

ISHRAE Standard - ISHRAE 10004: 2026 Refrigerant Recovery, Recycling, and Reclaiming – Standard for Safe and Effective Management

First Edition



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ISHRAE

Indian Society of Heating, Refrigerating and Air Conditioning Engineers

COVER 2

**ISHRAE Standard -
ISHRAE 10004: 2026
Refrigerant Recovery, Recycling, and
Reclaiming – Standard for Safe and
Effective Management**



Indian Society of Heating, Refrigerating and Air Conditioning Engineers

Foreword

ISHRAE (the Indian Society of Heating, Refrigerating and Air Conditioning Engineers) is a technical society dedicated to the advancement of the HVAC&R industry. The work of developing ISHRAE Standards is carried out through technical committees staffed by experts from relevant fields. ISHRAE coordinates its standards development process with international standardization bodies and aligns its practices closely with the ISO/IEC framework. In particular, ISHRAE works closely with the Bureau of Indian Standards (BIS) and International Organization for Standardization (ISO) to ensure that its standards are consistent with WTO principles for SDOs, global best practices in both process and technical content.

The procedures used to develop this document, and those intended for its future maintenance, are in accordance with internationally recognized guidelines (e.g. the ISO/IEC Directives, Part 1). This document was drafted in accordance with the editorial rules of the IS-12 (see www.bis.gov.in). By following these directives, ISHRAE ensures that its standards use clear and consistent language, structure, and terminology, and meet the rigorous consensus-based requirements of formal standardization.

Attention is drawn to the possibility that some elements of this document may be the subject of patent rights. ISHRAE shall not be held responsible for identifying any or all such patent rights. Any trade name or commercial product mentioned in this document is given for the convenience of users and does not constitute an endorsement by ISHRAE.

For an explanation of the voluntary nature of standards, the meaning of terms and expressions specific to conformity assessment, as well as information on adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), users are directed to consult the relevant guidelines on standardization.

This first edition of the ISHRAE Standard “*Refrigerant Recovery, Recycling, and Reclaiming – Standard for Safe and Effective Management*” has been prepared by ISHRAE following the above principles. It is a new standard and does not replace any previous edition. The development of this standard involved broad consultation and input from industry and subject-matter experts, ensuring that the requirements reflect current best practices and are compatible with international standards on safe *Refrigerant* management.

Recognition of referenced standards

This document acknowledges the contributions of other recognized standards development organizations, including **Bureau of Indian Standards (BIS)**, **Underwriters Laboratories (UL)** and the **Air-Conditioning, Heating, and Refrigeration Institute (AHRI)**, whose standards are referenced where appropriate. These organizations have established widely accepted safety, performance, and test requirements that are relevant to Refrigerant recovery, recycling, and reclaiming practices. References

to IS (BIS), UL and AHRI standards are made to promote technical alignment, consistency, and interoperability with existing industry practices. Such references do not imply endorsement by ISHRAE of any organization or its publications, nor do they alter the provisions of the referenced standards, which remain the responsibility of their respective issuing bodies.

Importance of Refrigerant Management

Proper *Refrigerant* management is critical for several reasons:

1. **Environmental Protection:** Uncontrolled release of *Refrigerants* can significantly harm the environment by depleting the ozone layer and contributing to climate change. This standard seeks to mitigate these effects through responsible management practices.
2. **Safety:** Handling *Refrigerants* poses various risks, including exposure to toxic substances and potential accidents during recovery and recycling processes. This standard outlines safety measures to protect personnel involved and the surrounding environment.
3. **Regulatory Compliance:** Adhering to this standard facilitates compliance with international and local regulations, such as those set by the national or international regulatory authorities and international treaties like the Montreal Protocol. Compliance helps avoid legal penalties and enhances public trust in responsible *Refrigerant* management.
4. **Economic Efficiency:** By optimizing recovery, recycling, and reclaiming processes, this standard promotes efficient use of resources and reduces costs associated with *Refrigerant* procurement and waste management.

NOTE 1 Some national and international regulatory authorities are listed in Annex B; the list is not comprehensive.

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ISHRAE Standard - ISHRAE 10004: 2026

Refrigerant Recovery, Recycling, and Reclaiming – Standard for Safe and Effective Management

1 Purpose

The primary purpose of this standard is to establish guidelines for the effective and safe recovery, recycling, and reclaiming of *Refrigerants* used in various refrigerating and air conditioning systems. It aims to protect the environment by minimizing the release of Refrigerants that contribute to ozone depletion and global warming. Additionally, the standard ensures the safety of personnel involved in these processes by providing robust safety protocols and compliance requirements.

2 Scope

This document specifies requirements for the safe and effective recovery, recycling and reclamation of *Refrigerants* used in refrigerating and air conditioning systems. It applies to Refrigerants classified as A1, A2L, A2, A3 and B1 in accordance with ISO 817 and to Refrigerants with positive global warming potential, including CFCs, HCFCs, HFCs, HFOs, HCFOs and hydrocarbons, where such Refrigerants are used in systems within the scope of this document. This document is intended for use by manufacturers, technicians, contractors, facility managers and other persons involved in manufacturing, installation, maintenance, servicing and disposal of refrigerating and air-conditioning systems.

