newsTRAC

NEWSLETTER FOR TECHNICIANS IN REFRIGERATION AND AIRCONDITIONING (RAC) SECTOR

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Inside...

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The Energy and Resources Institute
Creating Innovative Solutions for a Sustainable Future

Foreword

Dear Reader,

It gives me immense joy to communicate with you that India has become the first country to release a National Cooling Action Plan. The then Hon'ble Union Minister for Environment, Forest and Climate Change Dr. Harsh Vardhan released the India Cooling Action Plan (ICAP) on 8th March, 2019. The ICAP addresses India's cooling requirement across sectors for the next two decades.

ICAP lists out synergistic actions towards securing environment as well as socio-economic benefits for the society. It emphasises the importance of skilled service technicians in the room air conditioning sector. The plan highlights the need for skill development, training and certification of Refrigeration and Air-conditioning (RAC) service technicians.

As per estimates, there are 2,00,000 service technicians in India, most of whom are in the informal sector. The Ministry of Skill Development and Entrepreneurship (MSDE) is mandated to develop skill ecosystem in the country. It oversees and administers skilling and vocational training. The National Skill Qualification Framework (NSQF) under MSDE provides for certification of skills through National Skill Development Corporation, which implements the certification programme through Thematic Sector Skill Councils. The Electronics Sector Skills Council of India caters to the RAC servicing sector trade.

There is an opportunity to further strengthen the training infrastructure of the country and update the technical content of training programmes. Training and certification of RAC service technicians have potential to provide significant environment and livelihood benefits. These could be achieved through appropriate skill development of service technicians, along with creating a market demand for certified technicians.

I am happy to share that The Ministry of Environment, Forest and Climate Change (MoEF&CC) and Ministry of Skill Development & Entrepreneurship (MSDE) have signed an MoU to skill and certify 1,00,000 service technicians under the Pradhan Mantri Kaushal Vikas Yojana – Skill India Mission.

The latest edition of NewsTRAC will apprise you of the salient features of ICAP. It will also highlight the challenges in the RAC servicing sector and underscore the need for energy-efficient servicing practices for technicians.

I congratulate The Energy and Resources Institute (TERI), and the United Nations Environment Programme (UNEP), the coordinating agency under HPMP and GIZ, for bringing out the bumper issue of this newsletter.

Geeta Menon
Joint Secretary
Ministry of Environment, Forest & Climate Change

A LEAP TOWARDS SUSTAINABLE DEVELOPMENT

By A.K Jain, Additional Secretary, MoEFCC

The year gone by has been the fourth hottest year in recorded human history. With populations worldwide facing the adverse effect of high temperatures, cooling has become more important than ever to ensure productivity and health. Despite summer temperatures in India nearing 50°C[1] in recent years, only 8% of Indian households have access to air conditioners (ACs). With scorching temperatures becoming the norm, ACs have fast transitioned from being a luxury to necessity.

India's largely underserved cooling demand also presents an opportunity to leapfrog to sustainable cooling. Ensuring advanced and affordable cooling, which also reduces the use of climate-warming refrigerants will reap multiple benefits such as lower emissions and food wastage along with convenience for farmers (with regard to the cold chain), and comfortable living for all. Displaying proactiveness in addressing the need for sustainable cooling, India is one of the first country in the world to develop a comprehensive Cooling Action Plan – India Cooling Action Plan (ICAP). The plan outlines the action which can help reduce India's cooling demand for the next 20 years, while presenting a long-term vision to address multi-sectoral cooling requirements. The ICAP synergizes technology innovations, policy analysis, and India's climate goals.

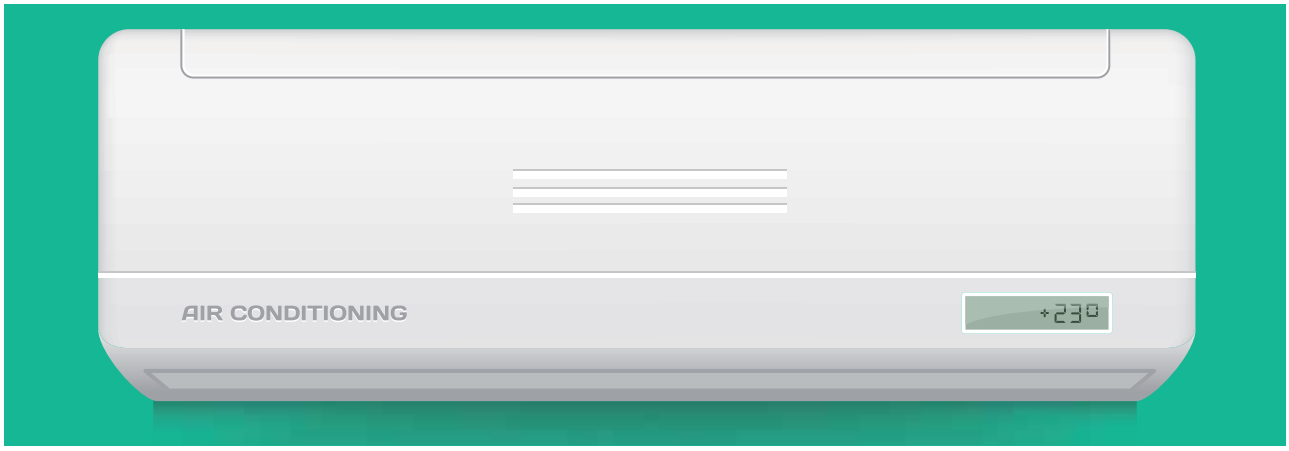
Underscoring both environmental and socio-economic benefits of sustainable cooling, ICAP has identified five goals, including recognition of 'cooling and related areas' as a thrust area of research under the national science and technology programme, to support the development of technological solutions and encourage innovation challenges. Reduction of cooling demand by 20-25%, and refrigerant demand by 25-30% across sectors by 2037-38 is part of the goals. The remaining goals include reduction of cooling energy requirements by 25-40% by 2037-38, and training and certification of 1, 00,000 servicing-sector technicians in synergy with the Skill India Mission by 2022-23.

Achieving these goals requires multi-stakeholder collaboration and facilitative regulatory frameworks. For effective implementation of ICAP, it is proposed that the plan is monitored and executed under the governance of a high-level inter-ministerial framework.

The ICAP recommends synergies with ongoing government programmes and schemes such as Housing for All, the Smart Cities Mission, Doubling Farmers Income, Skill India Mission, in order to maximize the socio-economic co-benefits. ICAP integrates short, medium and long-term goals to address rising cooling demand.

ICAP underscores the need for market-based mechanisms and innovative business models which enable mass adoption of affordable, energy-efficient RAC equipment. The ICAP provides short, medium and long term recommendations across different sectors while providing linkages with various programmes of the Government aimed at providing sustainable cooling and thermal comfort for all.

