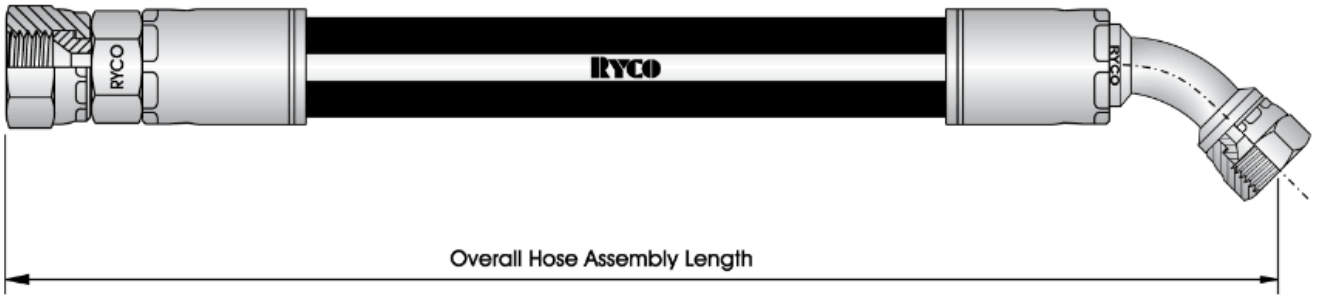
A6 Measuring Flexible Hose Assemblies

- Seat to Seat Length



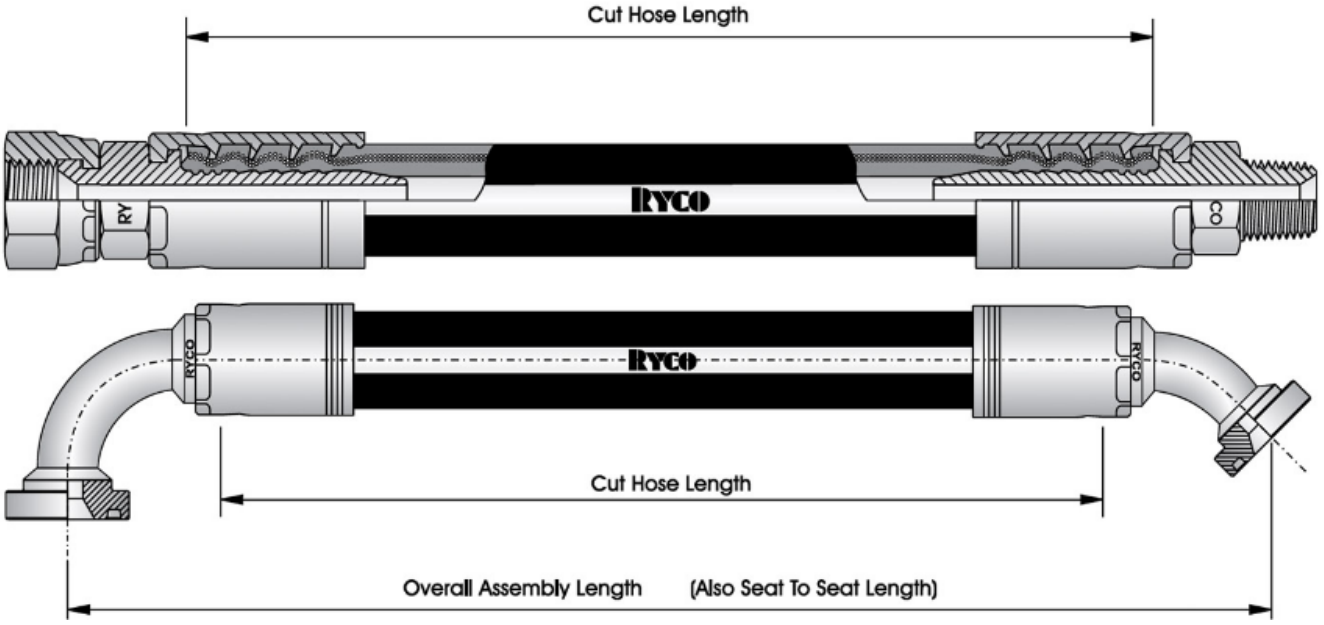
Length is measured from tip of seat to tip of seat.