This document does not apply to:

1. *Refrigerants* that cater to the following:
 - 1.1 Aerosol applications
 - 1.2 Essential critical applications as defined by the regulations in India.
 - 1.3 Applications using *Refrigerants* not listed in ISO 817:2024
2. Handling or processing of *Refrigerants* for destruction / disposal
3. Systems that use CO₂
4. Mobile Refrigeration & AC Units

3 Normative/informative references

The following documents are referred to in the text in such a way that their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

- AHRI Standard 740:2016 – Performance Rating of Refrigerant Recovery Equipment and Recovery/Recycling Equipment
- ISO 11650:1999 - Performance of Refrigerant recovery and recycling equipment
- UL 1963: 2025 - Standard for Safety: Refrigerant Recovery/Recycling Equipment.
- ISO 817 – Refrigerants – Designation and Safety Classification
- IS 5610: 2025 - Refrigerants - Specification
- 40 CFR Part 82, Subpart F - Protection of Stratospheric Ozone: Recycling and

Emissions Reduction (Section 608 of the Clean Air Act)

- Montreal Protocol on Substances that Deplete the Ozone Layer, 1987 (as amended)
- Kyoto Protocol to the United Nations Framework Convention on Climate Change, 1997
- Paris Agreement under the United Nations Framework Convention on Climate Change, 2015
- Ozone Depleting Substances (Regulation and Control) Rules, 2000 (as amended)
- E-Waste (Management) Rules, 2022 (as amended)
- Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended)
- Gas Cylinders Rules, 2016 (as amended)

4 Terms and definitions

This section provides clear definitions of key terms used in the Refrigerant recovery, recycling, and reclaiming standard to ensure consistent understanding across all stakeholders. Accurate definitions are crucial for maintaining clarity and compliance throughout the processes. In addition to the definitions of IS 3615 and IS 5610, the below definitions apply :

4.1 Refrigerant

The fluid used for heat transfer in a *refrigerating system*.

Note 1 to entry: A *Refrigerant* absorbs heat at a low temperature and a low pressure of the fluid and rejects heat at a higher temperature and a higher pressure of the fluid, usually involving changes of state of the fluid, as defined in ISO 817:2024

4.2 Refrigerating System

A heating or refrigerating scheme or machine usually confined to those parts in contact with the heating or refrigerating medium.

4.3 Recover

To remove *Refrigerant* in any condition from a system and store it in an external container.

4.4 Recycle

To reduce contaminants in used *Refrigerants* by separating oil, removing non-condensables, and using devices such as filter driers to reduce moisture, acidity, and particulate matter.

4.5 Recovery Efficiency (%)

The ratio of the mass of *Refrigerant* recovered to the total *Refrigerant* originally present in the system, expressed as a percentage.

4.6 Recovery Machine

A device specifically designed to safely extract *Refrigerants* from systems and store them in external containers. *Recovery Machines* must meet specific performance standards to ensure effective and safe operation.

4.7 Storage cylinder

A closed metal container having a volume exceeding 500 millilitres but not exceeding 1000 litres intended for the storage and transport of compressed gas, but does not include any other such container specifically excluded under these rules.

4.8 Manifold Gauge Set

An assembly of pressure gauges, hoses, and valves used to monitor and control *Refrigerant* flow during recovery and recycling processes. These sets provide critical pressure readings necessary for safe *Refrigerant* handling.

4.9 Personal Protective Equipment (PPE)

Gear worn by personnel to minimize exposure to hazards associated with *Refrigerant* handling. Common PPE includes gloves, goggles, respirators, and protective clothing.

4.10 Recovery

pumping out (removal) of **refrigerant** from air conditioning or refrigeration equipment

4.11 Recycle

pumping out (removal) and cleaning of **refrigerant** from air conditioning or refrigeration equipment

4.12 Reclaim

reprocess the refrigerant to the same specifications as new *Refrigerants* by any means, including *distillation*. Such *Refrigerants* have been chemically analyzed to verify that those specifications have been met as per IS 5610:2025.

4.13 Distillation

Distillation is a process involving vaporization and condensation used to separate *Refrigerant* constituents and contaminants based on differences in boiling points.

4.14 Separation

Separation refers to the application of physical or chemical processes to remove contaminants or to isolate components from a *Refrigerant mixture*.

5 General requirements

5.1 Equipment, tools and cylinders

Equipment and tools used for recovery, recycling and reclamation shall be suitable for the *Refrigerant* type, operating pressure and intended operation. Equipment and tools shall be selected, used and maintained in accordance with the applicable requirements of this document and the manufacturer's instructions.

5.2 Recovery and recycling machines

5.2.1 Types and Specifications:

5.2.1.1 Recovery and recycling machines shall be designed and certified for the *Refrigerant* type being handled.

5.2.1.2 Recovery and recycling machines shall conform to applicable safety and performance standards.

- a. UL 1963 - *Refrigerant Recovery/ Recycling Equipment* or equivalent standard – for safety,
- b. IEC 60335-2-104 - Particular requirements for appliances to Recover and/or Recycle *Refrigerant* from air conditioning and refrigeration equipment,

- c. AHRI Standard 740 - Performance Rating of *Refrigerant Recovery Equipment* and Recovery/Recycling Equipment or ISO 11650 - Performance of *Refrigerant* recovery and recycling equipment or equivalent standard for performance requirement of equipment.

5.2.2 Performance requirement :

1. The *Refrigerant Recovery Machine* shall be capable of achieving adequate vacuum levels to support efficient recovery of *Refrigerant*. Informative guidance on recovery equipment evacuation levels is provided in Annex C.
2. The *Refrigerant recycling machine* shall be capable of achieving adequate contaminant-reduction levels. Informative guidance on recycling equipment performance is provided in Annex C.
3. Prior to opening any system, recovery equipment shall be capable of removing *Refrigerant* to meet the evacuation requirements as specified in Annex C

5.2.3 Maintenance and Calibration:

Recovery and recycling equipment shall be maintained to conform to the performance requirements specified in 7.1 and 7.2.

5.3 Storage cylinders

Refrigerant cylinders shall comply with the applicable provisions of the Gas Cylinders Rules, 2016, as amended, or other applicable national regulations.

5.3.1 Design and Pressure Ratings:

1. *Storage cylinders* shall be designed and approved for *Refrigerant* storage and shall have pressure ratings suitable for the *Refrigerant* type.
2. Cylinders shall be equipped with pressure relief devices and valves compatible with the *Refrigerant* type.

5.3.2 Labeling and Identification:

1. Clearly label all Storage cylinders with the type and quantity of *Refrigerant*, along with any relevant hazard information.

