

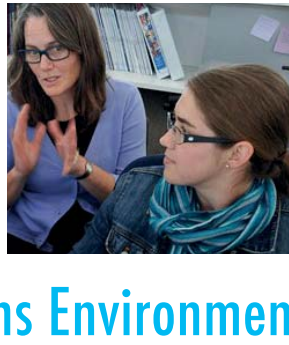
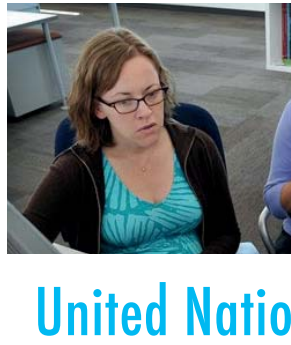





United Nations Environment Programme



Women in the Refrigeration and Air-conditioning Industry: Personal Experiences and Achievements



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Women in the Refrigeration and Air-conditioning Industry

Personal Experiences and Achievements



Foreword

If you ask the average person on the street who they think designs, manufactures, installs and services the refrigeration and air conditioning (RAC) equipment that cools our homes and offices, keeps our food fresh and preserves our vaccines, most people would not typically think of a woman. And yet, they should. Women engineers, technicians, trainers and professors are increasingly working in this traditionally male-dominated field and making significant contributions to its professional development. Refrigeration and air conditioning are crucial for our health, nutrition, comfort and well-being, and women and men alike are making it happen.

The United Nations Environment Programme's (UNEP) OzonAction and UN Women have produced this booklet to shine a spotlight on the largely untold story of women working in this sector, focusing on their motivation, background, challenges and daily work experience. All of the professionals presented in the following pages are pioneers. They are role models whose stories should inspire a new generation of young women to enter the field and follow in their footsteps.

They are also making tremendous contributions to society. The appropriate implementation of refrigeration and air-conditioning technology can assist countries in achieving the United Nations Sustainable Development Goals (SDGs). Specifically, it contributes to achieving food security, improved nutrition and sustainable food systems (SDGs 2 and 12), ensuring healthy lives and promoting well-being (SDG 3), and promoting sustained, inclusive and sustainable economic growth (SDG 8). Making the transition from ozone depleting substances (ODS) and chemicals with high global warming potentials (GWPs) has already made a significant impact on combatting climate change (SDG 13). Encouraging women to pursue refrigeration and air conditioning careers and facilitating the process for them also

contributes to gender equality and empowering women and girls (SDG 5).

The refrigeration and air conditioning (RAC) sector is crucial to all countries in successfully phasing out hydrochlorofluorocarbons (HCFCs) and, soon, slowing the use of hydrofluorocarbons (HFCs) under the Montreal Protocol on Substances that Deplete the Ozone Layer. Through its role as an implementing agency of the Multilateral Fund, OzonAction assists developing countries in complying with their commitments under the Montreal Protocol, through a combination of compliance assistance services and national, regional and global projects. For the majority of developing countries, the refrigeration and air-conditioning servicing sector continues to be the largest, or only, consumer of ozone depleting substances and is therefore one of the most important sectors addressed. This fast-growing sector can offer a wide variety of interesting and fulfilling careers for women as well as men.

UN Women is the United Nations organization dedicated to gender equality and the empowerment of women. A global champion for women and girls, UN Women was established to accelerate progress on meeting their needs worldwide. Therefore, an awareness of the experiences of women working in the refrigeration and air conditioning sector and the opportunities available could encourage and inspire other women to consider careers in the sector and support girls in following a career path in this important, fast-growing sector.

We are proud to jointly launch this publication to raise awareness of the opportunities available to women and recognise their successes. The booklet identifies some challenging issues, struggles, success stories and very inspiring, motivating experiences.

We hope this booklet is educational, informative and, above all, encouraging to both women and men in the RAC sector and those considering a career.



A handwritten signature in blue ink that reads "Elizabeth Maruma Mrema".

Elizabeth Maruma Mrema,
Director, Law Division,
UN Environment Programme



A handwritten signature in black ink that reads "Maria-Noel Vaeza".

Maria-Noel Vaeza,
Director, Programme Division,
UN Women

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Introduction

The refrigeration and air-conditioning sector is a broad sector that includes the installation, commissioning, maintenance, repair, servicing and decommissioning of both domestic and commercial refrigeration and air-conditioning equipment. The workforce employed in this sector is very varied and diverse and includes occupations and positions such as automotive service technician, building maintenance technician, business finance officer, business owner, civil engineer, construction engineer, contractor, electrical engineer, electrician, energy engineer, engineering manager, installer, mechanic, information technology specialist, maintenance technician, manufacturer, mechanical engineer, professor, refrigeration technician, salesperson, trainer, etc...

The refrigeration and air-conditioning sector plays a major part in the wellbeing and comfort of the global population and the economy. The sector intersects with a wide range of topics including food preservation and safety, human health and comfort, medical issues (such as the transport and storage of vaccines and blood), energy efficiency and the related financial outlays, environmental issues (such as climate change and ozone depletion) and standards and certification for equipment and practitioners, as well as national legislation.

The requirement for and operation of refrigeration and cooling appliances is growing rapidly around the globe. The substantially expanding market mirrors economic growth, the continuous rise in the global population, shifting lifestyles, the global trend toward urbanisation, the expansion of the food cold chain and particularly the growing middle classes in many developing countries and emerging economies. This expansion of installed refrigeration and air-conditioning equipment and the concomitant use of a wide range of refrigerants are expected to continue to accelerate due to the rising requirements for cooling in various fields, especially in the context of increasing global temperatures. According to the International Institute of Refrigeration, approximately 12 million people around the world are employed in the refrigeration and air-conditioning sector. The need for skilled technical servicing and engineering personnel is currently increasing to meet the increasing demand for refrigeration and air-conditioning equipment.

Women are significantly and noticeably under-represented in the refrigeration and air-conditioning sector. There is, however, a lack of reliable official records or statistics regarding the proportion

of women working in the sector. In engineering more generally, data indicates that women are significantly under-represented, constituting an average of 10-20% of engineering workers around the globe. In 2017 in the US refrigeration and air-conditioning sector, the industrial group "Women in HVACR" (heating, ventilation, air conditioning and refrigeration) reported that women constituted only around 1.2% of the heating, refrigeration and air-conditioning mechanics, technicians and installers. The proportion was similar for Canada. Given the paucity of representative information, the International Institute of Refrigeration carried out a preliminary survey to gather data on the number of women registered as private members of national refrigeration associations. This was intended to shed some light on potential figures for female representation in the sector. The great majority of results indicated levels of female membership that ranged from zero to less than 10%, with only two countries reporting significantly higher percentages: China and Romania, with 19.5% and 33% respectively.

Ozone depleting substances, particularly hydrochlorofluorocarbons (HCFCs), and non-ozone-depleting alternatives such as hydrofluorocarbons (HFCs) are the most commonly used substances in refrigeration and air-conditioning applications. Most HCFCs and HFCs used in these applications have global warming potentials (GWPs) that are in the range of 1,000 to 4,000 times more powerful as greenhouse gases than carbon dioxide. These substances, like the chlorofluorocarbons (CFCs) that they were introduced to replace, are controlled by the Montreal Protocol on Substances that Deplete the Ozone Layer - an international environmental treaty of which all countries of the world are members. The Montreal Protocol plays a key role in the refrigeration and air-conditioning sector, since this sector is the largest worldwide consumer of ozone-depleting substances and replacement substances such as HFCs, which were included in the Montreal Protocol as controlled substances in 2016 through the Kigali Amendment to the Protocol. The Montreal Protocol and its funding body, the Multilateral Fund, have considered the phaseout of controlled substances that are used in the refrigeration servicing sector to be one of their priorities. For the majority of developing countries, the refrigeration and air-conditioning servicing sector continues to be the largest, or only, consumer of ozone-depleting substances and is therefore one of the most important sectors addressed. It is largely thanks to the individuals working in the sector that the treaty has achieved the tremendous success that it has so far, and it

is on their shoulders that the future success of ozone layer and climate protection will be built. The men and women who install, service, repair and dismantle RAC equipment are at the heart of the phaseout of HCFCs, the future slowing of the use of HFCs and the introduction of energy-efficient and low-GWP alternatives. For a country to be ready and equipped to adopt alternative refrigerants (i.e., non-ozone depleting, low to zero GWP), which include hydrocarbons, ammonia, carbon dioxide and hydrofluoroolefins (HFOs), it needs to have informed and well-trained servicing technicians.

Through its role as an implementing agency of the Multilateral Fund (the Montreal Protocol's funding body), UN Environment Programme's OzonAction assists developing countries in complying with their commitments under the Montreal Protocol, through a combination of compliance assistance services and national, regional and global projects. OzonAction supports the upgrade of the skills and knowledge of technicians as part of overall refrigerant management strategies for developing countries. OzonAction recommends that countries adopt minimum requirements for the training and certification of contractors handling low-GWP refrigerants at the national level. OzonAction provides National Ozone Units and refrigeration servicing technicians with technician training, including in-person training courses, online e-courses, training curricula, smartphone applications and fact sheets. The training is conducted through national projects known as "HCFC Phaseout Management Plans", which integrate investment projects, policies and capacity building to phase out HCFCs and introduce low-GWP, energy-efficient alternatives. The country-level activities are frequently organized in cooperation with national refrigeration associations or RAC training institutes. OzonAction also has partnerships with associations and the industry to jointly promote RAC technician training. OzonAction is committed to gender equality and actively promoting the opportunities available to women in its training and capacity building programmes, as well as encouraging women in the RAC sector and those considering the great variety of interesting and fulfilling careers in this fast-growing sector.

In developing this document, the review team made the decision to be inclusive; to incorporate, to the extent possible, all the submissions that were received, including those that arrived after the deadline, those that were handwritten, the

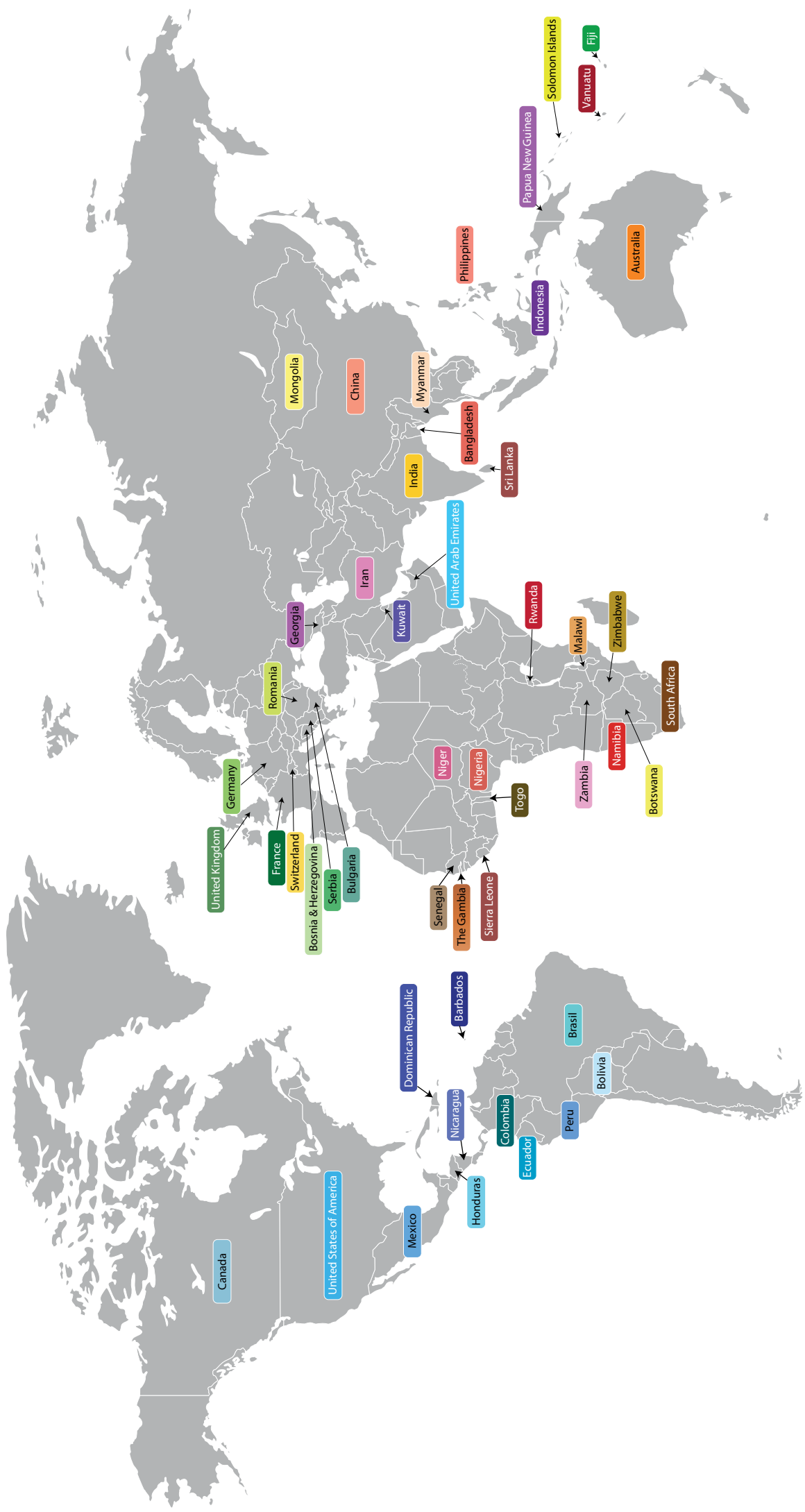
long submissions, the short and the very short, the technical and the heart-felt. The team even permitted the inclusion of one story submitted by a man (regarding a particular company). Other than some light editing for language, commercial details and text length, the stories have been left as they were so the reader can experience them in the style in which they were submitted. Therefore, in the next pages, you will find a great variety of styles and formats. The acronyms used by the authors are maintained in the text, with explanations added. A glossary is provided on page 220. Some stories were accompanied by numerous images, some with none. Some read more like curriculum vitae, some were very moving and personal, others were more straightforward and explanatory. Some stories were written in the third person, the great majority were in the first person. However, all the submissions that were submitted from most regions of the world (see map below) provide important information and experiences and bring some insight into the lives of women working in the refrigeration and air-conditioning sector around the world.

Publication content disclaimer:

The content of the stories included in this document are the responsibility of the individuals who submitted them and have not been verified by UN Environment Programme or its partners. The information provided in this publication is for information purposes only. While reasonable efforts have been made to ensure that the contents are factually correct and properly referenced, UNEP does not accept responsibility for the accuracy or completeness of the contents, and shall not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on, the contents of this publication. The citation of trade names of any substance or commercial processes does not constitute an endorsement of the companies or products by UNEP.



Women in the Refrigeration and Air Conditioning Sector: Stories Submitted



NOTE: This is not an official UN map



Australia

- Hayley Bremner
- Elizabeth Gregory
- Wendy and Roxi Kenny
- Kristina Khougaz
- Catherine Reinecke
- Jenny Smith
- Liza Taylor

Hayley Bremner



I have always been determined to use my passion for science to make a positive impact. After completing a Bachelor of Science, I started a PhD in Analytical Chemistry at Victoria University; performing this work heightened my interest in entering the industry, so I left academia for hands-on experience and started my career as an Industrial Chemist.

After a few changes I became a QA Chemist at A-Gas, excited to be a part of such a great company and to play (even a small) part in combating global warming. By helping to prevent releases of ozone-depleting substances (ODS) and synthetic greenhouse gases (SGS) during analytical processes, I am contributing to making a difference now for the benefit of future generations.

My daily responsibilities include working with refrigerants and taking samples of, and performing analysis, on halons and other ozone-depleting substances in accordance with the ISO 17025 requirements. The laboratory at A-Gas in Melbourne manages the National Halon Bank on behalf of the Australian Department of Environment and

Energy, and our obligation is to provide laboratory services. Halon 1211 and Halon 1301 are liquified, compressed gases that are extraordinarily effective fire extinguishers and can combat fires without the production of residues that could damage the assets being protected. These halons are ozone-depleting substances and are no longer produced (with a few exceptions for “essential uses”), but halons are still in use in some circumstances as they are a necessary part of modern life and must be carefully and responsibly managed. My role in this is to conduct tests so the Halon Bank can provide halons that are high in purity and meet the requirements of ASTM D5632 and D7673. This then means that the agents are fit for purpose and should operate as designed.