All stakeholders must contribute to the implementation of ICAP.



1 https://www.theguardian.com/world/2016/may/20/india-records-its-hottest-day-ever-as-temperature-hits-51c-thats-1238f

A GLOBALLY SIGNIFICANT DEVELOPMENT

By Dr. Ajay Mathur, DG, TERI

India's large-scale and transformative steps towards climate change mitigation have started gaining global recognition -- be it the mass scale adoption of energy-efficient equipment like LED bulbs, fans and ACs or rapid capacity addition in new and renewable sources of energy. Today, the global community is looking at India not only as an investment destination with a significant ease of doing business but as a nation moving ahead by leaps and bounds towards ensuring 'ease of living' for all. With sustainability at the core of its philosophy, India has drawn major developmental targets. The recent release of the **India Cooling Action Plan (ICAP)** is yet another link in this journey towards a sustainable future. The Government of India recognises the importance of the cooling sector and this reflected in ICAP which aims to address the country's cooling demand sustainably.

Cooling with optimum thermal comfort has become an inevitable need for many aspects of modern life especially better health and productivity. A large part of the cooling demand globally is catered through refrigerant-based cooling across sectors such as buildings, cold-chain, refrigeration and transport. India's aggregate cooling related energy demand is expected to soar from 90 TWh (billion units of kWh) in 2015 to 1,350 TWh by 2050 signifying a 15-fold increase. India, along with China and Indonesia, is expected to contribute a lion's share in energy for space cooling by 2050 - contributing half of global cooling energy demand growth. Also, the country's peak electricity load for space cooling is projected to jump from 10% now to 45% in 2050.

Cooling requirement is cross-sectoral and an essential part of economic growth for all nations. Most importantly synergistic actions with respect to cooling across sectors will have a higher impact than any action taken in isolation – which is the core idea behind the ICAP. Another important element which makes it globally relevant is that ICAP looks at the socio-economic implications of climate change, and accessible, sustainable cooling across all sectors.

As per the recent International Energy Agency report, the usage of air-conditioners and fans currently accounts for nearly 20% of the total electricity used in buildings around the world. If left unchecked, the global energy demand from air-conditioners will triple by 2050 that is equivalent to China's electricity demand today. From the environmental perspective, over 80% of global warming potential (GWP) impact of refrigeration sector is associated with indirect emissions generated during the production of electricity used in the operation.

To fast track sustainable cooling, governments must start with curbing the rapid growth in demand and promote the practice of advanced energy efficient technologies that use environment-friendly refrigerants. In middle income group countries, like India, the high upfront cost of energy-efficient cooling appliances is one of the key constraints in their wide adoption. This can be mitigated through innovative financial models such as bulk procurement and demand aggregation that drive down prices.

Efforts must be made to bridge the gap in technology transfer from developed countries to developing and under-developed nations. Sustainable cooling can be achieved through reduction in cooling load, passive cooling interventions for buildings, moving towards more energy efficient RAC equipment, operational efficiency enhancements, and use of new and alternative technologies. The move to sustainable cooling also requires a robust innovation ecosystem and a skilled RAC service technicians' workforce.

We owe it to our future generations to leave them a world that is habitable, civilised, resourceful, and sustainable. Measures like the ICAP are now more relevant than ever as they provide us with a platform to cohesively work towards our collective goal of sustainable development. The battle against climate change and environmental hazards has never been easy. Nor can this battle be fought and won alone. The answer, therefore, lies in synergised and concerted efforts from each one of us. ICAP has set the ball rolling. It is time we joined forces to add to this momentum.

Global Standards for Certification of Service Technicians

Certification of technicians in the refrigeration and air conditioning sector helps in monitoring the labour market according to national qualification classification systems. It not only enhances their skill set but also improves over all quality of service in the industry. Certification of RAC technicians helps in reducing refrigerant emissions and increasing energy efficiency.

This article gives an overview of some of the global certification standards for RAC technicians.

Australia: An RAC technician is required to hold a Refrigerant Handling License and those that purchase (as well as possess and dispose of) refrigerants require a Refrigerant Trading Authorization. The system is administered by the Australian Refrigeration Council Ltd. on behalf of the Australian Government.

China: The operation and monitoring of the certification systems for RAC technicians is the responsibility of the Ministry of Human Resources and Social Security (MHRSS). The Foreign Economic Cooperation Office (FECO) / Ministry of Environmental Protection (MEP) cover good practices during servicing and maintenance, as well as handling the new generation of refrigerants which can be flammable, toxic or with higher working pressure.

European Union: There are several European standards and regulations that control certification including the EU "F-Gas" Regulation No 517/2014. This regulation, which covers all 28 EU member states, includes specifications requiring personnel to cover a large variety of tasks and equipment related to the RAC sector.

Japan: RAC technicians are required to hold a Refrigeration Safety Manager Certificate. The Japan Society of RAC Engineers also provides additional certification including the one focusing on refrigerant leak prevention.

South Africa: There is a national standard (SANS 10147) which, inter alia, requires that RAC technicians involved in servicing and handling of refrigerants should be registered by the South African Qualification & Certification Committee as being competent in their specific fields.

USA: The Environmental Protection Agency (EPA) established a mandatory certification programme. RAC technicians are required to pass an EPA approved test implemented by an approved certifying organisation (if the technician is not under close and continual supervision from a certified technician)

Here is a comparative study of certification between Pacific Island Countries, Malaysia, and European Union on the basis of course content

	Pacific Island Countries	Malaysia	European Union
Course Standards Setup and Institutional Framework	Through Australia Pacific Technical College (APTC), in 2006	Under National CFC Phase-Out Plan (NCFCP), through Authorised Training Centres (ATCs), since 2007	National Advisory, Certifying Bodies, Advisory Committee of experts, since 1989
Course Content	Installation, Servicing, Repairs	Best Practices regarding services, Recovery, Machine set up	Installation, Services, Maintenance, Repairs, Leakage checking, Recovery

Following are the examples of standardisation organisations.