2. Implement a color-coding or tagging system to easily distinguish between different *Refrigerant* types and their status (e.g., recovered, recycled, reclaimed).

5.3.3 Transport and Handling:

1. Ensure cylinders are secured and handled using appropriate lifting and transport equipment to prevent accidents and spills.
2. Follow the applicable provisions of the Gas Cylinders Rules, 2016 (as amended), and Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 (as amended) for the transport of hazardous materials, including securing cylinders during transit.

5.4 Tools and accessories

5.4.1 Hoses and Connectors:

1. *Refrigerant*-grade hoses and quick-connect fittings shall be used and shall be suitable for the operating pressure and *Refrigerant* type.
2. Hoses and connectors shall be inspected for wear, damage and *Refrigerant* compatibility before use.

5.4.2 Manifold Gauges:

1. Utilize *manifold gauge* sets to monitor system pressures accurately during recovery and recycling processes.
2. Ensure gauges are calibrated and compatible with the *Refrigerants* being handled.

5.4.3 Filters and Dryers:

1. Equip recovery and recycling systems with appropriate filters and dryers to remove particulates, moisture, and other contaminants.
2. Replace filters and desiccants regularly to maintain efficiency and prevent blockages.

5.5 Safety and compliance

Refrigerant recovery, recycling and reclamation operations shall be carried out

using safety controls appropriate to the *Refrigerant* hazards, work location, equipment used and applicable regulations.

5.5.1 Personal Protective Equipment (PPE)

1. **Eye protection:** Safety goggles or face shields shall be worn where splashes or exposure to *Refrigerant* gases can occur.
2. **Gloves:** Chemical-resistant gloves shall be used where skin contact with *Refrigerant* can occur.
3. **Respiratory protection:** Appropriate respiratory protection shall be used where ventilation is inadequate, or exposure limits can be exceeded.
4. **Protective Clothing:** Long sleeves and pants made of non-absorbent materials are recommended to minimize skin exposure.

5.5.2 Safe Work Environment

1. **Ventilation:** Work areas shall be adequately ventilated to prevent hazardous accumulation of *Refrigerant* gases.
2. **Spill Containment:** Have absorbent materials and spill kits readily available to manage accidental leaks or spills effectively. Train personnel in spill response procedures to minimize environmental impact and exposure risks.
3. **Emergency Equipment:** Install eyewash stations and safety showers in areas where *Refrigerants* are handled to provide immediate decontamination for exposed personnel.
4. **Fire Safety:** Ensure fire extinguishers rated for chemical fires are accessible, and personnel are trained in their use.

5.5.3 Emergency Shut-off Valves: Install emergency shut-off valves on equipment to quickly halt operations in case of leaks or other emergencies. Train personnel in the proper operation and location of these safety devices.

5.5.4 Handling and Storage

1. **Proper Labeling:** All *Refrigerant* containers must be clearly labeled with contents and hazard information to prevent accidental misuse or exposure.
2. **Storage Conditions:** Store *Refrigerants* in well-ventilated areas away from heat sources and direct sunlight to prevent pressure build-up in containers.

5.5.5 Operational Safety

1. *Refrigerant* recovery operations involving flammable *Refrigerants* shall be conducted so that potential sources of ignition are not present within the extent of any flammable atmosphere that can be generated during the operation. The extent of such atmosphere shall be determined in accordance with applicable hazardous area classification principles or equivalent national standards.
Note 1: potential sources of ignition as per IS 302 Part 2, Sec 40: 2025
2. **System Shut-Down:** Ensure systems are properly shut down and isolated before beginning recovery, recycling, or reclaiming processes to prevent accidental discharge of *Refrigerants*.
3. **Connection Procedures:** Follow manufacturer guidelines for connecting *Recovery Machines* and hoses to prevent leaks and ensure secure connections.
4. **Monitoring:** Continuously monitor pressure, temperature, and *Refrigerant* levels during operations to detect and address potential hazards promptly.

5.5.6 Procedures for Emergency Situations

1. **Evacuation Plans:** Develop and communicate clear evacuation procedures in the event of a significant leak or spill.
2. **Incident Reporting:** Establish procedures for reporting and documenting accidents, exposures, or near-misses to improve safety protocols and prevent future incidents.
3. **First Aid Training:** Ensure personnel are trained in administering first aid specific

to *Refrigerant* exposure and related injuries.

This detailed outline of safety procedures aims to protect personnel and the environment by promoting best practices in the handling and management of *Refrigerants*.

5.6 Documentation and Reporting

Record-keeping requirements for recovery, recycling, reclaiming, storage, and disposal.

1. **Record-Keeping Requirements:** Maintain accurate and detailed records of all *Refrigerant* transactions, including recovery, recycling, and reclaiming activities, to demonstrate compliance with regulatory requirements.
2. **Reporting Obligations:** Submit regular reports to regulatory bodies documenting *Refrigerant* usage, emissions, and disposal activities, ensuring transparency and accountability.

5.7 Compliance Verification

Procedures for personnel certification, regular audits, and third-party verification.

1. **Certification for Personnel:** Ensure all personnel involved in *Refrigerant* handling are certified according to local and international requirements, such as any regulations set aside by Ozone Cell or other regulators.
2. **Regular Audits and Inspections:** Conduct regular internal audits and inspections to verify compliance with all applicable regulations and standards. Adjust practices and procedures as necessary to address any identified non-compliance issues.
3. **Third-Party Verification:** Engage third-party auditors or inspectors to provide independent verification of compliance and to offer recommendations for improvements in *Refrigerant* management practices.

5.8 Environmental and Safety Considerations

Leak detection and repair, waste management, and environmental impact controls.

