S14 Testing Procedures of Watertight Compartments

(1996) (Rev.1 Feb 2001) (Rev.2 May 2001) (Rev.3 May 2010) (Rev.4 Aug 2012) (Rev.5 Jan 2015)

S14.1 Application

Revision 5 of this UR is to be complied with in respect of the testing of watertight compartments in accordance with Notes 1, 2 and 3.

S14.2 General

Testing procedures of watertight compartments is to be carried out in accordance with ANNEX I, the “PROCEDURES FOR TESTING TANKS AND TIGHT BOUNDARIES”.

Notes:

1. Revision 4 of this UR is to be applied by IACS Societies to ships contracted for construction on or after 1 July 2013.

2. Revision 5 of this UR is to be applied by IACS Societies to ships contracted for construction on or after 1 January 2016.

3. The “contracted for construction” date means the date on which the contract to build the vessel is signed between the prospective owner and the shipbuilder. For further details regarding the date of “contract for construction”, refer to IACS Procedural Requirement (PR) No. 29.

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ANNEX I

PROCEDURES FOR TESTING TANKS AND TIGHT BOUNDARIES

1 GENERAL

These test procedures are to confirm the watertightness of tanks and watertight boundaries and the structural adequacy of tanks which consist of the watertight subdivisions of ships. These procedures may also be applied to verify the weathertightness of structures and shipboard outfitting. The tightness of all tanks and watertight boundaries of ships during new construction and those relevant to major conversions or major repairs[1] is to be confirmed by these test procedures prior to the delivery of the ship.

2 APPLICATION

2.1 All gravity tanks[2] and other boundaries required to be watertight or weathertight are to be tested in accordance with this Procedure and proven to be tight and structurally adequate as follows:

1. Gravity Tanks for their tightness and structural adequacy,

2. Watertight Boundaries Other Than Tank Boundaries for their watertightness, and

3. Weathertight Boundaries for their weathertightness.

2.2 The testing of cargo containment systems of liquefied gas carriers is to be in accordance with standards deemed appropriate by the Classification Society.

2.3 The testing of structures not listed in Table 1 or 2 is to be specially considered.

3 TEST TYPES AND DEFINITIONS

3.1 The following two types of tests are specified in this requirement:

Structural Test:

A test to verify the structural adequacy of tank construction. This may be a hydrostatic test or, where the situation warrants, a hydropneumatic test.

Leak Test:

A test to verify the tightness of a boundary. Unless a specific test is indicated, this may be a hydrostatic/hydropneumatic test or an air test. A hose test may be considered an acceptable form of leak test for certain boundaries, as indicated by Footnote 3 of Table 1.

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[1] Major repair means a repair affecting structural integrity.
[2] Gravity tank means a tank that is subject to vapour pressure not greater than 70 kPa.

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3.2 The definition of each test type is as follows:

Hydrostatic Test: *(Leak and Structural)*	A test wherein a space is filled with a liquid to a specified head.
Hydropneumatic Test: *(Leak and Structural)*	A test combining a hydrostatic test and an air test, wherein a space is partially filled with a liquid and pressurized with air.
Hose Test: *(Leak)*	A test to verify the tightness of a joint by a jet of water with the joint visible from the opposite side.
Air Test: *(Leak)*	A test to verify tightness by means of air pressure differential and leak indicating solution. It includes tank air test and joint air tests, such as *compressed air fillet weld tests* and *vacuum box tests*.
Compressed Air Fillet Weld Test: *(Leak)*	An air test of fillet welded tee joints wherein leak indicating solution is applied on fillet welds.
Vacuum Box Test: *(Leak)*	A box over a joint with leak indicating solution applied on the welds. A vacuum is created inside the box to detect any leaks.
Ultrasonic Test: *(Leak)*	A test to verify the tightness of the sealing of closing devices such as hatch covers by means of ultrasonic detection techniques.
Penetration Test: *(Leak)*	A test to verify that no visual dye penetrant indications of potential continuous leakages exist in the boundaries of a compartment by means of low surface tension liquids (i.e. dye penetrant test).