“The world needs the best and brightest minds to address the major issues seen today, and there are so many exciting opportunities for women in the industry!”

The analytical tests that I perform include testing for purity and non-condensable gases by gas chromatography, and for water by Karl Fischer titration as well as several other wet chemistry techniques. I am also responsible for maintaining the calibrations of the equipment, ensuring compliance with statutory and regulatory requirements, and monitoring our lab systems’ performance. Another large part of my work is research and development of in-house test methods for new products used as halon alternatives.

The world needs the best and brightest minds to address the major issues seen today, and there are so many exciting opportunities for women in the industry! In a traditionally male-dominated environment, women bring balance as we can provide different points of view and opinions. For me, working in the refrigerant industry has been a rewarding and fun ride so far. I have learnt so much about ozone-depleting substances and synthetic greenhouse gases and their effects on the atmosphere and climate. Especially today, when the war on climate change is such an important issue that effects everyone, education, understanding and research are the way forward. My role in testing halons, quality control of ODS and SGS, and preventing any releases during the analysis process, is my contribution towards this fight against climate change.

I used to lack confidence in myself when presenting my ideas, and found I would then doubt my opinions or allow others with louder voices to overshadow my own. If I couldn’t express myself with confidence, how would I ever be able to convince others that I had worthy opinions? Luckily, I had a senior female role model (Elvira Nigido, National Halon Bank Manager) who gave me a pep talk after one such meeting and told me that I was not only a chemist, but a good chemist and I knew what I was talking about! I needed to believe that and not let others convince me otherwise. It seems like such a simple statement, but it made a world of change in my daily working life. Since then, I speak with confidence, assured that

I know my work best and can better explain scientific data and results in a convincing and clear way. I now find that male colleagues take notice and do not just listen to me but hear what I have to say. It was so important for me to have another woman advocating for me, especially in such a male-dominated industry. Having other women pave the way and improve the system, allows women to gain more opportunities for women in these critical industries – no matter how small the contribution.

For the future, I hope I can expand the work I do as a chemist and contribute more to our capabilities in testing replacements for ODS and SGS in the environment. My personal belief is that everyone should have a positive impact on the environment, so we can leave a legacy for the next generation. As I have two young children, I want them to grow up in a green, sustainable planet and for this to happen, we need to make changes now.

Women shouldn't second guess themselves, they should trust their intuition and advocate for themselves. Don't accept gender stereotypes and speak up against misguided comments. Don't apologize for having an opinion. You matter, your role in this industry matters, even though sometimes it may not feel that way. I believe it is important to allow yourself to stand up and be heard, and to be confident in your abilities.

Elizabeth Gregory

In my career, I have been fortunate to work in a variety of industries, from manufacturing to sports event management, where I have gained experience in supporting women in male-dominated environments. I have also gained a wealth of experience from my role as the Community Sponsorship and Marketing Manager for the Aberfeldie Sports Club. The Sports Club is committed to "Inspiring Women Through Football" with participation of female players in the Youth Girls and Senior Women's Team. Now I am able to transfer my expertise into my current role in the RAC sector.

When I saw the role of Part Time People & Culture Advisor for A-Gas advertised, I knew without one shadow of a doubt that I wanted to apply for the post and learn more about A-Gas and the wider RAC industry. My aim was to return to a manufacturing environment where process, procedure and culture were at the forefront of the business. From my investigations prior to interview, it was obvious that A-Gas had something different to offer and had a strong focus not only on its product offering, but its staff, the environment and the community.

I had never been directly involved or connected with the RAC sector prior to commencing at A-Gas, but since joining I have been extremely impressed with what I have seen and learned, and I have identified where I can personally make a difference to women within the company and in the wider industry.

My introduction to the RAC sector was marked not only by what I learned at A-Gas, but also by an inhouse training programme where the presenters were Michael Bennet (General Manager RRA) and Greg Picker (Executive Director, Refrigerants Australia). Both gentlemen provided the attendees with valuable information about the industry, and it was during that training session that I realized that there is still so much to learn, and perhaps the sharing of information is something that, as an industry, we can all do more of.



“As part of a global company, I can share the work we have done in Australia regarding women in our industry, to inspire the People & Culture teams in other regions... and enhance our efforts to encourage opportunities for women across the board. ”

In that training session I became excited about my own role and the part I could play in this training and education process. That day was my lightbulb moment: my awakening to the magnitude of the sector and the global impact we can all have.

My role as People and Culture Advisor is an opportunity to bring to A-Gas and the wider industry an additional stream of people, talent and expertise.

Inspiring women in traditionally male environments is something that I have always been passionate about, and I have brought my experience from the sports club to my role at A-Gas, where I can inspire women in the RAC industry.

Being the first point of contact for our business with regard to People & Culture is important. I am part of a committed team that inspires and encourages women to consider careers in the RAC sector and supports women who seek further opportunities and career progression.

A-Gas gives me the tools to support each individual with opportunities for girls and women, and there are training and development programmes in place to ensure they can achieve their goals. My team has a genuine commitment to each individual, encouraging and facilitating women to pursue careers in the refrigeration and air-conditioning sector, empowering people from across the world.

I also see my role in People & Culture as being something of a spokesperson. Through recruitment I can share important messages regarding environmental services. I have available to me a forum to raise awareness and promote interest in working work in our industry. How do I do this? Through education, through facilitating training sessions, through advertising current recruitment roles, through all kinds of media from LinkedIn to social media and through networking within the industry to encourage others to do the same!

From a personal perspective, to be sharing the same office as Elvira Nigido, who is a representative to the United Nations, is an honour. Elvira is also a member of the United Nations Environment Programme's Halons Technical Options Committee (HTOC). At the national level, she is the first female member of the Australian Fire Protection Industry (ODS & SGG) Board.

I am so inspired by Elvira's career achievements and I feel quite fortunate to have the opportunity to work alongside her. Having women in the Refrigeration and Air-Conditioning sector is as important as it is in any industry. Elvira is a knowledge bank of information, and I feel I can use her as a case study to inspire other women in our office, within the wider company and in the industry, to help them gain confidence and work towards reaching for more in their careers.

As part of a global company, I can share the work we have done in Australia regarding women in our industry, to inspire the People & Culture teams in other regions (such as South Africa, Asia and Europe) and enhance our efforts to encourage opportunities for women across the board. This is vital as we continue to grow as a business, with more opportunities for women in various roles.

Through my own learning and experience, I truly hope I can not only provide value to the staff at A-Gas, but also help add to the knowledge bank within the RAC Sector and the "Who's Who" of women in the industry!

In an ideal world there should be no barriers for women in the workplace, and to draw on the experience of other women who are achieving so much already would be just incredible.

Wendy and Roxi Kenny



There are always similarities between any mother and daughter such as looks, personality and mannerisms. Wendy and Roxi Kenny are similar in a unique way, with their mother-daughter bond of twin careers in the refrigeration and air conditioning industry.

Although Wendy is Managing Director and Roxi works in accounts at their family-owned, Queensland-based business, Air-Rite Mechanical Services, their careers in the RAC industry started in a similar fashion – a need for a receptionist.

At 16, Wendy was at a crossroads: she had to choose between getting a job or going back to school after finishing year ten. Fate intervened in the form of her electrician friend, who informed her that his boss at Diamond Air Conditioning, John Urch, was looking for a secretary.

As Wendy was being shown the secretarial ropes by John's wife, Nancy, John took it upon himself to teach her the ins-and-outs of the RAC industry.

"John was fantastic. He taught me how to do heat load calculations and how air conditioning worked as he also had a manufacturing plant. I was also lucky enough to visit some sites, the safety issues were not as strict as they are now. Verbal communication was very important and the paperwork trail was definitely not as it is today – things could be done on a handshake."

Even though Wendy considered herself lucky to visit sites, and gained a lot of experience on the job, she eventually realised she needed formal industry training. Over the course of her career, which spans almost 40 years, she has completed a course in management skills for trade contractors, gained a Diploma of Engineering Technology (Refrigeration and Air-Conditioning), gained a NSW Contractors Licence and is currently studying for her law degree.

"RAC is a great industry, just make sure that you are knowledgeable and gain experience on a practical level."

As Wendy progressed on her educational journey, she also progressed on the job. From junior office girl, Wendy went on to work as a private secretary at John's private company, before moving to Brisbane with her husband, Alistair, and working at Uniflex. She was eventually asked to run Air-Rite Mechanical Services by her former boss, eventually buying the business with Alistair and two business partners. In 1997, Wendy and Alistair bought out their business partners, making Air-Rite Mechanical Services their family business.

Years after being shown the ropes by John, now Wendy is interested in showing the ropes to Roxi so she can eventually take the reins.

While Wendy says she fell into the industry by chance, Roxi believes that the RAC industry chose her.

Growing up with her parents owning and operating a refrigeration and air conditioning business, it was inevitable that she would herself work there one day, even when she was helping out from time to time while pursuing other career options.

When Roxi was 24, the receptionist working for the business left and there was no one to replace her, so Roxi took time off to help out once a week. It wasn't long before she took over the position as a full-time

employee. She has now been working for the business for five years.

Not only is Roxi following in her mother's footsteps in the RAC office environment, she is also following them in education. She's also studying law at university, as well as mechanical engineering, so she can eventually take over the family business.

"When I began working at Air-Rite, Mum suggested I study mechanical engineering to assist with my progress within the business and hopefully it will allow me to hold the Unlimited Design Licence in the future when she wants to retire."

"My (mechanical engineering) degree will hopefully assist me in learning more about the project side of the business as I want to be more involved with tendering on the mechanical packages for builders and running projects we have won. The law degree is to assist with the contracts aspect."

While Wendy and Roxi have pursued their ambitions with the support of their family and employers, that doesn't mean they've had it easy. The RAC industry's male-dominated nature has presented them with plenty of challenges to overcome.

"The hardest challenge I faced was when I first started working full-time at Air-Rite and I would go to the construction sites with the project manager to better understand their role. Very rarely would there be a female on site," Roxi said.

"I would get harassed by other construction workers with inappropriate sexual comments and gestures, which made being on site extremely uncomfortable ... other times I found myself belittled over the phone by male builders."

"In the earlier stages of working in the industry, I would get harassed by other construction workers with inappropriate sexual comments and gestures, which made being on site extremely uncomfortable ... other times I found myself belittled over the phone by male builders when I would request information."

While Wendy also recalled challenges in being taken seriously by male counterparts, both

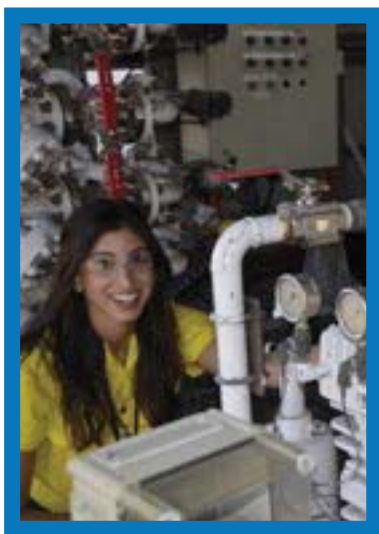
of them emphasized that there has been improvement in the RAC industry on this front. Wendy has noticed improvement during her years of studying and running the business, while Roxi has noticed improvement through the implementation of workplace laws to prevent the kind of harassment she endured.

Even though the RAC industry is male-dominated, with their years of experience and the lessons learned along the way, Wendy and Roxi encourage any woman interested in a career in the RAC industry to go for it.

"There are some great individuals in our industry and I am lucky enough to have met numerous company owners, managers, consultants, suppliers and so on who have been respectful, courteous and sometimes helpful throughout my studying for my diploma. RAC is a great industry, just make sure that you are knowledgeable and gain experience on a practical level," is what Wendy recommends, while Roxi believes that women interested in a RAC career should reach for the stars.

"Don't let anyone deter you from what you want to do and what you want to achieve. Make sure you work hard and learn as much as you can so if anyone wants to doubt you, take satisfaction in proving them wrong."

Kristina Khougaz



Chemistry and mathematics were subjects that interested me throughout my schooling. These interests, alongside my passion for problem solving, led me to undertake a Bachelor of Chemical Engineering at university. While there, I worked as a Student Process Engineer in a manufacturing facility and from this I determined that I wanted to work in a challenging and practical role within a fast-paced environment. As a graduate, I was offered a position at A-Gas as a Process Engineer.

Throughout my time at A-Gas, I have grown considerably in my capabilities as an engineer in this industry. This is a direct result of the opportunities I have had to extend my skills within a global team environment that inspires open exchange of knowledge. A-Gas encourages continuous learning and growth; I have been on many training courses including PLC training, process safety training and autoCAD training. I am a member of both iChemE and Engineers Australia and hold a Refrigerant Handling License.

My day-to-day duties involve both the design and implementation of new and improved processes. This includes undertaking calculations, participating in risk assessments and HAZOPs, the procurement of components followed by the installation, and commissioning and training operators on how to run the process which has been implemented. I assist in troubleshooting when there is a breakdown or process irregularity, to ensure that the process is running efficiently.

As a Process Engineer on a production site, there are many projects being worked on concurrently. High importance is placed on our Environmental Services sector, which promotes the recovery and reclamation of refrigerants to stop emissions and the unnecessary destruction of the atmosphere. One project that I have recently been working on is the upgrade of a state-of-the-art Environmental Services reclamation process to allow for increased production efficiencies, and as such, ensure even greater reclamation of substances with ozone-depleting and high global warming potential. I am proud to be a part of a dedicated team of people, united in their commitment to finding and refining processes to support the transition away from ozone-depleting substances.

“Although this industry is traditionally male-dominated, I think it offers a great challenge and opportunity for women and they shouldn’t be afraid to get involved.”

I have been fortunate enough not to have faced many challenges as a woman in a traditionally male-dominated environment within the industry. A-Gas has an exceptional culture that doesn’t differentiate negatively between genders, and I think the industry can learn from A-Gas’ attitude to women in business, and feel inspired. I am fortunate to work alongside some inspiring women; A-Gas’ Managing Director in Australia is a woman who has worked in this industry for many years, and there are many other women who hold positions in our Leadership Team. These women have helped carve the way for other females in our company and are role models for future generations.

In saying that, there have been times when external contractors have not treated me the same as my male colleagues. An example of this was when a Project Manager went around the room in a suppliers’ meeting asking who would like a coffee, and then proceeded to say, “Ok, beautiful, go and make the coffees”, directing this at me – the only female in the room. At the time, I was a young graduate who didn’t know how to handle the situation, so I made the coffees, shocked and shaken by the instruction. I learnt from that experience and how it made me feel. Experiences like that have made me a stronger person, someone who tries my absolute best at anything that is thrown my way, and it has given me the drive to continuously learn and grow. Looking back now, I know for certain that if a situation as described above was ever to arise again, I would handle it in a different manner and I am proud of myself for this.

Although this industry is traditionally male-dominated, I think it offers a great challenge and opportunity for women and they shouldn't be afraid to get involved. I believe sharing the stories, experiences and learning of women across the RAC sector can help inspire and encourage others and can highlight how women are coming to the forefront of the industry. Given that team work is vital for any successful business, I think it is of great importance to ensure that a team is made up of people from a diverse background. That way, many ideas and opinions can be considered. In my position as an engineer, when designing or implementing changes to a process, a diverse team ensures that all aspects of safety and design have been carefully measured to the best of the team's ability. I believe that women provide an exceptional benefit to any team and therefore also to the refrigeration industry.

Catherine Reinecke

We all dream of following in the footsteps of our loved ones at one point or another as we grow up. Whether it's our mother, father, siblings, grandparents, aunts and uncles, our loved ones have the power to inspire us to be just like them when we grow up and reach adulthood.

While not all of us manage or choose to follow in our loved ones' footsteps, Catherine Reinecke has managed to do so many times over.

Catherine's desire to follow in her grandfather's, father's, brother's and uncles' footsteps started to show itself when she was a child growing up in South Africa watching them hard at work in the RAC industry.

"From the age of 7, I used to see my father and brother work in big banana plants. This type of specialized work intrigued me, however being a girl in South Africa it was beyond my reach."