1. **Leak Detection and Repair:** Implement proactive leak detection and repair programs to minimize Refrigerant emissions, complying with regulations that mandate prompt addressing of leaks.
2. **Waste Management:**
 - a. Follow best practices for the disposal and destruction of *Refrigerants*, ensuring that waste management methods meet environmental standards and regulatory requirements.
 - b. Disposal or destruction of *Refrigerants* shall comply with relevant national regulations and guidelines, including E-Waste (Management) Rules, 2022, and Central Pollution Control Board (CPCB) Guidelines for Common Hazardous Waste Incineration Facilities, which provide technical guidance for the destruction of ozone-depleting substances and fluorinated *Refrigerants*.
 - c. These guidelines are aligned with recommendations of the Montreal Protocol Technology and Economic Assessment Panel (TEAP) for destruction of ozone-depleting substances and related *Refrigerants*.

6. Procedures

6.1 Recovery process

Recovery shall be performed by extracting *Refrigerant* from a system into an external cylinder using equipment suitable for the *Refrigerant* type and operating conditions. The procedure shall minimize *Refrigerant* release and shall conform to the safety and documentation requirements of this document.

6.1.1 Preparation

1. System Shutdown:

- a. The system shall be powered off and isolated from electrical and mechanical operation before recovery begins.
- b. Verify that all necessary permits and approvals are obtained, particularly in regulated environments.

2. Inspection:

- a. The system shall be inspected for leaks or damaged components that can affect recovery.
- b. Inspect recovery equipment and tools to ensure they are in optimal working condition and meet required standards.

3. Equipment Setup:

- a. Gather all necessary equipment, including *Recovery Machines*, hoses, gauges, and Storage cylinders.
- b. Ensure that *Recovery Machines* are suitable for the type of Refrigerant being handled.

6.1.2 Connection to System

1. Hose Connection:

- a. Connect the *Recovery Machine* to the service ports of the refrigeration or air conditioning system using compatible hoses.
- b. Use quick-connect fittings to prevent *Refrigerant* loss and ensure tight connections.

2. Gauge Installation:

- a. Attach gauges to monitor system pressure and ensure accurate readings throughout the recovery process.

3. Leak Testing:

- a. Conduct a pressure test to confirm hose and connection integrity before starting the recovery process.

Note1- For recovery at the end of life of equipment, puncturing of *Refrigerant* lines as opposed to connecting to service ports is acceptable if sealed piercing valves or similar equipment are used to prevent *Refrigerant* leakage

6.1.3 Execution

1. Start the Recovery Machine:

- a. Follow the manufacturer's operating instructions to start the Recovery Machine.
- b. Monitor pressure levels closely, ensuring they remain within specified limits to avoid system damage.

2. Refrigerant Transfer:

Operate the *Recovery Machine* until the system pressure is reduced to the specified evacuation level, so that the

Refrigerant recovery criteria specified in Annex A are achieved.

- a. Periodically check hoses and connections for any signs of leaks or irregularities.

3. **Maintain Logs:**

- a. Record the quantity, type of *Refrigerant* recovered, and *Recovery Efficiency* in a logbook or digital record-keeping system for compliance and tracking.

6.1.4 Completion

1. **System Verification:**

- a. Once recovery is complete, verify the system is fully depressurized and no *Refrigerant* remains in the system.

2. **Disconnect Equipment:**

- a. Safely disconnect hoses and gauges, ensuring all valves are closed to prevent *Refrigerant* release.

3. **Storage and Labeling:**

- a. The *recovered refrigerant storage* cylinder shall be labeled indicating the type and quantity for future reuse or disposal.
- b. Store cylinders in a designated, secure area with appropriate labeling to prevent unauthorized access or misuse.

4. **Final Inspection:**

- a. Conduct a final inspection of the *Recovery Machine* and tools, checking for any signs of wear or damage requiring maintenance or replacement.

6.2 Recycling process

Recycling shall reduce contaminants in *recovered refrigerant* by suitable processes such as oil *separation*, filtration, drying or other contaminant-reduction methods.

The recycling process involves cleaning used *Refrigerants* to remove impurities so they can be reused in the same equipment or system. This section provides guidelines and procedures to ensure effective recycling while maintaining quality and environmental standards.

6.2.1 Preparation

1. **Equipment Check:**

- a. Ensure the recycling equipment, such as filters and *distillation* units, is in good working condition and appropriate for the type of *Refrigerant* being processed.
- b. Verify that all safety and operational protocols are in place before starting the recycling process.

2. **Refrigerant Assessment:**

- a. Analyze the *recovered refrigerant* to determine the types and levels of contaminants present, such as oil, moisture, acids, and particulate matter.
- b. Determine the appropriate recycling method based on the contaminant analysis.

6.2.2 Cleaning Methods

1. **Filtration:**

- a. Use high-efficiency filters to remove solid particulates and debris from the *Refrigerant*.
- b. Replace filters regularly to maintain efficiency and prevent clogging.

2. **Moisture Removal:**

- a. Employ desiccant dryers or molecular sieve technology to extract moisture from the *Refrigerant*, preventing corrosion and freezing issues in the system.
- b. Monitor the moisture content to ensure it meets specified limits for reuse.

3. **Acid Neutralization:**

- a. Utilize acid neutralization kits or additives to address any acidic compounds generated during system operation or storage.
- b. Conduct periodic testing to confirm that acid levels are within acceptable ranges.

4. **Distillation:**

- a. For *Refrigerants* with significant contamination, employ distillation methods to separate *Refrigerants* from non-volatile impurities, ensuring a higher purity level.
- b. Maintain constant monitoring of temperatures and pressures during

the *distillation* process to optimize efficiency and safety.

6.2.3 Testing for Purity

1. Sampling and Analysis:

- a. Take representative samples of the *recycled refrigerant* for laboratory analysis, focusing on key parameters such as purity, moisture content, and acidity.
- b. Compare results against industry standards and specifications to ensure the *Refrigerant* is suitable for reuse.

2. Quality Assurance:

- a. Implement a quality assurance program to regularly verify that recycled *refrigerants* meet or exceed required specifications.
- b. Document all test results and corrective actions taken to resolve any discrepancies.