1. **International**: International Organisation for Standardization (ISO), and International Electrotechnical Commission (IEC)
2. **Regional**: Career Readiness and Work (CEW), and European Committee for Electrotechnical Standardization (CENELEC)
3. **National**: British Standards Institution (BSI), German Institute for Standardization (DIN), American National Standards Institute (ANSI), Institute of Standards and Industrial Research of Iran (ISIRI), Standardization Administration of Peoples' Republic of China (SAC), Standards Australia, Japanese Standards Association (JSA), Standards New Zealand, Environmental Quality Standards (EQS)
4. **National (Indian Industries)**: American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), Indian Society of Heating, Refrigerating & Air-conditioning Engineers (ISHRAE), Underwriters Laboratory (UL)

Following are the examples of Standards for Training and Certification

1. EN 13313:2010 Refrigerating systems and heat pumps – Competence of personnel
2. EN 378:2008 Refrigerating systems and heat pumps - Safety and environmental requirements
3. ISO 5149:2014 Mechanical refrigerating systems used for cooling and heating – Safety requirements
4. ISO 817:2014 Refrigerants – Designation and Safety Classification
5. ISO 17024:2012 Conformity assessment - General requirements for bodies operating certification of persons

Other International Examples for Standards through different organisations:

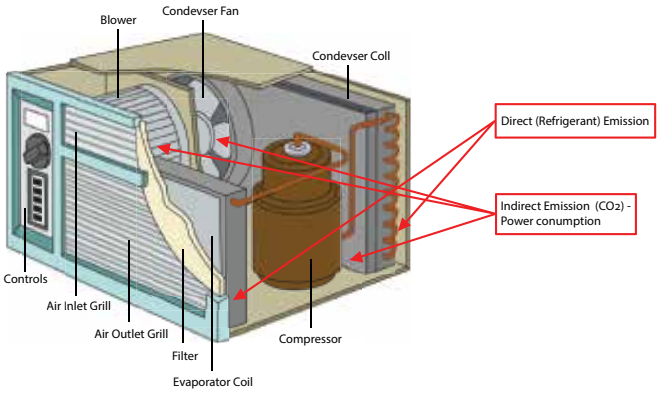
1. ISO 5149:2014 Mechanical refrigerating systems used for cooling and heating – Safety requirements; ISO 817:2014 Refrigerants – Designation and Safety Classification; ISO 17584:2005 Refrigerant properties; ISO 11650:1999 Performance of refrigerant recovery and/or recycling equipment
2. International Electrotechnical Commission: IEC 60335-1:2012 Household and similar electrical appliances – Safety, general requirements
3. European Committee for Standardization: CEN: EN 378:2008 Refrigerating systems and heat pumps - Safety and environmental requirements; CEN: EN 13313:2010 Refrigerating systems and heat pumps – competence of personnel; CEN: EN 1127-1:2011 Explosive atmospheres — Explosion prevention and protection Part 1: Basic concepts and methodology; IEC
4. European Committee for Electrotechnical Standardization: CENELEC: EN 60335-1:2012 Household and similar electrical appliances – Safety, general requirements; CENELEC: EN 60079 Electrical Apparatus for Explosive Gas Atmospheres
5. American National Standards Institute/ American Society of Heating, Refrigeration and Air-Conditioning Engineers: ANSI/ASHRAE 15-2013 Safety Standard for Refrigeration Systems; ANSI/ASHRAE 34-2010 Designation and Safety Classification of Refrigerants
6. Underwriters Laboratories- UL- 207, 250, 471, 474, 484, 984. 1995, 60335-2-40
7. Australian Standard/ New Zealand Standard: AS/NZS 1677.2 -1998 Refrigerating systems part 2: Safety requirements for fixed applications; AS/NZS 2022 – 2003 Anhydrous Ammonia – storage and handling

Air-conditioning, Heating, & Refrigeration Institute; AHRI 700-2012 Specifications for Fluorocarbon Refrigerants

ENERGY EFFICIENT OPERATION OF ROOM AIR-CONDITIONERS

As an air conditioner (AC) technician, you are responsible to not only maintain the quality of cooling, but also reduce the appliance's impact on our environment.

Here is how air conditioners affect the environment



Source: http://ozonecell.in/wp-content/themes/twentyseventeen-child/Documentation/assets/pdf/Technician%20Handbook.pdf

Direct emissions: Hydrochlorofluorocarbons (HCFCs) and Hydrofluorocarbons (HFCs) are the most common AC refrigerants. They are harmful for the environment as they contribute to global warming. A technician should, therefore, avoid refrigerant leakage during AC installation, servicing, or disposal at its end-of-life.

Indirect emissions: The electricity consumed by ACs during their life time causes indirect emission. Power generation for cooling contributes to Greenhouse Gases (GHGs) production and emission, at a rate which is four times greater than refrigerant emissions.

Preventive Maintenance for Efficient Operation of ACs

Technicians should follow the manufacturer-recommended preventive maintenance schedule. Timely inspection, cleaning and replacement of defective parts can prevent sudden AC failure. Poor functioning of parts increases energy consumption or refrigerant leakage.

Good Service Practices for Energy Efficient Operation

These are the good service practices that should be followed for energy efficient operation of room ACs.

Cleaning of Condenser and Evaporator Coils

Dust, debris or contaminant create fouling on evaporator surfaces, reducing airflow and causing poor heat transfer in

Source: http://ozonecell.in/wp-content/themes/twentyseventeen-child/Documentation/assets/pdf/Technician%20Handbook.pdf

condenser and evaporator. This reduces overall performance and efficiency of ACs. Dirt accumulation on the evaporator may cause ice formation on the coil's surface. Dust and debris can also be sucked into a condensing unit coil's fins when air is drawn through them. This lowers the coil's effectiveness, increases condensing temperature and reduces efficiency.

A technician can visually inspect the coil to confirm if it needs to be cleaned. Even if there is no obstruction, cleaning it is still likely to improve efficiency. Evaporator and condensers coil should be cleaned at least twice in a year. The filters of ACs should be cleaned frequently.

Energy Efficiency Consideration on Electrical Components

All wires and cables should be properly connected. Loose connections should be avoided, as they cause energy loss, and chances of overheating and sparking. Only manufacturer-recommended parts, especially the capacitor, should be used for replacement of electrical parts, as a capacitor of the

wrong size can cause the compressor or fan motor to overheat, decreasing efficiency and shortening its life.

Avoid Restriction of Airflow Over Condensing Coil and Evaporator Coil:

There should not be any obstruction to the circulation of air, restriction on air flow will reduce performance of the AC.

Air-conditioners are designed to work with a fixed amount of refrigerant charge. If refrigerant is insufficient, the system must be checked for leaks, and then repaired and recharged.

Performing a leak test: Apply soap solution to joints, connections and fittings while system is running or under a standing pressure of nitrogen. Appearance of bubbles indicates leak points. An electronic leak detector can also be used.

Source: http://ozonecell.in/wp-content/themes/twentyseventeen-child/Documentation/assets/pdf/Technician%20Handbook.pdf

Recommended measurements:	
Space around the Outdoor Unit (ODU):	Space requirements for the Indoor Unit (IDU):

More than 150-250 mm (6"–9.8"): for rear
More than 1500 mm (59"): for front
	More than 150 mm (6") around the IDU
	• The distance between the ceiling and the IDU
	  • More than 50 mm (2") for front suction or grille design
	  • more than 150 mm (6") in the case of top suction or flat front panel design

Aim for Zero Refrigerant Emissions

Refrigerant charge leakage can reduce performance and efficiency. It is important to follow the correct method and good service practices for copper tube operation to prevent leakage from copper tubing joints.

