ISHRAE

# ISHRAE Guidelines on Safe and Responsible Use of Refrigerants in HVAC&R Systems

# Foreword

ISHRAE stands committed to the dissemination of knowledge and the advancement of the arts and sciences of heating, ventilation, air conditioning and refrigeration engineering & related services.

In our continuous efforts to share knowledge, the ISHRAE Technical Committee has been regularly launching books and publications on subjects of interests in the HVAC&R Industry.

Of late the safe and responsible use of refrigerants in HVAC&R systems has been a matter of concern, both at the global level and specifically in the Indian context. ISHRAE Refrigerant Committee was set up and chaired by Dr. S. Devotta- Former Director, NEERI, Nagpur & a senior member of ISHRAE, to address issues connected with refrigerants. Their pioneering work was to publish "ISHRAE Position Document on Refrigerants".

It is commendable, that the ISHRAE Refrigerant Committee has now published "ISHRAE Guidelines on Safe and Responsible Use of Refrigerants in HVAC&R Systems" and it gives me great pleasure to launch this book and add it to the ISHRAE list of Publications.

We trust you find this publication informative and beneficial.

Best Regards,

Vishal Kapur
President

| **ISHRAE Refrigerant Committee** | | | |
|---|---|---|---|
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# INDEX

# INTRODUCTION

CFCs (e.g. CFC-12, CFC-11), HCFCs (e.g. HCFC-22, HCFC-123) and their blends have many desirable characteristics such as thermal and chemical stability, thermodynamic suitability, non-toxicity, non-flammability, material compatibility, low cost and above all efficiency. With the discovery of link between CFCs and HCFCs to the ozone layer depletion, these have been mandated to be phased out under the Montreal Protocol (MP). Accordingly, CFCs were phased out by 2010 in India. As per the amended Indian Ozone Depleting Substances (Regulation and Control) Amendment Rules, 2014, all users of HCFCs have to phase out HCFCs by 1st January 2025 (MOEFCC, 2014).

HFCs (e.g. HFC-134a) and their blends (e.g. R-410A and R-404A) are now extensively used as alternatives to both CFCs and HCFCs and generally have very high GWPs, typically in the range 600 to 4000. HFC emissions are projected to grow significantly up to 2050, largely due to increasing demand for RAC sectors in developing countries. Kigali Amendment to MP in 2016 mandates the phase down of high GWP HFCs as per the prescribed schedule. India is to start the HFC phase down from 2018.

The search for alternatives to HCFCs and HFCs simultaneously is much more compounded than the earlier search alternatives to CFCs. Currently there are HCFCs, HFCs, HFOs (unsaturated HFCs), natural refrigerants including R-717 (ammonia), Hydrocarbons (HC-600a and HC-290), R-744 (Carbon dioxide) in use as refrigerants in a variety of applications, globally as well as in India. It is obvious that some of the refrigerants are flammable unlike CFCs, HCFCs and HFCs. Most of the low GWP refrigerants, including HFC-32, HFO-1234yf, HFO-1234ze, HC-290, and R717 are flammable. This introduces additional factors to be considered by the HVAC&R community in the design, construction, operation, and service and decommissioning of systems using flammable and toxic refrigerants. In India, there may not be codes, standards and regulations to adequately address the safe and responsible use of these refrigerants, in general, and flammable refrigerants, in particular, although HFC-32 and HC-290 are already in commercial use. Therefore, there is a need for some guidelines to address safety and environment, particularly while using flammable refrigerants.

Scope of this Guidelines Document: This document attempts to provide brief guidelines to some of the global safety standards and regulations, in addition to some of the existing Indian standards and regulations. A system lifecycle may include design, testing, manufacture, storage, transportation, installation, commissioning, operation, service and maintenance, decommissioning and disposal, initially within manufacturing sites, mainly dealt by manufacturer, and later in the field involving manufacturer, service technicians and end-users (UNEP, 2017a and d). These standards do not comprehensively address the entire lifecycle of a system, particularly storage, transportation, servicing, decommissioning and disposal. There are standards to address general electrical, line and safety related components, compressors, refrigerant charge, particularly for flammable and toxic refrigerants, refrigerant gas detectors, marking instructions, installation and desirable locations, electrical parts for potential flammable conditions, system integrity and servicing practices. Most of the standards are not developed in isolations but in combination with other existing standards and are interrelated, Readers are also reminded that most of the current standards are under revision due to the introduction of new refrigerants in various RAC applications e.g. flammable refrigerants including HFC-32, HFO1234yf and HC-290 and high-pressure refrigerants like CO2, and toxic and flammable refrigerants like R-717 (UNEP, 2017 a and c). Therefore, one should take extra care to refer to the most recent version of any standard and due diligence and risk assessment should be carried out by any individual or organisations for their applications to mitigate associated risks.

There are some independent guidelines for safe use of flammable refrigerants and related standards (AIAHRI, 2013; BRA, 2010; GIZ, 2010; OSHB, 2015; UNEP, 2010, 2014, 2015, 2016, 2017a, 2017b, 2017 c, 2017d). These reports are good sources of information for design, manufacturing, installation and servicing of AC&R systems. Readers are also directed to ISHRAE Position Document on

Refrigerants (ISHRAE, 2015) on the current and future aspects of refrigerants.

## REFRIGERANT SAFETY

The use, storage and handling of refrigerants pose safety hazards. These hazards may be related to number of aspects, including:

- Storage at high pressure
- Displacement of oxygen when released in air
- Toxicity
- Flammability
- Dangerous decomposition products

Safety Classification: The most significant aspect of a refrigerant selection, besides energy efficiency and thermal and chemical stability is safety. Refrigerants are classified in terms of two general safety criteria: toxicity and flammability. Flammability and toxicity aspects are covered under IS 16656: 2017/ ISO 817: 2014_Refrigerants - Designation and Safety Classification

Types/grades/classes, if any covered in the standard:

i) Flammability classification - General

a) Class 1 (no flame propagation)

b) Class 2L (lower flammability: LFL > 0.10 kg/m3, heat of combustion < 19 MJ/kg and w/ burning velocity < 10 cm/s)

c) Class 2 (flammable: LFL > 0.10 kg/m3 and heat of combustion < 19 MJ/kg)

d) Class 3 (higher flammability: LFL < 0.10 kg/m3 or heat of combustion > 19 MJ/kg) where LFL is the lower flammability limit

ii) Toxicity classification Refrigerants are assigned to one of two classes, A or B, based on allowable exposure:

a) class A (lower chronic toxicity) signifies refrigerants that have an occupational exposure limit of 400 ppm or greater;

b) class B (higher chronic toxicity) signifies refrigerants that have an occupational exposure limit of less than 400 ppm

Refrigerant flammability can affect the safety of service personnel, occupants and property, mainly during handling and servicing activities, and it influences the design of equipment. The flammability of a refrigerant is gauged by the lower flammability limit (LFL), which is the lowest concentration of the refrigerant in air required for it to be able to be ignited. Flammability is also considered according to the refrigerants' heat of combustion (HOC), which is the energy released when it burns, and flame propagation velocity.