While her prospects of working in the South African RAC industry were limited, she would later discover that the sky would be the limit for her and her family when they were given the chance to move to Australia.

However, the increased opportunities weren't given to Catherine on a silver platter, as moving to Australia presented her and her family with several challenges that would have led lesser people to give up.

"In 2006, my father, Theo, was given the chance to come to Australia with the help of my uncle Reymond. We were separated for a year until dad got enough money to bring the family over. Finishing school was difficult due to not being able to speak and write in English. I had to overcome this hurdle of learning a new language in Australia."

Seven years after her father was given the chance by her uncle to come to Australia, they gave her the chance to kick off her career in the RAC industry.

"In 2013, my dad and uncle gave me the opportunity to try out the trade to see if I would enjoy working with tools. I ended up enjoying the work and I told my dad I wanted to start working in the trade."

While Catherine says that her grandfather, father, brothers and two uncles were her biggest influences and continuing the family trade is important to her, especially as she is the first female in her family to work in the RAC industry, she emphasizes that her father is by far her biggest supporter.

"My father has been my biggest motivator. He's supported me and has been there for me throughout all the difficult challenges I have faced and without him I don't know where I would be. We have our ups and downs but I wouldn't trade working with him for the world."

Despite the large amount of support from her male family members, not every man has been kind. Catherine says that some male customers find it hard to accept her working in the RAC industry, but she



"This trade can be very rewarding, male or female you have to have a strong personality and the will to succeed under all circumstances."

hasn't let them or anyone else hinder her career. While she doesn't know what the future holds for her, she is determined to perfect her skills and continue learning every day. Hard work and determination are traits she advises that anyone, let alone women, with their own ambitions and desires to work in the RAC industry needs to have.

"This trade can be very rewarding, male or female you have to have a strong personality and the will to succeed under all circumstances."

"To all the young girls and women out there willing to do the hard work, give it a go and never stop trying. Keep moving forward."

Jenny Smith



I completed Year 11 with good grades in Physics, Biology, Mathematics, English and Chemistry but I knew I wanted something more than what was on offer for women. My options were administration, nursing or secretarial positions but then I saw an advert in the local paper for a "Refrigeration & Air-conditioning Mechanic" intake that would consider a woman if suitable. I applied and after two interviews and an interview with my parents to make sure I had their support, I got the apprenticeship. I was only 15 when I started my journey.

In 1982 I was employed as the first female Federal Refrigeration & Air-conditioning Apprentice in Australia with the Government in Darwin, Northern Territory. It had never been done before and they wanted to see if a woman could succeed in a mechanical trade. I wasn't welcomed by the men on the floor or the woman in administration at first and no-one knew what to do with me. The steel cap boots didn't fit, the pants and safety gear did not come in my size. They called me "she" for the few months and couldn't recall my name, but I worked very hard and

was apprentice of the year every year, and soon the tradesman realized that I wanted this job. I found the subjects of refrigeration, air conditioning and electricity interesting and was always putting my hand up for the opportunities that were offered. I was thirsty for knowledge and spent every moment making self-sustaining freezer boxes for long-range camping trips, fixing anything I could get my hands on, and I even started my own business on the side specializing in car air-conditioning. I earned the respect and admiration of my fellow workers, administration staff, TAFE lecturers and the clients that I served. I have a hundred funny stories of things said to me while on the job regarding being a woman in this trade. I graduated at the top of my trade class armed with a B Grade electrical licence, and was nominated for Apprentice of the Year.

I worked on all the federal sites and had the opportunity to work on Naval boats, submarines, RAAF, Army and Naval bases on large plant, both in Refrigeration and Air conditioning. As a large central plant mechanic everything was big, heavy and dirty but I was strong and held my own with the others. The Northern Territory government arranged for me to obtain my driver's licence at 15 years of age to help me carry out my trade. This allowed me to go on 24/7 after hours callout in the second year of my apprenticeship, which solidified my learning curve. Being in a plantroom in the middle of the night with a major breakdown and no-one but yourself to get it back on line is a marvellous way to reinforce your knowledge. It was those opportunities that allowed me to learn my craft and become very confident with my abilities. A federal apprenticeship was worth its weight in gold as I was taught by tradesmen on large and medium-sized plant with large budgets that allowed us to do regular high-quality major service, on-site training and plant upgrades that honed my skills. On the weekends I worked at the wharfs on the

"I was thirsty for knowledge and spent every moment making self-sustaining freezer boxes for long-range camping trips, fixing anything I could get my hands on..."

prawning fleet's ammonia freezer systems under the decks, trying to diagnose the problem in a confined space, like a canary, before the boat had to head out to sea again. I spent hours studying electrical diagrams spread across plant room walls to find the one contact that didn't work that had caused the problem. I worked hard but I really loved it.

When I completed my apprenticeship, I started Mechanical Engineering, but I wasn't welcomed by the all-male class and decided to do a Diploma in Supervision & Management by correspondence. The government Department of Education, Employment & Training (DEET) funded the "Women in Trades" pilot course and wanted a woman to run it, so I was seconded to run the course while still working in my trade position for the remainder of the week. The course was so popular and successful that I took it on full time and completed my Diploma in Education. I was then promoted to Manager of Vocational Studies, which saw me teaching and managing both Women in Trades, Aboriginals in Trades and Prevocational Studies at TAFE for several years. I had a full management and teaching load as well as work experience placement for some 200 students. Many of those female and Aboriginal students ended up with jobs in the mining and trades sectors around the Pilbara and Darwin areas.

I left Darwin for Adelaide and worked for 13 years across three large companies. I started with Simms Refrigeration, who were heavily invested in the supermarket, service station and pizza chains industry within the service and installation sector. I then moved to Dunnair International to be senior mechanic on the Roseworthy and Waite Campuses of Adelaide University. I had the opportunity to work on custom projects with major funding, managing stakeholders' expectations and delivering the projects as per the scope of works. Air conditioning and heating for huge glass houses during summer and winter, mouse houses with critical humidity and temperature control, glycol chillers cooling the wine industry's latest top-secret beverage process, scientific equipment custom made to achieve a specific outcome for an experiment, and low temperature (minus 100 degrees) freezers. Finally, I worked for Logic Air who specialized in large chillers for clients like Adelaide University, Port Adelaide TAFE and the University of South Australia. I also had experience with San Remo custom-made Italian pasta process machines, and computer room experience in both the Holden factory and in hospitals and theatres around Adelaide. In my time of being "on the tools" I have trained and influenced around 26 apprentices in Heating, ventilation, air conditioning and refrigeration (HVAC&R) and have enjoyed the on-site training and watching their learning curve as they succeed in their own trade journeys.

In 2005 I returned to Darwin and started my own business called About Airconditioning. The business flourished by offering high-level customer service to a variety of clients. That led me to complete my Diploma in Business Management and Diploma in Project Management as I was involved in building management, facilities management and project management with clients. I have managed several buildings in Darwin that were being refurbished and having their HVAC&R upgraded with complete modern systems. I have also project managed remote sites with building contractors building houses, schools, offices and recreation facilities, meeting their individual HVAC&R scope of works with design, installation, service and continuing maintenance in Aboriginal communities.

I have worked closely with Midea in Guangzhou, China, testing and developing the world's first Domestic Solar Air-conditioning Split System. We had the opportunity to test this solar air-conditioning system in at two sites in Darwin and one, Preston, in Melbourne. Testing went on for three years and moved the solar air conditioner system from Generation 2 to Generation 5. This opportunity to measure, interpret and develop this innovative solar product was a real highlight of my career.

I am an active member of Women of AIRAH, the women's group of the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) and the Committee of the NT Chapter of AIRAH. I have been the unofficial female face of Refrigeration & Air conditioning for almost four decades across the HVAC & R industry, the building industry, the education sector and building facilities management.

I have thoroughly enjoyed every day I am involved in the HVAC&R industry and although difficult at times, it has rewarded me for a lifetime.

I love my trade.

Liza Taylor

As the co-CEO and co-founder of Global IQ Group and a Non-Executive Director of the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH), my passion for innovation has been a driving force throughout my life. Little did I know that when I embarked on my journey, my career trajectory would ironically follow the innovation life cycle!

How did I get here?

Growing up in the western suburbs of Sydney, I was one of those kids who were good at everything except for sport. My love of maths, chemistry and physics was matched by my love of art and economics. Choosing between two great loves was difficult. And just as I handed in my choice to pursue a business degree, fate intervened. I was thrilled to be awarded a Co-op Scholarship to study Industrial Chemistry at the University of New South Wales. The first stage of the innovation cycle is Research and Development, and this is where my career begins. Graduating with a Bachelor of Science (Hons) in Industrial Chemistry, I worked in the R&D laboratory where I learned the important role innovation plays in solving our day-to-day problems. The next stage of my career was spent in product management, where I learned how to develop and commercialize new technologies and make them mainstream. This was followed by marketing and senior management roles, where I learned how to transform these products into thriving business growth opportunities.

Like many people, I fell into the air conditioning and refrigeration industry over a decade ago. One of the key motivating factors was that I love a challenge. After working for some of Australia's most loved brands, I decided that if I could make air conditioning sexy, I could do anything! I was fortunate to be part of a senior leadership team which transformed a little-known family air conditioning business into an iconic \$100m+ Australian brand.

Leading the product management, marketing and demand management team, one of my responsibilities was commercializing new products. Our passion for challenging the status quo delivered energy savings of up to 60% compared to traditional technology. For a technology leader, one of the challenges is the slow rate of adoption of new products. Changing mindsets across the industry is critical. This was achieved through development of evidence-based marketing communication tools, demonstration projects and a national training programme to achieve a step change in energy efficiency. Not only was this good for business, it was good for the planet too!

One of the things that you first notice about the industry is the people. Super talented, quiet achievers bringing our buildings and communities to life. The second thing is the technology. These were ordinary people doing extraordinary things to make the world a better place. I had reached a point in my career where I wanted to use my superpowers to do more good in the world. And just like the pathway that products take when they reach maturity, it was time for me to pivot.

My leap into the entrepreneurial abyss has been the most challenging and yet most rewarding time in my career. Global IQ Group was formed to provide specialist strategy, innovation and marketing advice to the HVAC&R and built environment sector. Our clients include blue chip companies listed on the New York Stock Exchange (NYSE) and the Australian Securities Exchange (ASX), clean technology start-ups, not for-profit and government agencies. Some of the highlights have been facilitating a design thinking workshop in Shanghai, sourcing new products from original equipment manufacturers (OEMs)



“The HVAC&R industry of the future will be a nexus of mechanical, electrical, chemical, big data, photovoltaics, renewables, economics, policy and the social sciences to bring about behavioural change.”

world-wide, developing technical manuals, meeting the wonderful Women of ASHRAE (formerly the American Society of Heating, Refrigeration and Air-Conditioning Engineers) in Chicago, working with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and AIRAH to create an innovation hub and showcasing new technology through communications. I'm grateful my business partner Nathan Groenhout encourages me to focus on the important things like family. The freedom and flexibility of entrepreneurial life has allowed me to give back to the industry. I am a Non-Executive Director (AIRAH), co-founding Co-Chair of the AIRAH Resilience Special Technical Group and an advocate for raising the profile of women in our industry. I have also been fortunate to pursue other life goals including completing my Master of Business Administration (Executive) at The Australian Graduate School of Management.

HVAC&R for life

As scientists, engineers and business leaders in the HVAC&R industry, we have an enormous responsibility to enable life – from the food we eat, to health and well-being to building communities around the globe. Life as we know it could not exist without the important role we play. However, this lifestyle of comfort and convenience has come at a cost. Air conditioning is energy intensive and accounts for over 22% of electricity consumed in Australia. It has both a direct and indirect impact on the environment. Paul Hawken's book "Drawdown" has identified refrigerant management as the number one activity that can reverse the effects of climate change.

To solve these global problems, we need an integrated approach across the entire industry. A one-size-fits-all solution does not exist. Diversity of thinking will be critical in putting together a multi-disciplinary approach to solving these complex problems.

The HVAC&R industry of the future will be a nexus of mechanical, electrical, chemical, big data, photovoltaics, renewables, economics, policy and the social sciences to bring about behavioural change. As we approach the hydrofluorocarbon (HFC) phasedown, technological change is inevitable. To be successful, collaboration will be essential across disciplines, and across the entire supply chain from researchers, manufacturers, contractors, designers, engineers, installers and facilities managers to property owners, service and maintenance providers. For women embarking on their careers, this provides a wonderful opportunity to grow in an industry which is poised for growth.

One day I will enter the final stage of the innovation life cycle, obsolescence. Reflecting on my career, I have been incredibly fortunate to be a part of an industry where change is a constant. As a "mumpreneur", a friend, a student of life and dreamer of impossible things, I am living proof that women can have it all. We just need to redefine "all", for the future belongs to those who dare to make a difference.

Bangladesh

- Shamsad Sharmin

Shamsad Sharmin

I passed my Cambridge O Levels with As in Maths, Additional Maths, Physics, and Chemistry. I was interested in science and innovation during my secondary education and that interest further deepened during my college studies. Later, I got my Bachelor's degree in Material Science and Engineering.

For about two years, I have been working in the Refrigeration and Air-conditioning (RAC) sector of Walton Hi-Tech Industries, situated in Dhaka, Bangladesh. Here, I serve as a Material Engineer in the motor manufacturing sector producing compressors for R-600a based refrigerators. My responsibilities include the management of technical research on the die casting process and the heat treatment process for rotor and stator laminations. I was involved designing the compressor manufactured by my company. Moreover, with my colleagues, I have been working to carefully select the best combination of materials for the electrical steel sheets for rotor and stator laminations and the aluminium for rotor cages.

Starting with the basic science regarding metallurgy, an extremely broad field of knowledge is involved in the process of heat treating (decarburizing) the stator laminates after the punching process, in order to reduce the carbon content and increase the grain size, both intended to reduce hysteresis loss. We optimize the process by designing heat cycles for annealing and other associated heat treatment processes. This reduces efforts devoted to rework and lowers rejection costs. The control systems of existing processes are improved for satisfactory results. The decarburizing process also involves eliminating burrs. Another important step at the decarburizing furnace is the production of a thin, but usually good quality, Fe_3O_4 oxide layer to provide electrical insulation between laminates. The decarburizing process described above is useful for stator laminates, which carry flux at line frequency, leading to significant iron losses in the stator cores. However, for rotor laminates, only oil vaporization is required, since in most rotor cores, flux variations are low in frequency.

We have a fully equipped metallographic lab for analysing our products. The laboratory personnel create and analyse macro sections and micro sections and carry out a variety of hardness tests. Other services offered by the lab include metallurgical microscopy and material analyses.

To cast squirrel cage rotors, the 100 tonne, high-pressure THT die-cast machine is operated. The molten aluminium must flow through the lower end-ring and rotor slots and reach the upper end-ring before solidifying. The aluminium must be injected rapidly so it does not solidify in the rotor bar slots in the lamination stack.

Afterwards, rotor castings are tempered or annealed. The rotor annealing cycle is hence optimized to reduce the inter-bar current, leading to significant improvements in maximum torque and power factor. Additionally, annealing relieves the mechanical stress of cast aluminium, increasing its conductivity.

To verify the effect of annealing in motor performance, we use a multi cycle 450°C heat treatment to detach the rotor bars from the steel. All assembled rotors have laminates with thin Fe_3O_4 film and cages obtained through high-pressure die-casting.

The first thing I noticed is that male employees are predominantly employed in this sector and my company. I have only a few female colleagues and I often feel that my voice is not heard in such a male-dominated group. I do not want to leave my job, so I reach out to people who have experienced a similar situation to advise me on how to position myself within the group. This has helped me to build the self-confidence I need to thrive in similar contexts and to recognize the importance of having women work together and share experiences. Additionally, working at a compressor manufacturing plant has opened my eyes to the vast possibilities in the field and made me want to pursue jobs that allow me to create things and think differently.

As I very enthusiastically carry out my responsibilities here, at some point, I could experience the cultural

“ I think the best method to establish an equivalent participation of female and male employees in the RAC sector is by engaging young female students in work discovery programmes enabling them to explore their potential, curiosity and passion for innovation.”

expectation to marry and settle down with a husband, which could eventually lead me to quit my job. I needed something more than a desire to continue my job. I felt envy combined with inspiration, from the step I took in Walton. I remember walking down the long corridor of our manufacturing site, seeing through the transparent doors of my working zone and wanting to belong there. The initial tasks seemed so much harder than I had imagined. Knowing that nothing could miraculously fix my situation made me work harder and push myself to the point where I now believe that I can succeed. I am fortunate to have some people around me who supported my decision to carry on with my job.

