Section 4.4. Leak Detection of Storage Tanks and Piping Systems

4.4.1. General

4.4.1.1. Application

1) Except as provided in Sentence (2) and except as otherwise specified in this Code, this Section provides the minimum requirements regarding the detection of leaks in aboveground and underground *storage tanks*, piping systems and sumps.

2) This Section shall not apply to *storage tanks* that have been taken out of service in compliance with the applicable provisions of Subsection 4.3.16.

4.4.1.2. Frequency and Methods of Leak Detection Testing and Monitoring

1) Every *storage tank*, piping system and sump, including those at *fuel-dispensing stations*, shall be tested and monitored for leaks in conformance with Tables 4.4.1.2.-A to 4.4.1.2.-E, which establish the minimum requirements regarding the frequency and methods to be used for

a) commissioning testing,

b) subsequent in-service monitoring, and

c) testing when a leak is suspected.

(See Note A-4.4.1.2.(1).)

2) The methods referred to in Sentence (1) shall conform to Subsections 4.4.2. to 4.4.4.

3) The commissioning testing referred to in Sentence (1) shall be performed at the time of installation

a) once backfill and surfacing have been completed but before being put into service, in the case of an underground *storage tank* or underground piping system,

b) before being put into service, in the case of an aboveground *storage tank* or exposed piping system, and

c) once the final surface materials have been installed but before being put into service, in the case of a sump.

4) The frequency of the in-service monitoring referred to in Sentence (1) shall be calculated from the date of the commissioning test.

5) Immediate action shall be taken when a leak is suspected and the leak detection testing referred to in Sentence (1) shall be performed if

a) a loss of liquid or a gain of water is indicated by any of the leak detection measures described in this Section, or

b) the level of water at the bottom of an underground *storage tank* exceeds 50 mm.

6) Where *dispenser sumps*, *transition sumps* and *turbine sumps* are provided with electronic monitoring devices in accordance with Sentence 4.3.9.3.(1), the devices shall be interlocked with the dispenser or pump to shut it down upon detection of either product or a high liquid level.

7) The minimum requirements referred to in Sentence (1) shall not preclude the appropriate use of alternative solutions, innovative new technologies, or methods capable of achieving the same objectives.(See Note A-4.4.1.2.(7).)

Table 4.4.1.2.-A
Leak Detection Testing and Monitoring of Underground Storage Tanks
Forming Part of Sentences 4.4.1.2.(1) and 4.4.2.1.(5)

Type of Containment	Commissioning Test	In-Service Monitoring		Leak Suspected
		Continuous	Periodic	
Single-walled[1]	N/A[2]	Inventory Reconciliation	Precision Leak Detection Test every 2 years	Precision Leak Detection Test
		Inventory Reconciliation and Monitoring Wells	Precision Leak Detection Test every 5 years	
		Statistical Inventory Reconciliation (SIR)		
		Automatic Tank Gauge	None required	
		Continuous In-Tank Leak Detection		
Double-walled[3]	Precision Leak Detection Test or Secondary Containment Test[4]	Secondary Containment Monitoring	None required	Precision Leak Detection Test or Secondary Containment Test[4]

Notes to Table 4.4.1.2.-A:

(1) Applies to single-walled *storage tanks* of typical construction, including *storage tanks* that do not meet the requirements for double-walled *storage tanks*.

(2) Not applicable because underground *storage tanks* must be of double-walled construction as per Sentence 4.3.8.1.(1).

(3) Applies to double-walled *storage tanks*, which have an interstitial space that allows for monitoring using high- or low-tech methods.

(4) The Secondary Containment Test is a precision test capable of detecting leaks in the interstitial space of the *storage tank*. Risers, connections and vents are also susceptible to leakage and must therefore also be precision-tested.

