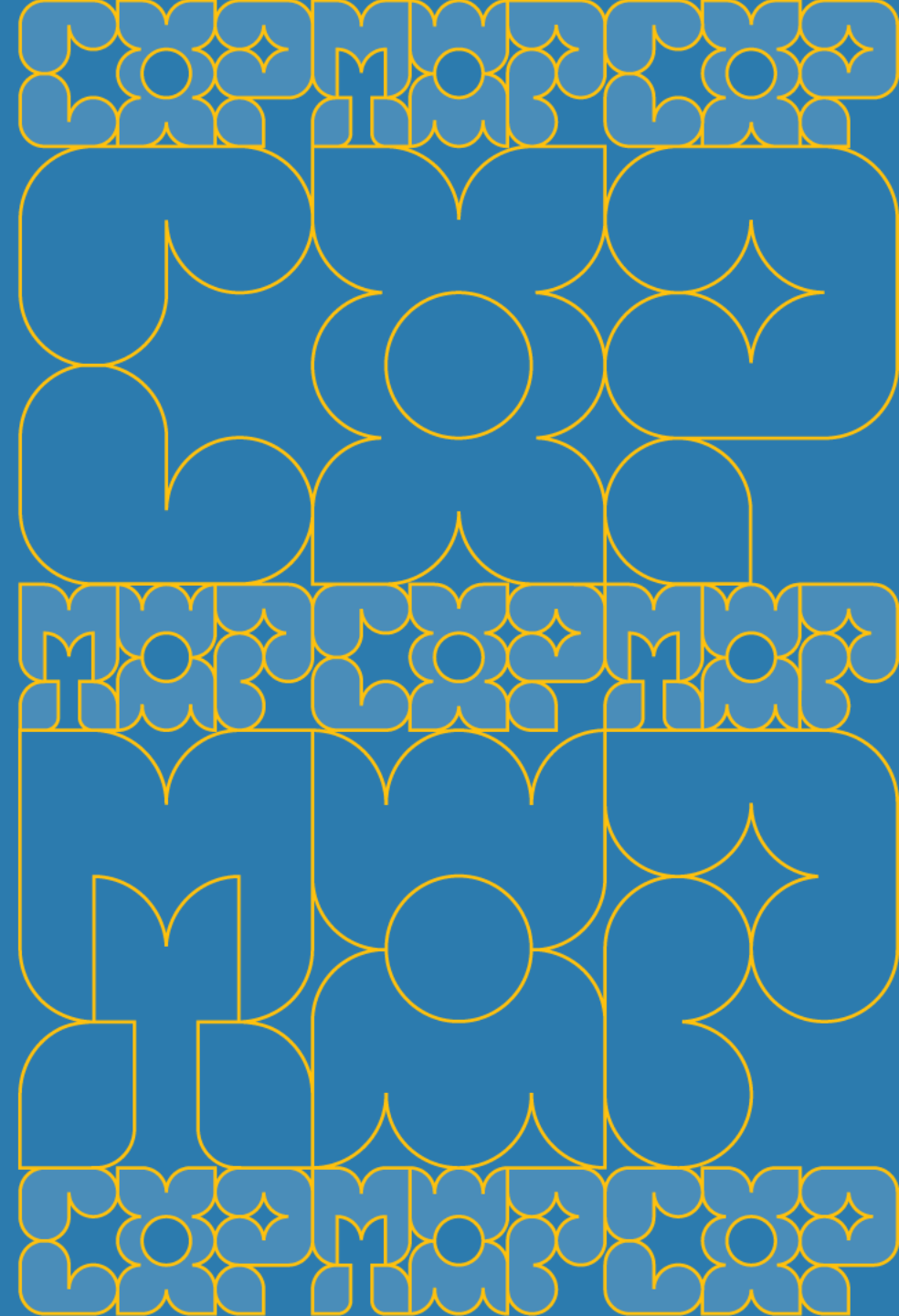


Leak Prevention

Based on - TEAP May 2024: Decision XXXV/11
Task Force report on life cycle refrigerant
management (volume 3)

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Leak Prevention

- **Leak prevention:** measures to **avoid** potential **refrigerant loss** during the equipment's life cycle. Technologies for preventing leaks are different depending on when, where and how during the **equipment life cycle** a refrigerant leak may occur.
- **Tightness inspection:** refers to **verifying** whether the refrigerant may leak from the RACHP refrigerant circuit at the time of manufacturing, installation, commissioning or use. This inspection can be done with **indirect or direct leak detection methods** or a combination thereof. Tightness inspection may be part of a regular maintenance scheme.
- **Leak identification:** refers to **locating** where exactly on the refrigerant circuit the leak occurs, so that measures can be taken to repair it. This is done via direct leak detection methods.



