



- Subject:** Inspection, testing and replacement requirements for fluid power system (hydraulic) flexible hoses on Domestic Commercial Vessels - roles and responsibilities.
- General:** This instruction provides guidance on the requirements for inspection, testing and replacement of flexible hydraulic hoses fitted on-board Domestic Commercial Vessels (DCV's).
- Background:** A recent fire on a DCV was caused by the failure of a flexible hydraulic hose which allowed pressurised hydraulic fluid to ignite on the exhaust manifold or turbo charger on one of the main propulsion engines. The subsequent investigation identified a number of operational, procedural and administrative failures which all contributed to the causal factors and ultimately resulted in the fire on-board.
- Issue:** The investigation identified that the failed hose was not part of any regular inspection regime conducted by either the crew or maintenance personnel. Notwithstanding, these items were listed on the crew daily checklist and noting the critical nature of the hose function as part of the hydraulic drive propulsion system. Investigations following the fire identified that the hose appeared to be the original hose that was installed when the vessel was built in 1995 and had not been properly inspected, tested or replaced in the intervening period. Unfortunately an opportunity was missed to remedy this when the engine was replaced two months prior to the fire and the original hydraulic hoses were re-installed following the installation of the new engine.

Safety Management Systems (SMS):

Owners, masters and crew have general safety duties to ensure that the vessel operation is so far as is reasonably practicable, safe which includes ensuring the validity, safe operation and maintenance of marine equipment and systems. All owners of DCV's are obliged to implement and maintain a safety management system that complies with the *National Standard for Commercial Vessel - Parts E or F*. As part of the risk assessment process, which will assist to determine inspection and servicing schedules, it should become clear what level of daily, monthly and other checks are required to ensure the operation remains safe.

In this circumstance, despite the hoses being included on the daily check list, the poor condition of this hose, and others, was not identified and neither was it scheduled for inspection or periodic replacement by the maintenance organisation. This incident has highlighted a failure of the SMS which did not adequately identify the risk of failure of a critical system component, nor prescribe appropriate mitigation strategies. Critically the vessels fire protection systems did not function. The fire alarm did not sound, vents to the engine space were seized and could not be closed and the remote activation mechanism for the fire suppression system did not function. The same deficiencies in the fire protection systems were evident during a fire on the same vessel two weeks prior to the most recent fire, but were not rectified.

The framework to ensure the operability and reliability of the fire protection systems were ineffective. There were gaps in the system that relied on a combination of owner inspection and maintenance, third party certification and regulatory oversight. The initial response to the fire by the crew highlighted, the absence of/or ignorance of promulgated emergency procedures, the lack of knowledge of the fixed firefighting system initiating procedure, the serviceability of essential items of safety equipment, the poor material condition of the vessel, an apparent lack of training or the failure to conduct emergency drills and the failure to select and use the most appropriate first aid appliance when the fire was first discovered. The resource and crew training requirements are contained within paragraph 6 of Part E – Operations and are reproduced below;

6 Resources and personnel

Training of crew

- (1) *The owner of a vessel must ensure that each crew member receives the following training:*
 - (a) *as soon as practicable after joining the vessel and before commencing duties — initial safety training that familiarises the person with safety matters about the person's presence and duties on board the vessel;*
 - (b) *sufficient training in key on-board operations to establish, maintain and*

verify the competence and capacity of the person to safely carry out assigned duties;
(c) sufficient training in emergency procedures to establish, maintain and verify the ability of the person to respond rapidly and effectively in an emergency and to follow the emergency plan.

Owners and operators should periodically review, and if necessary, update their SMS to ensure that it is both current and relevant to their individual vessels and operations.

Instructions: It is timely to remind vessel operators of the need to include regular inspection and scheduled replacement of hydraulic flexible hoses into both periodic inspections undertaken by designated members of the crew and also scheduled or planned maintenance regimes in line with manufacturers recommendations or the relevant Australian Standards. The requirements for Hydraulic Power Systems for DCVs are specified in the *National Standard for Commercial Vessels - Part C, Section C5A – Machinery (NSCV C5A)*. The application and installation of, and the fittings for, hydraulic hose and piping is to comply with the manufacturer's instructions. Unless otherwise provided for in NSCV C5A, Clause 7.9.5, hydraulic hose must comply with AS3791, and hydraulic piping is to comply with AS4041.