6.2.4 Documentation and Record-Keeping

1. Record Maintenance:

- a. Keep detailed records of the recycling process, including equipment used, methods applied, test results, and personnel involved.
- b. Ensure all documentation aligns with regulatory requirements and facilitates traceability.

2. Compliance Verification:

- a. Conduct regular audits to verify adherence to established protocols and standards, making adjustments as necessary to maintain compliance.

6.3 Reclamation process

Reclamation shall *restore recovered* refrigerant to the applicable purity specification for reuse as *reclaimed refrigerant* as per IS 5610:2025.

Reclaiming *Refrigerants* involves restoring used *Refrigerants* to a level of purity that meets or exceeds industry standards, making them comparable to new *Refrigerants*. This process is more rigorous than recycling and is typically performed by specialized facilities due to the advanced equipment and techniques required.

6.3.1 Preparation

1. Assessment of Refrigerant:

- a. Evaluate the condition and composition of the *Refrigerant* to determine the level of contamination and the appropriate reclaiming method.
- b. Ensure that the *Refrigerant* is free from significant quantities of mixed substances, as mixing can complicate the reclaiming process.

2. Facility and Equipment Readiness:

- a. Confirm that the reclaiming facility is equipped with advanced purification equipment, such as *distillation* columns, *separation* units, and chemical treatment systems.
- b. Perform routine maintenance checks on all equipment to ensure operational efficiency and safety.

6.3.2 Advanced Purification Methods

1. Distillation:

- a. Implement fractional distillation to separate the *Refrigerant* from impurities based on differences in boiling points. This process can effectively remove high-boiling-point contaminants.
- b. Continuously monitor temperature and pressure parameters to optimize *separation* efficiency and safety.

2. Chemical Treatment:

- a. Use chemical additives or processes to neutralize and remove acids, oils, and other corrosive elements that the *Refrigerant* may have acquired during use.
- b. Ensure that all chemical processes are conducted in compliance with environmental and safety regulations.

3. Separation Technologies:

- a. Apply advanced *separation* technologies, such as membrane *separation* or adsorption, to further purify the *Refrigerant* by removing specific contaminants and moisture.
- b. Select the appropriate technology based on the type and concentration of impurities present.

4. Oil and Moisture Removal:

- a. Implement high-efficiency oil separators and desiccant systems to remove residual oils and moisture, ensuring the *Refrigerant* achieves the purity level required for reclaiming.

6.3.3 Quality Assurance and Testing

1. Purity Testing:

- a. Conduct comprehensive laboratory analyses to assess the purity level of the *reclaimed refrigerant*, focusing on critical parameters such as moisture content, acidity, and presence of non-condensables.
- b. Compare test results against industry standards, such as AHRI Standard 700, to verify compliance.

2. Batch Certification:

- a. Certify each batch of *reclaimed refrigerant* to confirm it meets all necessary purity standards and specifications.
- b. Issue a certificate of analysis for each batch, documenting the test results and compliance status.

6.3.4 Documentation and Record-Keeping

1. Detailed Records:

- a. Maintain thorough records of the reclaiming process, including initial assessments, methods used, test results, and personnel involved.
- b. Ensure documentation is complete and accessible for audits and regulatory compliance.

2. Traceability:

- a. Implement systems to track the origin, processing, and final disposition of *reclaimed refrigerants* to ensure transparency and accountability.

6.3.5 Compliance and Environmental Considerations

1. Regulatory Adherence:

- a. Ensure all reclaiming activities comply with relevant local and international regulations, including those pertaining to environmental impact and safety.
- b. Regularly review and update practices to align with evolving standards and technological advancements.

2. Environmental Impact:

- a. Implement best practices to minimize environmental impact during the reclaiming process, including waste management and emissions control.
Note 1: See Annex C for informative guidance on best practices for Refrigerant losses during reclamation.

7 Documentation and record-keeping

Records shall be maintained for recovery, recycling, reclamation, storage, disposal, maintenance, inspection and personnel competence, as applicable.

Effective documentation and record-keeping are crucial for ensuring compliance with regulatory requirements, maintaining transparency, and facilitating audits in the *Refrigerant* recovery, recycling, and reclaiming processes. This section outlines the procedures and best practices for accurate and comprehensive record maintenance.

7.1 Importance of Documentation

1. Compliance:

- a. Demonstrates adherence to local, national, and international *regulations*, such as those set by Ozone Cell in India, the Environmental Protection Agency (EPA) in the United States, and other relevant national and international authorities.
- b. Supports compliance efforts by providing verifiable evidence of proper handling, storage, and disposal of *Refrigerants*.

2. Transparency:

- a. Enhances accountability and transparency by ensuring all activities involving *Refrigerants* are thoroughly documented.
- b. Facilitates traceability of *Refrigerant* quantities, sources, and destinations.

3. Audit Preparedness:

- a. Ensures readiness for inspections and audits by regulatory bodies, reducing the risk of fines and penalties.

- b. Provides a clear, organized record trail for internal and external reviews.

7.2 Essential Documentation

1. Recovery Records:

- a. Maintain logs of all *Refrigerant* recovery activities, specifying the type and quantity of *Refrigerant* extracted, the equipment used, and the date and location of recovery.
- b. Include details of the personnel involved and any issues encountered during the process.

2. Recycling and Reclamation Logs:

- a. Document the recycling and reclaiming processes, including methods used, equipment settings, and any impurities removed.
- b. Record test results and purity levels achieved, along with batch numbers and certificates of analysis.

3. Storage and Disposal Records:

- a. Keep records of *Refrigerant* storage conditions, including cylinder labeling, storage locations, and inventory levels.
- b. Document the disposal of *Refrigerants*, including quantities disposed of, disposal methods, and receipts from waste management facilities.