Table 4.4.1.2.-B
Leak Detection Testing and Monitoring of Aboveground Storage Tanks
Forming Part of Sentence 4.4.1.2.(1)

Type of Containment[1]	Commissioning Test	In-Service Monitoring		Leak Suspected
		Continuous	Periodic	
Contained open[2] vertical tank	Visual inspection[3] during Liquid Media Test	Inventory Reconciliation and Secondary Containment Monitoring	API 653 or Tank floor inspection every 10 years	API 653 or Tank floor inspection
Contained open[2] horizontal tank	Visual inspection[3] during Liquid Media Test		None required	Visual inspection[3]
Double-walled[4]	Visual inspection[3]	Secondary Containment Monitoring	None required	Secondary Containment Test

Notes to Table 4.4.1.2.-B:

(1) See Subsection 4.3.7.

(2) Applies to *storage tanks* contained in an open arrangement that do not meet the requirements for double-walled *storage tanks*.

(3) Visual leak detection may apply to single- or double-walled *storage tanks* and piping. See Sentence 4.4.2.1.(8).

(4) Applies to double-walled *storage tanks*, which have an interstitial space that allows for monitoring using high- or low-tech methods.

Table 4.4.1.2.-C
Leak Detection Testing and Monitoring of Underground Piping Systems
Forming Part of Sentence 4.4.1.2.(1)

Type of Containment	Commissioning Test	In-Service Monitoring		Leak Suspected
		Continuous	Periodic	
Single-walled[1] and single-walled, buried mechanical threaded connections[2]	N/A[3]	Inventory Reconciliation	Pipe Leak Detection Test[4] every 2 years (annually for mechanical connections)	Pipe Leak Detection Test[4]
		Inventory Reconciliation and Monitoring Wells	Pipe Leak Detection Test[4] every 5 years (annually for mechanical connections)	
		SIR		
		Single Check Valve[5]		
		Electronic Line Leak Detection (with a detectable limit of 0.76 L/h monthly)	Electronic Line Leak Detection (with a detectable limit of 0.38 L/h annually)	
		Continuous Electronic Line and Tank Leak Detection (with a detectable limit of 0.76 L/h monthly)	Continuous Electronic Line and Tank Leak Detection (with a detectable limit of 0.38 L/h annually)	
Double-walled[6]	Pipe Leak Detection Test and Secondary Containment Test[7]	Secondary Containment Monitoring	None required	Pipe Leak Detection Test[4] or Secondary Containment Test[7]

Notes to Table 4.4.1.2.-C:

(1) Applies to single-walled piping systems of typical construction, including piping systems that do not meet the requirements for double-walled piping systems.
(2) See Article 4.5.5.6.
(3) Not applicable because underground piping systems must be of double-walled construction as per Sentence 4.5.6.1.(1).
(4) The Pipe Leak Detection Test results shall conform to Sentence 4.4.3.4.(9) with a probability of detection of 0.95 or greater and a probability of false alarm of 0.05 or less.
(5) Applies to suction line only.
(6) Applies to double-walled piping systems, which have an interstitial space that allows for monitoring using high- or low-tech methods. Monitoring of the sump using high-tech methods in accordance with Table 4.4.1.2.-E is considered as meeting the requirements for monitoring of an open-draining interstitial space of double-walled piping.
(7) The Secondary Containment Test shall conform to Article 4.4.3.3.

Table 4.4.1.2.-D
Leak Detection Testing and Monitoring of Exposed Piping Systems
Forming Part of Sentence 4.4.1.2.(1)

Type of Containment	Commissioning Test	In-Service Monitoring		Leak Suspected
		Continuous	Periodic	
Single-walled[1]	Pipe Leak Detection Test	Visual inspection[2]	None required	Identify and repair
Flexible hose lines over water			Pipe Leak Detection Test[3] every 12 months	
Double-walled[4]		Secondary Containment Monitoring	None required	Identify and repair
Contained open[5]		Visual inspection[2]	None required	Identify and repair

Notes to Table 4.4.1.2.-D:

(1) Applies to single-walled piping systems of typical construction, including piping systems that do not meet the requirements for double-walled or contained open piping systems.
(2) See Sentence 4.4.2.1.(8).
(3) The Pipe Leak Detection Test results shall conform to Sentence 4.4.3.4.(9) with a probability of detection of 0.95 or greater and a probability of false alarm of 0.05 or less.
(4) Applies to double-walled piping systems with an interstitial space contiguous to the primary containment that can be monitored using high- or low-tech methods.
(5) Applies to piping systems contained in an open arrangement that do not meet the requirements for double-walled piping systems and do not conform to Subsection 4.3.7.