According to various national and international safety standards e.g. IS16656 (2017) /ISO 817 (2015), EN 378 (2016) and ASHRAE 34 (2016), refrigerants are categorised according to their flammability and toxicity. Most of the developed countries tend to follow harmonised standards not only to comply with national directives and regulations but also to demonstrate the quality of the products and installations.

**Safety Considerations:** As these are common to most of the refrigerants in use, a variety of precautions must be followed to ensure against injury to persons and damage to property. Thus, safety begins with observing basic precautions and following simple procedures. Before using or handling any refrigerant, personnel should become familiar with the characteristics of the specific refrigerant, which are mostly available from the supplier and manufacturer.

Safety hazards equally apply to other materials used with refrigerating systems. These include refrigeration lubricating oils, nitrogen (used for flushing or leak test), cleaning agents and oxy-acetylene (used for brazing).

Whenever handling hazardous fluids, a risk assessment should be carried out, in order to

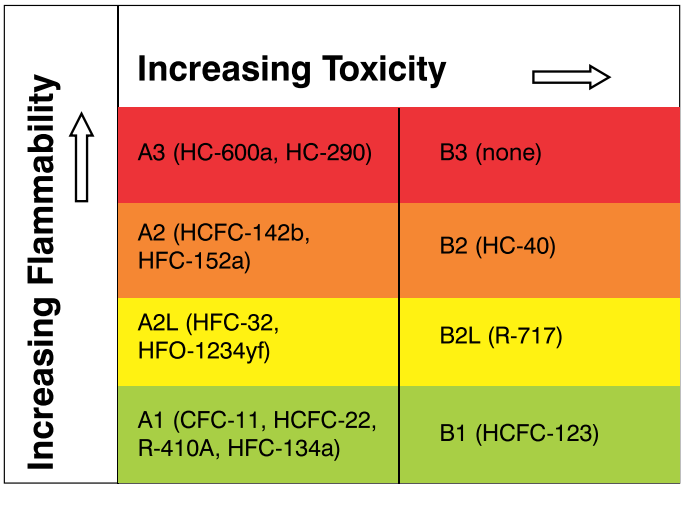


**Fig. 1.** Safety Classification of Refrigerants

determine what the potential risks are, what the consequences could be, and most significantly, to identify the safeguards and precautions to be put in place to ensure that all risks are addressed and safety is ensured.

**High pressure:** Most refrigerants are stored in cylinders under pressure, several times higher than atmospheric pressure, as they would be normally vapour at atmospheric pressure. A fluid being stored at a higher pressure has the potential to produce a rapid expansion, which may be explosive in nature and produce shock waves that can injure people and property. Therefore, it is important to ensure that whenever a high pressure fluid is handled, it is done so under strict safety procedures.

**Spill:** When a pressurised liquid is released into atmospheric pressure, it will rapidly boil off, thus drawing heat from its surroundings. In the event that a liquid spill occurs on the skin, this can result in freezing or frost bite. Thus, whenever handling refrigerants, one must always use and wear personal protective equipment like safety glasses and gloves. In case of any spill or skin contact, manufacturer's guidelines should be followed.

**Asphyxiation (Oxygen deprivation):** All refrigerants, if released, will displace air and when oxygen levels in the atmosphere are depleted, asphyxiation of people (and also animals) occurs. As most refrigerants (except ammonia) are denser than air, leaked refrigerants tend to settle in rooms below ground and enclosed spaces. As most refrigerants are odourless, occupants may not be aware that oxygen is being displaced, and may become asphyxiated without any notice of this problem. Generally, the areas where high concentrations of the refrigerant vapour could accumulate should be well ventilated. If there is any large leak, the area should be evacuated, must be ventilated using blowers or fans to circulate the air at floor-level: the lowest point possible. Before performing maintenance in areas where refrigerants could have accumulated, a thorough assessment must be carried out in order to determine whether respiratory protection is required. It is worth noting that there have been many accidents (including fatalities) due to asphyxiation in the field of RAC. It is essential to use appropriate breathing apparatus to retrieve someone who has lost consciousness.

**Degradation Products:** Depending upon the characteristics of a particular refrigerant, the consequences of ignition can be severe. It is essential to take the appropriate precautions whenever designing, constructing or working on a system that uses flammable refrigerants.

Whilst many CFC, HCFCs and HFC refrigerants are not flammable under normal conditions, they can become flammable when under pressure and mixed with air and/or oil. Because of this potential, the refrigerants should never be mixed with air in tanks or supply lines, or allowed to accumulate in storage tanks, and sources of ignition should also be avoided. These fluids may decompose at high temperatures, e.g. exposed to gas flames or electric heaters. The degradation products that result under these circumstances always include hydrofluoric acid (HF). If the refrigerant molecule contains chlorine, in addition to the formation of hydrochloric acid, if water (or oxygen), is present, a smaller amount of phosgene may also be formed. Halogen acids have a very sharp and stinging effect on the nose and if they are detected, the area should be evacuated until the air has been cleared of decomposition products. If exposed to HF, seeking medical attention is advised.

## SAFETY STANDARDS AND CODES OF PRACTICE

For R/AC sector, there are currently nine main safety standards (five product safety standards and four group safety standards) that cover systems, appliances, and products. If a product safety standard is available for a specific product or equipment of interest, then it should be preferentially used over a group safety standard. Unless mandated by a national legislation, the choice of product safety standard is voluntary. Compliance with safety standards plays important for manufacturers to manage the legal risk associated with commercial systems or services associated with systems. As there are many enterprises operating internationally, there is a preference for international standards, with national variations kept to the minimum (UNEP, 2017a). In some cases, international safety standards are commonly adopted fully into national legislations e.g. IS/ISO 5140 (2014) and IS16656 (2017)/ ISO 817 (2015).

Generally, refrigeration systems should be designed and constructed in accordance with general machinery requirements. There are a number of codes and safety standards that are appropriate to the use of refrigerants and flammable refrigerants, in

particular, in HVAC&R applications and systems. There are several international e.g. ISO and IEC and several regional e.g. CEN, CENELC from EU and national e.g. IS from India, ANSI/ASHRAE, UL from US relevant to HCAC&R. These standards and codes of practice are being constantly updated (UNEP 2017a and c). Due diligence should be made to ensure the standards being referred are the most recent and updated ones.