4 TEST PROCEDURES

4.1 General

Tests are to be carried out in the presence of a Surveyor at a stage sufficiently close to the completion of work with all hatches, doors, windows, etc. installed and all penetrations including pipe connections fitted, and before any ceiling and cement work is applied over the joints. Specific test requirements are given in 4.4 and Table 1. For the timing of the application of coating and the provision of safe access to joints, see 4.5, 4.6 and Table 3.

4.2 Structural test procedures

4.2.1 Type and time of test

Where a structural test is specified in Table 1 or Table 2, a hydrostatic test in accordance with 4.4.1 will be acceptable. Where practical limitations (strength of building berth, light density of liquid, etc.) prevent the performance of a hydrostatic test, a hydropneumatic test in accordance with 4.4.2 may be accepted instead.

A hydrostatic test or hydropneumatic test for the confirmation of structural adequacy may be carried out while the vessel is afloat, provided the results of a leak test are confirmed to be satisfactory before the vessel is afloat.

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4.2.2 Testing Schedule for New Construction or Major Structural Conversion

4.2.2.1 The tank boundaries are to be tested from at least one side. The tanks for structural test are to be selected so that all representative structural members are tested for the expected tension and compression.

4.2.2.2 Structural tests are to be carried out for at least one tank of a group of tanks having structural similarity (i.e. same design conditions, alike structural configurations with only minor localised differences determined to be acceptable by the attending Surveyor) on each vessel provided all other tanks are tested for leaks by an air test. The acceptance of leak testing using an air test instead of a structural test does not apply to cargo space boundaries adjacent to other compartments in tankers and combination carriers or to the boundaries of tanks for segregated cargoes or pollutant cargoes in other types of ships.

4.2.2.3 Additional tanks may require structural testing if found necessary after the structural testing of the first tank.

4.2.2.4 Where the structural adequacy of the tanks of a vessel were verified by the structural testing required in Table 1, subsequent vessels in the series (i.e. sister ships built from the same plans at the same shipyard) may be exempted from structural testing of tanks, provided that:

1. Water-tightness of boundaries of all tanks is verified by leak tests and thorough inspections are carried out.

2. Structural testing is carried out for at least one tank of each type among all tanks of each sister vessel.

3. Additional tanks may require structural testing if found necessary after the structural testing of the first tank or if deemed necessary by the attending Surveyor.

For cargo space boundaries adjacent to other compartments in tankers and combination carriers or boundaries of tanks for segregated cargoes or pollutant cargoes in other types of ships, the provisions of paragraph 4.2.2.2 shall apply in lieu of paragraph 4.2.2.4.2.

4.2.2.5 Sister ships built (i.e. keel laid) two years or more after the delivery of the last ship of the series, may be tested in accordance with 4.2.2.4 at the discretion of the Classification Society, provided that:

1. general workmanship has been maintained (i.e. there has been no discontinuity of shipbuilding or significant changes in the construction methodology or technology at the yard, shipyard personnel are appropriately qualified and demonstrate an adequate level of workmanship as determined by the Classification Society) and:

2. an enhanced NDT programme is implemented for the tanks not subject to structural tests.

4.2.2.6 For the watertight boundaries of spaces other than tanks structural testing may be exempted, provided that the water-tightness of boundaries of exempted spaces is verified by leak tests and inspections. Structural testing may not be exempt and the requirements for structural testing of tanks in 4.2.2.1 to 4.2.2.5 shall apply, for ballast holds, chain lockers and a representative cargo hold if intended for in-port ballasting.

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4.3 Leak test procedures

For the leak tests specified in Table 1, tank air tests, compressed air fillet weld tests, vacuum box tests in accordance with 4.4.4 through 4.4.6, or their combination, will be acceptable. Hydrostatic or hydropneumatic tests may also be accepted as leak tests provided that 4.5, 4.6 and 4.7 are complied with. Hose tests will also be acceptable for such locations as specified in Table 1, Footnote 3, in accordance with 4.4.3.