On the basis of my experience and reflections, I think the best method to establish an equivalent participation of female and male employees in the RAC sector is by engaging young female students in work discovery programmes enabling them to explore their potential, curiosity and passion for innovation.





Barbados

- Shakira Boyce

Shakira Boyce

My childhood dream was to become a veterinarian. However, that all changed one day when, as a teenager, I stopped to observe a technician in my home who was repairing my mother's malfunctioning washing machine. Upon his departure, we found that the washer was still faulty. When the technician returned to correct the problem, he had the audacity to charge my mother a second time for work he should have initially done correctly. Seeing my mother taken advantage of in that way made something click within me and I thought: "I could do this work!" It was in that moment that I decided that this was what I wanted to do. I promised myself that I would learn the trade that would lead to me ultimately becoming both an appliance service technician and a refrigeration and air conditioning (RAC) service technician. This was an uncommon choice for a girl, as the field was, and still is, male-dominated, but I believed that this was my niche.



Upon leaving secondary school in 2003 at the age of 15, I was accepted at the Samuel Jackman Prescod Polytechnic (SJPP). Now renamed the Samuel Jackman Prescod Institute of Technology (SJPI), it is the premier technical training institution in Barbados. There, I enrolled in the RAC Diploma programme, in which Home Appliance Servicing and Repairs was a required course. As one of only two girls in a class with 14 boys, I experienced sexism, harassment, and intimidation at the hands of some of our classmates. However, having grown up with three older brothers, male intimidation had very little effect on me. In addition, although there were many other distractions, I managed to maintain my focus and worked steadily towards successfully completing my studies.

"Sometimes, I felt as though I had to work twice as hard to prove that I was just as capable as any male technician... so I persevered and eventually earned the respect of my peers."

Where intimidation failed, the theoretical aspect of the programme proved to be my biggest challenge. However, engaging with the practical component was where I excelled. Coming from a family of tradesmen, I learnt that most adversity is often overcome by trial and error; I noted that if you've tried and failed, an error must have been made and that, therefore, you need to try again until you succeed! That stuck with me, and I still use that lesson today as a motto to drive me to succeed.

After graduating in 2005, I entered the RAC industry. The transition from studying to working life was an adjustment, and no one was easy on me. Sometimes, I felt as though I had to work twice as hard to prove that I was just as capable as any male technician. However, I was determined never to be classified as incompetent, so I persevered and eventually earned the respect of my peers. Those experiences have helped to mould me into the woman and technician that I am today.

Things took a downward spiral in 2011, after my position at an establishment I had worked at for five years was made redundant during my pregnancy. When I was given the reason for being dismissed, I felt as if my employers were taunting me, especially since they knew both that I was pregnant and that my daughter's father had died earlier in my pregnancy.

The reality of my position being made redundant hit me hard. I thought it was unfair, since, though they were not RAC technicians, other females at the company were treated much more favourably under similar circumstances.

I remained at home for approximately two years, mothering my daughter. In 2014, I was presented with the opportunity to apply for a part-time tutoring position as a RAC instructor at the SJPP. Initially, I was hesitant to submit the application because I didn't think that I had the ability to fulfil the job requirements. However, one of my former tutors relentlessly encouraged me to submit the necessary information for the position, and I did. Subsequently, I got the job. In the beginning, I was met with

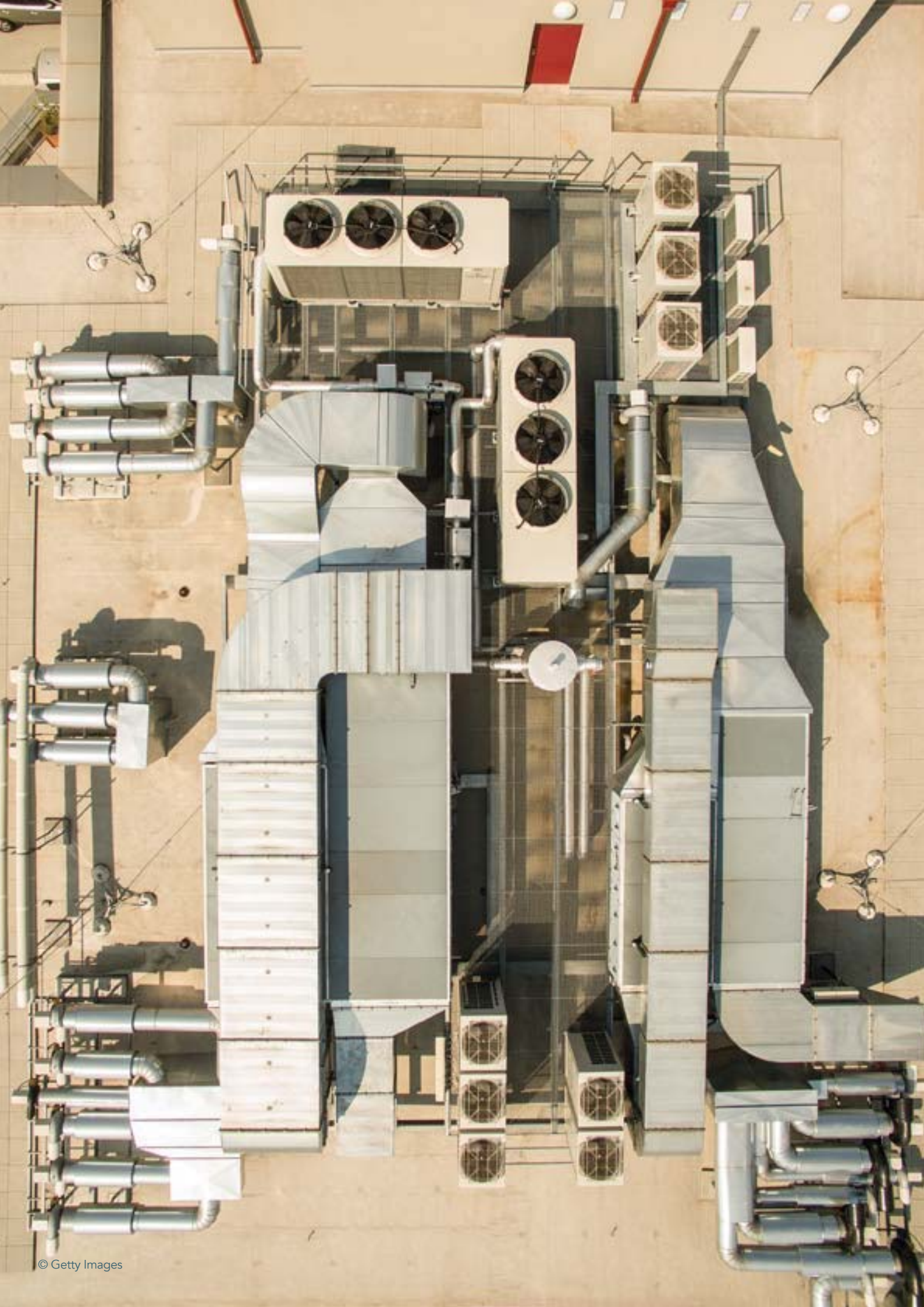
opposition from persons I believed should have encouraged me as a young female instructor, and I was extremely doubtful about whether I would continue.

However, I have grown to love teaching. I am strict with my students when required. I put a great deal of thought and effort into identifying the most effective ways of reaching and encouraging each of them. Ultimately, the best reward for me is hearing my students' success stories and seeing students with difficult backgrounds transform and work towards excellence right in front of me.

At this stage in my life, I'm quite satisfied with where I am and what I've accomplished. My present goals are to gain more qualifications in RAC and to ensure that I keep abreast of the technological advances being made in the industry. Thinking back on the challenges I've faced, I believe that I have developed a good reputation amongst my co-workers. In the end, I have no regrets and each path I took was worth it!

My advice to young women interested in entering any male-dominated industry is this: although it will be a challenge to prove your worth, let nothing stop you from becoming the best at what you do; know that there will always be hindrances and that you are your greatest adversary.

Ladies, I believe that success is ours!



Bolivia

- Lucia Condori Gutierrez
- Lucero Cortez Ustariz

Lucia Condori Gutierrez

My name is Lucia Condori and I was born in the city of Cochabamba, Bolivia. Below I tell the story of how I made the decision to pursue a career as a refrigeration technician. I finished my studies in management in 2004. In 2005, I entered university to study public accounting. In the first few months, it became clear that I needed to look for a job to pay for my study expenses, since I lived alone with my mother.

I started working in mid-2005 as a secretary at Refrigeración Consul, a workshop, while studying at university. As I progressed in my position at the workshop, customers began asking me questions about the possible reasons for the breakdown of their refrigeration equipment. I could not answer these questions, since the owner and the technicians were constantly servicing clients outside the workshop. It was then that I decided to train and learn more about the field. I completed the public accounting course in 2010. In 2012, I learned that there were courses that would be taught by an engineer named Villegas at the University of San Simón, and without hesitation, I enrolled and took all those courses, from basic refrigeration to industrial refrigeration. After passing the courses satisfactorily, I began working as an assistant technician in the same workshop so I could attend to customers and explain to them all the possible technical problems that a refrigeration system could have. I then realized that it was my calling to be a refrigeration and air conditioning (RAC) technician.

Time passed, and in 2016, I married the technician who owned the workshop. We now have two beautiful children and we continue to work together, making our company grow much more, maintaining its prestige, and keeping ourselves up to date. My supportive husband encouraged me to submit my application when the Government Ozone Commission issued a call for applications to join an accredited team of technicians that will provide services in customs-free zones in Bolivia. Thank God I was accepted; this accreditation gave me new job opportunities, and to date, I am still performing my duties efficiently and responsibly.

There are many male technicians who consider this job not suitable for a woman, but it is satisfying to show many of them that a woman can indeed do the job. Over the years, I have seen that there are already women in my environment who do this work in a very professional way.

As a female technician, I find that the most difficult thing about my job is balancing the time spent on work, the time spent taking care of my children and helping them with homework, and the time spent on housework. My situation is not unique, as many women leave their trades and professions in order to care for their children. However, working as a team with my husband enables me to stay active at work and helps me manage my time properly in the business without neglecting my children.

I believe that it is never too late to learn and that nothing is impossible. If you put your mind to it, you can achieve your goal. No job is beyond limits - you can be whatever you decide to be.



"I believe that it is never too late to learn and that nothing is impossible. If you put your mind to it, you can achieve your goal. No job is beyond limits - you can be whatever you decide to be."

Lucero Cortez Ustariz



My name is Lucero and I'm 22 years old. Since I was a child, I have always been surrounded by people who work in the refrigeration and air conditioning (RAC) sector: my grandfather taught my father and all of my uncles, who to this day are working in the RAC sector. Working in the RAC sector is something not common for a woman, and I wanted to do something out of the ordinary.

My grandfather and my father patiently taught me to repair all kinds of refrigeration equipment. I decided to take training courses to learn more and be able to give better service to clients, which, little by little, earned me good,

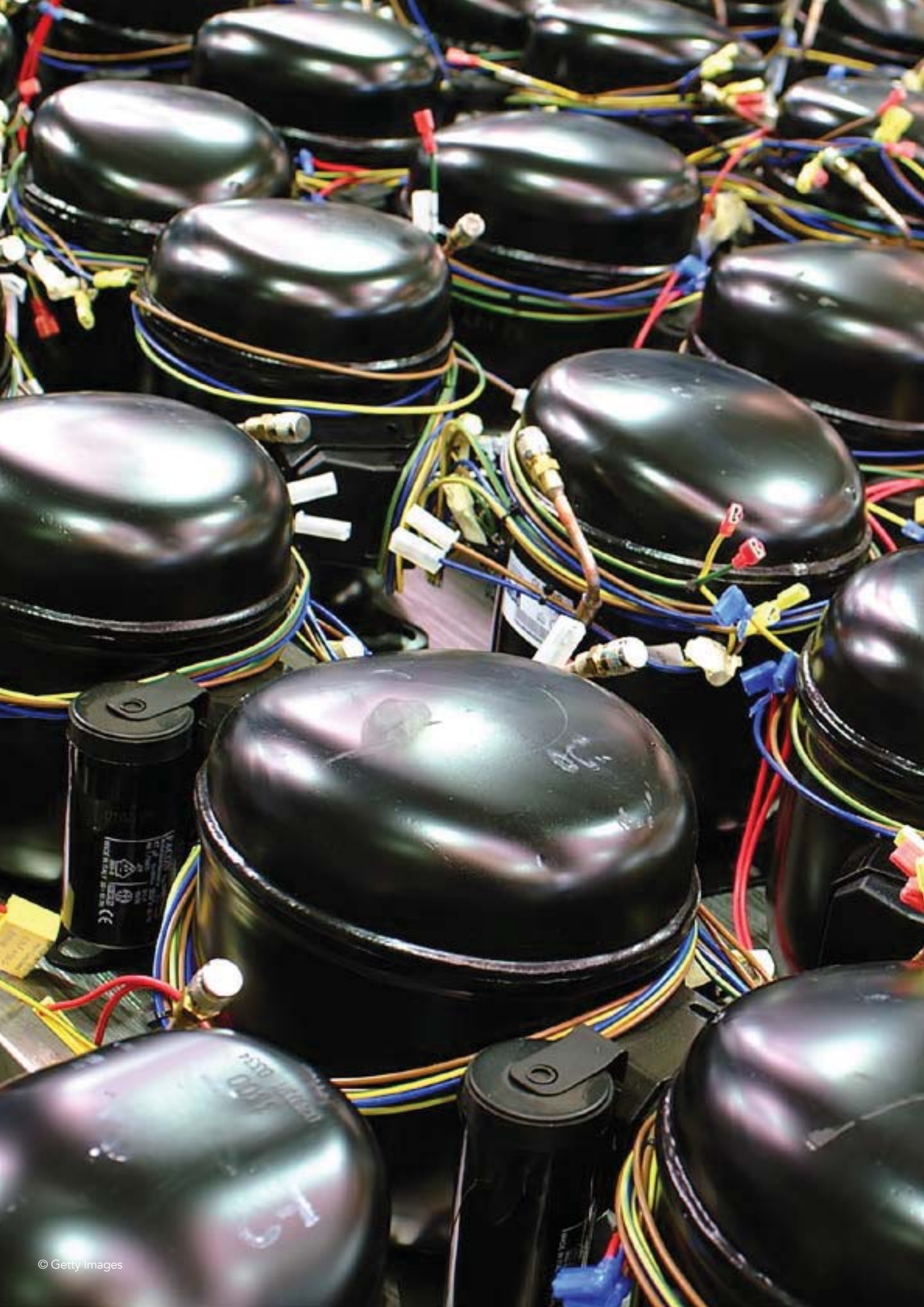
“I decided to take training courses to learn more and be able to give better service to clients, which, little by little, earned me good, guaranteed employment.”

guaranteed employment. It also gave me the responsibility, at the time, of delivering their refrigeration equipment.

But it was not easy getting started in the RAC sector because there is so much sexism in Bolivia. The first jobs I found were not easy because some clients doubted my capacity to do the job or were surprised to learn that I was the technician who would repair their refrigeration equipment. Meanwhile, others preferred to look for another technician who was not a woman.

One of my goals is to do something for the environment, since a RAC technician has a lot of responsibility towards the environment in terms of the types of refrigerants we handle.

I am very happy working in the refrigeration and air conditioning sector. I have my own service workshop, and I feel glad because my clients recommend me to other people because of the work I do.



Bosnia and Herzegovina

- Gordana Tica

Gordana Tica



I was born in Banja Luka on March 31, 1964, where I completed elementary school and high school. I entered the Faculty of Mechanical Engineering, Department of Thermotechnics and Motorization in 1983. I graduated in April 1989.