For buildings in India, The National Building Code of India 2016 (BIS, 2016) may be referred. Part 4 in Vol I deals with Fire and Life Safety while Part 8 Section in Vol II deals with Air Conditioning, Heating and Ventilation. The latest version of the NBC has been updated for refrigerant classifications, including new refrigerants with zero OPD, ultra-low GWP and A2L. Although the code mentions about safety aspects of air-conditioned spaces in general, it does not yet address the incremental safety requirements arising out of the use of flammable refrigerants like HFC0-32 and HC-290. This may be set back for Indian RAC sector but may be overcome by using the existing international standards, wherever needed.

Table 1 lists some of the important product and group IEC and ISO standards for AC&R. Some of these are also presented briefly. More detailed discussion are presented in UNEP (2017a)

**IS/ ISO5149 (2014) - Refrigerating Systems and Heat Pumps - Safety and Environmental Requirements**

It is to be noted that BIS has already adopted ISO 5149 as the Indian standard IS/ISO 5149 (2014). This group standard is in four parts. This standard covers the safety issues for refrigerating systems almost to the entire life cycle, though not comprehensively for some aspects. Generally, any conversion of system designed for non-flammable refrigerants (A1) to use flammable refrigerants (A2, A2L and A3) is not recommended, as this may violate some of the safety standards. This is standard is cross referred in many other ISO and IEC standards for compliance.

**Part 1: Definitions, classification and selection criteria -** This most important standard specifies the requirements for the safety of persons and property, provides guidance for the protection of the environment, and establishes procedures for the operation, maintenance, and repair of refrigerating systems and the recovery of refrigerants. It also specifies the classification and selection criteria applicable to the refrigerating systems and heat pumps. Systems containing refrigerants which are not listed in ISO 817 are not covered in ISO 5149-1. It is also applicable in the case of the conversion of a system to another refrigerant e.g. retrofitting.

**Part 2: Design, construction, testing, marking and documentation -** This part of the standard is applicable to the design, construction, and installation of refrigerating systems, including piping, components, materials, and ancillary equipment directly associated with such systems, which are not covered in ISO 5149. It also specifies requirements for testing, commissioning, marking, and documentation. It applies to: a) refrigerating systems, stationary or mobile, of all sizes including heat pumps; b) secondary cooling or heating systems; c) the location of the refrigerating systems; and d) replaced parts and added components. It does not cover "mobile air conditioners".

**Part 3: Installation site-** This standard is applicable to the installation site (plant space and services). It specifies requirements for the site for safety, which could be needed because of, but not directly connected with, the refrigerating system and its ancillary components. It also applies in the case of the conversion of a system for another refrigerant e.g. retrofitting.

**Part 4: Operation, maintenance, repair and recovery-** This standard specifies requirements for safety and environmental aspects in relation to operation, maintenance and repair of refrigerating systems and the recovery, reuse and disposal of all types of refrigerant, refrigerant oil, heat transfer fluid, refrigerating system and part thereof. These requirements are intended to minimize risks of injury to persons and damage to property and the environment resulting from improper handling of the refrigerants or from contaminants leading to system breakdown and resultant emission of the refrigerant.

**ISO 12100:2010 Safety of Machinery - General Principles for Design - Risk Assessment and Risk Reduction**

Where very large quantities of flammable refrigerant are being employed, it is appropriate to consider standards that deal with hazardous areas. These standards are aimed directly at very large commercial and industrial type applications where flammable refrigerants are used and provide a general approach to risk assessment and design of

Table 1. Some Important Product and Group Safety Standards

| Sector | Product Safety Standards | | | | | Group Safety Standard | | | |
|---|---|---|---|---|---|---|---|---|---|
| | IEC 60335 -2-24 | IEC 60335 -2-40 | IEC 60335 -2-89 | ISO 13043[1] | ISO 20854[2] | IS/ISO 5149 -1 | IS/ISO 5149 -2 | IS/ISO 5149 -3 | IS/ISO 5149 -4 |
| **Domestic Refrigerator** | √ | | | | | √ | √ | √ | √ |
| **Commercial refrigeration** | | | √ | | | √ | √ | √ | √ |
| **Industrial Refrigeration** | | | | | | √ | √ | √ | √ |
| **Transport refrigeration** | | | | | | √ | √ | √ | √ |
| **Room air conditioner & heat pump** | | √ | | | | √ | √ | √ | √ |
| **Water heating heat pump** | | √ | | | | √ | √ | √ | √ |
| **Chiller** | | √ | | | | √ | √ | √ | √ |
| **Mobile air conditioning** | | | | √ | | | | | √ |
| **Reefer container** | | | | | √ | √ | √ | √ | √ |
| **Some equivalent national or regional standards** | EN 60335-2-24, UL-250, UL 60335-2-24 | EN 60335-2-24, UL 484[3], UL 60335-2-40 | EN 60335 -2-89, UL 471, 60335 -2-89 | | | IS/ISO 5149(2014), EN 3786, ASHRAE 15 | | | |

[1]ISO 13043 only covers R134a, R744 and R1234yf for mobile air conditioning (MAC), so all other alternative refrigerants are out of its scope.
[2]ISO 20854 Freight Container - Thermal containers — Safety standard for refrigerating systems using flammable refrigerants: Recommendations Requirements for design and operation is under preparation.
[3]UL484 – Room ACs only

such environments. ISO 12100 (2010) specifies methodologies for achieving safety in the design of machinery. It specifies principles of risk assessment and risk reduction based on knowledgebase. The hazards from explosions are to be considered in accordance with appropriate standards. The most significant difference between systems using flammable and non-flammable refrigerants is the use of suitable electrical equipment that will not pose a risk in the event of any leak or release. IS/IEC 60079-0 2007, which is identical to IEC 60079-0: 2007 'Explosive atmospheres - Part 0: Equipment - General requirements' issued by IEC was adopted by the BIS. This standard provides information on the general approach for using electrical equipment in any potentially flammable areas:

## DOMESTIC AND SMALL HERMETIC REFRIGERATION SYSTEMS

These systems often have other safety issues such as electrics related to them since they are considered as appliances. These are covered under IEC standards linked to ISO 817 for the safety classification of refrigerants and ISO 5149 for certain safety aspects.

**IEC 60335-2-24:2010 Household and similar electrical appliances - Safety - Part 2-24 Particular requirements for refrigerating appliances, ice-cream appliances and ice maker:** This standard deal with compression-type appliances for household and similar use, which use flammable refrigerants and requirements for appliances using transcritical refrigerant systems e.g. R744.