Table 4.4.1.2.-E
Leak Detection Testing and Monitoring of Turbine, Transition, Dispenser and Spill Containment Sumps
Forming Part of Sentence 4.4.1.2.(1)

Type of Containment	Commissioning Test	In-Service Monitoring		Leak Suspected
		Continuous	Periodic	
Dispenser, turbine and transition sumps	Static Liquid Media Leak Detection Test(1)	Weekly visual inspection or electronic monitoring(2)	Annual visual inspection(3)	Identify and repair
Spill containment sumps		Weekly visual inspection at fill point		

Notes to Table 4.4.1.2.-E:
(1) See Article 4.4.3.5.
(2) Electronic monitoring devices need to be tested at least once annually in conformance with the manufacturer's recommendations.
(3) See Note A-4.4.1.2.(1).

4.4.1.3. Remedial Action

1) Except as provided in Sentence (2), when a leak detection test required by this Section detects a leak in a *storage tank*, piping system or sump, the leaking components or system shall be

a) repaired and tested,

b) replaced, or

c) removed.

2) When a leak detection test required by this Section detects a leak in a single-walled construction underground *storage tank* or piping system, the leaking components or system shall be

a) replaced in conformance with Articles 4.3.8.1. and 4.5.6.1., or

b) taken out of service in conformance with Subsection 4.3.16.

3) Where a leak is detected as described in Sentence (1) or (2), the escaped liquid shall be removed in conformance with Subsection 4.1.6.

4.4.1.4. Retention of Records

1) Records of the tests referred to in this Section shall be retained in conformance with Article 2.2.1.2. of Division C.

4.4.2. Leak Detection Testing and Monitoring Methods

4.4.2.1. Definition and Performance of Leak Detection Testing and Monitoring Methods

1) This Subsection applies to the leak detection testing and monitoring methods referred to in this Section.

2) Inventory reconciliation referred to in this Section shall

a) for the time period designated, determine product loss or gain based on the reconciliation of

i) change in physical inventory,

ii) inventory additions (deliveries),

iii) inventory removals (sales), and

iv) miscellaneous inventory alterations, and

b) determine the level of water in the tank.

(See Note A-4.4.2.1.(2).)

3) A leak detection method that monitors vapours in the soil or liquids on the groundwater shall conform to good engineering practice and meet the requirements of vapour monitoring or groundwater monitoring systems. (See Note A-4.4.2.1.(3).)

4) Statistical inventory reconciliation (SIR) methodology shall be capable of detecting a leak

a) of 0.38 L/h with a probability of detection of 0.95 or greater and a probability of false alarm of 0.05 or less, based on an inventory record of specified length to be considered as an annual test, or

b) of 0.76 L/h with a probability of detection of 0.95 or greater and a probability of false alarm of 0.05 or less, based on an inventory record of specified length to be considered as a monthly test.

(See Note A-4.4.2.1.(4).)

5) Where inventory reconciliation is performed using automatic tank gauging referred to in Sentence (2), the system shall conform to good engineering practice and meet the requirements of a precision leak detection test when a leak is suspected in conformance with Table 4.4.1.2.-A. (See Note A-4.4.2.1.(5).)

6) A continuous in-tank leak detection system shall conform to good engineering practice and meet the requirements of a precision leak detection test. (See Note A-4.4.2.1.(6).)

7) High-tech secondary containment monitoring referred to in this Section shall include the use of an automatic device that continuously monitors the interstitial space between the inner tank or inner piping and the secondary containment. (See Sentence 4.3.7.7.(1).) (See Note A-4.4.2.1.(7) for low-tech method.)