- Overall Assembly Length



Length is measured from tip of nut to tip of nut.

- Cut Hose Length

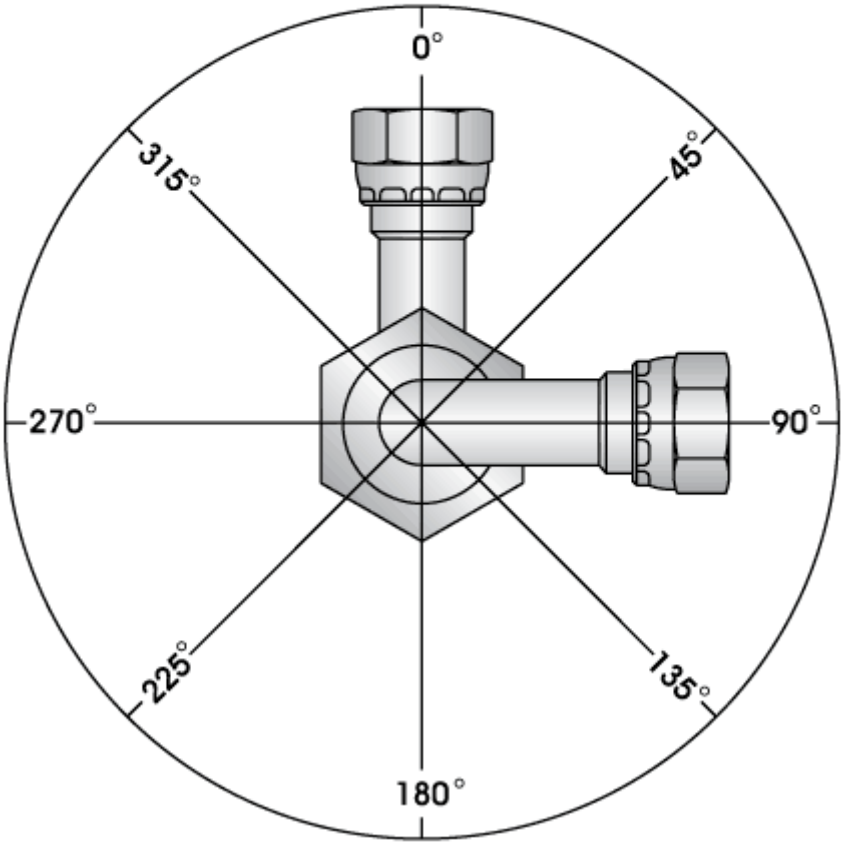


- Hose Orientation

Orientation Tolerances:

± 3° on lengths up to 600 mm (24").

± 5° on lengths over 600 mm (24").



A7 References - Design

Information for this Document was collected from:

- Pirtek Catalogue Sect A – Technical
- SAE J1273 - Recommended Practices for Hydraulic Hose Assemblies
- SAE J517 – Hydraulic Hose
- ISO 8331 - Rubber and plastic hoses and hose assemblies - Guide to selection, storage, use and maintenance
- ISO 3862 - Rubber hoses and hose assemblies - Rubber-covered spiral-wire-reinforced hydraulic types for oil-based or water-based fluids – Specification
- ISO 6802 – Rubber and plastics hoses and hose assemblies with wire reinforcement – Hydraulic impulse test with flexing
- ISO 6803 – Rubber and plastics hoses and hose assemblies – Hydraulic-pressure impulse test without flexing
- ISO 10380 – Pipework – Corrugated metal hoses and hose assemblies
- Flexible Hose Management Guidelines by Health and Safety Executive (HSE) and Institute of Petroleum (IP)