**IEC 60335-2-40:2013 Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers:** This standard deals with the safety of electric heat pumps, including air-conditioners, and dehumidifiers incorporating motor-compressors and hydronic room fan coils. This standard also applies to appliances using flammable refrigerant. If provided in more than one assembly, the separate assemblies are to be used together, and the requirements are based on the use of matched assemblies. It may be mentioned here that this standard is also under revision, particularly for the use of flammable refrigerants (A2, A2L and A3).

**IEC 60335-2-89:2010 (including amendments till 2015) Household and similar electrical appliances - Safety - Part 2-89:** Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor: This standard also covers requirements for appliances using trans-critical refrigerant systems e.g. R744. This standard specifies safety requirements for electrically operated commercial refrigerating appliances that have an incorporated compressor or that are supplied in two units for assembly as a single appliance in accordance with the manufacturer's instructions (split system) including:

- refrigerated display and storage cabinets;
- refrigerated trolley cabinets;
- service counters and self-service counters;
- blast chillers and blast freezers.

**IEC 60335-2-34:2012 Household and similar electrical appliances - Safety - Part 2-34:** Particular requirements for motor-compressors: This standard deals with the safety of sealed (hermetic and semi-hermetic type) motor-compressors, which are intended for use in equipment for household and similar purposes, e.g. refrigerators, food freezers and ice makers (IEC 60335-2-24); air-conditioners, electric heat pumps and dehumidifiers (IEC 60335-2-40); commercial dispensing appliances and vending machines (IEC 60335-2-75); commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor (IEC 60335-2-89) and factory-built assemblies for transferring heat in applications for refrigerating, air-conditioning or heating purposes or a combination of such purposes.

## RESTRICTIONS ON REFRIGERANT USES

Specific design requirements are generally applied to a system based on the refrigerant charge size and location. If manufacturer's data are not available, charge sizes can be estimated. The rules governing equipment design are given below.

**Refrigerant Concentration Limits (RCL):** According to IS 16656 (2017) /ISO 817 (2014), the determination of RCL assumes full vaporisation and uniform mixing; no removal by dissolution, reaction and decomposition in the volume to which it is released. The RCL for each refrigerant is the lowest of the quantities calculated in accordance with acute Toxicity Exposure Limit (ATEL), Oxygen Deprivation Limit (ODL), and Flammable concentration limit (FCL). It may be mentioned that most of the refrigerants, as they are heavier than air, may be

covered for ODL in enclosed spaces. There are very few toxic refrigerants in current use e.g. R717 and HCFC-123 and safety issues related to R-717 (ammonia) have to be dealt differently for both flammability and toxicity, particularly for the latter.

As most of the low GWP refrigerants are flammable, including HFC-32, HFO 1234yf, R-717 and HCs, and these fluids are considered for applications so far uncommon. Therefore the revision of standards, including IEC 60335-2-40 is focussing to address safety of using such flammable refrigerants. The following discussions are mostly addressing safety aspects of using flammable refrigerants.

**Allowable Flammable Refrigerant Charge:** The limiting factor associated with the use of flammable refrigerants is the refrigerant charge size in a single circuit, the occupancy category and the room size. The charge size requirements according to IS/ISO 5149 (2014), IEC 60335-2-40 (2013) and EN 378 (2016) follow this approach. The practical limit is defined as 20% of the LFL for applications which are not “human comfort”. For “human comfort”, the application there is a minimum room area, which needs to be checked. For ventilated enclosures, there are no conditions of minimum room area or 20% LFL to consider.

**Occupational Category (IS/ISO 5149, 2014)**

The various requirements are prescribed for various occupation categories in IS/ISO 5149 (2015). Generally occupancy types are categorised as follows:

**General Occupancy Category A -** Rooms, parts of buildings or buildings where people may sleep, people are restricted in their movements or an uncontrolled number of people are present or to which any person has access without being personally acquainted with the general safety precautions (e.g. hospitals, courts, prisons, theatres, supermarkets, schools, lecture halls, public transport termini, hotels, dwellings, restaurants).

**Supervised Occupancy Category B -** Rooms, parts of buildings or buildings where only a limited number of people may be assembled, some being necessarily acquainted with the general safety precautions of the establishment (e.g. business or professional offices, small shops, small restaurants, laboratories, places for general manufacturing and where people work).

**Authorised Occupancy Category C -** Rooms, parts of buildings or buildings where only authorised persons have access, who are acquainted with general and special safety precautions of the establishment and where manufacturing, processing or storage of materials or products takes place.

Machinery rooms should not be considered as an occupied space except as defined in IS/ISO 5149-3 (2014). It is to be mentioned here that ASHRAE 15 (2016) has a few more and different classifications. Occupancy categories are used to determine the safety issues and refrigerant charge limits for flammable refrigerants.

System Classification (IS/ISO 5149, 2014)

Refrigerating systems are generally classified in IS/ISO 5149-1 (2014) according to

- the method of extracting heat from the atmosphere cooling,
- the method of adding heat to the atmosphere heating,
- the substance to be treated, or
- the refrigerant leak entering the occupied space.

These are further divided into direct releasable, including direct , open spray, direct ducted, and open vented spray systems, and indirect systems including indirect closed, indirect vented, indirect closed vented, double direct and high-pressure indirect systems. System classification is used to determine the refrigerant charge limits.

**Location classification**

Charge limit requirements for refrigerating systems are to be calculated as per the location class and the toxicity and/or the flammability of the refrigerant as specified in IS 16656 (2017) /ISO-817 (2014). The locations are classified as mechanical equipment located within the occupied space, compressors in machinery room or open air, machinery room or open air and ventilated enclosures. Location classification is used to determine the refrigerant charge limits.

**Refrigerant per Occupied Space**

IS/ISO 5149 (2014) specifies the allowable refrigerant charge depending on the occupancy category, location of the system, refrigerant class and few other conditions.

1. The amount of a refrigerant charge that could enter into the occupied space is determined by

- for occupied spaces, the refrigerant quantity is not to exceed the amounts specified in this standard.
- the refrigerant quantity is the quantity that can be released in an occupied space, and is the largest charge of any single refrigerating system, unless otherwise specified in this standard.

2. Where IEC or ISO product standards exist for particular types of systems and where these product standards refer to refrigerant quantities limits, such quantities overrule the requirements of this standard.

IS/ISO 5149 (2014) states that for factory-sealed appliances containing not more than 0.15 kg of A3 refrigerant, the requirements of IEC 60335-2-24 and IEC 60335-2-89, as applicable, is to be applied. There are also specifications for air-conditioner and heat pumps for human comfort and the use of A3 refrigerants. This standard prescribes the alternative risk management, for certain conditions, to choose the allowable refrigerant charge instead of the practical limit values given. All occupied spaces, where refrigerant-containing parts are located, should be considered in calculating the system charge. This standard lists some of the potential hazards of refrigerating systems. Where fluids are used as heat-transfer fluids, the circuit is to be treated as a refrigerating circuit and the fluid as a refrigerant. The designer has to take into account certain criteria described in this standard when selecting a heat-transfer fluid.