Replace with Clean and Correct Size of Copper Tubes

Copper tube coils are filled with low-pressure nitrogen gas and sealed with a cap at each end to keep the tubing safe from contamination by airborne oxygen, dust and moisture. Air should never be used for system pressurising and cleaning, as it may can cause contamination. Oxygen reacts with copper to create a layer of copper oxide inside the tube.

To prevent this, always close the remaining parts of the copper tubes with caps after cutting as well as those in the system, if it opened for servicing. Ensure the use of proper size of the copper tubes. Tubes with incorrect size and more bends than required can result in pressure drop in the refrigeration circuit, increasing energy consumption.

Source: http://ozonecell.in/wp-content/themes/twentyseventeen-child/Documentation/assets/pdf/Technician%20Handbook.pdf

Using oxygen-free dry nitrogen (OFDN): After repairing and joining processes, the system must be tightened and pressure-tested. Pressurise the system with OFDN to a pressure higher than the operating pressure, and check pressure holding for at least fifteen minutes to confirm no leakage. Keep noticing the pressure gauge for the pressure drop, if any.

Avoid sludge and oxide formation: After long operation and possible exposure to contaminants, there may be sludge

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and oxide formation inside the system that can reduce heat transfer rate and cooling capacity. Clean the condenser and evaporator coil with solvent. To flush the system thoroughly, slowly pass low-pressure OFDN through the tubes.

Properly Evacuating the System

The system should be free of air, moisture, and non-condensable gases. Presence of moisture causes choking of capillary, strainers, filter or drier. Non-condensable gases increase system pressure, higher condenser and discharge pressure and decrease energy efficiency of the system. These can also cause sludge formation. To completely evacuate the system before charging refrigerant, evacuation must be carried out to 500- or lower-microns level. Evacuate the system at least for 30 minutes to ensure adequate vacuum, if micron gauge is not available

Use Quality Refrigerants and Compatible Lubricant

Ensure that refrigerants of proper quality and purity are used. Avoid cross contamination of refrigerants, as it may result in reduced performance and even failure of the system. Always use recommended lubricating oils. Changing oil may cause improper miscibility of refrigerant and lubricant, resulting in separation of oil in the cooling coil.

Refrigerant Charge Quantity

ACs are very sensitive to charge quantity. Overcharging refrigerant increases the compressor power consumption. High operating pressures or temperatures indicate that system is overcharged. There is more chance of leakage from overcharged system. Undercharging will reduce cooling, thus decreasing the system efficiency. Charge refrigerant quantity as per the manufacturer's recommendation, stated on the AC's outdoor unit.

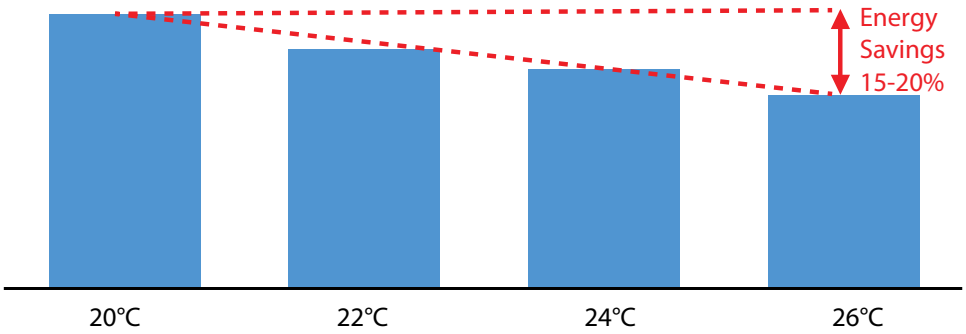
AC Energy Labelling Standard

1. BEE began mandatory energy efficiency star ratings from 2010 for room ACs up to a rated cooling capacity of 10.465 kW.
2. Vapour compression type room ACs, up to a rated cooling capacity of 10,465 Watts (9,000 kcal/hour) which are manufactured, commercially purchased or sold in India should –
3. Meet compliance requirements of the maximum operating conditions test in accordance with IS 1391(Part1) for unitary air conditioner and IS 1391(Part2) for split air conditioner
4. Be certified against IS/ISO 9000 or above. The BEE label to room air conditioner is maximum of 5 stars with an interval of 1 star, and the room air conditioner is rated from star 1 to star 5 based on their relative energy efficiencies. From 2018 BEE labels the system based on the Indian Seasonal Energy Efficiency Ratio (ISEER), means the ratio of the total annual amount of heat that the equipment may remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period.

How technicians can educate consumers about using ACs efficiently

1. Consumers should purchase Bureau of Energy Efficiency (BEE) energy-star labeled room ACs. These ACs require less energy, and therefore have a lower impact on the environment
2. AC filters must be cleaned once every 15 days, to ensure proper cooling, air circulation and less running time. Technicians should educate consumers on how to do this on their own.
3. Doors and windows of air-conditioned spaces be closed, to prevent entry of warm air, which can reduce efficiency. Similarly, using curtains, drapes and blinds can reduce heat transfer through windows and walls.
4. Use the ceiling fan while using AC, as it helps proper circulation of the cooled air
5. Use LED lights, which consume less energy and generate less heat for same output lumens.
6. Set the temperature range between 24-27°C. At lower temperatures, it will consume more power.
7. AC should be serviced at least twice in a year by a certified technician

ANNUAL ENERGY-USE REDUCTION WITH INCREASING ROOM TEMPERATURE SET



Checklist for Good Service Practices

Actions
• Check air filter and perform cleaning
• Check Condenser coil wash outdoor unit condenser coil annually at least once a year to maximize efficiency and enhance AC working life;
• Check Evaporator coil and clean it at least once a year;
• Perform leak and pressure testing
• Use Oxygen Free Dry Nitrogen to remove contaminants form the system
• Ensure correct Refrigerant Charge as recoommended by the manufacturer
• Treat AC drian pans to prevent its
• Check air filter and perform cleaning clogging may be due to algae growth
• Check compressor amps
• Check condenser fan amps
• Tighten electrical connections
• Check capacitance of Capacitors
• Educate customer on Energy Efficient operations

CHILLER MAINTENANCE

By Ravinder K Mehta, Secretary
Refrigeration and Air-Conditioning Manufacturers Association of India (RAMA)

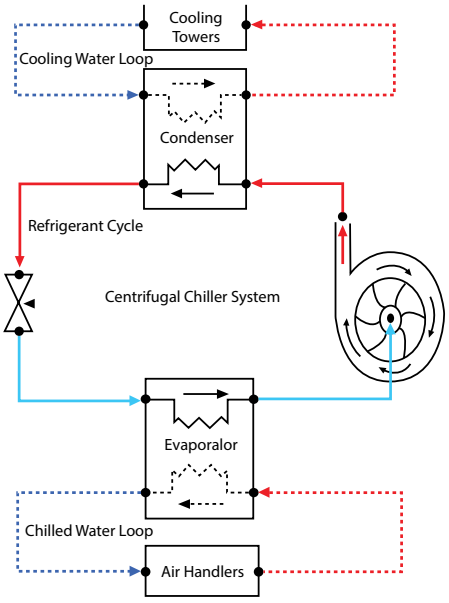
Chillers are the machines that remove heat from a liquid via vapor-compression or absorption refrigeration cycle. This liquid can then be circulated through a heat exchanger to cool the equipment, or through another process stream (such as air or water). As a necessary by-product, refrigeration creates waste heat that must be exhausted for greater efficiency.