Air tests of joints may be carried out in the block stage provided that all work on the block that may affect the tightness of a joint is completed before the test. See also 4.5.1 for the application of final coatings and 4.6 for the safe access to joints and the summary in Table 3.

4.4 Test Methods

4.4.1 Hydrostatic test

Unless another liquid is approved, hydrostatic tests are to consist of filling the space with fresh water or sea water, whichever is appropriate for testing, to the level specified in Table 1 or Table 2.

In cases where a tank for higher density cargoes is to be tested with fresh water or sea water, the testing pressure height is to be specially considered.

All external surfaces of the tested space are to be examined for structural distortion, bulging and buckling, other related damage and leaks.

4.4.2 Hydropneumatic test

Hydropneumatic tests, where approved, are to be such that the test condition, in conjunction with the approved liquid level and supplemental air pressure, will simulate the actual loading as far as practicable. The requirements and recommendations for tank air tests in 4.4.4 will also apply to hydropneumatic tests.

All external surfaces of the tested space are to be examined for structural distortion, bulging and buckling, other related damage and leaks.

4.4.3 Hose test

Hose tests are to be carried out with the pressure in the hose nozzle maintained at least at $2 \cdot 10^5$ Pa during the test. The nozzle is to have a minimum inside diameter of 12 mm and be at a perpendicular distance from the joint not exceeding 1.5 m. The water jet is to impinge directly upon the weld.

Where a hose test is not practical because of possible damage to machinery, electrical equipment insulation or outfitting items, it may be replaced by a careful visual examination of welded connections, supported where necessary by means such as a dye penetrant test or ultrasonic leak test or the equivalent.

4.4.4 Tank air test

All boundary welds, erection joints and penetrations, including pipe connections, are to be examined in accordance with approved procedure and under a stabilized pressure differential above atmospheric pressure not less than $0.15 \cdot 10^5$ Pa, with a leak indicating solution such as soapy water/detergent or a proprietary brand applied.

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A U-tube with a height sufficient to hold a head of water corresponding to the required test pressure is to be arranged. The cross sectional area of the U-tube is not to be less than that of the pipe supplying air to the tank. Instead of using a U-tube, two calibrated pressure gauges may be acceptable to verify required test pressure.

A double inspection is to be made of tested welds. The first is to be immediately upon applying the leak indication solution; the second is to be after approximately four or five minutes in order to detect those smaller leaks which may take time to appear.

4.4.5 Compressed air fillet weld test

In this air test, compressed air is injected from one end of a fillet welded joint and the pressure verified at the other end of the joint by a pressure gauge. Pressure gauges are to be arranged so that an air pressure of at least $0.15 \cdot 10^5$ Pa can be verified at each end of all passages within the portion being tested.

Note: Where a leak test is required for fabrication involving partial penetration welds, a compressed air test is also to be applied in the same manner as to fillet weld where the root face is large, i.e., 6-8 mm.

4.4.6 Vacuum box test

A box (vacuum testing box) with air connections, gauges and an inspection window is placed over the joint with a leak indicating solution applied to the weld cap vicinity. The air within the box is removed by an ejector to create a vacuum of $0.20 \cdot 10^5 – 0.26 \cdot 10^5$ Pa inside the box.

4.4.7 Ultrasonic test

An ultrasonic echo transmitter is to be arranged inside of a compartment and a receiver is to be arranged on the outside. The watertight/weathertight boundaries of the compartment are scanned with the receiver in order to detect an ultrasonic leak indication. A location where sound is detectable by the receiver indicates a leakage in the sealing of the compartment.

4.4.8 Penetration test

A test of butt welds or other weld joints uses the application of a low surface tension liquid at one side of a compartment boundary or structural arrangement. If no liquid is detected on the opposite sides of the boundaries after the expiration of a defined period of time, this indicates tightness of the boundaries. In certain cases, a developer solution may be painted or sprayed on the other side of the weld to aid leak detection.