8) Visual inspection referred to in this Section shall,

a) in the case of an exposed piping system, conform to Article 4.5.10.5., and

b) in the case of an aboveground *storage tank*, consist of

i) a visual examination of the tank shell, or

ii) if the bottom of the tank is not amenable to a visual examination, testing the bottom of the tank (see Note A-4.4.2.1.(8)(b)(ii)).

9) A static liquid media leak detection test shall conform to Article 4.4.3.5.

10) The precision leak detection test for underground *storage tanks* that is referred to in this Section shall

a) be capable of detecting a *storage tank* leak rate as small as 0.38 L/h within 24 h with a probability of detection of 0.95 or greater and a probability of false alarm of 0.05 or less (see Note A-4.4.2.1.(10)(a)), and

b) be conducted by an individual who has been trained in the proper care and use of the test equipment and the operating procedures.

(See also Sentences 4.4.3.1.(2) and (3).)

11) Pipe leak detection referred to in this Section shall conform to ULC/ORD-C107.12, "Line Leak Detection Devices for Flammable Liquid Piping." (See also Articles 4.4.3.3. and 4.4.3.4.)

12) A single vertical check valve referred to in this Section shall

a) consist of a vertical check valve located immediately under the pump,

b) be installed with no other check valve between the suction pump and the *storage tank*, and

c) be part of an installation where lines must be sufficiently sloped so that any liquid in the line will drain back into the *storage tank* should a leak occur in the piping system.

(See Note A-4.4.2.1.(12).)

4.4.3. Leak Detection Testing of Storage Tanks, Piping Systems and Sumps

4.4.3.1. Leak Detection Tests

1) Where field test methods are included in the *storage tank* construction standards referred to in Articles 4.3.1.2. and 4.3.1.3., such tests shall be permitted for *storage tanks* conforming to those standards.

2) If a precision leak detection test referred to in Sentence 4.4.2.1.(10) detects a leak rate exceeding 0.38 L/h on an underground *storage tank*, the tank shall be considered to be leaking.

3) During a leak detection test on a *storage tank*, the pressure at the bottom of the tank shall not exceed the tank manufacturer's specifications.

4.4.3.2. Pneumatic Leak Detection Tests

1) Pneumatic leak detection tests using compressed air shall not be performed on *storage tanks* and piping systems having once contained *flammable liquids* or *combustible liquids*.

2) Except as provided in Sentence (1), pneumatic leak detection tests using compressed air or an inert gas shall include the application of soap and water to the *storage tank* and piping surface, fittings, joints and connections to help in the detection of leaks.

3) In the case of underground *storage tanks* or piping, the test referred to in Sentence (2) shall be conducted prior to covering the tank or piping system.

4) Where a pneumatic leak detection test is conducted before an underground *storage tank* is backfilled, in the case of a new tank, or after the tank is uncovered, in the case of a previously installed tank, the test pressure shall be in conformance with the production testing requirements of

a) CAN/ULC-S603, "Steel Underground Tanks for Flammable and Combustible Liquids," or

b) CAN/ULC-S615, "Fibre Reinforced Plastic Underground Tanks for Flammable and Combustible Liquids."

5) Pneumatic leak detection tests shall not be performed on field-erected aboveground *storage tanks*.

6) Measures shall be taken to guard against the hazards associated with pneumatic leak detection testing in areas where explosive mixtures of *flammable liquid* or *combustible liquid* vapours and air may be present in the vicinity of a *storage tank* that has been in use.

4.4.3.3. Protocols for Pneumatic Leak Detection Testing of Piping Systems

1) A pressure decline test using an inert gas is permitted to be used as a leak detection test for piping systems that

a) are new or in use, and

b) convey a volume of less than 1 000 L.

2) A pressure decline test performed on a piping system shall conform to Sentences (3) to (9).

3) The design and installation of the piping system permitting, the piping system's contents shall be drained prior to conducting the pressure decline test procedure.