- AS 3791-1991 – Hydraulic Hose
- AS 1180 – Method of Test for Hose made from Elastomeric Materials
- AS 1179-1972 – Glossary of Terms for Rubber Hose
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- AS/NZS 2554:1998 – Hosen and Hose Assemblies for Air
- AS/NZS 3499:2006 – Water Supply - Flexible Hose Assemblies

APPENDIX B - INSTALLATION

B1 General

Flexible hoses are to be:

- neat and tidy, with minimal crossover to eliminate rubbing.
- mechanically protected from damage in high wear or impact areas.
- connected to adaptors which allow for full articulation for the intended movement.
- the correct length as required for the intended movement.
- routed to prevent coming into contact with sharp edges or other surfaces that may wear the hose cover.
- protected from shock or surge pressures which exceed the manufacturer's recommendations.
- properly supported and not allowed to hang between equipment, vessels, plant or installations that can move and cause the hose to become over-bent or trapped.
- installed in clearly visible and readily accessible locations wherever possible.

B2 Supporting

- Hose supports and saddles shall be designed to ensure minimum bend radius is not compromised.
- Single rope slings and wires are not suitable for many support application since they can lead to local kinking, abrasion or non-compliance with minimum bend radius requirements.
- Flexible Hose is to be secure and be adequately supported along the entire length such that external loads are not transferred to the hose end or adaptor.

B3 Load

- Minimise external loads during installation.
- Torsion can be reduced by using Swivel type fittings
- Hose assemblies are designed for internal forces only, they shall not be used in applications which apply external forces to the hose or hose end.

B4 Length

In general, flexible hoses are to be limited to a length necessary to provide for relative movement between fixed and flexibly mounted items of machinery, equipment or systems.

- Only correctly sized hose lengths shall be used
- Incorrectly sized hoses will stress end connections

B5 Routing

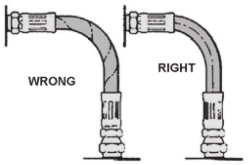
- Route hose assemblies in straight lines following the contours of the equipment on which they are used.
- Use brackets and clamps to secure hoses in position and to prevent excessive rubbing and abrasion. Cable trays with a suitable load rating may also be used for the support and routing of flexible hose assemblies.
- Use elbow couplings to provide more direct routing thus reducing the amount of hose in the system.
- Swivel adaptors may be used for dynamic assemblies to reduce stress. For assemblies with threaded fittings, swivel type adaptors must be used to ensure that no twist is put into the hose during installation or service.
- Hoses containing flammable or toxic materials shall not be routed through normal working areas.
- Do not overlap hoses.
- Avoid contact with sharp edges or moving parts.
- The recommended minimum bend radius must not be exceeded. It shall be noted that a fitting is not a flexible part of the assembly.

- To prevent twisting, the hose shall be bent in the same plane as the motion of the item to which it is connected.
- Hoses shall be routed away from hot manifolds or other high outside temperature whenever possible. If this is not practical, a protective sleeve or baffle plate shall be installed to protect the hose.
- Ensure that the correct hose length is calculated for both static and flexing conditions.
- A length of straight hose at least twice the inside diameter is required at each end of the unit so that the bend starts away from the end fitting.

B6 Installation - Good Practice Guidelines.

B6.1 General

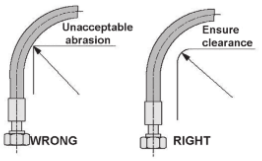
- Use the ley line to determine that no twist has been induced when tightening. Use 2 spanners to counteract twist.



Use the layline to determine that no twist has been induced when tightening. Use 2 spanners to counteract twist

Figure 1 – Hose twist

- Avoid sharp corners

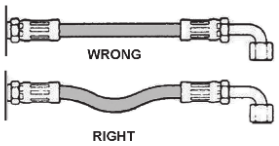


Avoid sharp corners

Figure 2 – Sharp corners

Fixed Applications

- Sufficient slack hose shall be allowed for in order to compensate for any contraction in length. Hose under pressure may reduce in length.