4. Maintenance and Inspection Reports:

- a. Maintain a schedule of regular maintenance and inspections for all equipment used in recovery, recycling, and reclaiming.
- b. Document inspection findings, maintenance performed, and any corrective actions taken.

7.3 Record-Keeping Best Practices

1. Accuracy and Completeness:

- a. Ensure all records are accurately completed, with no omissions or errors. Double-check entries for accuracy before finalizing documentation.
- b. Use standardized forms and templates to maintain consistency in record-keeping practices.

2. Digital Record Systems:

- a. Implement digital record-keeping systems to enhance efficiency and accessibility. Use software solutions that allow for secure storage, easy retrieval, and automated backups.
- b. Ensure digital records are protected from unauthorized access through secure authentication and encryption methods.

3. Retention and Archiving:

- a. Adhere to regulatory requirements for record retention periods, ensuring records are kept for the specified duration.
- b. Archive older records systematically, so they remain accessible for historical reference or audits if needed.

4. Training and Awareness:

- a. Train personnel in proper documentation and record-keeping procedures, emphasizing the importance of accuracy and timeliness.
- b. Foster a culture of accountability and diligence in record-keeping practices among all team members involved in *Refrigerant* management.

8 Training and competence

Personnel performing *Refrigerant* recovery, recycling, reclamation, storage, handling or disposal shall be trained and competent for the tasks assigned to them.

Training and certification are critical to ensuring that personnel involved in *Refrigerant* recovery, recycling, and reclaiming are competent and knowledgeable about safety, environmental regulations, and technical processes. This section outlines the necessary training programs and certification requirements to uphold industry standards and promote best practices.

8.1 Importance of Training and Certification

1. Safety Compliance:

- a. Ensures personnel are well-versed in safety protocols to mitigate risks associated with handling *Refrigerants*.

- b. Reduces the likelihood of accidents and exposure to hazardous substances through proper safety practices.

2. **Regulatory Compliance:**

- a. Aligns personnel skills and knowledge with local and international regulations governing *Refrigerant* management.
- b. Facilitates compliance with Environmental Protection Agency (EPA) standards and other relevant regulatory bodies.

3. **Technical Proficiency:**

- a. Enhances technical skills required for efficient and effective *Refrigerant* recovery, recycling, and reclaiming.
- b. Improves problem-solving abilities and operational efficiency through advanced training in equipment use and maintenance.

8.2 Recommended Training Programs

1. **Basic Refrigerant Handling:**

- a. Covers fundamental principles of *Refrigerant* types, properties, and safe handling techniques.
- b. Provides an overview of environmental impacts and regulatory requirements related to Refrigerants.

2. **Advanced Recovery and Recycling Techniques:**

- a. Focuses on advanced methods for *Refrigerant* extraction, recycling, and reclaiming, including the use of specialized equipment.
- b. Includes hands-on training with Recovery Machines, filtration systems, and monitoring tools.

3. **Safety Procedures and Emergency Response:**

- a. Instructs on the use of personal protective equipment (PPE), emergency procedures, and spill response protocols.
- b. Trains personnel in first aid and incident reporting specific to Refrigerant-related exposures and accidents.

4. **Equipment Maintenance and Troubleshooting:**

- a. Provides detailed guidance on routine maintenance, inspection, and troubleshooting of recovery and recycling equipment.
- b. Emphasizes the importance of equipment calibration and care to ensure optimal performance.

Further guidance on certification requirements and implementation is provided in Annex C.

Annex A

(Informative)

Determination of Refrigerant Recovery Efficiency

Determination of Refrigerant Recovery Efficiency

A.1 Scope

This annex specifies a method for determining the *Recovery Efficiency* of *Refrigerant* from refrigerating or air-conditioning systems using suitable recovery equipment. It applies to *Refrigerants* covered by this document.

A.2 References

ISO 817, *Refrigerants* — Designation and safety classification

A.3 Informative references

UL 1963, *Refrigerant Recovery/Recycling Equipment*, or equivalent standard for safety.
AHRI Standard 740, *Performance Rating of Refrigerant Recovery Equipment and Recovery/Recycling Equipment*.

A.4 Terms and definitions

Recovery Efficiency : The ratio of the mass of *Refrigerant* recovered to the total mass of *Refrigerant* originally present in the system, expressed as a percentage.

NOTE 1 Where the *Refrigerant* charge is declared by the manufacturer, the declared charge is used as the denominator in the *Recovery Efficiency* calculation. Where additional *Refrigerant* is charged on site, the total *Refrigerant* charge is the sum of

the manufacturer-declared charge and the additional site charge.

A.5 Apparatus

Recovery Machine suitable for the *Refrigerant* type and compliant with an applicable national, international or industry standard.

1. Calibrated weighing scale.

NOTE 1 The weighing instrument should be a calibrated non-automatic weighing instrument selected with an appropriate accuracy class, maximum capacity and verification scale interval for the intended *Refrigerant* mass and, where applicable, verified and stamped in accordance with applicable legal metrology requirements.

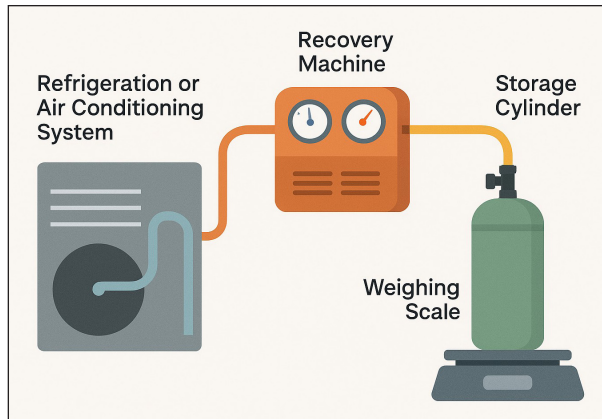
Storage cylinder rated for the *Refrigerant* pressure.

Calibrated manifold gauge set.