The charge limits for an appliance, installation location, type of location or the appliance are prescribed in Annex GG of IEC 60335-2-40. This standard also prescribes the requirements for charge limits in unventilated areas (for non-factory sealed single package units) appliances and mechanically ventilated areas (for fixed appliances). This standard further stipulates requirements for mechanical ventilation within the appliance enclosure and for refrigerating systems using secondary heat exchangers. The maximum charge for HC-290, HC-1270 and HFC-32 for a given floor area for an appliance located at different heights and minimum room area for a given refrigerant charge are also specified. The testing protocols are also described.

In Annex FF of IEC-60335-2-40 (2013), a leak simulation test from critical joints and bends is described to determine the integrity of joints in a system and also the amount refrigerant leaked out of the system. This is also described for refrigerant blends. This test has to be conducted in a leak tight, draft free room of sufficient size.

**Space Volume and Ventilation (IS/ISO 5149, 2014)**

According to IS/ISO 5149 (2014), the space considered is any occupied space, which contains refrigerant-containing parts. The smallest, enclosed, occupied space volume has to be used in the determination of the refrigerant quantity limits. Multiple spaces that have appropriate openings (which cannot be closed) between the individual spaces or are connected with a common ventilation supply return, or exhaust system not containing the evaporator or the condenser has to be treated as a single space.

Where the evaporator or condenser is located in an air supply duct system serving multiple spaces, the volume of the smallest single space is to be used. If the air flow to a space cannot be reduced to less than 10% of the maximum air flow by the use of an air flow reducer, then that space is to be included in the volume of the smallest occupied space. Where the evaporator or condenser is located in an air supply duct system and the system serves an unpartitioned multi-storey building, the occupied volume of the smallest occupied storey of the building is to be used.

The space above a false ceiling or partition has to be included in the volume calculation unless the false ceiling is airtight. Where an indoor unit of a system or any refrigerant-containing pipe work is located in a space such that the total charge exceeds the allowable charge, special provisions has to be made to ensure safety (IS/ISO 5149, 2014).

**Installation (IS/ISO 5149 -3, 2014)**

ISO 5149-3:2014 is applicable to the installation site (plant space and services). This standard specifies requirements for the safety of the site (location and machinery rooms) and persons and property on or near the premises where refrigeration facilities are located (electrical installations, safety alarm and gas detectors, instruction manuals, notices and inspection).

IS/ISO 5149-3 (2014) provides criteria for safety and

environmental considerations of different refrigerants used in refrigeration and air conditioning. It also specifies the amount of refrigerant in a given space, when exceeded, requires additional consideration including use of a machinery room or additional protective measures to avoid the risk of a hazard. The hazards are essentially associated with the physical and chemical characteristics of refrigerants, their mixtures and combinations with oils, water and other materials as well as the pressures and temperatures occurring in the refrigeration cycles. The potential hazards include from (Annex C of IS/ISO-5149-1, 2014):

a) the direct effect of extreme temperature,

b) excessive pressure

c) the direct effect of the liquid phase

d) from the leakage of refrigerants

e) from the moving parts of the machinery

Open (naked) flames are to be avoided in machinery rooms or refrigeration machinery rooms, except for welding, brazing or similar activity only where the refrigerant concentration is monitored and adequate ventilation is ensured. Such open flames should not be left unattended after ensuring that there is no detectable refrigerant by refrigerant detector. In case the refrigerant in the machinery is R-744, the use of an open flame may be permitted.

Commonly used refrigerants, except R-717 (ammonia), are heavier than air. Care should be taken to avoid stagnant pockets of heavy refrigerant vapours by proper location of ventilation inlet and exhaust openings. All machinery rooms are required to have mechanical ventilation controlled by oxygen deficiency alarms or refrigerant vapour alarms.

Overall, the standard promotes the safe design, construction, disposal, installation, and operation of refrigerating systems. It includes specifications for fabricating a leak tight system. This also provides guidance for the protection of the environment and establishes procedures for the operation, maintenance and repair of refrigerating systems and the recovery of refrigerants.

Other standards which are relevant to installation are: IEC 60364 for general electrical installations, IEC 60079-10-1 for potentially flammable areas, IEC 60079-0, -14, -17, -19 for electrics for flammable areas, ISO 5149-4 for worker practices: IEC 60335 2-40 (Annex DD) for safe handling of flammable refrigerants:

Attention is also drawn to ISHRAE Handbook – Installation Guide (ISHRAE, 2009), where some general guidelines for installation of AC&R systems are provided.

**Handling of Refrigerant Cylinders**

Refrigerant cylinders tend to be transported widely and subjected to a variety of conditions. IS/ISO 5149-4 Annex C provide information for handling refrigerant cylinders, as these gases are stored under pressure and some of these refrigerants are also flammable. The Indian Gas Cylinder Rules (2016) have to be followed while handling refrigerant cylinders. For these reasons, it is important to ensure that refrigerant gas cylinders are handled carefully to avoid severe consequences:

a. Always store and transport refrigerant cylinders in upright position to keep the valve in contact with the vapour space.

b. Do not throw or drop refrigerant cylinders during transportation, and never permit them to strike each other violently.

c. Do not apply direct heat to refrigerant cylinder while charging a system to maintain inside pressure; a warm water bath should be used for that purpose.

d. Ensure only regulators and pressure gauges designed for the particular refrigerant in the cylinder are used. Never attempt to repair cylinders or valves.

e. Never use a lifting magnet or a sling. A crane may be used when a safe cradle is provided to hold the cylinders.

f. Never tamper with cylinder valves or pressure relief devices, or other safety devices.

g. Ensure the cylinder valve outlet threads are the same as what is being connected to it. Never force connections that do not fit.

h. Cylinders should always be stored upright, and larger cylinders should be chained in place to avoid falling.

i. It is preferable to store cylinders within a secured and shady cage protected from extremes of weather and direct sunlight. Cylinders should never be exposed to

temperature above 52°C.

j. Mark and store full and empty cylinders apart to avoid confusion.

k. Never store cylinders near elevators or gangways, or near highly flammable substances.

l. Refrigerant cylinders should never be filled over 80% of their capacity because the liquid expansion may cause the cylinder to burst.

m. Always check the refrigerant number before charging to avoid mixing refrigerants.

n. Do not use the cylinders if they show signs of rust, distortion, denting, or corrosion.

o. Disposable cylinders are not permitted to be used in India.