Length may vary +2% to -4% when pressure is applied
Allow enough slack to accommodate this movement

Figure 3 – Hose length

- Excessive hose lengths shall not be used, as this often results in too many bends being employed.

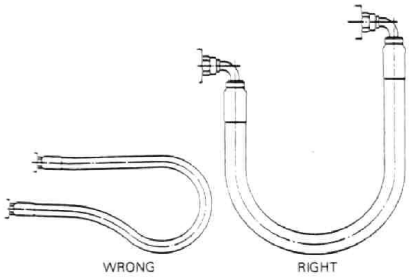
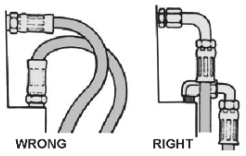


Figure 4 – Excessive hose length

- Should there be a risk of abrasion from rough or sharp edges, moving parts etc. hoses shall be re-routed or clamps used where necessary to keep it clear. Secondary to this, consideration shall be given to abrasion sleeve or spiral wrap to the hose assemblies.

- Where sharp changes in direction are required, elbow hose ends shall be used. This avoids space congestion and does not stress the hose.

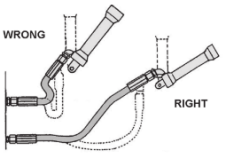


Use elbows and adaptors to relieve strain and allow neater installations for easier accessibility and maintenance

Figure 5 – Use of elbow couplings

B6.2 Flexing Applications

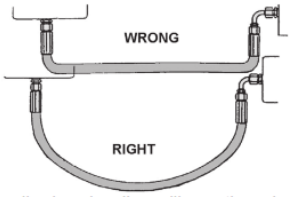
- Sufficient hose length shall be allowed to permit required movement.



Remember that the metal hose fittings are not part of the flexible portion. Allow ample free length for flexing

Figure 6 – Flexing applications

- Hose shall not be bent to less than its minimum bend radius at the point of flexing.



Using too small a bend radius will greatly reduce hose life, and may cause line collapse and flow restriction

Figure 7 – Hose Bend

- Avoid whenever possible hose bends in two planes. If this is not possible clamps shall be used.

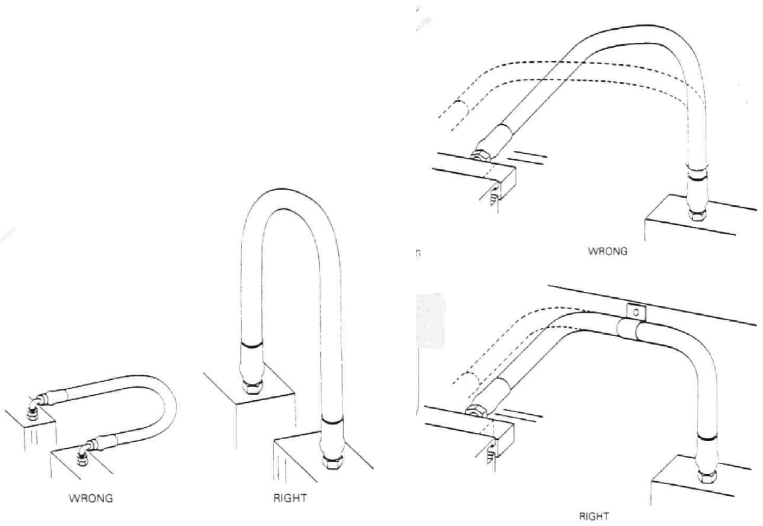


Figure 8 – Bends in two plans

B6.3 Hose Restraints

Flexible hose restraints, or whip checks, can be used at hose to equipment or hose to hose attachment points. They are safety devices designed to restrain a flexible hose that has parted at the couplings in an uncontrolled manner. These devices are designed to reduce, dissipate and in some cases stop the energy that is produced when two hoses come apart under pressure should the coupling fail.