4.4.9 Other test

Other methods of testing may be considered by each Classification Society upon submission of full particulars prior to the commencement of testing.

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4.5 Application of coating

4.5.1 Final coating

For butt joints welded by an automatic process, the final coating may be applied any time before the completion of a leak test of spaces bounded by the joints, provided that the welds have been carefully inspected visually to the satisfaction of the Surveyor.

Surveyors reserve the right to require a leak test prior to the application of final coating over automatic erection butt welds.

For all other joints, the final coating is to be applied after the completion of the leak test of the joint. See also Table 3.

4.5.2 Temporary coating

Any temporary coating which may conceal defects or leaks is to be applied at the time as specified for the final coating (see 4.5.1). This requirement does not apply to shop primer.

4.6 Safe access to joints

For leak tests, safe access to all joints under examination is to be provided. See also Table 3.

4.7 Hydrostatic or hydropneumatic tightness test

In cases where the hydrostatic or hydropneumatic tests are applied instead of a specific leak test, examined boundaries must be dew-free, otherwise small leaks are not visible.

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Table 1
Test Requirements for Tanks and Boundaries

	Tank or boundary to be tested	Test type	Test head or pressure	Remarks
1	Double bottom tanks[4]	Leak and structural[1]	The greater of - top of the overflow, - to 2.4m above top of tank[2], or - to bulkhead deck	
2	Double bottom voids[5]	Leak	See 4.4.4 through 4.4.6, as applicable	including pump room double bottom and bunker tank protection double hull required by MARPOL Annex I
3	Double side tanks	Leak and structural[1]	The greater of - top of the overflow, - to 2.4m above top of tank[2], or - to bulkhead deck	
4	Double side voids	Leak	See 4.4.4 through 4.4.6, as applicable	
5	Deep tanks other than those listed elsewhere in this table	Leak and structural[1]	The greater of - top of the overflow, or - to 2.4m above top of tank[2]	
6	Cargo oil tanks	Leak and structural[1]	The greater of - top of the overflow, - to 2.4m above top of tank[2], or - to top of tank[2] plus setting of any pressure relief valve	
7	Ballast hold of bulk carriers	Leak and structural[1]	Top of cargo hatch coaming	
8	Peak tanks	Leak and structural[1]	The greater of - top of the overflow, or - to 2.4m above top of tank[2]	After peak to be tested after installation of stern tube
9	.1 Fore peak spaces with equipment	Leak	See 4.4.3 through 4.4.6, as applicable	
	.2 Fore peak voids	Leak and structural[1, 9]	To bulkhead deck	
	.3 Aft peak spaces with equipment	Leak	See 4.4.3 through 4.4.6, as applicable	
	.4 Aft peak voids	Leak	See 4.4.4 through 4.4.6, as applicable	After peak to be tested after installation of stern tube
10	Cofferdams	Leak	See 4.4.4 through 4.4.6, as applicable	

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	Tank or boundary to be tested	Test type	Test head or pressure	Remarks
11	.1 Watertight bulkheads	Leak[8]	See 4.4.3 through 4.4.6, as applicable[7]	
	.2 Superstructure end bulkheads	Leak	See 4.4.3 through 4.4.6, as applicable	
12	Watertight doors below freeboard or bulkhead deck	Leak[6, 7]	See 4.4.3 through 4.4.6, as applicable	
13	Double plate rudder blades	Leak	See 4.4.4 through 4.4.6, as applicable	
14	Shaft tunnels clear of deep tanks	Leak[3]	See 4.4.3 through 4.4.6, as applicable	
15	Shell doors	Leak[3]	See 4.4.3 through 4.4.6, as applicable	
16	Weathertight hatch covers and closing appliances	Leak[3, 7]	See 4.4.3 through 4.4.6, as applicable	Hatch covers closed by tarpaulins and battens excluded
17	Dual purpose tanks/dry cargo hatch covers	Leak[3, 7]	See 4.4.3 through 4.4.6, as applicable	In addition to structural test in item 6 or 7
18	Chain lockers	Leak and structural[1]	Top of chain pipe	
19	L.O. sump. tanks and other similar tanks/spaces under main engines	Leak	See 4.4.3 through 4.4.6, as applicable	
20	Ballast ducts	Leak and structural[1]	The greater of - ballast pump maximum pressure, or - setting of any pressure relief valve	
21	Fuel Oil Tanks	Leak and structural[1]	The greater of - top of the overflow, - to 2.4m above top of tank[2], or - to top of tank[2] plus setting of any pressure relief valves, or - to bulkhead deck	