In November 1992, I was employed at the Faculty of Mechanical Engineering in Banja Luka as an assistant in "Thermal devices" and "Turbo and piston machines". I completed my Master's degree in 2002, also at the Faculty of Mechanical Engineering in Banja Luka. I defended my Master's thesis entitled "Possibilities of using geothermal energy of the northern part of the Republic of Srpska for the production of electricity", in April 2002. After that, I was selected as a senior assistant working in "Pumps and fans", "Heat turbo machines" and "Cooling devices".

I completed my doctoral studies in 2010 at the Faculty of Mechanical Engineering in Banja Luka and on 19 March 2010 I defended my doctoral thesis entitled "Contribution to the study of the interaction

between the cooled object and its surroundings".

After that, I was given the title of Assistant Professor and my teaching included lectures on the Refrigeration plant (first-year students), exercises on Pumps and fans, also on Heat turbo machines (first-year students), and giving one part of the lecture on Renewable Heat Sources (second-year students). My research areas in the period after my last election have been renewable energy sources, cooling and air conditioning, and energy efficiency and ecology.

In the Faculty of Mechanical Engineering, Banja Luka, I have held the following teaching and scientific titles: Assistant, 1 November 1992 – 4 October 2002; Senior Assistant, 4 October 2002 – 28 December 2010; Assistant Professor, 28 December 2010; and Associate professor, 12 December 2015 to date.

"My research areas have been renewable energy sources, cooling and air conditioning, and energy efficiency and ecology."

I am a member of several scientific and professional organizations and associations: Member of the Federation of Energy Sector of the Republic of Srpska; Member of the Banja Luka City Council for Climate Change (expert appointed by the Banja Luka City Assembly); and Member of the Energy Efficiency Committee established by the City Administration and Towns of the Republic of Srpska.

In working with international instances and institutions, I work with contractors including Bosnia and Herzegovina's local UNDP consultants and experts in the areas of renewable energy sources, heating and cooling, and F-gases in the field of work and refrigerant research and their impact on the environment, also with the expert for Refrigeration & Air conditioning, and engineers and architects for Europe and Central Asia (ECA).

Botswana

- Dineo Mabhekede

Dineo Mabhekede

My plan was to train as a doctor or nurse but things did not turn out as I intended. My uncle, who is a plumber by profession, encouraged me to take up the refrigeration and air-conditioning trade. I then started my four-year training/apprenticeship with Gaborone Technical College from 1995 to 1999. I wanted to inspire other women to take up a trade believed to be male-dominated, help my country to do its best in food preservation, well-being and nutrition and also challenge myself to prove that women too can embrace and deliver any assignment that they are given.

“I wanted to inspire other women to take up a trade believed to be male-dominated, help my country to do its best in food preservation, well-being and nutrition.”

absorbed in the system – having to prove to the management that you could deliver and share your experience – and the fact that the management was male-dominated and not used to working with women. They are afraid to hire you; also as a woman you have to bear children and then who’s going to take care of the operation/production while you’re away on maternity leave?

I and two male counterparts submitted letters requesting sponsorship from a parastatal in my country. They got a yes, and I got a no, the reason being that the organization was only sponsoring core business-related. My counterparts were diesel mechanics and afterwards they would be absorbed as engine mechanics or locomotive mechanics. My field was classified as secondary. Being very determined and committed, I queried the response, obviously through a reasoned reply with the argument that, since they were a commercial enterprise, nowadays customers needed to travel in comfort. Sponsorship was offered until I finished my apprenticeship.

In 1999 I qualified as a refrigeration and air-conditioning mechanic with the rail industry, responsible for comfort cooling of blue trains and for office/domestic refrigeration. In 2003 I joined the mining sector, also as a refrigeration mechanic, until in 2006 management saw my commitment and I was promoted to the rank of trainer and senior refrigeration and air-conditioning technician because I double as a mechanic. I also sit on the trade advisory team, advising management on development of new gases, for example, as well as implementation of the Montreal Protocol, related courses and development of RAC-related training matrices. In addition, I mentor and train apprentices, also working hand in hand with the Department of Tertiary Education to establish standards through BQA (Botswana Qualifications Authority) and the BOTA (Botswana Training Authority) meteorology section (ozone office) to sensitize technicians and contractors to use, safe handling and recovery of CFC gases and draw attention to and update them on the latest developments relating to the refrigeration field, such as expos and training on handling new gases.

I’m thankful to the Government of Botswana for making available the platform for equal opportunity, and I’m also thankful to Botswana Railways for sponsoring my training and making me a seasoned refrigeration and air-conditioning technician, and of course to my former lecturers for their encouragement and a former employee of the Debswana Diamond Company for developing into a trainer (assessor).

My training was filled with excitement: the first years were hard, but as time went on it got better and more exciting as I got used to it. At times we had to be released for industrial block attachment to gain practical exposure. The hardest part was having to secure a sponsorship for yourself to get



Brazil

- Acosta Rodrigues Alfaia Dos Santos
- Natália Dantas Borges
- Gabriela Giacomini
- Jossineide Oliveira E Silva
- Leylla Christian Lisboa Silva

Carmosinda Rodrigues Alfaia Dos Santos



Since I was a teenager, I have been interested in mechanical equipment and electrical and civil engineering. At the beginning of my professional life, I worked as a marketer, mason's assistant, salesperson, errand clerk, and administrative assistant.

When I was 22 years old, on 2 April 2007, I started working as an administrative assistant at Automoção Analítica (today named Superlab), a company selling chemical and physical analysis instruments.

One instrument in particular caught my attention: the climatic chamber (made by Vötsch). I became really interested in how that equipment works. When I was looking into this for more information, I was introduced to refrigeration, which to me was only about the refrigerator that I have at home. Through a co-worker who was a maintenance service technician for these chambers, I found a technical course at the National Service for Industrial Training (SENAI) in São Paulo.

When I was 24 years old, I passed the SENAI selection process and I started a technical course in refrigeration and air conditioning; I fell in love with it. Because the course was in the afternoon from 1.30 p.m. to 5 p.m., I had to choose between my job as an administrative assistant and the course. I dedicated myself to the course. I tried to support myself financially; then, with a classmate from the course, I started to perform maintenance on split-type units and refrigerators. This way, I supported myself financially during my studies, and in July 2011, I graduated as a refrigeration and air conditioning technician.

"I always made sure the work is done meticulously. Over time, I became known in the market and today I am more respected."

At the same time, the company Carrier do Brasil launched a selection process for a project called Técnico Trainee. I applied. There were four openings and some 500 applicants, and I was hired by Carrier do Brasil on 15 August 2011, becoming the first woman trainee technician at Carrier do Brasil. The Técnico Trainee project was 18 months long, and it

involved job rotation in after-sales and the division of liquid coolers (BSS). After the 18 months, there would be another test for trainees.

During my period as a trainee, I worked in after-sales for 12 months. I was the first woman after-sales refrigeration technician at Carrier do Brasil. I used to assist in the accreditation of authorized networks and in the process of guaranteeing humidifiers, ice machines, split-type units, self-contained air conditioning units, fan coils, and chillers. In the last six months of the project, I worked in the BSS division: three months doing administrative activities and three months accompanying service technicians in the field. At the end of the trainee project, on 1 February 2013, I became the first female technician in the BSS field division, and I started working with liquid chillers.

I received a vehicle and tools, and then I started my activities as a technician, always travelling to the client's location to do preventive and corrective work and to perform care and start-up maintenance involving chillers, alternatives, scroll technology, screws, centrifugation, and absorption. I worked as a field technician at Carrier do Brasil until 12 May 2017. On 15 May 2017, I became the first female technician in Latin America at Vertiv (formerly Emerson Liebert) working only with precision air conditioners and performing preventive, corrective, care, and start-up work involving self-contained air-conditioning units, fan coils, and chillers, (AFC and EFC screws and scrolls).

Then, Equinix, the largest data centre provider (international business exchanges [IBX] locations), invited me to be part of the BX SP4 technician team in São Paulo. Nowadays, the international business exchange SP4 from Equinix houses the most important point of NAP Internet traffic exchange in Latin

America. I accepted the challenge and on 2 April 2018, I became the first female refrigeration technician at Equinix. I received an amazing gift. I participated in the start-up of the first precision chiller, with free cooling technology, installed in the Americas (model AFC/manufacturer Vertiv). Today at Equinix, I work on the conservation of IBX air conditioning. In the structure we have 50 precision fan coils, seven Carrier chillers (300 TR each), three precision Vertiv chillers (350 TR each), plus split-type units and self-contained air-conditioning units, used for office comfort, refrigerators, and water fountains.

In my career, I have faced numerous challenges. I will try to name a few. During the SENAI test, the other candidates looked at me crossly because I was the only woman. On the first day of school, once again, I was the only woman in my class. During the selection process at Carrier, some competitors looked at me with contempt. At first, as Carrier's technique was very difficult, in addition to the mean jokes I heard daily from some colleagues and clients, there were also inappropriate jokes. I always made sure the work is done meticulously. Over time, I became known in the market and today I am more respected. There are still some jokes, but they are isolated; the situation is nothing at all like it was in the beginning. On my own, I carried out a survey of the refrigeration market in Latin America. I did not find any other woman in the field like me. Maybe I'm the first Latin American technician to work with chiller alternatives, scrolls, bolts, centrifuge, and absorption, and with precision air conditioners (self-contained units, fan coils, and chillers) – am I?

Natália Dantas Borges

“I intend to improve further, learning about chillers and variable refrigerant flow (VRF), in order to be an excellent professional in the refrigeration sector.”

also taken a basic refrigeration course, and in the future, I intend to improve further, learning about chillers and variable refrigerant flow (VRF), in order to be an excellent professional in the refrigeration sector.

I have worked in the refrigeration sector since 2016. I assist in the purchasing sector and in corrective maintenance. I have a mechanical and electronic technician's degree, which helps me a lot in the profession. I have



Gabriela Giacomini



My history with refrigeration and air conditioning (RAC) actually started unintentionally. In 2014, I was hired as an intern at my workplace, but I didn't know the job was related to air conditioning because the company that owns WebArCondicionado is a big data enterprise (WebGlobal Ltda) which uses technology to develop an air conditioning price-comparison system.

When I realized that my job would basically be to write about air conditioning and everything that involves air conditioning, I confess that I was scared because I had never imagined that I would work with this, and my knowledge in the area was null. However, I viewed this as a challenge to be overcome, and gradually I became familiar with the industry. I write blog posts on topics ranging from news about the air conditioning sector to technical information aimed at consumers and professionals in the area, at different levels.

I have to admit that there have been times when some difficulties have grown, and this happens to this day. But with each passing day, I

derive increased satisfaction from my work. I say this for two main reasons. One is that the audience for whom I write and with whom I interact is predominantly male, and because of this, I have already witnessed many sexist situations, where women are disparaged and given little space in our industry. This requires me to have a lot of patience, persistence, and love for what I do. Obstacles like these are the things that motivate me to move forward and to give voice to women in our industry, because I see myself as an influencer.

“My concern is about more than just obtaining information; it is about having an impact on our readers and followers, disseminating knowledge concerning our sector, and, whenever possible, promoting women’s work and showing how capable we are. ”

Another challenge I encounter daily, as a journalist, is the need to reinvent myself as a person who generates content. I have spent more than four years writing about the same subject, so there is a need to always be up to date and sharing information with the public in the best way. I must also say that, although these difficulties exist, I take immense pride in what I have built over the years and will continue to build. The WebArCondicionado portal today has an average of 1 million visits per month and 80 per cent of this traffic comes from the blog. It is lovely work and it took a lot of effort to get here; we celebrated our 10-year anniversary in 2018. In the meantime, I graduated with a degree in journalism – I have a degree in languages as well – and this has made me evolve a lot as a person and as a professional.

My concern is about more than just obtaining information; it is about having an impact on our readers and followers, disseminating knowledge concerning our sector, and, whenever possible, promoting women’s work and showing how capable we are. By the way, we published a post about this initiative on our blog, and we helped many of our readers in sending this form to tell their stories. You can read about it by clicking on this link:

<http://www.webarcondicionado.com.br/onu-convida-mulheres-do-setor-de-hvac-para-contar-sua-historia>

I also wrote a special post for Women’s Day this year, showcasing some of the women in our industry. It’s all available here: <http://www.webarcondicionado.com.br/hvac-empoderado-quem-sao-as-mulheres-do-setor-de-climatizacao> (Unfortunately, the blog is only in Portuguese, but who knows if that might change in the future?)

Finally, I am grateful for the opportunity to participate in an initiative like this, and I am ready to continue strengthening our industry, especially when it comes to women’s participation in our sector.

Jossineide Oliveira E Silva



Twenty-five years in a nutshell

Jossineide: The challenge of being a refrigeration technician in the Amazon, in the heart of Brazil

When we are facing a challenge, we have two alternatives: stop, and spend our whole life at the same point; or overcome the challenge, move on, and maybe become an inspiration for others. This is what happened when I was 14 years old and it was time to take the traditional sewing course, as my parents recommended. As there were no vacancies left anymore, the challenge had begun. I had to decide between coming back home and choosing the technical course in refrigeration and air conditioning (RAC) at the National Service for Industrial Training (SENAI) in Pôrto Velho, in the state of Rondônia, Brazil. I decided to go ahead with the technical course.

Everything about this course was new to me. The classroom was full, and I was the only woman. There were sexist jokes, which everybody

laughed at, without realizing my presence. There was a lack of trust from my teachers and colleagues. I had to work very hard to complete this course, and so I decided to study harder. I searched for unpaid volunteer jobs so I could practice what I had learned. This way, I claimed my space and I stood out at the RAC mechanic course.

As a result of my efforts, my teacher at the time chose me to participate in the Professional Training Tournament in 1996, in Brasília. The tournament was an exciting high-level national competition between refrigeration and air conditioning technicians from all the technical schools in the country. I competed against male students from several Brazilian metropolises, and I won third place!

I was very grateful for this result because my professional education had taken place in the middle of the Amazon, where technology is always behind the technology in southern Brazilian cities. This achievement opened doors for me. Then, I was offered the opportunity to work as an instructor for a RAC mechanic course at the SENAI-Pôrto Velho school. Despite my qualifications being the same as those of a male instructor, I was hired only as an assistant. Even though I had to replace the teachers often, I was paid less, as happens to a lot of women in other professions in Brazil and in the rest of the world.

When I was 18 years old and discontented with being constantly undervalued, I followed the advice of a former SENAI director and went to Minas Gerais to take a more complete RAC technologist course. The course was three years long and included installation and project knowledge. This course allowed me to be recognized and registered by the Engineering Council so that I could work in this field. Around this time, I got married and started a family. I have three kids, who are by my side to this day.

After this, I came back to my state, Rondônia, to teach at SENAI, but now as an official instructor. I taught the RAC mechanic course, but I was earning about one third of a male instructor's salary. I took the job wondering whether I could change that situation. I complained about the injustice and because of this, I ended up being terminated.

As soon as I left SENAI, I was invited to work in the technical assistance area of a RAC company in my city, the Polo Frio Comercio e Serviço. Even though the company owner was aware of my skills, I had to go through the same lack of trust I had experienced before. The company owner sent me to carry out difficult work assignments for clients, to test me. One month later, he recognized that I could not only do a good job, but that I also had the ability to train teams. He promoted me and made me responsible for standardizing and managing all the services that the company was providing.

"Today, when I come into a classroom to teach RAC systems courses, I don't see only people, men and women, wanting to learn; I see professionals capable of changing the world."

After that, I decided to work with industrial refrigeration systems. I became a partner at Vento Sul Soluções Térmicas Ltda. At this company, we combined our dream to work with both variant refrigerant flow (VRF) and industrial chiller climatization systems. Today, 50% of the VRF systems installed in the state of Rondônia are made by our company, Vento Sul.

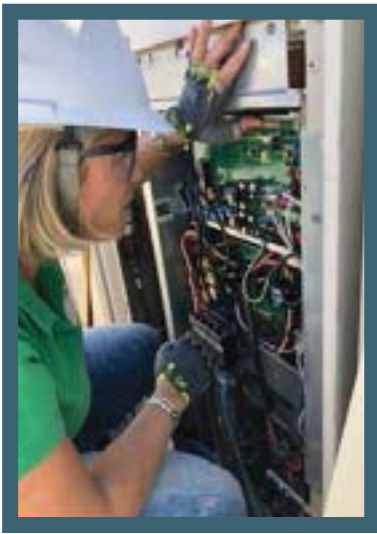
In 2016, I was still working at my company. I also came back to work at SENAI, where I restructured the RAC mechanic courses at the institution in the state of Rondônia. Also, I established SENAI's participation in the HCFC phase-out management plan (HPMP)/German Agency for International Cooperation (GIZ) project, so the school could administer the best refrigeration practice training courses.