1. Pressure-rated hoses and quick-connect fittings.
2. Thermometer and pressure sensors.

A.6 Test setup

1. Select a system charged with a known quantity of *Refrigerant* (record initial mass).
2. Ensure the system is powered off and isolated.
3. Connect *Recovery Machine* to service ports using appropriate hoses.
4. Place *Storage cylinder* on calibrated scale and record tare weight.



A.7 Procedure

1. Initial Measurement:

Record the initial *Refrigerant* charge (manufacturer data or pre-weighing).

2. Start recovery:

Operate the *Recovery Machine* in accordance with the manufacturer's instructions until the system pressure reaches the specified final pressure or evacuation level.

3. Monitor Conditions:

Continuously monitor pressure and temperature for safe operation.

4. Final Measurement:

Weigh the *Storage cylinder* after recovery to determine *recovered refrigerant* mass.

5. Residual Check:

Confirm system pressure remains stable at near-vacuum for at least 5 minutes.

A.8 Calculation

Recovery Efficiency (%) = $\frac{\text{Mass recovered}}{\text{Original charge}} \times 100$

A.9 Acceptance criteria

Minimum benchmark: **Recovery Efficiency** of at least 95 % by mass.

1. Residual *Refrigerant* ≤ 5% of original charge.

A.10 Test report

The test report shall include the following information:

1. Identification of system and Refrigerant type.
 2. Equipment details and calibration certificates.
 3. Initial and final weights.
 4. Calculated Recovery Efficiency.
 5. Environmental conditions during test.
- Declaration of conformity with the specified acceptance criteria.

Annex B

(Informative)

Regulatory and Compliance Information

Regulatory and Compliance Information

This annex provides informative regulatory and compliance information relevant to *Refrigerant recovery*, recycling and reclamation. Users are responsible for identifying and complying with applicable national, regional and local requirements.

B.1 International and national regulations

United States Environmental Protection Agency regulations

Clean Air Act: The Clean Air Act includes requirements related to safe handling, recycling and reclamation of *Refrigerants* to reduce ozone-depletion and climate impacts.

Section 608: Section 608 regulations include requirements for technician certification, restrictions on venting, equipment servicing and Refrigerant management.

1 Montreal Protocol and Kigali Amendment:

The Montreal Protocol and the Kigali Amendment address the phase-out of ozone-depleting substances and the phase-down of certain high-GWP *Refrigerants*.

2. Kyoto Protocol and Paris Agreement:

Align *Refrigerant* management practices with international efforts to reduce greenhouse gas emissions as

outlined in the Kyoto Protocol and the Paris Agreement.

B.2 Local, regional and industry standards

1. State and Local Laws:

In India, relevant requirements may include regulations and guidance issued by the Ozone Cell, Ministry of Environment, Forest and Climate Change, and other competent authorities.

Users should identify and comply with applicable state, local or regional requirements that apply to *Refrigerant* handling, storage, transport, recovery, recycling, reclamation or disposal.

2. Industry Standards:

- i) IS 302 Part 2, Sec 40: 2025 - Safety of Household and Similar Electrical Appliances Part 2 Particular Requirements Section 40 Electrical Heat Pumps, Air-Conditioners and Dehumidifiers
- ii) IS 5610 - *Refrigerants* — Specification
- iii) UL 1963, *Refrigerant Recovery/ Recycling Equipment*, or equivalent standard for safety.
- iv) IS/ISO/IEC 17024, Conformity assessment - General requirements for bodies operating certification of persons.
- v) IEC 60335-2-104, Particular requirements for appliances to

Refrigerant Recovery, Recycling, and Reclaiming – Standard for Safe and Effective Management

Recover and/or Recycle Refrigerant from air-conditioning and refrigeration equipment.

- vi) AHRI Standard 740, Performance Rating of *Refrigerant* Recovery Equipment and Recovery/Recycling Equipment, ISO 11650, Performance

of Refrigerant recovery and recycling equipment, or equivalent performance standard.

Industry standards from organizations such as AHRI, ISO, IEC, UL and ASHRAE may provide useful practices for equipment performance, safety and personnel competence.

Annex C

(Informative)

Performance Guidelines and Best Practices

Performance guidelines and best practices

This annex provides informative guidance and examples of best practices for *Refrigerant* recovery, recycling, reclamation, equipment maintenance, evacuation levels and training.

1. Recovery equipment: maintenance and calibration best practices

- a. Establish regular maintenance schedules, including filter changes, leak checks, inspection of hoses, fittings, valves, oil separators, and electrical and mechanical components used in *Recovery Machines* to ensure optimal performance.
- b. Calibrate equipment periodically to maintain accuracy in pressure measurements and operational efficiency.
- c. Keep records of maintenance and calibration activities.

2. Recovery and recycling equipment evacuation levels

The following information is based on examples of evacuation levels and performance practices used in regulatory or industry guidance. It is provided for reference only and does not replace applicable national or regional requirements.

- a. For small appliances with 2.27 kg or less of *Refrigerant* charge, recovery equipment may be evaluated using one of the following approaches:
 - Recover 80 % of the *Refrigerant* when

the compressor in the system is not operating;

- Recover 90 % of the *Refrigerant* when the compressor in the system is operating; or
 - evacuate the appliance to 4 inHg vacuum.
- b. For all other systems, recovery equipment shall achieve the following evacuation levels prior to opening the system:

Type of Appliance	Achievable Relative Vacuum (kPa)
Very high-pressure appliance	0
High-pressure appliance, or isolated component of such appliance, with a full charge of less than 90.7 kg of <i>Refrigerant</i>	0
High-pressure appliance, or isolated component of such appliance, with a full charge of 90.7 kg or more of <i>Refrigerant</i>	33.9
Medium-pressure appliance, or isolated component of such appliance, with a full charge of less than 90.7 kg of <i>Refrigerant</i>	33.9
Medium-pressure appliance, or isolated component of such appliance, with a full charge of 90.7 kg or more of <i>Refrigerant</i>	50.8
Low-pressure appliance	3.33 kPa absolute

- c. Guidance for motor vehicle air-conditioning appliances should be taken from the applicable regulations and standards for those appliances.
- 3. **Refrigerant releases during reclamation processes**
 - a. As an example of regulatory practice, US EPA requirements for *Refrigerant* reclamation include limits on releases during reclamation. Users should verify and apply the requirements applicable in their jurisdiction.
- 4. **Training and certification**

The following provides best-practice guidance for technician training and certification. Certification schemes may use conformity assessment principles such as those in IS/ISO/IEC 17024.