Chillers can be classified in to following categories:

1. Water-cooled chillers – Typically intended for indoor installation and operation, these chillers are cooled by a separate condenser water loop. They are connected to outdoor cooling towers to expel heat into the atmosphere

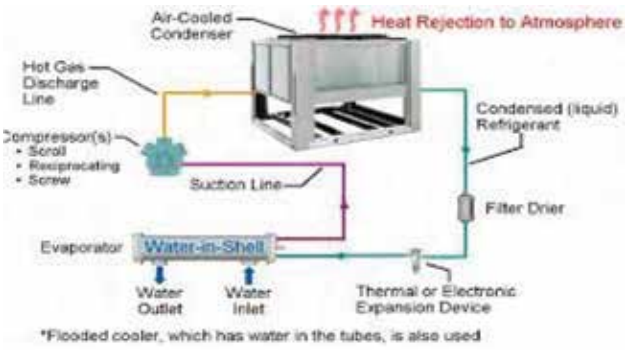
Major components of water-cooled chillers are:

1. Compressor
2. Condenser
3. Condenser Pumps
4. Cooling tower
5. Filter Drier
6. Expansion Valve
7. Refrigerant level controller
8. Evaporator/Cooler
9. Chilled wated Pumps
10. Controllers



11. Air-cooled chillers

These are intended for outdoor installation and operation. Air-cooled machines are directly cooled by ambient air being mechanically circulated through the condenser coil to expel heat in to the atmosphere.



Major components of air-cooled chillers are

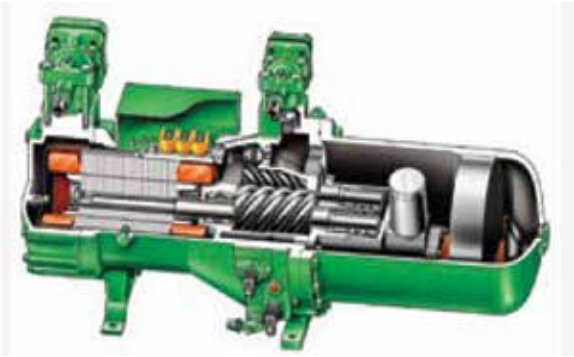
1. Compressor
2. Condenser
3. Condenser Fans
4. Filter Drier
5. Expansion Valve
6. Refrigerant level controller
7. Evaporator/ Cooler
8. Chilled wated pumps
9. Controllers

Chiller Classifications Based on Compressors

Reciprocating Chiller: This chiller has positive-displacement compressor that uses pistons driven by a crankshaft to deliver gases at high pressure.

Scroll Chiller - Has scroll compressors with orbital motion and positive displacement that compress with two inter fitting spiral-shaped scroll members.

Screw Chiller – Made like a rotary compressor, screw chiller compresses vapour through its screw action. The main advantage of using this compressor is that it can supply compressed vapour continuously with minimum fluctuation in delivery pressure



Centrifugal Chiller - It is made with a dynamic compressor, or turbo compressor, with a radial design. Vapour is drawn into the center of a rotating impeller with radial blades and is pushed towards the center by centrifugal force. This radial movement of vapour results in a pressure rise and the generation of kinetic energy.

Following are the chiller log parameters

- **Suction Pressure** – It is the pressure unit which is measured at the outlet of the evaporator and at the compressor inlet. Suction pressure can vary according to the refrigerant which is used and the load at evaporator. Same is measured through analogue gauges and digital pressure transducers.
- **Discharge Pressure** – It is the pressure unit which is measured at the outlet of the compressor and before the condenser. In water-cooled chillers, discharge pressure is measured at condenser top. Discharge pressure can vary according to the refrigerant and the load at condenser with respect to the condenser water inlet and ambient air temperature. It is measured through analogue gauges and digital pressure transducers.
- **Oil Pressure** – Is measured before the compressor entry at oil port. Some original equipment manufacturers (OEMs) have the facility to obtain the pressure before and after the oil filters. Oil pressure will vary according to the OEM's recommendations where pumps have been installed. If the pumps have not been installed, then oil will flow on positive displacement where the pressure is slightly less than the discharge pressure.
- **Suction Temperature** – It is the temperature unit which is measured at the outlet of the evaporator and before compressor inlet. Suction temperature can vary according to the refrigerant which is used at the load at evaporator
- **Discharge Temperature** – It is the temperature unit which is measured at the outlet of the compressor and before condenser inlet. Discharge temperature can vary according to the refrigerant which is used and according to the load at condenser
- **Suction super heat** – It is the temperature difference between suction temperature and the saturated suction temperature. Suction super heat can be of 0 to 1 Deg F and 8 to 12 Deg F according to the type of evaporator which avoids the liquid flooding in the compressor and protects the winding when it gets over heated. Electronic expansion valve operates based on the suction super heat as per certain OEM's design
- **Discharge Super heat** – It is the temperature difference between discharge temperature and the saturated discharge temperature. Discharge super heat can be of 12 to 18 Deg F and 35 to 45 Deg F according to the type of condenser which avoids the liquid flooding in the compressor and protects the winding on over heating. Electronic expansion valve operates based on the discharge super heat as per certain OEM's design
- **Cooler Approach** - is the temperature difference between the refrigerant temperature or saturated suction temperature and the temperature of the water leaving the evaporator. Normally, it can be of 0 to 5 Deg F for the flooded and 12 to 20 Deg F for the DX evaporator
- **Condenser Approach** - is the temperature difference between the condenser saturation temperature and the temperature of the water leaving the condenser. Normally it can be of 0 to 5 Deg F

- Subcooling - is the temperature difference between the condenser saturation temperature and the condenser liquid temperature. Normally it can be of 8 to 12 Deg F

Technicians must follow these good service practices in chiller operation and maintenance