With my story, I hope to encourage any person who has an interest in this profession to overcome limitations, whether they are geographical, intellectual, physical, racial, related to social status, or of any other nature. Many times, I have wanted to quit my profession and only take care of my family. When I was growing up, this is what my family culture had taught me was my "obligation". When I look back at the beginning of everything, 25 years ago, I see how perseverance was important. How important it was to be dedicated and to experience the obstacles of my professional life, even the obstacles of bullying and sexual harassment.

I am also sure that I will overcome all future obstacles. This is how it happens, when we actually know who we were, who we are, and who we want to be in the future. I affirm this: challenges will not stop arising; a lot of them still crop up today. In the training classrooms, for example, the technicians always ask strange questions and make jokes until I earn their trust. This happens when they realize that I am an expert in RAC systems. Unfortunately, we still live in a prejudiced society in which people judge other people by the way they look.

Today, when I come into a classroom to teach RAC systems courses, I don't see only people, men and women, wanting to learn; I see professionals capable of changing the world, adding value to their lives by overcoming difficulties and through determination and social and environmental awareness. This is my legacy. This is my work.

Leylla Christian Lisboa Silva



My professional career started in 2006, when I moved from my hometown of 4,000 inhabitants to go to college and look for a job in Belo Horizonte. Arriving there, I got a job in a construction company, where I worked for a number of years to raise money to pay for my administration course. The electrical and refrigeration industry has always interested me, even though it is a predominantly male market, so I joined my brother in 2015 and started a small air conditioning and electrical repair company based at our house. During this time, I tried to do courses on refrigeration and electrical construction. Even though the company was small, I always tried to serve my clients in the best possible way and to upgrade my skills to better understand the market. We had few clients and went through difficult times; I faced a lot of prejudice, but I could always count on the support of my brother and partner.

At first, venturing into the refrigeration market seemed unreal. When I finished the qualification courses, I felt more confident talking and

asking about the field, I learned all about what I was selling, and I started to perform services. With that, we gained credibility in the market and recognition among professionals in the field. Slowly, the company was growing and we moved to a head office. We specialized in the installation and maintenance of air conditioning. However, I felt that I needed to take another step. I started a course in mechanical engineering and, once again, I faced an environment where women do not have a place. But this time, I already knew how we can and should occupy spaces that are still predominantly masculine.

Today, just over three years after our founding and with a portfolio of 900 loyal customers, we are a recognized company in the refrigeration market and we have a team of nine people. Good customer service has always been my priority, and I always want to hear the opinion of my clients: "End-to-end service, technically qualified, far exceeded initial expectations for the maintenance and installation of air conditioning; I recommend!" says Julio Cesar, client, professor, and holder of a master's degree in administration. I try to tell my story to everyone who lives with me as a way of encouraging people never to give up their dreams and, especially, never to give up their studies. Access to higher education was essential to my professional career; it opened doors for me and gave me knowledge which not only qualifies me professionally, but also makes me a better person.

"What makes me even happier is breaking down the barriers of a male market and earning the respect and confidence of the people who work with me. "

What makes me even happier is breaking down the barriers of a male market and earning the respect and confidence of the people who work with me. I thank all the people who participated in my journey.



Bulgaria

- Violeta Ivanova

Violeta Ivanova

I was born, and have always lived and worked, in Sofia, the capital city of a beautiful country called Bulgaria.

I finished high school with honours and could have continued my education in any field. My interests, however, were mathematics and physics. I chose the Technical University in Sofia. At that point I was still unsure what career to pursue. A close relative, Prof. Tencho Todorov, a professor of refrigeration engineering at the same university, helped me make up my mind. From him I learned how important this profession is, as people will always need quality, well preserved food (refrigeration) and comfortable living and working conditions (heating, ventilation and air conditioning).

Later on I found out that this branch of engineering had many more practical applications. So I decided to apply for the Machine Engineering/Industrial Heating programme. In those days, as now, men and women in Bulgaria enjoyed equal opportunities. But when I began my studies, it turned out it was a man's world. The vast majority of the students were male, and so were the professors. I had to prove myself. And I must have succeeded because at graduation I was the top student in my class.

That granted me the privilege to choose where to start. I chose the Institute of Refrigeration and Air Conditioning in Sofia. That is how I married refrigeration engineering before I married my husband. From that moment on I have never betrayed that marriage.

The Institute was a very prestigious institution, responsible for the research, development and deployment in production of all new RAC solutions in Bulgaria. It had a brilliant team of highly educated and experienced specialists. Wonderful conditions were created for R&D and design. I started as a researcher of heat exchangers – air coolers and condensers, taking particular interest in the processes of heat and mass transfer. I was also involved in setting up an experimental research laboratory. At that time only two other labs of this kind existed in Europe. The focus of my research was frost formation on air coolers. And throughout, I had the invaluable support of Prof. Theophil Gachilov, Director of the Institute and my research supervisor.

My scientific interest, as well as a competition-based scholarship, took me to the University of Refrigeration Engineering in Odessa (Ukraine), where three years later I earned my Ph.D. Eventually, I returned to the Institute to continue my work, which also involved the use of research findings in the design of new products. These findings I have reported at many international congresses and seminars organized by the International Institute of Refrigeration (Paris) and in Bulgaria; my articles have been published in various scientific journals and enjoy a high citation index. I was also invited to join the faculty of the Technical University in Sofia as a part-time lecturer in refrigeration engineering. This I did for some time, in addition to my work at the Institute.

A successful career is essential to a woman. It brings self-confidence and respect. And yet, it is not enough to make one's happiness complete. Becoming a mother and raising your children is a woman's most important vocation. I dare say I am a happy person. I gave birth to, and raised with my husband, three wonderful children. Our daughter is an architect, and our twin boys graduated from the Technical University and followed in my footsteps.



“For the first time, the industry had to face restrictions and targets needed to achieve the overarching goal: protection and restoration of the ozone layer. I am very proud of being part of Bulgaria’s substantial contribution to this process.”

In Bulgaria, environmental protection has always been a priority, and the country was one of the first to join the Montreal Protocol on Substances that Deplete the Ozone Layer. In 1989 I was appointed head of a research team at the Institute assigned with the task of drafting specific measures implementing the Protocol's requirements in RAC. For the first time, the industry had to face restrictions and targets needed to achieve the overarching goal: protection and restoration of the ozone layer. I am very proud of being part of Bulgaria's substantial contribution to this process.

The year 1989 brought serious social and economic changes in my country. New opportunities emerged, and the structure of the entire RAC industry was changed. These affected my career as well. I started a private business, which I headed for 23 years. The company offered components for industrial refrigeration, design and implementation of refrigeration projects in various sectors of the food industry (meat and milk processing, storage and processing of fruit and vegetables, fish and fish products). The company grew as a leader in the Bulgarian RAC market with support from our international suppliers.

However, developments in the manufacturing industry result in higher risk and damage to the environment. It is my utmost conviction that care for the environment must always be our top priority. Our company's motto is "Refrigeration for environmental protection". We offer our clients optimized energy products and solutions.

Business relations with our supplier Chemours (former DuPont) provided the opportunity to get acquainted with all the new products designed to replace refrigerants with a high ozone-depleting and global warming potential. I was, and still am, a pioneer in their use in Bulgaria. The changes we need to make are a source of substantial stress for our economy. Presently, I continue to make my modest contribution to solving refrigerant-related issues. I operate as an auditor with the Bulgarian Branch Chamber – Machine Building in the certification of compliance with F-gas regulations. My interest in refrigeration engineering has never declined. I keep track of new developments and innovations. And I closely follow the operations of the company, of which my sons are now in charge, so that they can always rely on my back-up.

I would like to convey to all ladies who might be reading this the following message: If you have come to like the story of my life and career, do not be afraid to follow. If you want, in a man's world, to enjoy equal opportunities and respect, you have to work for it. And if you manage to build yourself up as a knowledgeable and capable human being, I can guarantee you will take your rightful place. Throughout my entire life and career I have not once been looked down upon for being a woman.

Before you start fighting for your own place under the sun, you must fall in love with your profession. And I really hope it will have something to do with RAC. This is a most interesting field offering plenty of opportunities. And most importantly, it is essential for the lives of all human beings – above all, for the lives of our children.



Canada

- Elvira Kadyrova

Elvira Kadyrova



As Confucius said: "Choose a job you love, and you will never have to work a day in your life." You know how it happens. You are going through your daily routine, doing something that you don't like, that makes you feel absolutely useless, and one day you wake up with only one thought: "Enough!" This happened to me nine years ago, and it was like a fresh breeze on the hottest summer day. This is a little story about friendship, betrayal, ups and downs, and love.

Refrigeration engineering is in my blood; I get this from my father. He always told me: "If you do something, do your best or do not do it at all." Even after many years, this is still my main strategy. I was the only girl who took the refrigeration engineering course at university. I was the only woman who was working as an engineer in my company. But I have always remembered that I have to be the best.

***"My father ... always told me:
"If you do something, do your
best or do not do it at all."***

I started my career as an engineering assistant in a small family company. It was tricky; nobody wanted to teach me, to explain how refrigeration equipment works. Sometimes people think that if you are a woman, your only purpose is to raise children and do housework. Some people would always tell me: "Refrigeration engineering is not for you; you won't understand it." When my colleagues talked about work, it used to be like white noise for me. But it was a challenge; it was a dream. I used to read refrigeration engineering books again and again, trying to find answers. And soon I started to understand what my colleagues were talking about. It was an awesome time. We worked on lots of different, tricky projects: banana-ripening rooms, absolutely unique energy-efficient grocery stores, a refrigeration test chamber. My work inspired me to be better, to study more and more, and to design something new for our clients.

But nothing lasts forever.

My business partner decided he wanted all money we had made. It was my first time facing an illegal takeover. I lost everything: my work, my money, my team, my inspiration. I found that not all my friends were really my friends. Now it's funny to think about it, but at the time, it was awful. I had to start entirely from scratch.

I believe that if you fall down and lose everything, it means that you are ready for new opportunities. I worked as a freelance refrigeration designer with clients all around the world – Russia, the USA, France, and so on. I accepted any project that I could do. At that time, there was no such thing as bad or uninteresting work. I needed money; I had to move forward.

I spent several years attempting to start everything from square one. Interesting projects, new acquaintances, new friends, new work, and new achievements. As a result, I was invited to live and work in Canada. Now I design ice rinks all around North America and I am happy.

Nine years in refrigeration engineering has given me more than I expected at the beginning. I have new knowledge, close friends, and fantastic work. And finally, I met a man whom I really fell in love with and this is most incredible for me. I feel I am the happiest girl – I do what I really love and I love this wonderful man.

I am grateful to my father for everything he did for me, and to my boyfriend, who supports me, who inspires me, who makes me happy. And I am convinced that if you have a dream, you should do everything to make it come true. Everything is possible and as a result, you'll get more than you can imagine. That is the truth.

China

- Feng Jiang
- Jiang Shaoming
- Jing Yang
- Chun-hui Liu
- Lin SHI
- Wang Da
- Wu Zhijuan
- Xu Guofen
- Zhang Xiuping
- Zhao Yang
- Zhou Yanrui

Feng Jiang



After graduating from university in 1982, I was assigned to work in the Household Electrical Appliances Bureau, Ministry of Light Industry of China. My main responsibility was industry management, such as formulating industry development plans, annual production plans and industry policies and standards, as well as promoting technology and so on. In 1992, I joined the China Household Electrical Appliances Association (CHEAA) as Deputy Secretary-General. From 1999 to 2009, I was the Vice President and Secretary-General of CHEAA, responsible for managing the operations of the association. Since January 2010, I have been the President of the association and take full responsibility for its operations.

As CHEAA's team leader for coordinating industrial strategy, and especially the technical options for the phaseout of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs) in the domestic RAC sector, in light of the commitment made by the Chinese Government at the beginning of the 1990s, I have been increasingly engaged in the RAC sector.

In the early 1990s, the RAC industry globally worked hard for the phaseout of CFCs, with a view to protecting the ozone layer. My office coordinated the CFC phaseout work in the manufacturing sector of the domestic refrigerator, which had just been introduced to Chinese families. However, two different technological alternatives to CFCs for domestic refrigerators were dominating the market. One was man-made chemicals such as HFC-134a, supported by the world's chemical companies; another was natural gas such as R 600a. Even though natural refrigerants are widely recognized as more environmentally friendly and could be a long-term solution without the worry of a second conversion, the industry was still divided. In consulting with national and international experts and holding extensive discussions with industry stakeholders, I was convinced that natural refrigerants were the right option. Therefore, we organized the Chinese industry to visit international refrigeration companies to gain experience in using hydrocarbon technology in the domestic refrigeration sector. I also personally encouraged and lobbied Chinese companies to develop research and development and line conversions on using hydrocarbons in the domestic refrigerator sector. Now, HC-600a and cyclopentane are widely used as refrigerants and foaming agents respectively in the domestic refrigeration sector in China and in the world. The annual production of domestic refrigerators in China has increased from several million units to more than 70 million units.

When attention shifted to the phaseout of HCFC-22 in the residential AC sector at the beginning of the 2000s, I noted that the alternative was facing similar challenges as in the 1990s with the CFC phaseout in the refrigerator sector. In about 2007, I initiated and facilitated a project to conduct a feasibility study to replace HCFC-22 with HC-290, in close collaboration with China's government departments, manufacturers and CHEAA. The study revealed that HC-290 was an excellent refrigerant for residential AC, except for the challenge of its high flammability, which could be overcome through technology and engineering. To promote further R&D and global cooperation on this technology, in the following years, I initiated a series of international workshops and domestic seminars on alternatives to HCFC-22 in the residential AC sector so that domestic and international experts could exchange views and come up with options in areas such as techniques, standards, policy and servicing related to the adoption of HC-290. I, as the leader of the technical committee for the phase out of HCFCs in the AC sector, led and promoted

“The women in the domestic RAC industry are in positions spanning the whole product chain such as management, research, testing, assembly and servicing. I feel that women are playing an increasingly important role in the development of the domestic RAC industry in China.”

the development and adoption of international standards and other activities to promote the use of HC-290, not only benefiting the protection of the ozone layer, but also contributing to mitigating climate change. With the strong leadership of CHEAA, China's industry finally adopted R 290 as the alternative and converted 19 residential AC production lines and four compressor lines.

In addition to the work on the protection of the ozone layer, I led a series of initiatives to improve the energy efficiency of domestic refrigerators and residential AC. From 1999 to 2007, I, as the domestic specialist of the Global Environment Facility (GEF) project on promoting energy efficient refrigerators in China, played a leading role in designing and implementing the project. This project successfully removed the market barriers for commercializing highly energy-efficient refrigerators in China. Through this project, the daily power consumption of average refrigerators improved by 28.7%, from 0.794 kWh in 1999 to 0.566 kWh in 2005. In the following years, we cooperated with China's Government to design and implement the GEF project on promoting energy efficient residential AC in China. I, as the leader of the CHEAA team, undertook a series of activities to promote the commercialization of energy-efficient residential AC in China.

Additionally, to promote the sustainable development of the industry, I participated in the formulation of several national policies for the home appliance industry in recent years, including Home Appliances going to the Countryside, Household Appliance Trade-in Subsidies, subsidizing and popularizing efficient home appliances, and China's approval of rules governing the waste of electrical and electronic equipment (WEEE). As a representative of the Chinese home appliance industry, I have offered the Government ideas, comments and suggestions to make such policies more conducive to industrial development.

I have worked with China's domestic RAC industry for more than 30 years. I am proud of myself for being part of industrial development and the leading role China played in the phaseout of ozone depleting substances (ODS) and the improvement of energy efficiency. As a working woman, I found that more and more women started to work in the home appliance industry in China. For example, there were about eight female engineers from residential AC compressor manufacturers who participated in the technical training for energy efficiency organized by CHEAA in 2013. They accounted for 25% of the total number of trainees. The women in the domestic RAC industry are in positions spanning the whole product chain such as management, research, testing, assembly and servicing. I feel that women are playing an increasingly important role in the development of the domestic RAC industry in China.