 - a. Certification Requirements
 - i) Certified Technician Programs:
 - 1. Outline certification requirements for technicians, such as passing written and practical exams that assess knowledge and skills.

Note 1: IS/ISO/IEC 17024: Conformity assessment - General requirements for bodies operating certification of persons may be used.
 - 2. Endorse certifications from recognized industry organizations, such as the National Skill Development Corporation (NSDC), North American Technician Excellence (NATE) or Refrigeration Service Engineers Society (RSES).
 - ii) Renewal and Continuing Education:
 - 1. Require periodic renewal of certifications to ensure personnel stay updated on new technologies, regulations, and best practices.
 - 2. Encourage participation in continuing education courses, workshops, and seminars to enhance expertise and career advancement.
 - iii) Documentation and Record-Keeping:
 - 1. Maintain records of all training and certification activities, including participant names, dates, course content, and outcomes.
 - 2. Ensure certificates are issued and stored securely, providing a record of personnel qualifications for compliance verification.
 - b. Implementation and Monitoring
 - i. Training Program Development:
 - 1. Collaborate with industry experts, educational institutions, and regulatory bodies to develop comprehensive training curricula.
 - 2. Tailor training programs to the specific needs and roles of different personnel within the organization.
 - ii. Performance Evaluation:
 - 1. Conduct regular assessments to evaluate the effectiveness of training programs and identify areas for improvement.
 - 2. Gather feedback from participants to refine training content and delivery methods.
 - iii. Quality Assurance:
 - 1. Implement quality assurance measures to ensure training programs meet industry standards and achieve desired outcomes.
 - 2. Audit training providers and facilities to verify adherence to established criteria and objectives.

COVER 3

About ISHRAE

The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) was founded in 1981 at New Delhi by a distinguished group of HVAC&R professionals. Today, ISHRAE represents a strong network of over 25,000 members, including student members, and functions through 57 chapters and sub-chapters across the globe, with its headquarters located in New Delhi. It is led by a team of elected officers who are members of the Society working on a voluntary basis, collectively called the Board of Governors. In pursuance of its objectives, ISHRAE works in the areas of Research, Standards, Education and Training, and Publication of Technical Books and a Journal. It also organizes world-class annual exhibitions ACREX and REFCOLD, besides hosting technical seminars and conferences. ISHRAE is a responsible and socially-conscious Technical Society.

Purpose

- Nurturing the built environment

Vision

- Enabling climate positive built environment

Mission

- Global leadership & trusted knowledge partner for planet centric HVAC&R solutions, unifying professionals across industry, academia & government by setting standards, enabling policy, creating capacity and building resilience

Activities

Knowledge Dissemination: ISHRAE conducts conferences, seminars, exhibitions, workshops, panel discussions and product presentations throughout the country with both national and international participants to discuss, promote and display the state-of-the-art technologies, systems, products and services.

Books and Publications: ISHRAE publications help its members and the industry to keep up with technical developments, latest trends and sunrise technologies. ISHRAE publishes Standards, books on fundamentals of various topics, HVAC&R Handbooks and the extremely popular and informative ISHRAE Journal. The latest publication is on Insulation

Exhibitions cum Conferences: ISHRAE organises ACREX India, the largest international exposition in South Asia on the Air Conditioning, Refrigeration, Ventilation and Building Services industry. Held annually, ACREX showcases the latest technologies and innovations, and provides a platform for buyer-seller meets for technical and commercial personnel in the HVAC&R field. To serve the interests of the Refrigeration and Cold-chain sector, ISHRAE organises REFCOLD annually. ISHRAE is a member and active supporter of the National Centre for Cold-chain Development (NCCD).

Education: ISHRAE is actively engaged in Education and Training, and offers several courses for technical professionals, some with post-examination certification. This helps to bring trained manpower into the HVAC&R industry.

Research: ISHRAE promotes research in the field of HVAC&R technologies. It offers financial support to graduate and post-graduate students to carry out innovative R&D work in technology, systems and processes. ISHRAE partners with the industry, academia and the government to carry out scientific research at Institutes of Excellence associated with ISHRAE.

Standards: ISHRAE works in the national interest with various government ministries and departments; for example, in the development of Standards and drafting of the National Building Code for the Bureau of Indian Standards, working on Energy Conservation Building Code with the Bureau of Energy Efficiency, and with the Ozone Cell of the Ministry of Environment, Forest and Climate Change on refrigerant gases. ISHRAE has also developed a pioneering Standard on Indoor Environmental Quality.

Student Activities: ISHRAE student chapters in more than 150 engineering colleges encourage students to opt for careers in the HVAC&R industry with industry exposure including factory visits. The K-12 initiative of ISHRAE reaches out to young school children to make them aware of subjects like energy conservation and environmental concerns through drawing competitions, poster designs, quizzes and more, with emphasis on STEM education to inculcate scientific fervour and help them to grow up as responsible citizens.

Global Reach: ISHRAE works in close co-operation with other similar societies and organisations, both at national and international levels, for the promotion and development of concepts like health and safety, sustainability, Green buildings, energy efficiency and environmental responsibility, often interacting with UN bodies like UNDP and UNEP.

ISHRAE is indeed looked upon as a repository of technical knowledge in the HVAC&R and Building Services Industry globally by peer organizations and the Government.