1. Keep a daily log - The daily log is still the first step toward maintaining an efficiently-run chiller plant. The log allows you to build a history of operating conditions including temperatures, pressures, fluid levels, and flow rates. Remote monitoring technologies allow you to inspect machines continually rather than monthly or every other month. And, it allows you to easily generate trend reports that help to identify maintenance needs before they become an issue
2. Keep tubes clean for efficient heat transfer - Heat transfer efficiency has the greatest single effect on chiller performance. Therefore, clean heat transfer is fundamental to maintaining high efficiency. Contaminants such as minerals, scale, mud, algae and other impurities increase thermal resistance and reduce overall performance. Approach temperatures are a good indicator of heat transfer efficiency. Higher approach temperatures are prime indicators that heat transfer efficiency is decreasing.
3. Condenser tubes should be brushed clean at least annually, or per your demand maintenance schedule to keep them free of contaminants.
4. Treat condenser water to prevent scale and corrosion
5. All condenser water loops using open cooling sources (such as atmospheric cooling towers) require water treatment of some sort to eliminate scale, corrosion, and biological growth. This leads to fouling in the condensers and impedes heat transfer decreasing tube and piping effectiveness.
6. Inspect chilled water loops once a year or regularly with remote monitoring for general water quality and evidence of corrosion
7. Approach temperatures are a good indicator of heat transfer efficiency. Higher approach temperatures are prime indicators that heat transfer efficiency is decreasing.
8. **Lower entering water temperature** - Lowering the temperature of the water that is entering the condenser will improve the chiller's efficiency. On some building systems, the operator lowers the chilled water set point to overcome air handler deficiencies such as dirty coils. This cures the symptom but not the problem and makes the chiller work harder for the same net cooling effect.

- M**aintain adequate refrigerant charge** - The actual amountof cooling a chiller provides depends on how much refrigerant it moves through the compressor. It is important to maintain the proper level of refrigerant for the conditions desired. Refrigerant leaks, as well as air and moisture introduced into the system, will decrease efficiency and the reliability of the system. A low refrigerant charge will cause the compressor to work harder for less cooling effect.
- Prevent inefficiencies caused by non-condensables - Non-condensables such as air and moisture leak into low pressure chillers because their evaporators operate in a vacuum. Non-condensables can lower the real efficiency of the chiller from the rated performance by as much as 4% at 60% load and 7% at 100% load. Purge units minimise the effect of non-condensables. In low-pressure chillers, air and moisture will leak in. Air and moisture can produce harmful acids. These acids can corrode the internal chiller components leading to premature chiller failure. Repairing this type of failure can cost between $25,000 and $50,000 (INR 17,50,000 – 34,50,000) depending on the level of damage.
- Analyse compressor oil: Send a sample of the lubrication oil to a laboratory for a "spectrometric" chemical analysis once a year. Like any hermetically sealed refrigeration system, the oil should only be replaced if the analysis indicates that it is needed. High moisture can indicate a problem with the purge unit. Sample low pressure chillers more frequently, based on purge run hours. Check oil filters for pressure drop and replace them if the oil charge is replaced. New, magnetic bearing frictionless chillers require distinctly different maintenance and operations from traditional centrifugal chillers. Oil has been eliminated in the design of these chiller systems, further reducing maintenance costs.
- Check operation of starters and motors: For efficient operation of starters and motors, check the safety calibrations on controls (consult manufacturer's guidelines). Check electrical connections, wiring, and switchgear related to the chiller for hot spots and worn contacts. To prevent insulation faults, test electrical motor windings for insulation resistance to ground and winding-to-winding. Check the shaft seal of open drive motors for possible refrigerant leaks, and clean motor cooling air vents to ensure maximum cooling effect. Megger the compressor motor windings annually or as required

Check List for Chiller Operation & Maintenance

1. Check water flows and interlocks
2. Carry out leak test
3. Check operational set points and performance
4. Check operation of all safety devices and interlocks
5. Inspect contacts and tighten terminals
6. Carry out oil analysis and replace oil as recommended
7. Replace oil filter
8. Check unit operation at load with respect sto various parameters
9. Lubricate motor bearings (where applicable)
10. Megger the compressor motor windings
11. Replace line drier cores on each circuit (if applicable)
12. Clean the condenser coils
13. Check the approach and descale the condenser tubes
14. Check the approach and brush the cooler tubes
15. Check for the vibrations
16. Check for the noise levels
17. Maintain the water quality

YOUR GUIDE TO REFRIGERANT BLENDS

By Prof R.S Agarwal

The availability of single component zero-ozone depleting potential refrigerants is limited. Therefore, several refrigerants are being developed by mixing two or more components, usually hydrofluorocarbons (HFCs), hydrofluoroolephenes (HFOs) and others in various proportions to find a non-ozone depleting substance (ODS) low-global warming potential (GWP) refrigerant. The resulting mixtures (blends) fall into two categories: Azeotropic Blend and Zeotropic Blend.

Azeotropic Blends boil and condense at single evaporator and condensing temperature at a given pressure like a single component refrigerant. Azeotropic blends thermodynamically behave in similar ways as single component refrigerants.

Azeotropic blends are very useful and preferred. Azeotropic blends – R-500 and R-502 – which have been banned globally because of their ozone depleting potential, were the commonly used blends before being banned. In recent years, attempts have been made to develop similar blends using HFC and HFO refrigerants. The possibility of formation of azeotropic blend is always rare. A few such blends which have been developed in recent years and have potential for commercialisation are:

Zeotropic Blends are mixtures of two or more components, which evaporate (and condense) at a range of temperature. The refrigerant is at the bubble temperature when it just starts to evaporate and is at the dew temperature when it just starts to condense. The range of temperature between the dew point and the bubble point is called the temperature glide (see Fig. 1).

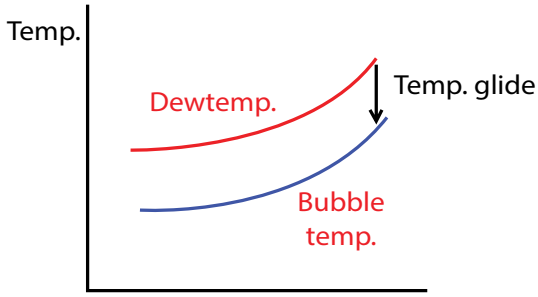


Figure 1: Zeotropic Blend

Some of the HFC and HFO-based zeotropic blends developed and commercialised as alternatives to HCFCs and HFCs are given below:

HFC and HFO based Azeotropic Blends and their characteristics

Azeotropic Blend	Components	Composition (%)	Boiling Point (°C) at atm. Pressure
R-507	HFC-125/ HFC-143a	50.0/50.0	-47.1
R-508A	HFC-23/ FC-116	39.0/61.0	-87.41
R-513A	HFC-134a/HFO-1234yf	44.0/56.0	-29.2
R-514A	HFO-1336mzz/trans-dichloroethylene (t-DCE	74.7/25.3	+29.1

HFC and HFO-based Zeotropic Blends and their characteristics

Zeotropic Blend	Components	Composition (%)	Bubble Point (°C)	Temperature Glide (°C)
R-404A	HFC-125/HFC-143a/HFC-134a	44.0/52.0/4.0	-43.8	1.5
R-407C	HFC-32/HFC-125/HFC-134a	23.0/25.0/52.0	-43.8	7.1
R-410A	HFC-32/ HFC-125	50.0/50.0	-51.6	0.1
R-417A	HFC-125/HFC-134a/HC-600	46.6/50.0/3.4	-38.0	5.1
R-444B	HFC-32/HFO-1234ze /HFC-152a	41.5/48.5/10.0	-44.6	9.7
R-448A	HFC-32/HFC-125/HFO-1234yf/HFC-134a/ HFO-1234ze	26.0/26.0/20.0/ 21.0/7.0	-45.9	6.1
R-452B	HFC-32/HFC-125/HFO-1234yf	67.0/7.0/26.0	-51.0	0.7

As you see, some blends have very small temperature glide. Such blends are as good as azeotropic blends.