4) Pumps, dispensers and other auxiliary equipment that are connected to the piping system and cannot withstand the pressure of the test shall be isolated from the test procedure to prevent damage to the equipment.

5) A stabilization period of up to 30 min is required after pressurization.

6) Pipe volumes of 500 L or less shall be pressurized for at least 60 min after stabilization.

7) Pipe volumes greater than 500 L but less than 1 000 L shall be pressurized for at least 2 h after stabilization.

8) Test pressures shall

a) be the greater of 350 kPa (gauge) or 1.5 times the maximum operating pressure, and

b) not exceed the piping manufacturer's test specifications.

9) The piping system shall be considered to be leaking if any pressure decline is detected within the time periods stated.

4.4.3.4. Protocols for Liquid Media Leak Detection Testing of Piping Systems

1) Liquid media leak detection testing of piping systems shall conform to Sentences (2) to (9).

2) Test devices and methods shall conform to the performance requirements of ULC/ORD-C107.12, "Line Leak Detection Devices for Flammable Liquid Piping."

3) Tests shall be conducted by an individual who has been trained in the proper use of the test device and the operating procedures.

4) A sufficient amount of time shall be allocated to stabilize the temperature of the liquid throughout the volume of the piping during the test.

5) Except as provided in Sentences (6) and (7), test pressure shall

a) be the greater of 350 kPa (gauge) or 1.5 times the maximum operating pressure, and

b) not exceed the piping manufacturer's test specifications.

6) Test pressures exceeding 700 kPa (gauge) shall not be permitted unless the piping system is designed for such pressures.

7) Where test pressures exceed the design pressures for pumps or similar components connected to the piping system being tested, such pumps or components shall be isolated from the test procedure.

8) Class I liquids shall not be used for pressure testing piping systems, except that pressure piping normally containing Class I liquids is permitted to be tested with such liquids at pressures not exceeding their maximum operating pressures.

9) The piping system shall be considered to be leaking if the leak rate exceeds 0.38 L/h.

4.4.3.5. Protocols for Leak Detection Testing of Sumps

1) Static liquid media leak detection testing of *turbine*, *transition*, *dispenser* and pump sumps shall conform to Sentences (2) to (4).

2) Static liquid media testing of sumps shall be performed at the installation stage after all electrical and mechanical work passing through the sump wall has been completed but before any backfilling around the exterior of the sump is completed.

3) The liquid used for the test shall

a) exceed the elevation of the piping and other points of entry into the sump by at least 50 mm, and

b) not be a *flammable liquid* or a *combustible liquid*.

4) The minimum duration of the test shall be 1 h with no visual or measured evidence of leakage.

4.4.4. Leak Detection Monitoring of Storage Tanks and Piping Systems

4.4.4.1. Inventory Reconciliation

(See Note A-4.4.4.1.)

1) Where inventory reconciliation is required by this Section, the liquid level in any *storage tank* shall be measured at intervals not greater than 7 days in conformance with Sentences (2) to (4), except that at *fuel-dispensing stations* the measurements shall be taken each day the station is in operation.

2) The level of water at the bottom of an underground *storage tank* shall be measured at intervals not greater than 7 days, except that at *fuel-dispensing stations* the measurements shall be taken each day the station is in operation.

3) Investigative action shall be undertaken if the inventory reconciliation described in Sentence 4.4.2.1.(2) indicates the following inexplicable conditions:

a) a monthly loss of

i) 0.5 percent or more of the throughput from an underground *storage tank*, or

ii) 1.0 percent or more of the throughput from an aboveground *storage tank*,

b) three consecutive losses greater than 200 L/day, and

c) a water level greater than 50 mm.

4) A record of the measurements for each *storage tank* and of the computations described in Sentence (3) shall be retained, in conformance with Article 2.2.1.2. of Division C.

4.4.4.2. Leakage Detection

1) Where continuous leak detection is provided on an underground piping system, it shall conform to ULC/ORD-C107.12, "Line Leak Detection Devices for Flammable Liquid Piping."