**Transport of cylinders by vehicles:**

a. Cylinders filled with any compressed gas should not be transported by a bicycle, or any other two wheeled mechanically propelled vehicle.

b. Transported cylinders are not to project in the horizontal plane beyond the sides or ends of the vehicle by which they are transported.

c. There has to be no sharp projections on the inside of the vehicle.

d. Cylinders are to be adequately secured to prevent their falling off the vehicle and being subjected to rough handling, excessive shocks or local stresses.

e. Cylinders transported in vehicles are to be secured so as to prevent movement, striking each other or falling down.

f. Cylinders filled with any compressed gas should not be transported along with any other article of a highly flammable or corrosive nature.

g. No person is permitted to tender or transport any leaky cylinder.

h. Any cylinder containing a flammable or toxic gas, which develops a leak during transport has to be promptly removed to an isolated open place away from any source of ignition and the person responsible for transportation has to immediately contact the filler or the consignor as the case may be, for necessary advice.

**Protection of valves during transport:**

a. Every cylinder containing compressed gas, when transported, has to have its valve protected against damage in the manner provided in sub-rules (b) and (c) unless it is securely packed in a box or crate.

b. Where the design of the cylinder does not provide for the valve lying wholly below the level of the body of the cylinder, a stout metal cap, metal cover or a protective metal ring or grill of a design approved by the Chief Controller of Explosives are to be provided, the design being such that the cap or cover or ring or grill is nowhere in close proximity to any part of the valve or valve body.

**Licence for filling and possession:**

a. No person can fill any cylinder with compressed gas and no cylinder filled with compressed gas can be possessed by anyone except under and in accordance with the conditions of a licence granted under Gas Cylinder Rules (2016).

b. The licensee is responsible, for all operations connected with the filling and possession of cylinders in the licensed premises.

c. No licence needed for possession in the following cases: (a) possession of any cylinder filled with a compressed gas by a carrier or other person for the purpose of transport in accordance with the provisions of these rules; (b) possession of cylinders for own use and not meant for sale filled with,

1. any other flammable but non-toxic gas when the total number of cylinders containing such gas does not exceed 25 or the total weight of gas does not exceed 200 kg., whichever is less, at a time;

2. any non-flammable and non-toxic gas when the total number of such cylinders does not exceed 200 at a time;

3. any toxic gas when the total quantity of such cylinders does not exceed 5 at a time;

**Working pressure and filling ratios:** The working or internal pressure in any cylinder charged with a liquefiable gases should not be filled in excess of the filling ratios specified in IS: 3710 for low pressure liquefiable gases and IS:8866 for high pressure liquefiable gases.

**Storage of cylinders:** Cylinders should be stored in a cool, dry, well ventilated place under cover, away from boilers, open flames, steam pipes or any potential sources of heat and such place of storage should be easily accessible. The storage room or shed has to be of fire resistant construction. Cylinders containing flammable gases and toxic gases should be kept separated from each other and from cylinders containing other types of gases by an adequate distance or by a suitable partition wall. Cylinders are not to be stored under conditions, which will cause them to corrode. Cylinders should not be stored along with any combustible material. Empty cylinders are to be segregated from the filled ones and care should be taken that all the valves are tightly shut.

**Transportation of Systems Using Flammable Refrigerants:** IEC 60335-2-40 Annex CC briefly describes transportation, marking and storage of appliances and units that employ flammable refrigerants.

**Electrical installations:** In premises for filling and storing flammable gases in cylinders all electric meters, distribution boards, switches, fuses, plugs and sockets, all electric fittings, fixed lamps, portable hand lamps and motors, should be of flame proof construction conforming to IS/IEC-60079-1, IS/IEC-60079-11 as amended from time to time (In lieu of IS:2148) and other relevant standards as approved by the Chief Controller of Explosives and should be effectively earthed.

**Servicing of AC&R Systems**

Annex HH of IEC 60335-2-40 describes the competence requirement of service personnel including additional training for commissioning, maintenance, repair, decommissioning and disposal of systems using and safe handling flammable refrigerants and systems. IS/ISO 5149-4 (2014) Section 5 prescribes the norms for maintenance repair of refrigerating systems.

There are some guidelines published by GIZ and UNEP for the service sector. It is worth referring the following while formulating any service manuals for technicians as they provide very detailed insight into the various requirements of RAC technicians.

- GIZ, Guidelines for the safe use of hydrocarbon refrigerants (2010)
- Manual for Refrigeration Servicing Technicians (UNEP, 2010)
- Good Servicing Practices: Phasing out HCFCs in the Refrigeration and Air-Conditioning Servicing Sector, (UNEP, 2015)
- Good Servicing Practices for Flammable Refrigerants- A Quick Guide (UNEP, 2016)

National Certification Schemes for Refrigeration and Air-conditioning Service Technicians (UNEP, 2015) aims to provide introductory information for institutions in developing countries to better understand the issue of certification in the field of RAC, to assist in the creation of such certification and training schemes and to demonstrate to service technicians and enterprises on the importance of certification. This guidance is provided through four main examples of existing certification schemes. It is intended for a variety of governmental agencies, industry associations, professional bodies as well as Certification Bodies. Certification is also an important element in customer protection and the servicing sector to adopt appropriate certification. Certification in the RAC sector can also act as an incentive for technicians to prove their competence and proficiency in the current dynamic situation of RAC sector.

**Refrigerant Recovery & Disposal:** IS/ISO 5140-4 (2014) prescribes the requirements for recovery, reuse and disposal, including, recovery and reuse of refrigerant, refrigerant transfer, transport and storage, recovery equipment, disposal and documentation. Annex B of IS/ISO5149-4 (2014) also provides guidelines on specifications for recycled refrigerants.

In Annex DD of IEC 60335-2-40 (2013), detailed information on servicing of refrigerant containing appliances, including those using flammable refrigerants, is provided. This includes safety checks, repairs of sealed units, safety components, leak detection methods, refrigerant removal and evacuation, charging, decommissioning, labelling and recovery of refrigerants.

ISO 11650:1999, which has been reconfirmed in 2014, deals with the performance of refrigerant recovery and/or recycling equipment

Specification of the test apparatus, test gas mixtures, sampling procedures and analytical techniques used to determine the performance of refrigerant recovery and/or recycling equipment

Specification of the refrigerants to be used for the evaluation of equipment

**Concluding Remarks**

TEAP (UNEP, 2017a) concluded in its report, that the current international safety standards impose some restriction on the application of flammable refrigerants, depending upon the type of refrigeration system and location of the system. There are some implications of the International Standards for the implementation of HPMP and Kigali amendment. The critical issue is whether a flammable refrigerant can be used in a safe and cost-effective way using state-of-the-art systems. The major constraints that the various international safety standards impose on flammable refrigerants are: exclude certain class of flammable refrigerants totally, or above a certain quantity; prohibit charges above a certain quantity for a given type of system and/or place of installation or to a room size. The most critical situations concerning restrictions are in commercial refrigeration appliances, small air conditioning and heat pump appliances and systems, large air conditioning appliances.