The zeotropic blend refrigerants behave differently in the evaporator and in the condenser. The evaporator temperature rises as refrigerant changes from liquid into vapour as shown in Fig. 2. In the condenser, the temperature drops as vapour changes to liquid. The evaporation and condensation are over a range of temperature (non-isothermal evaporation and condensation).

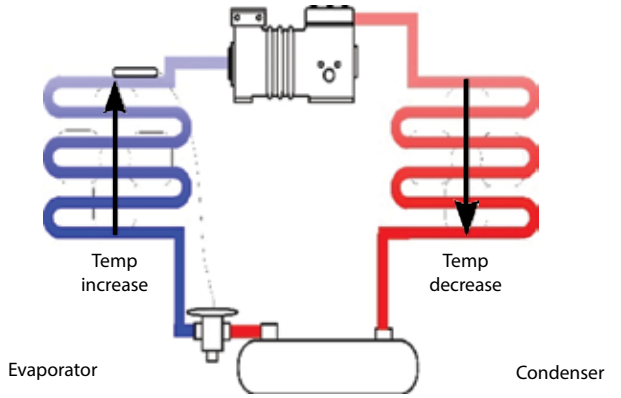


Figure 2: Effect of Temperature glide during condensation and Evaporation

Zeotropic blends like R-404A, R-407CA, R-410A, R-417A, R-444B, R-448A, R-452B etc, are to be removed as liquid from the cylinder so that there is no change in composition of the blend. If the zeotropic blend is in a cylinder fitted with a single port liquid off take valve, connect the charging hose to the liquid off take valve. If the zeotropic blend is in a cylinder with a single port gas off take valve, the cylinder must be inverted to remove the refrigerant in liquid form as shown in Fig. 3

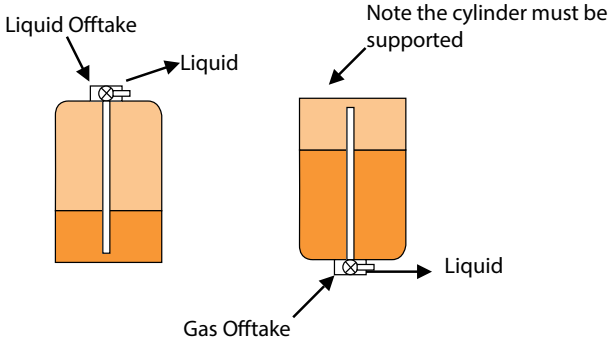


Figure 3: Removal of Zeotropic Blend Refrigerant from Cylinder

When charging zeotropic blend refrigerant, such as R-404A. R-407C, R-410A etc, ensure that only liquid is being removed from the cylinder. If refrigerant is charged into the suction port of the system or the compressor then it must be evaporated before it reaches the system. Connect an expansion device (short capillary) as shown in Fig 4. This is not necessary if refrigerant is charged into the liquid line or liquid receiver.

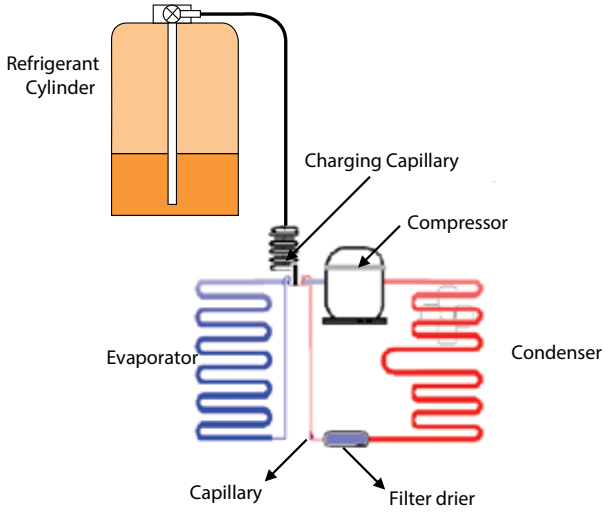


Figure 3: Removal of Zeotropic Blend Refrigerant from Cylinder

Recovery, Recycling and Reclamation of Refrigerant Blends

Azeotropic refrigerant blends can be recovered, recycled, reclaimed and reused like single component refrigerants. The zeotropic blends like R-404A, R-407C, etc., can't be reused by recycling or simple reclamation as the composition of the blend changes. The recovered zeotropic blend constituents can only be reclaimed in a refrigerant production plant.

Precautions

Most of the refrigerants and refrigerant blends used in refrigeration and air conditioning (RAC) equipment are either flammable or high pressure or both. This necessitates that the personnel associated with handling of refrigerants, installation and servicing of RAC equipment should acquire thorough technical understanding about the refrigerants including their safe use. The practicing personnel, for their own safety and providing requisite safe and good services, should undergo training and take all the safety measures recommended for flammable and high-pressure gasses including use of personal protection equipment (PPEs).

'From the field' is a series of interviews with service technicians to help them share their experience with the fraternity. The series is aimed at promoting mutual learning and camaraderie among RAC technicians.

In this issue, we have featured two technicians. The first one is Delhi-based Jai Prakash, 29, who works at a business centre in Gurgaon. In an interaction with newsTRAC, he said that the technical nature of his job makes it interesting and gives him a sense of accomplishment whenever he repairs a system. Excerpts from the interview are shared below:

What is the nature of your job?

Ans: I have a permanent job with a facility management company that offers building management and maintenance services. I repair and maintain central cooling systems. This is a shift job with seven-hour shifts in the day and ten-hour shifts at night.

Are you happy with your work? How would you rate your happiness on a scale of one to ten?

Ans: I am very happy with my work. It is a technical field and one continues to learn every day. Whenever I fix a technical glitch, I get a sense of accomplishment which is a great feeling. This work is my bread and butter. It is helping me sustain my family and I am grateful for that. On a scale of one to ten, I would rate my work a full ten.

How would you rate your happiness with your customer's conduct?