The following guidelines are recommended as a minimum for the use of hose restraints:

- Whip checks shall be used on all non-fixed hose assemblies.
- Whip checks shall be used on all fixed hose assemblies which are located in an area where there is an appreciable risk of injury to personnel if the hose detaches from the coupling.

Figure 9 – Metal whip check

Figure 10 – Nylon whip check

In order for hose restraints to be effective, they must be correctly specified, and well maintained. There are a number of industry examples of serious hose failures resulting in injury, despite the fact that hose restraints were fitted. The following guidelines are presented to help ensure correct functioning of the restraints:

- Restraints are visually inspected each time they are used. Evidence of frayed cables, or ferrule damage shall be cause for rejection of the restraint.

- When fitting restraints, care shall be taken to avoid contact with sharp edges on the hose coupling (e.g. bolted clamps) and on the equipment (e.g. flange edges).
- Where movement of the hose is not required, hoses shall be lashed to rigid structure in order to contain them in the event of a failure of the hose restrains. Lashing shall be as close as possible to connections so as to minimise the length of the free end.

B6.4 Cleaning and Flushing

All components used in a system shall be cleaned and flushed prior to use, to prevent debris being carried to other parts of the system and causing damage.

B6.5 Post Installation Inspection

The installed hose assembly shall be inspected for:
- Visual evidence of leaks. For hoses that carry air/gas spray soapy water on the connection and on the hose and watch for bubbles, do not immerse in water;
- External damage on cover or Braids;
- Cracked, damaged or badly corroded hose ends;
- Wrong bend radius;
- Incorrect hose routing;
- Incorrect length of hose.

If any of these conditions exist, the hose assemblies shall be replaced.

B6.6 Pressure testing

- The test pressure shall be 150% of the design working pressure unless the hose remains connected to a system protected by a relief valve, in this case 95% design pressure shall be used;
- Personnel involved with the control of pressure testing must be aware of the hazards associated with, and experienced in the procedures and precautions required when, pressure testing any equipment.

B6.7 Electrical

The installation should be checked for electrical continuity or earthing if applicable.

B7 References - Installation

Information for this document was collected from:
- Pirtek Catalogue Sect A – Technical
- SAE J1273 - Recommended Practices for Hydraulic Hose Assemblies
- ISO 8331 - Rubber and plastic hoses and hose assemblies - Guide to selection, storage, use and maintenance
- Flexible Hose Management Guidelines by Health and Safety Executive (HSE) and Institute of Petroleum (IP)
- AS 3791-1991 – Hydraulic Hose
- AS 1180 – Method of Test for Hose made from Elastomeric Materials
- AS 1179-1972 – Glossary of Terms for Rubber Hose
- AS 1257-1973 – Bore Sizes, Test Pressures and Tolerances on Length of Elastomeric Hose
- AS/NZS 1869:2012 – Hose and Hose Assemblies for Liquefied Petroleum Gases (LP Gas), Natural Gas and Town Gas
- AS/NZS 2554:1998 – Hose and Hose Assemblies for Air
- AS/NZS 3499:2006 – Water Supply - Flexible Hose Assemblies

APPENDIX C - INSPECTION GUIDELINES AND REJECTION CRITERIA

C1 Inspection

Hoses shall be located and visually examined for the following with observations recorded in the work order history.

- Air or liquid leaking from hose or fittings
- Blisters, looseness or surface cracks on the outer cover
- Kinks, indentations or flattening of the hose
- Wear or abrasion causing penetration of the outer cover
- Broken or corroded braids
- Partial displacement from original coupling-hose connection position
- Loose coupling
- Electrical continuity
- Severe deterioration of the cover material
- Over bending near end connections and along the length of the hose
- Illegible tag or tag missing required information

C2 Cleaning

During visual inspection, if there is material buildup on the outer cover or if the hose exhibits severe discolouration, the system is to be de-energised and the hose cleaned and inspected for signs of deterioration as listed in the Inspection section above.

C3 Rejection

Hoses shall be rejected and replaced with an assembly conforming with the required specifications if they exhibit any of the physical attributes listed in C1 Inspection.