There are still some gaps for the servicing sector not only with respect to good service practices and responsible use of refrigerants to mitigate any global environmental problems but also for the safe handling and use of flammable refrigerants. This has to be addressed as a part of the national strategy by all stakeholders.

The scope covered in this document includes design, construction and installation of products and systems and practical guidelines - for best practices when handling systems and refrigerants. As the scope is vast, an attempt has been made only to provide pointers to safety guidelines from national and international standards. This is only collection and review of standards and readers are advised to refer to the original standard documents for full details and carry out their own due diligence and risk assessment before design, construction, installation, servicing and decommissioning of appliances or plants, particularly those using flammable refrigerants. The views expressed do not necessarily represent the stated policy of the ISHRAE.

**Abbrevation**

| | |
|---|---|
| A/C | Air Conditioning |
| Article 5 (A5) | Countries operating under Article 5 of the Montreal Protocol |
| AIRAH | Australian Institute of Refrigeration, Air Conditioning and Heating |
| ANSI | American National Standards Institute |
| AREA | Air Conditioning and Refrigeration European Association |
| AHRI | Air-Conditioning, Heating, and Refrigeration Institute |
| ASHRAE | American Society of Heating, Refrigerating and Air-Conditioning Engineers |
| BIS | Bureau of Indian Standards |
| BRA | British Refrigeration Association |
| CEN | European Committee for Standardization |
| CENELEC | European Committee for Electrotechnical Standardization |
| CFC | Chlorofluorocarbon |
| GHG | Greenhouse gas |
| GWP | Global Warming Potential |
| HCFC | Hydrochlorofluorocarbon |
| HC | Hydrocarbon |
| HFC | Hydrofluorocarbon |
| HFO | Hydrofluoroolefin |
| HVAC&R | Heating, ventilation, air conditioning and refrigeration |
| IEC | International Electrotechnical Commission |
| IS | Indian Standard |
| ISO | International Organization for Standardization |
| LFL | Lower Flammability Limit |
| ODP | Ozone Depleting Potential |
| ODS | Ozone Depleting Substance |
| OEL | Occupational exposure limit |
| RAC | Refrigeration and Air-Conditioning |

| | |
|---|---|
| UL | Underwriters Laboratories |
| UNEP | United Nations Environment Programme |

**REFERENCE**

(While preparing this document considerable information has been drawn from standards and other references listed below. Some standards are listed here only for information although these may not be referred in the main text)


AIRAH (2013), Flammable Refrigerants, Safety Guide

ASHRAE Standard 15 (2016): Safety Standards for Refrigeration Systems, ASHRAE

ASHRAE Standard 34 (2013): Designation and Safety Classification of Refrigerants, ASHRAE

BIS (2014), Draft Indian Standard for liquid-chilling packages using the vapour compression cycle - Method of measurement of performance and energy efficiency rating and testing for performance

BIS (2016), National Building Codes of India 2016.

BRA (2010) Guide to Flammable Refrigerants, British Refrigeration Association.

EN 378 - 2000: Refrigerating Systems & Heat Pumps-Safety & Environmental Requirements, European Union.

EN 13313 - 2010: Refrigerating systems and heat pumps - Competence of Personnel

GIZ (2010), Guidelines for the safe use of hydrocarbon refrigerants

Government of India (1948), The Factories Act, 1948 and amended by the Factories (Amendment) Act, 1987 (Act 20 of 1987)

Government of India (2016), The Gas Cylinder Rules

Government of India (1981), The Static and Mobile Pressure Vessels (Unfired) Rules.

Government of India (2015), Central Motor Vehicles (Amendment) 1st Rules, 2015.

IEC 60335-1:2014, Household and similar electrical appliances – Safety – Part 1: General requirements

IEC 60335-2-24:2010, Household and similar electrical appliances - Safety - Part 2-24: Particular requirements for refrigerating appliances, ice-cream appliances and ice maker.

IEC 60335-2-34:2012, Household and similar electrical appliances - Safety - Part 2-34: Particular requirements for motor-compressors.

IEC 60335-2-40:2013, Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers.

IEC 60335-2-89:2010 (including amendments till 2015), Household and similar electrical appliances - Safety - Part 2-89: Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor.

IS 302-1 (2008), Safety of household and similar electrical appliances: Part 1 General Requirements

IS 302-2-21 (2011), Safety of Household and Similar Electrical Appliances, Part 2: Particular Requirements, Section 21: Stationary Storage Type Electric Water Heater

IS 659 (1964), Safety code for air conditioning

IS 660 (1963), Safety code for mechanical refrigeration

IS 1391-1 (1992), Room Air Conditioners, Part 1: Unitary Air Conditioners

IS 1391-2 (1992), Room Air Conditioners, Part 2: Split Air Conditioners

IS 1474 (1959), Commercial Refrigerators

IS 16656 (2017)/ISO 817 (2014), Refrigerants - Designation and safety classification

IS 2370 (2014), Walk-in Cold Rooms Specification

IS 5111 (1993), Testing of Refrigerant Compressors

IS 6044-1 (2013), Code of Practice for Liquefied Petroleum Gas Storage Installations, Part 1: Commercial and Industrial Cylinder Installations

IS 6044-2 (2001), Code of Practice for Liquefied Petroleum Gas Storage Installations, Part 2: Commercial, Industrial and Domestic Bulk Storage Installations

IS 8148 (2003), Packaged Air Conditioners

IS 9210 (1979), Refrigerated Display Cabinets

IS 10617 (2013), Hermetic Compressors - Specifications,

IS 10773 (1995), Wrought Copper Tubes for Refrigeration and Air-Conditioning Purposes

IS 11329 (1985), Specification for Finned Type Heat

Exchanger for Room Air Conditioner

IS 11338 (1985), Thermostats for Use in Refrigerators, Air Conditioners, Water Coolers and Beverage Coolers

IS 13408-1 (1992), Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for Use in Potentially Explosive Atmospheres (Other Than Mining Applications or Explosives Processing and Manufacture), Part 1: General Recommendations

IS 15750 (2006), Household frost-free refrigerating appliances - Refrigerators cooled by internal forced air circulation - Characteristics and test methods

ISHRAE Handbook 2009 (2009) Installation Guide

IS/IEC 60079-0 2007, Explosive atmospheres - Part 0: Equipment - General requirements

IS/ ISO5149 – 2014, Refrigeration systems and heat pumps-Safety and environmental requirements – Part 1 Definitions, classification and selection criteria (Under Development)

ISO 12100:2010, Safety of machinery - General principles for design - Risk assessment and risk reduction

IS/ISO 5149-2: 2014, Refrigeration systems and heat pumps-Safety and environmental requirements – Part 2: Design, construction, testing, marking and documentation

IS/ISO 5149-3: 2014, Refrigeration systems and heat pumps-Safety and environmental requirements – Part 3: Installation site (Under Development)

IS/ISO 5149-4: 2014, Refrigeration systems and heat pumps-Safety and environmental requirements – Part 4: Operation, maintenance, repair and recovery (Under Development)

ISO 11650:1999, Performance of refrigerant recovery and/or recycling equipment

OSHB, Guidance Notes on Work Safety and Health of Air-Conditioning Works, Occupation Safety & Health Branch Labour Department, Honk Kong (September, 2015)

Underwriter Laboratories (2011), UL White Paper: Revisiting Flammable Refrigerants.