Ans: Mostly, I get good clients. At times, when I come across a difficult client, I try to handle them calmly. If the problem persists, I transfer such cases to my superiors. On a scale of one to ten, I would rate my clients seven.

Are you professionally trained?

Ans: Yes, I did a distance learning course from a polytechnic college in Rajasthan. After that, I studied for two years at the Industrial Training Institute, Gorakhpur.

Do you feel your salary is adequate?

Ans: Given the cost of living in Delhi, I would say it is not adequate. To earn an extra income, I work part time at a cosmetic shop.

Do you feel your technical skills are adequate? How willing are you to learn more skills in this field?

Ans: While I feel that my technical skills are adequate, I am more than willing to get new trainings. The RAC field is a constantly evolving one and I would be happy to learn about new developments in the field. Also, since I already work on central cooling systems, I would like to get training in the repair and maintenance of domestic air conditioning units.

'From the field' is a series of interviews with service technicians to help them share their experience with the fraternity. The series is aimed at promoting mutual learning and camaraderie among RAC technicians.

The next technician to be featured in the series is Mumbai-based Firoj Mansuri who works with the service centres of LG. In an interaction with newsTRAC, Mansuri, 26, said that though he is a self-trained technician who continues to learn on the job, he is more than willing to sign up for a training programme, especially at a government run institution. Excerpts from the interview are shared below:

What is the nature of your job?

Ans: I work on a contract basis with service centres of LG. I specialise in the installation of the AC more than repair, maintenance and servicing work.

Are you happy with your work? How would you rate your happiness on a scale of one to ten?

Ans: I have been in this industry for quite some time now and it has been a very good experience. Before this, I used to make a living repairing laptops. When it comes to the happiness scale, I will give it seven out of 10 because I like what I do and consider this job my true calling.

What can be done to ensure your safety on the job?

Ans: : There are certain safety standards which we are expected to follow. For instance, since I am 5 feet tall, I am not allowed to install an AC that is to be fitted above 10 feet. In the initial inspection of the site where the fitting has to be done, if we find that the job is a difficult one, then we alert our managers at the service centre. They intervene wherever or whenever necessary. I believe that while providing the safety equipment and support is the responsibility of the companies, ensuring that the job is executed safely depends entirely on the technician.

How would you rate your happiness with your customer's conduct?

Ans: I am happy with my customers. When installing an AC, I always begin by asking them questions about where and how they want it placed and fitted. I get on with fixing only after showing them how it will look after hoisting the machine to their desired position and level. On the spot feedback from the customer is always welcome and I do not hesitate in giving recommendations or countering them in case I feel that something that they are asking is not doable.

Are you professionally trained?

Ans: No. I am a class X pass out. Whatever I know about fitting, repairing and servicing of ACs, I have learnt it from my friends who are technicians and on the job.

Do you feel your salary is adequate?

Ans: I get at least two calls a day from the service center. Yes, I am happy with what I earn.

Do you feel your technical skills are adequate? How willing are you to learn more skills in this field?

Ans: Though I am 75% trained for the job with no formal education in the field, I do feel that my current skills are adequate for the kind of work I am doing. I was hired at the LG service centre basis my knowledge and my conduct. I would certainly sign up for a course on Building Management System (BMS), especially if it is offered by a government-run institutes.

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CODE OF PRACTICES FOR RAC* SYSTEM SERVICING

- ✓ Always apply best practices within a safe working environment;
- ✓ Always recover refrigerants before servicing or scrapping a system;
- ✓ Recycle refrigerants for reuse whenever possible;
- ✓ Contaminated refrigerants must be stored safely prior to destruction;
- ✓ Leaks must be identified and repaired before the system is recharged with refrigerants. Never assume that only one leak is possible!
- ✓ Improve your handling of refrigerants, e.g. minimize purging refrigerant hoses;
- ✓ Completely empty disposable refrigerant cylinders before scrapping;
- ✓ Maintain the best possible and energy-efficient operational conditions of the RAC system;
- ✓ Keep record of service and maintenance and manage the RAC systems logbook;
- ✓ Maintain good relations with equipment operators and inform them about important, generalsystem features.

- ✗ If you can't work safe, don't do it;
- ✗ A well operating and leakproof system should not be subjected to rertofit or conversion;
- ✗ Never vent ODS** or refrigerants with high GWP*** into the atmosphere;
- ✗ Never use ODS or refrigerants with high GWP as a cleaning solvent for the system (except secured in a closed loop), or blowing-out the heat exchanger's surface;
- ✗ Do not break vacuum with refrigerant for multiple evacuation process, always use OFDN (Oxygen Free and Dry Nitrogen);
- ✗ Do not top-up the refrigerant charge of a RAC system without knowing the correct actual filling amount;
- ✗ Never use a recovery cylinder (or any other cylinder) which is not designed, certified or clearly labeled for the intended purpose;
- ✗ Never mix different types of refrigerants in one recovery cylinder;
- ✗ A RAC system designed for the use of low GWP refrigerants (such as HCs) should never be reverse-retrofitted to the use with HFCs/HCFCs/CFCs;
- ✗ Never attempt to work with damaged or defective tools or equipment, do not use longer refrigerant transfer hoses than necessary.

newsTRAC

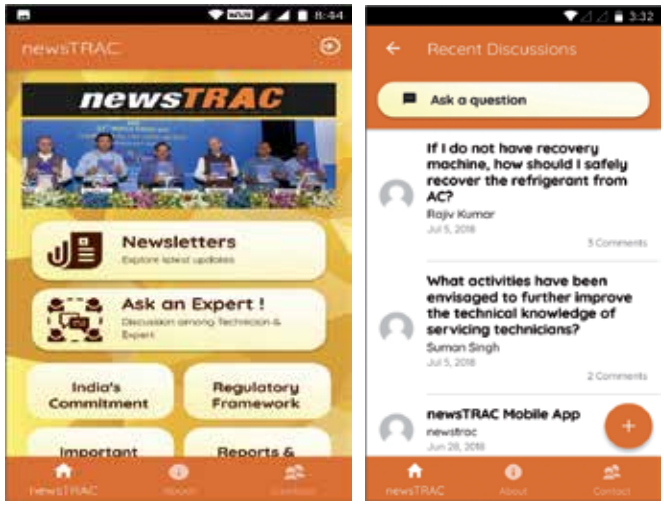
THE MOBILE APPLICATION FOR SERVICE TECHNICIANS

- As we move towards super-efficiency and new generation refrigerants, servicing sector needs become more pronounced
- Servicing sector professionals highlight lack of proper information on tools and tips for servicing new equipment and refrigerants as a major gap

newsTRAC – a mobile app intends to bridge this gap

- newsTRAC - a mobile based application will serve as a platform for the servicing agent in the field to ask a question directly to the team of experts either through a text based query or a picture.
- The query will be addressed within the stipulated period of time by our team of experts.

User Guide



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