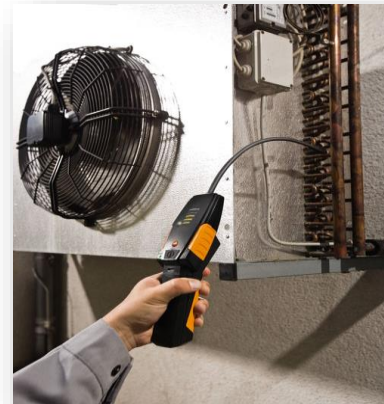
Leak Detection Technologies

- The technologies are deployed at the **stages of manufacturing, installation, commissioning, use and servicing.**
- **Refrigerant detection** technologies can be broadly classified as **indirect and direct methods.**
 - Tightness inspections can be done via indirect or direct methods, whereas leak identification needs to be done with a direct leak detection method.
- **Indirect methods** - based on **identifying abnormal system performance**, including analysis of relevant parameters over a period of time, such as pressure, temperature, compressor current, liquid levels etc.
- **Direct methods** use refrigerant **gas detection** devices to check parts of the refrigerant circuit representing a risk of leakage. These methods are used for tightness inspection, as well as for identifying the exact location of the leak to be followed by repair.



Leak Detection Technologies – Direct Methods

- **Examples** of direct methods –
 - **Helium or nitrogen sensing** for leak detection during manufacturing
 - **Handheld sensors or a soaking test** are used to detect leaks in smaller manufacturing sites. Hand-held sensors are also used at the time of commissioning and servicing.
 - **Remote automatic leak detectors** sample the air in the area around the equipment with an infrared sensor, and alert when refrigerant is detected.
 - **Soapy water and pressurised air underwater** can help to localise the leak for repair.
 - **Ultra-violet dye** additives may be introduced into the RACHP system and are carried through the system by the refrigerant/oil. The leak is identified when it is exposed to an ultraviolet light detector used by the technician.
 - **Acoustic cameras** can detect and process an acoustic signature generated by escaping pressurized refrigerant propagating through pipeline walls, even when surrounded by noisy machinery.



Leak Prevention

- The equipment life cycle stages or phases which are relevant in this context are:
 - Design
 - Manufacturing
 - Transport & Storage
 - Installation
 - Use
 - End-of-life



Leakage Prevention – Design

- Design to reduce and prevent leaks during the equipment life cycle.
- **Eliminate or minimize vibrations or friction** during the transport and operation of the equipment; minimize corrosion and corrosion protection coating
- International and national **standards provide guidance** and recommendations in this regard – Examples are: ISO5149 and ISO14903; IEC60335-2-40, IEC60335-2-89, and IEC60335-2-24.
- Conducting a **Failure Modes and Effects Analysis (FMEA)** to identify leak potential is a highly recommended step for the end of the design stage.



Leakage Prevention – Manufacturing

A typical manufacturing process could include the following stages:

Piping / Heat exchanger line	Material selection
	Processing
	Brazing
	Airtight test
	Completion
Assembly line	Piping assembly
	Airtight test
	Vacuum drying
	Refrigerant charging
	Electric voltage test
	Operation test
	Leakage test
Fitting out to completion	

Several best practices can be used during the manufacturing process, here are just a few examples:

Tightness test before charging	Pressurize (higher than product design pressure) with a high-pressure gas mixture (helium, air or nitrogen) and confirm tightness with a gas leak detector. Helium leak detection is more effective than pressurized air or nitrogen.
Refrigerant charging	With a refrigerant charging device that can achieve high accuracy levels
Refrigerant leak test	After completion of an operation test, confirm no leakage is present from connecting parts with a gas leak detector sensitivity of 3 g/year