Jiang Shaoming

My interest in the RAC sector started during my graduate studies at Tianjin University, where my tutor was developing carbon dioxide (CO₂) expander technology. Once I learned that this gas could be used as a refrigerant, I became determined to develop CO₂ technology to bring about a positive social impact.

At the time, working with environmentally friendly substances was becoming a trend within the European Union, the United States and Japan, so I was convinced that the research and development (R&D) on CO₂ as a natural refrigerant would be promising. MOON Environment Technology Co., Ltd, where I started working in 1987, was already a well-known leader in the development of screw compressors, heat exchangers and high efficiency refrigeration systems, so I became convinced that there would be an opportunity for me to explore my new passion.

I work for MOON Tech to this day and am devoted to the development of applications for refrigeration equipment and technology, and R&D on environmentally friendly refrigerant systems. I am the technological founder of the MOON NH₃/CO₂ cascade and secondary refrigerant system.



“ I believe that, in our industry, women have greater awareness than men with regards to environmental conservation, safety concerns, and energy-saving. ”

In the early stages of the project, we conducted extensive research and made calculations on refrigerants, and evaluated each refrigerant objectively. Based on a comprehensive consideration of safety, environmental protection and energy efficiency, we decided to use NH₃ and CO₂ refrigerants as substitutions to R 22. NH₃ is used in the high temperature stage of refrigeration due to its good refrigeration properties, while CO₂ is used in the system's low temperature stage because of its good flow and heat transfer properties in low temperatures.

In 2006, I led the team in starting the performance test on the NH₃/CO₂ cascade refrigeration system in the MOON laboratory. Meanwhile, we successfully developed the first high-pressure CO₂ screw refrigeration compressor in China. We tested the materials and heat transfer technology for various types of heat exchangers such as plate and shell exchangers, shell and tube exchangers, tube exchangers and air cooled exchangers. We then studied the applied technology in CO₂ refrigeration systems.

The hardest part of the project was neither R&D nor system optimization, but market promotion. As the technology was new, clients were hesitant to adopt it early on, especially as the pressure on the compressor, valve and pipe was relatively higher for the new system than the old, which meant that investment costs were about 10% higher. However, the new system was not only energy efficient, but, in time, would reduce operation and maintenance costs, as CO₂, as a natural refrigerant, was cheaper. To promote the project, I invited MOON Tech's first target client, Yantai Fengrun Food, to witness the system's safety, efficiency and reliability during the testing phase, which helped to win the client's confidence in the system. Additionally, as a senior manager of MOON Tech, I promised Yantai Fengrun Food that we would provide excellent after-sales and maintenance services. This was crucial to convince the client to adopt the new technology. Thus, after more than two years of work and continuous improvement, in 2008, China's first NH₃/CO₂ cascade refrigeration system was successfully operated in the factory of Yantai Fengrun Food Co., Ltd. The safe, environmentally friendly, efficient operation results broadened the application scope of the NH₃/CO₂ refrigeration system so that it flourished everywhere. The NH₃/CO₂ refrigeration system, initially used for quick-freezing, aquatic food processing, then found applications in beer, dairy, logistics, ice making, ice and snow projects and, currently, in artificial environments. The NH₃/CO₂ refrigeration system has provided guidance in finding a replacement for R-22 in China's commercial refrigeration sector. It has

also encouraged R&D for the NH₃/CO₂ refrigeration system at home and abroad.

According to statistics, more than 200 units of the NH₃/CO₂ refrigeration system have been sold in the Chinese market and all of them work well.

My dedication and determination resulted in the development and implementation of the demonstration project that replaced HCFC-22 technology with a NH₃-CO₂ cascade refrigeration system, in which I played a leadership role. In addition to researching solutions, I was responsible for reviewing every design of technology and choosing which would be applied in the project. The project was listed globally and received the "Exemplary Project Award" from the Secretariat of the "Montreal Protocol" at the 2017 Ozone Awards. It was a result of continuous hard work and learning by myself and my team. Moreover, R&D for the NH₃/CO₂ cascade refrigeration system has spearheaded the development of innovative technology in the industry and created a boom in R&D for the NH₃/CO₂ cascade refrigeration system. Since 2014, the NH₃/CO₂ cascade refrigeration system has been a popular product in every Chinese refrigeration exhibition and, in China's second phase of eliminating R-22, it has also become the main alternative technical route in the refrigeration field.

Until now, I have led the Yantai MOON team to complete the application, construction and industrialization work for the "Demonstration Project Using the NH₃/CO₂ Cascade Refrigeration System to Replace R-22", the "Industrialization Project Using the NH₃/CO₂ Secondary Refrigerant System to Replace R-22" and the "Heating Demonstration Project with an Environmentally Friendly and Low Carbon Heat Pump" and I am currently working on the replacement of R-22 with R-290 in the industrial refrigeration sector. With the implementation of the project, the application of China's two national standards, namely, "Safety Regulations for CO₂ Refrigeration Systems" (approved draft) and GB/T29030-2012 "Volumetric CO₂ Refrigeration Compressors (Unit)", has also been completed.

Regarding R&D, I believe that all phases must combine theory and practice and that technology should be something practical that requires people to experience, calculate and compare. Such a mindset is particularly important at the beginning of your design tasks. Taking CO₂ as an example, right at the start of your design, you should have a deep understanding of the characteristics and uniqueness of the gas and know where to locate compatible materials. No one should create designs based only on imagination – they have to be underpinned by knowledge and practice. My personal motto is "practice is the only standard to verify theory".

As for being a woman in the RAC sector, I think of myself as contributing to protecting the Earth just like the goddess Nüwa, from ancient Chinese mythology, who worked to mend the patches in the heavens to fix the destruction caused by evil forces. I believe that, in our industry, women have greater awareness than men with regards to environmental conservation, safety concerns, and energy-saving. Perhaps we are more strict about these aspects, as well.

Jing Yang

Educational background

1999-2003

School of Energy and Power Engineering, Huazhong University of Science and Technology

Major: Thermal Energy and Power Engineering - Degree: Bachelor's degree

2003-2006

School of Energy and Power Engineering, Huazhong University of Science and Technology

Major: Fluid Mechanics and Engineering - Degree: Master's degree

March 2013-October 2013 Guangdong Polytechnic Normal University, Guangdong Province

Major: Refrigeration Equipment Repair - Senior Technician



Work experience

2006 - present

I work as a vocational teacher in the field of refrigeration at Guangzhou Light Industry Senior Technical School. I am mainly responsible for daily teaching and equipment maintenance. Otherwise, I am the key teacher of the refrigeration research team, as I am responsible for teaching refrigeration. I am a member of the National Training Center for repairs in the Chinese refrigeration industry.

“ I am a trainer and have provided theoretical knowledge and practical training to over 260 trainees. ”

Other relevant experiences/activities

1. I have an operator licence for refrigeration equipment and can undertake all kinds of operation and maintenance work in that field;
2. I played a role in the declaration process of the National Training Center for repairs in the Chinese refrigeration industry. Now I am a trainer and have provided theoretical knowledge and practical training to over 260 trainees.
3. I have participated in Guangdong Province's teacher training course specializing in refrigeration. As a trainer, I provide theoretical knowledge and practical training to students.

Chun-hui Liu



Chun-hui Liu began to work for Shanghai Highly Electrical Appliances Co., Ltd (formerly known as Shanghai Hitachi Electrical Appliances Co., Ltd) after graduating from Shanghai Jiao Tong University, where she received her doctoral degree in Mechanical Engineering in August 1999. She has been working as the manager of the R&D Department, as well as the Compressor Development Department, and is currently acting as the head of the R&D Department. She was named Senior Engineer in April 2002 and Professorate Senior Engineer in 2008.

Chun-hui Liu has been responsible for a number of difficult compressor development projects. She is in charge of exploring and organizing basic and key technology in the company, as well as promoting numerical simulation technology, establishing the computer-aided, engineering analysing capabilities for fluid, noise, non linear structures, fatigue, materials and oil, and setting up the evaluation of material compatibility tests. In addition, she has cooperated with a large number of domestic and international universities and research institutions to support the company's technical research capabilities and, at the same

time, promote the development of the entire industry.

Chun-hui Liu has, so far, been granted 52 patents of 126 applications. Among nine patents for inventions, one Japanese patent and one U.S. patent have been approved. She has published 35 papers in journals and academic conferences, both in China and abroad, and has won high recognition in the industry.

With the signing of the Montreal Protocol, RAC technology is evolving to develop refrigerant products that protect the environment. Chun-hui Liu's research focus has thus changed to embrace this new trend and develop new compressors with environmentally friendly refrigerants such as R-407C, R-161, R-290, R-32 and CO₂. Her priority is mainly to establish a platform for the development of environmentally friendly compressors, develop key technology and promote the wide application of compressors with such refrigerants. Her main tasks are as follows:

“ Chun-hui Liu's achievements in developing compressor products... have been extraordinary, bringing the industry to improve energy efficiency and reduce emissions from a new perspective ”

1. Establish an evaluation platform for refrigerating machine oil for environmentally friendly compressors.

Refrigerant oil has been known as the blood of the compressor and has an effect on the performance and reliability of compressors. Each refrigerant needs the corresponding refrigerant oil and evaluating the refrigerant oil is one of the most important steps in the development of the new compressor. A comprehensive evaluation platform for compressors intended to protect the environment has thus been set up in the company. Through this platform, the lubricating oil of the refrigerant oil, the solubility of the new refrigerant and the compatibility of the material can be evaluated so that the suitable refrigerant oil can be developed quickly and the development process of the compressor can be accelerated.

2. Establish environmentally friendly performance optimization tools for compressors.

In order to further improve the performance of environmentally friendly compressors, compressor performance optimization tools have been established according to the characteristics of the ecological refrigerant. Through this optimization tool, the thermodynamic process and dynamic process inside the compressor can be thoroughly analysed. According to the results of the analysis, the structural parameters of the compressor can be optimized to improve the performance of the compressor to give it advantages in the protection of the environment and energy saving.

3. Solving the application problems of environmentally friendly compressors.

Each environmentally friendly refrigerant has its own, unique physical properties. For compressors, it is necessary to solve the application problems according to the characteristics of the refrigerant.

For R-290, because of its combustibility, it is necessary to reduce the amount in the compressor, thus reducing the amount of R-290 filling the system and improving its safety. The study of various methods of reducing refrigerant consumption in compressors has made it possible to develop an R-290 compressor with a low refrigerant volume.

For CO₂ refrigerants, the system is transcritical. The characteristics of the cycle are very different from those of the traditional subcritical cycle. Based on the CO₂ heat pump water heater, the characteristics of the transcritical cycle have thus been studied in depth, providing technical support for the promotion of CO₂ compressors.

For R-32, the exhaust temperature of the compressor is high, which will affect its reliability. The suction belt fluid of the R-32 compressor must thus be studied. To ensure the reliability of the compressor, the degree of suction dryness is clearly defined and used to guide manufacturers so they can balance the system.

On the basis of the above platform, Chun-hui Liu is responsible for developing R-407C, R-161, R-290, R-32 and CO₂ compressors and placing them at the forefront of the industry. Environmentally friendly compressors have achieved mass sales and also received a series of awards from the relevant organizations.

Chun-hui Liu's achievements in developing compressor products, including variable capacity compressors and independent temperature and humidity control compressors, have been extraordinary, bringing the industry to improve energy efficiency and reduce emissions from a new perspective.

Many female researchers have been involved and trained in her group, including three technicians specializing in compressor refrigeration technology and two in simulation technology under her guidance. They have made major contributions to the company. Thanks to her achievements in the field of refrigeration, the company has always held a leading position in the industry in terms of environmentally friendly and highly efficient compressors.

Lin SHI



I received my Bachelor's, Master's and PhD degrees from Xi'an Jiaotong University, which is the best university for refrigeration research in China. At the time, I was focusing on the other side of the refrigeration cycle: the power cycles for the generation of electricity. I then pursued my post-doctoral research at Tsinghua University, the top university in China, still working in the field of power cycles. In 1994, I started my academic career at Tsinghua by assisting Prof. Zhu Mingshan in a first project to introduce R-134a to China's refrigeration industry. That set me on the road to the study of refrigerants, which I have been walking for more than 20 years.

The field of refrigerants was an entirely new research field for me at the time, with many new words and concepts: CFCs, HFCs, HCFCs, ozone layer protection, greenhouse effect, Montreal Protocol, air conditioner, chiller and so on. Everything begins from nothing, full of challenges. Thanks to the

“ I work in a field in which men are in the majority and in which I have received respect and a sense of achievement, instead of isolation. ”

formal education I received, I learned quickly and taught others as I learned. At that time, less people in China knew and cared about the importance and urgency of refrigerant substitutes. I was involved in helping China's Ministry

of Environmental Protection to introduce the international conventions and China's programme on the protection of the ozone layer and suppression of greenhouse gases (GHGs) to the country's refrigerant industry.

At the time, the refrigerants industry was emerging in China and the newly built production lines for refrigerators and air conditioners using R-12 faced elimination. If the substitute technology from western countries was indiscriminately imitated, there would be huge economic losses. Our task was thus to help Chinese companies to meet environmental requirements while minimizing changes to production lines. Consequently, I began to study the feasibility of direct filling technology, which meant finding the alternative refrigerant mixture with the closest performance to that of the original refrigerant. The study needed to be supported by a large number of experiments and answer many questions, including whether the thermophysical properties of the two refrigerants were similar, whether the original refrigerant oil could be used, whether the materials used in the original systems needed to be changed, how the system performed and how flammable the mixture was. I tested the flammability of different refrigerants over and over again, dozens of times a day, for half a year, suffering from the bad smell of the hydrofluoric acid resulting from the combustion of the refrigerants. I visited various air-conditioner, refrigerator and compressor companies to test the performance of the refrigerant mixtures we developed. I needed to prepare a great deal of materials to apply for the US Environmental Protection Agency's (EPA) Significant New Alternatives Policy (SNAP) Programme (THR01, THR02, THR03 and THR04) and ASHRAE serial numbers (R-415A, R-415B and R-418A). We also needed to teach Chinese refrigerant manufacturers how to produce these refrigerants, assist them with developing product manuals and offer guidance for users in how to use the refrigerants. It is really tough to get people to accept a new refrigerant. What drove me onwards was confidence, together with my woman's tenacity.

My efforts were rewarded. I received a national award for my contributions to the development of refrigerants. Through books and articles I published on refrigerants to inform more people about them, I gradually became a specialist in the eyes of others. In the second stage of the international action on refrigerant replacement, I was selected as a member of the HCFC replacement technology expert committee for the national Ministry of Environmental Protection. I took part in developing the national programme on HCFC replacement in China's refrigeration industry and proposed R-32 as an alternative to R-22 in 2009, which garnered much attention and was included in the national programme. I have participated in the review of China's implementation project for the Multilateral Fund. I have attended the Ozone2Climate industry roundtable co-hosted by the United Nations Environment Programme (UNEP), the Foreign Economic Cooperation Office (FECO) and the Chinese Refrigeration and Air Conditioning Industry Association (CRAA).

I work in a field in which men are in the majority and in which I have received respect and a sense of achievement, instead of isolation. As a matter of fact, unlike the large scale of power plants, refrigerators and air conditioners are on a relatively small scale and they are close to our life, making the sector more suitable for women. I thus hope that more and more women will get involved and approach the beauty of the refrigerant world, becoming the new force in the field of refrigeration.

Wang Da



I come from the city of Tianjin, China. I am a secondary school vocational teacher. I graduated from Tianjin Normal University (TNU) in 2003. Since then, I have worked as a teacher. My job is teaching students the operation and maintenance of RAC equipment. They are enthusiastic and energetic, but lack professional knowledge and skills. These young people learn to be qualified workers. In 2014, I joined the project team for the smooth operation of refrigeration work in our school. In past years, many people, including students and workers, have obtained their certificates. Doing so will help them release less harmful refrigerants into the atmosphere in the course of their work.

Life resides in the world, hurried for decades. Happiness is most important. The world is always fair and rewarding, it is better to do than to say, to be a happy teacher. How to explain the word "happiness"? One of the headmasters once said: students may not remember the name of the headmaster and what he looks like, but they will definitely remember the head teacher. A teacher who

demonstrates the art of living in a classroom is a teacher who is remembered. It is happiness that is remembered, or resented. It depends on how we become a teacher.