UNEP (2010), Manual for Refrigeration Servicing Technicians

UNEP (2014), International Standards in Refrigeration and Air-Conditioning

UNEP (2015), National Certification Schemes for Refrigeration and Air-conditioning Service Technicians

UNEP (2015), Good Servicing Practices: Phasing out HCFCs in the Refrigeration and Air-Conditioning Servicing Sector

UNEP (2016), Good Servicing Practices for Flammable Refrigerants- A Quick Guide

UNEP (2017a), TEAP Report on Safety of Flammable Refrigerants

UNEP (2017b), Safety Standards Relevant to Refrigeration, Air-Conditioning and Heat Pump Equipment

UNEP (2017c), Updating the Refrigeration, Air-conditioning and Heat pump (RACHP) safety standards

UNEP (2017d), Application of Safety Standards to Refrigeration, Air-Conditioning and Heat Pump equipment – a Lifetime Perspective

# About ISHRAE

The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), was founded in 1981 at New Delhi by a group of eminent HVAC&R professionals. ISHRAE today has over 10,000 HVAC&R professionals as members and additionally there are 8,500 Student-members. ISHRAE operates from over 40 Chapters and sub Chapters spread all over India, with HQ in Delhi.

It is led by a team of elected offi cers, who are members of the Society, working on a voluntary basis, and collectively called the Board of Governors.

**ISHRAE Objectives:**

- Advancement of the Arts and Sciences of Heating, Ventilation, Air Conditioning and Refrigeration Engineering and Related Services.
- Continuing education of Members and other interested persons in the said sciences through Lectures, Workshops, Product Presentations, Publications and Expositions.
- Rendition of career guidance and financial assistance to students of the said sciences.
- Encouragement of scientific research.

**ISHRAE Mission**

To promote the goals of the Society for the benefit of the general public. Towards this objective, the Chapters of the Society participate in, and organize, activities to protect the Environment, improve Indoor Air Quality, help Energy Conservation, provide continuing education to the Members and others in the HVAC & related user Industries and offer certification programs, career guidance to students at the local colleges and tertiary institutions.

**Activities**

As part of its objectives to promote the interests of the HVAC&R Industry, ISHRAE is involved in various activities. ISHRAE reaches out to all its members and seeks their active participation & involvement in all the Events/Programs organized by the society.

**Programs**

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.

**Publications**

ISHRAE publications strive to help its members & the industry keep up-to date with the technical developments, latest trends, and sunrise technologies. ISHRAE Standards, Fundamental books on various topics, safety guidelines, HVAC&R Handbooks and the extremely popular & informative ISHRAE Journal, are a few such publications.

**ACREX INDIA**

ISHRAE organizes ACREX INDIA, the largest international exposition in South Asia on the Air-Conditioning, Refrigeration, Ventilation and Building services industry. Held annually, ACREX with nearly 500 exhibitors is considered to be a major opportunity to showcase the latest technologies/innovations, and provide a platform for buyer-seller meet, for technical & commercial personnel in the HVAC&R field.

**Education & Training**

ISHRAE Institute of Excellence (IIE), the educational arm of the Society, is working towards human resource development in the HVAC&R industry in the country by conducting various courses. One of the most important objectives of ISHRAE is Technical Training, and this is done at various levels.

At the apex of the pyramid we have the ICP (ISHRAE Certified Professional) Certification Courses on Clean rooms AC-Design, AC Service and others. At the next level ISHRAE offer a full time Diploma Course for graduate engineers. In addition at the Chapter level ISHRAE holds several successful training programs, workshops, short term courses and offers e-learning opportunities. ISHRAE is also working with associates in Skill Development activities.

**Student Activities**

ISHRAE student chapters in more than 150 engineering colleges encourage students to opt for careers in the HVAC&R industry. Knowledge dissemination is done through seminars, quiz contests like aQuest, plant and site visits.

ISHRAE has launched “ISHRAE Job Junction” nationally, providing a platform for leading employers to recruit candidates who are members from ISHRAE student chapters.

K-12 initiative of ISHRAE is focused on school students’ contests, in making them aware of subjects like, energy conservation and environmental concerns through drawing competitions, poster design, quiz and planting of trees. Emphasis on STEM education is stressed to inculcate a scientific fervor & help develop these young children into responsible citizens.

**Research**

ISHRAE promotes research in the field of HVAC&R technology. It offers financial support to Graduate/Post Graduate students, to carry out innovative work on R & D in Technology, Systems, and Processes. ISHRAE partners with Industry & academia to carry out scientific research associated with the HVAC&R Industry.

**SearchO**

Provides a unique platform for B2B and B2C users to share their expertise & requirements in an industry specific search engine. We wish to provide unparalleled user experience HVAC & R and Building Services Industry to increase their reach to all concerned in services & trade. This search engine will help promote the Make in India drive, by providing easy referencing to all stakeholders.

**Interaction with Govt. Departments and Associate Societies**

ISHRAE works in the National interest with various Govt. Ministries/Departments, e.g. in the development of Standards & drafting of NBC for BIS, working on ECBC with BEE, with Ozone Cell of MoEFCC, on refrigerant gases. ISHRAE is a member & active supporter of National Centre for ColdChain development (NCCD) Ministry of Agriculture & works closely with NCCD on refrigeration.

ISHRAE is also working in close co-operation with other similar Societies & Organizations, both at national and international level, for the promotion and development of issues like Sustainability, Green Buildings, Energy Efficiency, Environmental Responsibility, Indoor Air Quality, Fire & Safety. Interaction with Think-tanks & NGOs like NRDC, CEEW, TERI, CSE & UN bodies like UNDP/UNEP is a regular feature. ISHRAE is looked upon as a repository of technical knowledge in the HVAC&R & Building Industry field by peer Organizations & the Govt. of India.

A ISHRAE Initiative