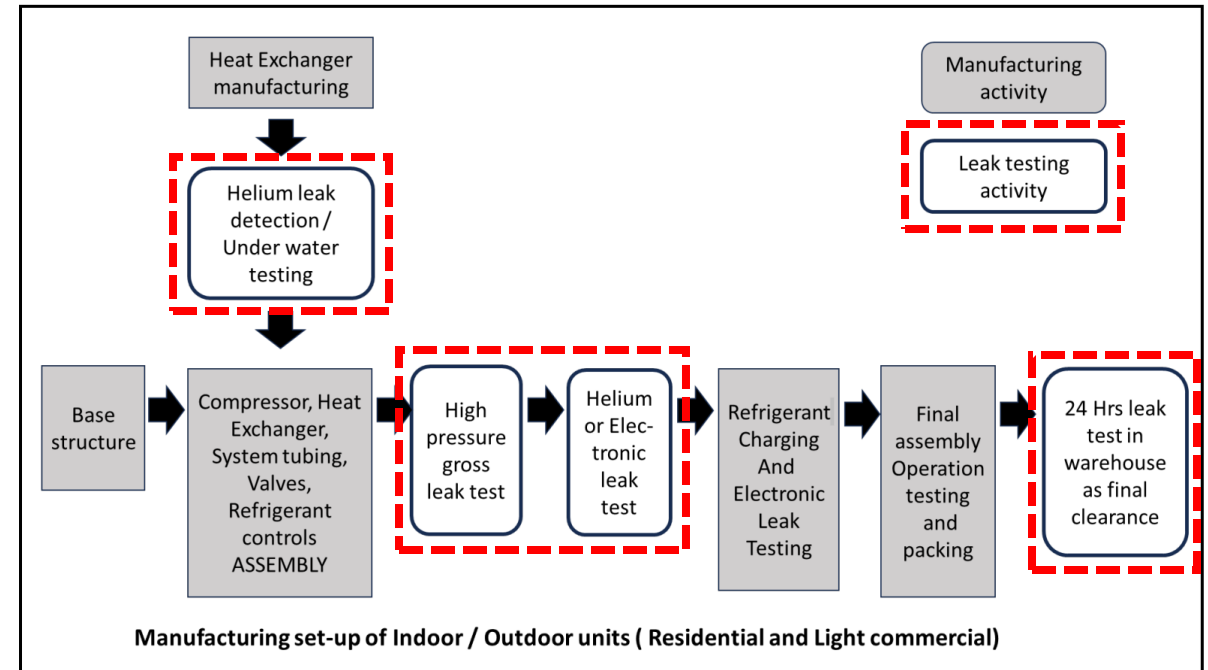


Figure 2.1 Example of factory layout



Leakage Prevention

Transport & Storage

- Equipment may be subject to harsh conditions during transport by road, air and sea. The **resiliency** of the equipment during transportation must be considered during the equipment design stage.
- In addition, **suitable packaging** needs to be provided to avoid damage during both transport and storage. Standards and instruments can be used to test how the equipment behaves during simulated conditions, such as **vibration and drop tests**.
- The popular **standards** used as reference are: ISO 2248, IEC 60068-2-27, IEC 60068-2-64

Installation

- **Installation and commissioning** are important, and **trained, competent service technicians play a crucial role in leak prevention**.
- Selection of the location of the unit is the first important step to ensure adequate **air circulation** and **approachability for servicing**.
- The quality and range of available **tools** used such as torque wrenches, pressure gauges, leak detectors also play a role in leak prevention. The **technicians should be trained** to consider the environmental impact and the potential for leakage, mainly due to corrosion.



Leakage Prevention – Use

- During use phase, it is recommended to **regularly check** if the refrigerant circuit is still “tight”. Tightness inspection starts with a visual inspection, followed by direct or indirect leak detection methods.
- **Visual inspection** focuses on the presence or absence of frost on the heat exchanger, oil bleeding, abnormal vibrations and noise, corrosion or physical damage.
- When the **tightness inspection** concludes that a leak is likely to be present, then the location of the leak needs to be identified using a direct method, followed by a repair.
- **Standards** such as ISO5149 and national regulation may define frequency of tightness inspection.
- Trained and competent service personnel are critical for use and decommissioning at end-of-life phases of equipment.

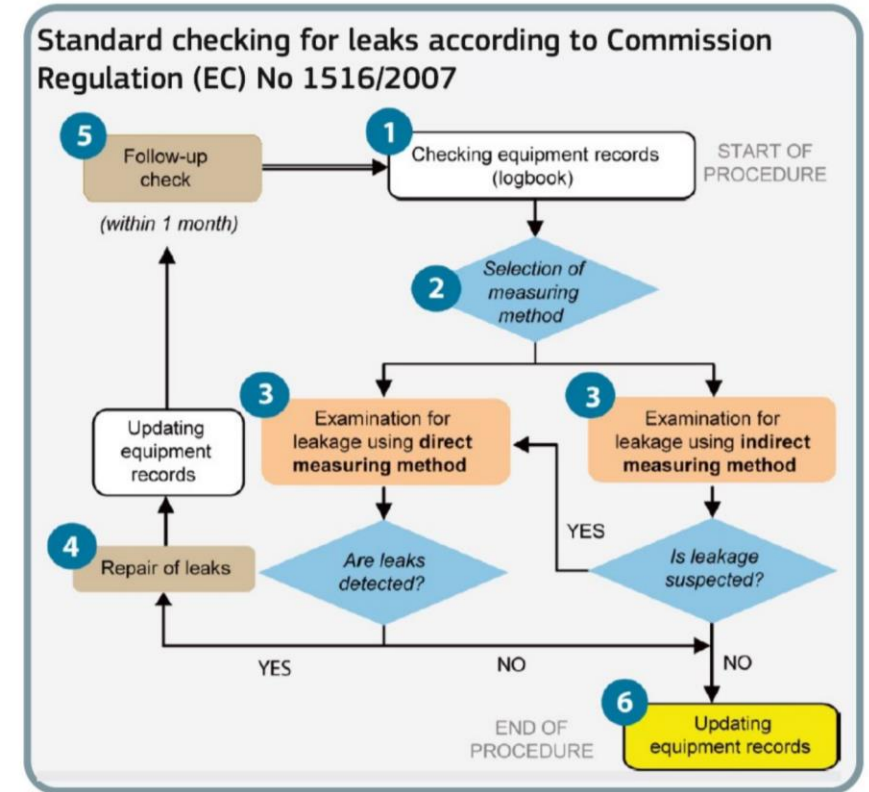


Figure 2.2 Standard checking for leaks according to Commission Regulation EC 1516/2007 (EU, 2015)