Notes:

1 “Refer to section 4.2.2”

2 The top of a tank is the deck forming the top of the tank, excluding any hatchways.

3 *Hose Test* may also be considered as a medium of the test. See 3.2.

4 Including tanks arranged in accordance with the provisions of SOLAS regulation II-1/9.4.

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5 Including duct keels and dry compartments arranged in accordance with the provisions of SOLAS regulation II-1/11.2 and II-1/9.4 respectively, and/or oil fuel tank protection and pump room bottom protection arranged in accordance with the provisions of MARPOL Annex I, Chapter 3, Part A regulation 12A and Chapter 4, Part A, regulation 22 respectively.

6 Where water tightness of a watertight door has not been confirmed by prototype test, testing by filling watertight spaces with water is to be carried out. See SOLAS regulation II-1/16.2 and MSC/Circ.1176.

7 As an alternative to the hose testing, other testing methods listed in 4.4.7 through 4.4.9 may be applicable subject to adequacy of such testing methods being verified. See SOLAS regulation II-1/11.1. For watertight bulkheads (item 11.1) alternatives to the hose testing may only be used where a hose test is not practicable.

8 A “Leak and structural test”, see 4.2.2 is to be carried out for a representative cargo hold if intended for in-port ballasting. The filling level requirement for testing cargo holds intended for in-port ballasting is to be the maximum loading that will occur in-port as indicated in the loading manual.

9 Structural test may be waived where demonstrated to be impracticable to the satisfaction of the Classification Society.

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Table 2
Additional Test Requirements for Special Service Ships/Tanks

	Type of Ship/Tank	Structures to be tested	Type of Test	Test Head or Pressure	Remarks
1	Liquefied gas carriers	Integral tanks	Leak and structural	Refer to UR G1	
		Hull structure supporting membrane or semi-membrane tanks			
		Independent tanks type A			
		Independent tanks type B			
		Independent tanks type C		Refer to UR G2	
2	Edible liquid tanks	Independent tanks	Leak and structural	The greater of - top of the overflow, or - to 0.9m above top of tank[1]	
3	Chemical carriers	Integral or independent cargo tanks	Leak and structural	The greater of - to 2.4m above top of tank[1], or - to top of tank[1] plus setting of any pressure relief valve	Where a cargo tank is designed for the carriage of cargoes with specific gravities larger than 1.0, an appropriate additional head is to be considered

Note:

1 Top of tank is deck forming the top of the tank excluding any hatchways.

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Table 3
Application of Leak Test, Coating and Provision of Safe Access
For Type of Welded Joints

Type of welded joints		Leak test	Coating[1]		Safe Access[2]	
			Before leak test	After leak test but before structural test	Leak test	Structural test
Butt	Automatic	Not required	Allowed[3]	N/A	Not required	Not required
	Manual or Semi-automatic[4]	Required	Not allowed	Allowed	Required	Not required
Fillet	Boundary including penetrations	Required	Not allowed	Allowed	Required	Not required

Notes:

1 Coating refers to internal (tank/hold coating), where applied, and external (shell/deck) painting. It does not refer to shop primer.

2 Temporary means of access for verification of the leak test.

3 The condition applies provided that the welds have been carefully inspected visually to the satisfaction of the Surveyor.

4 Flux Core Arc Welding (FCAW) semiautomatic butt welds need not be tested provided that careful visual inspections show continuous uniform weld profile shape, free from repairs, and the results of NDE testing show no significant defects.

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