INSPECTION REQUIREMENTS

All flexible hydraulic hoses should be subjected to regular inspections as specified in the relevant planned maintenance routines or as specified in the manufacturer's literature. Additional criterion for rejection of hoses over and above any that may be referenced in planned maintenance documentation is also provided below.

Hose In-service Inspections

Periodic visual inspections should be made of all installed flexible hydraulic hose assemblies for signs of physical damage. This periodicity should be in accordance with the appropriate planned maintenance requirements, but should be at least annually. Inspection of assemblies whilst subject to system pressure is desirable, must be limited to those locations where personnel safety is not placed at unacceptable risk. Hose assemblies found to be defective or due for life expiry should be replaced at the first opportunity. Hoses should be correctly routed to avoid undue external stress from:

- mechanical loads, tensile, side loads
- abrasion and rubbing from insufficient clearance
- flattening
- kinking and minimum bend radii
- twisting
- thread and seal damage
- equipment mobility

All hose assemblies should be visually inspected for the following:

- visual evidence of leaks along the hose or around the hose ends
- damaged, abraded, or corroded braid; or broken braid wires
- cracked, damaged, or badly corroded hose ends
- wrong bend radius
- outer sheath damage
- incorrect hose routing
- incorrect length of hose
- kinked crushed or flattened hose
- hard, stiff, charred, blistered, soft, degraded hose
- fitting thread is damaged
- any signs of exposed wire
- functional testing of devices

Where any of the above conditions exist, the hose assemblies should be replaced. The period of inspections should be consistent with the hose duty and operating environment but should not be less than 12 months.

HOSE LIFE REQUIREMENTS

Polytetrafluoroethylene (PTFE), Thermoplastic and Metal Hose

These hose materials do not normally degrade from exposure to atmospheric conditions and they are not subject to any shelf or service life limitations, except where recommended by the manufacturer or as determined by periodic inspections and any subsequent hydrostatic tests; or as required in accordance with the appropriate planned maintenance requirements.

Synthetic Rubber Hose

Synthetic rubber deteriorates, both in storage and in use, and ultimately becomes unserviceable. Therefore the following shelf and service life is specified so that the optimum life may be obtained from these hoses:

Shelf Life

The shelf life for rubber hose, either in bulk form or as a hose assembly, is four years (16 quarters) from the date of manufacture not counting the quarter of manufacture. For example, a hose manufactured in the second quarter of 1998, denoted as 2Q98 at repetitive intervals on the lay line, has a shelf life that ends on the 30th of September 2002.

Service Life

The service life is determined by the criticality of the system in which it is installed. For critical systems the service life is a maximum of 12 years. For non-critical systems it is as determined by condition based monitoring (CBM). Service life begins from the date of installation to the fitted system or equipment. This date may mark an event such as system hydrostatic test, date system filled with fluid, system start up, etc.

Rubber Hose Rejection

Irrespective of the results obtained from any other inspection, any of the following conditions should be cause for rejection of rubber hoses;

- cover rubbed thin by abrasion or chafing,
- cracking, blistering or hardening of the cover due to ageing or exposure to the elements,
- soft spots or bulges of the cover which would indicate weakening of the adhesive bond between the cover and carcass or deterioration of the reinforcing wire, or
- the life period expires before the next scheduled inspection

PTFE Hose Rejection

Irrespective of the results obtained from any other inspection, any of the following conditions should be cause for rejection of PTFE hoses;

- twenty or more wires of the external wire braid broken or corroded through at random
- any gouge or cut involving four or more adjacent wires, or
- tube showing signs of cracking, blistering, splitting or other signs of failure

Thermoplastic Hose Rejection

Irrespective of the results obtained from any other inspection, the following conditions should be cause for rejection of thermoplastic hoses;

- cover rubbed thin by abrasion or chafing, or
- tube showing signs of cracking, blistering, splitting or other signs of failure

Metal Hose Rejection

Irrespective of the results obtained from any other inspection, the following conditions should be cause for rejection of metal hoses:

- twenty or more wires of the external braid broken or corroded through at random or;
- any gouge or cut involving four or more adjacent wires

RECORDING OF INFORMATION

In line with current best practice, the person responsible for vessel maintenance should maintain a register of all fitted flexible hose assemblies in which the following minimum information should be recorded for each individual hose assembly:

- a unique identifier,
- position/assembly where fitted,
- test pressure,
- date last tested,
- hose type and size, and
- hose cure date

The person responsible for vessel maintenance should ensure that the register is up to date in all respects and ensure that records are updated each time any of the listed register items are altered or replaced.

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