Be a happy teacher and love this educational cause. I am able to hold peace in my mind and have a dedicated spirit. I have great love and tolerance for my students and I have a strong sense of responsibility for society. Because of love, we are deeply moved; because of love, we seek relentless pursuit; because of love, we are extremely happy.

“ I have great love and tolerance for my students and I have a strong sense of responsibility for society.”

Over the years, I have taught many professional courses, including theoretical and training courses. I have taught more than 120 students each year since 2003. I also train students to participate in the Tianjin Skills Competition and the national Skills Competition. Those students were awarded the first, second or third prize. I tell all my students “Air pollution is now the world’s largest single environmental health risk, responsible for about seven million deaths annually, which are preventable.” I tell them that to protect the atmosphere at work is to protect themselves.

To be happy teachers, we should pay attention to our own growth. Education is not only about students getting higher marks, but also seeing if our students have good hearts and stable personalities. Students’ abilities are not suitable for the needs of the times. We are responsible for students’ overall and lifelong development.

Consequently, I improve my level through various ways. In 2013, I obtained my Master’s degree from Tianjin University of Technology and Education (TUTE). In 2014, I participated in the National Vocational Backbone Teachers National Training.

I was awarded two professional senior technician qualification certificates (for AC installation and maintenance and electrics and electrical technology) by the National Occupational Qualification Certificate Refrigerant Senior Technician.

We often say to students happy learning and happy growth. If our teachers can enjoy teaching, then our educational career is a happy life and our students can enjoy their work. Under the blue sky and white clouds, we should enjoy every day of work and live happily ever after.

Wu Zhijuan

I started university in 1982 and studied refrigeration. Growing up in a time of material and spiritual scarcity, I did not have much ambition, but thought mostly of feeding myself. I had no hesitation choosing my major at the time, merely because my father told me that I could work at a meat processing factory and get more meat after graduating. That was years ago, of course. In the last thirty years, since my graduation from university, my country has achieved significant economic growth. Meanwhile, refrigeration technology also developed substantially from merely food preservation to all kinds of applications in production and life. Personally, I have worked in the following areas: the operation and maintenance of refrigeration systems, the design and installation of refrigeration equipment, vocational teaching and so on. In the above jobs, I worked on energy consumption in the operation of refrigeration systems, selected appropriate components for refrigeration equipment and designed matching pipe systems, as well as trained students so that they could work professionally in the RAC sector.



“Come on, girls, join the air conditioning sector! This is a sector with millions of career opportunities, which can contribute to combatting climate change and protecting our living environment.”

In 2010, I joined the Chongqing Association of Refrigeration. By accident, when I was cleaning an AC filter screen, I suddenly found that by merely cleaning AC filter screens and reducing the standby power consumption of air conditioners, we could reduce electric power consumption in Chongqing by hundreds of millions of Watts each year (ten million families in Chongqing). That meant that we could reduce carbon dioxide emissions by hundreds of thousands of tonnes. From then on, we began to carry out the popular science education activities “The Participation of the Chongqing

Public in Energy Saving Action”, which was supported by the Global Environment Facility’s (GEF) Small Grants Programme (SGP) in 2014. Activities aim to raise the awareness of Chongqing primary and secondary school teachers, parents, high school students and local residents on the correct use of household air conditioners and methods to save energy and reduce CO₂ emissions.

In 2014, as a member of the first group to receive regional training on good practices for the maintenance of Chinese refrigeration equipment, I was aware that the impact on global warming of 1 kg of refrigerant released into the atmosphere was equivalent to the CO₂ emissions generated by driving a car for thousands of kilometres. It was a profound realization that led me to recognize my responsibility as a refrigeration professional. Following that, we started to organize public activities advocating for the protection of the ozone layer and against climate change, including the responsible use of refrigerants and training on good operation methods for the maintenance of refrigeration equipment. In addition, we organized professional training on the installation and maintenance of RAC systems, systematically explaining refrigeration principles and the application methods for refrigeration equipment. Now, more than 50 trainees have obtained a national vocational qualification and obtained vocational technician qualifications at senior, intermediate and junior levels. We also set up the “technical and artificer working committee” of the Chongqing Association of Refrigeration so that the association can improve technicians’ skills and artificers’ ability.

Come on, girls, join the air conditioning sector! This is a sector with millions of career opportunities, which can contribute to combatting climate change and protecting our living environment. For the sake of our common Earth, you are welcome to join us!

Xu Guofen



I majored in refrigeration at Tianjin University of Commerce from 1982 to 1986 and obtained a Bachelor of Engineering degree. I worked in the power engineering department of Suzhou Aquatic Refrigeration Plant as a member of staff from 1986 and was promoted to refrigeration engineer in 1993. Then I worked for Suzhou Vocational School, which was renamed and is now Suzhou Senior Technical Institute. I was promoted to senior lecturer in 2000 and was certified with a professional senior refrigeration worker qualification in 2004. I am a member of the Suzhou Institute of Refrigeration, an Expert Committee Member of Occupation Skill Appraisal in Jiangsu Province, and one of the National Primary Evaluation Staff (Refrigeration Major).

“To protect and save lives’ is our common missions.”

My job back at the Suzhou Aquatic Refrigeration Plant was refrigeration engineering related R&D, equipment management, power technology energy saving and environmental protection, etc. I was also responsible for training workers, not just in the refrigeration plant, but also in city-wide training courses. I continued to provide professional training and theoretical tutoring in refrigeration after working for Suzhou Vocational School. I published *The Calculation Method of Homemade Air-conditioner Evaporator*, in *Cold Storage Technology*, and *Experience for Skill Improvement in Practice Education*, in *Vocational and Technical Education*. I was also in charge of professional teaching and skills assessment for Suzhou refrigeration and air conditioning.

I was one of the professional trainers in the Suzhou central AC technical re-employment training programme between 2002 and 2007 and also participated in the Feasibility Study Report for Refrigeration Equipment Maintenance Personnel Vocational Skills Appraisal Environmental Protection Requirements Project, which was hosted by China’s Association of Worker Education and Vocational Training. I have submitted the investigation report on Environmental Protection of Refrigeration Equipment Repair Industry in Suzhou and Suzhou Refrigeration Equipment Maintenance Training Pilot Proposal listed in the appendix section of the report.

I became social training lecturer for HVAC workers in 2013 and a lecturer in the Suzhou Refrigeration Maintenance Theory and Practice Training in 2014. I participated in the China Refrigeration Maintenance Training Workshop Application for Suzhou Public Training Institutions and was a trainer in their training programme. In 2015, I edited the Refrigeration Equipment Maintenance Worker Basic and Intermediate Vocational Skills Certification Collection, which is a project of institution-wide priority. I participated in a training programme hosted by Landesinnug Kälte-Klima Technik Bundesfachschule, Germany, in December 2015, and obtained my BFS Refrigeration Training Certificate.

I served as referee for the first RAC skills competition in the refrigeration industry of Suzhou and the Gusu District RAC Good Operation Skills Competition in 2017. “To protect the ozone layer and save lives” is our common mission. I will keep working to preserve resources, save energy and regulate pollution in the refrigeration industry to protect our environment more effectively.

Zhang Xiuping

Zhang Xiuping is currently the chief engineer and researcher of the Refrigeration and Air Conditioning Division of the environmental company Hefei General Machinery Research Institute Co., Ltd. She is also the Deputy Secretary-General of National Technical Committee 238 on Refrigeration & Air-Conditioning Equipment of Standardization Administration of China.

She has been committed to research on energy-saving, the protection of the environment and test and evaluation technology in the field of RAC for a long time and is the academic and technical leader of Anhui province. In 2008, she won the Special Government Allowances of the State Council. In 2015, she was selected for the “National Hundred, Thousand and Ten Thousand Talent Project” and was awarded the honorary title of “Outstanding mid-aged expert”. In 2017, she was appointed chief expert of the China National Machinery Industry Corporation. In the same year, she was awarded the honorary certificate “Make valuable contributions and efforts” by five



“She actively promoted the international integration of technical standards for environmentally friendly CO₂ compressors.”

institutions: the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), the United Nations Industrial Development Organization (UNIDO), the World Bank and the Foreign Economic Cooperation Office (FECO) of China’s Ministry of Environmental Protection.

Zhang Xiuping has conducted technical research in the field of RAC for more than 20 years, always working on the front line of scientific research. Facing the problem of insufficient research and testing capabilities in China’s RAC industry, she has actively developed RAC detection technology and finally filled in the major domestic technical gaps. For the first time, performance test methods were proposed for multi-connected air conditioning units, total heat exchangers, large, air-cooled heat pump units, etc., and the first product performance testing device in the world was built. Meanwhile, key technology – the screw and centrifugal refrigeration compressor testing device – was rendered outdated, providing support for the localization of large refrigeration compressors.

Since 2010, given the major national demands to implement international conventions, Zhang Xiuping has led the research team working on refrigerant alternatives for hydrochlorofluorocarbons (HCFCs) and other ozone depleting substances (ODS) with the support of the Technology Research Center of Refrigeration and Air Conditioning Engineering in Machinery Industry and the State Key Laboratory of Compressor Technology. HCFC refrigerants were clearly outlined as controlled substances in the Montreal Protocol. To overcome the technical bottleneck in alternating and reducing certain varieties of refrigerants in China’s industrial and commercial refrigeration industry, she actively undertook research on HCFC phaseout projects, such as “Standard revision of industrial and commercial refrigeration products”, “Study on the applicability of the application of R-32 refrigerants” and “Study on the applicability of the application of natural substances”, etc. She also focused on carrying out major projects such as “research on the testing technology of new refrigeration equipment and key components using environment-friendly alternative refrigerants”. All of her unremitting efforts have successfully laid the foundation for the implementation of international conventions and the promotion of the HCFC phaseout. Comprehensive analysis and test evaluation led to several positive outcomes. First, a systemic solution for applying R-32 in small RAC equipment was devised. Then, the long standing “forbidden zone” in utilizing weak flammable refrigerants at home and abroad was transcended. Finally, the safe use of alternative refrigerants and the development of the industry’s technical level were simultaneously promoted, and the industry’s scientific and technological progress in R&D, safety risk assessment and environmental impact assessment in the areas of internal parts and complete machines were all accelerated. The

implementation of the project gave a new impetus to the replacement and elimination of traditional refrigerants and laid a solid foundation for the promotion of new refrigeration technology that would protect the environment. In addition, she made important contributions to the implementation of international conventions by China and its industry. Thus, China could present the good international image of a "responsible country" to the world.

While carrying out common technical research, she also paid attention to the transformation of scientific research results into standards. This led her to preside over the formulation and revision of many national standards that could solve the bottleneck problem of the promotion and application of alternative refrigerants. Moreover, she actively promoted the international integration of technical standards for environmentally friendly CO₂ compressors. Under her guidance, product manufacturing and industrial development improved and became steadier.



Zhao Yang

Introduction

Prof. Zhao Yang was born in Zhangjiakou City in northern China, a famous city that was appointed to host the XXIV Olympic Winter Games together with Beijing. In northern China, heating is necessary in winter and air conditioning indispensable in summer. In Zhao's childhood, at night, it was her great joy to play with her tiny toy near the stove with her parents, but she disliked the nuisance of smoke and the smell of the burning coals. Little Zhao wished to be satisfied with both effects, without knowing how to achieve such an outcome. The problem puzzled her until she went to Tianjin University in the 1990s. There, she met Prof. Canren Lv, her doctoral supervisor and one of the well-known pioneers in heat pump technology in China. Ms Yang found she was quite interested in refrigeration and heat pump engineering in her postgraduate years and decided to devote all her efforts to developing the RAC technology that would improve quality of life and protect the environment. At the age of 37, she was promoted to the rank of professor and, only two years later, she qualified as a young female doctoral supervisor.



In the past 20 years, Prof. Yang has made a great many contributions to the following areas: novel RAC technology (for energy efficiency and sustainable development), refrigerant substitution (for the environment and climate), flammability characteristics and inerting mechanisms (for the safe operation of RAC technology), gas engine driven heat pumps (for remote areas that are off the grid), the cold chain (for food storage) and subway ventilation (for urban development). All of these are financially supported by nearly 50 research projects. Scholar Yang has published more than 260 research papers, which have been quoted more than 2,500 times. Teacher Yang has earned many honours and is hailed as the young and middle-aged backbone teacher of China's Ministry of Education. She is diligent, gracious and respectable in the eyes of her 60 Master's and doctoral graduates, as well as those of hundreds of undergraduates.

“Teacher Yang has earned many honours and is hailed as the young and middle-aged backbone teacher of China’s Ministry of Education.”

Day to day, she works with great enthusiasm, and, at the same time, she lives with fascinating elegance. Lady Yang is seen as a successful career woman by society and an excellent wife and mother by her family.

The sun rises and sets, spring goes and autumn comes and age increases as time goes by, however, Prof. Yang still harbours the same desire: that of doing something well to improve the quality of human life. Best wishes for the Earth.

Detailed Information

Zhao Yang is a professor, doctoral supervisor and the academic leader for Refrigeration and Cryogenic Engineering at Tianjin University. She has worked in education and research in the field of energy-efficient, environmentally friendly refrigeration systems since she obtained her PhD at Tianjin University more than twenty years ago.

Experience and achievements in the field of scientific research

Prof. Yang has a rigorous attitude towards scientific research and always encourages her students and partners to seek the truth. Her team has undertaken and completed a total of nearly 50 research projects to solve some key scientific problems in the fields of energy and the environment. These projects include six National Natural Science Foundation (NSFC) projects, one National High tech R&D Program project, and 13 provincial and ministerial level projects.

The relevant results have been published in more than 260 research papers, which have been quoted by other researchers more than 2,500 times. Among them, more than 50 papers have been published in internationally renowned journals. Many internationally renowned scholars have highly praised some of her achievements.

Because of her outstanding contributions, she has received many certificates of honour such as:

- the 2017 Tianjin Natural Science Award for her research on the heating-refrigerating combined cycle and leakage-combustion characteristics of alternative working fluids,
- the 2008 Science and Technology Invention Award of the Chinese Association of Refrigeration for her research and development of a new expander for CO₂ transcritical cycle systems,
- the 2006 Tianjin Technical Invention Award for her work on highly efficient, environmentally friendly refrigerants and new, optimal, matching technology,
- the 2005 National Award for the harvest of Agricultural, pastoral, fisheries.
- Prof. Yang has obtained more than 30 patents for her inventions, some of which have been put in practice.

Experiences and achievements in the field of international communication and cooperation

Prof. Yang was invited to be a member of the following bodies: Commission B1 of the International Institute of Refrigeration (IIR), the IIR Working Group on Refrigeration Safety and the IIR Working Group on Life Cycle Climate Performance Evaluation (LCCP). As a reviewer for several international academic journals, she has reviewed a large number of papers every year.

Prof. Yang has carried out many missions at an international level and accomplished remarkable achievements in the fields of energy conservation and environmental protection.

The specific missions she has completed are as follows.

She has carried out the related research on the accelerated elimination of CFCs and HCFCs and completed research on and the technical promotion of new lower GWP refrigerants. She has supervised and reviewed the progress and implementation of the Montreal Protocol in China.

She has been the reviewer for many national energy saving standards in refrigeration, air condition and heat pump systems.

In collaboration with UNEP, she also completed the review and acceptance of the cancellation and transfer of HCFC production lines in Chinese companies under the Montreal Protocol.

Experience and achievements in the field of Education

Prof. Zhao Yang has been teaching at Tianjin University for over 20 years. She has taught and trained a number of outstanding students. She is diligent, gracious and respectable, as viewed by her 60 Master's and doctoral graduates and hundreds of undergraduates. Two of her students were honoured by Tianjin University for their excellent dissertations in 2016 and in 2017. Five of her graduates have become university professors and 20 have become the leaders of well known companies.

Prof. Yang has also made remarkable achievements in her teaching career. She published a textbook «Energy and Environment Technology» for the common higher education. Up to now, the textbook has been used by the undergraduates of several majors in many universities of China. She also participated in editing an international academic book for postgraduate students entitled «Energy Efficiency Research» as well as three other local textbooks.

Experience or social services in some academic organizations

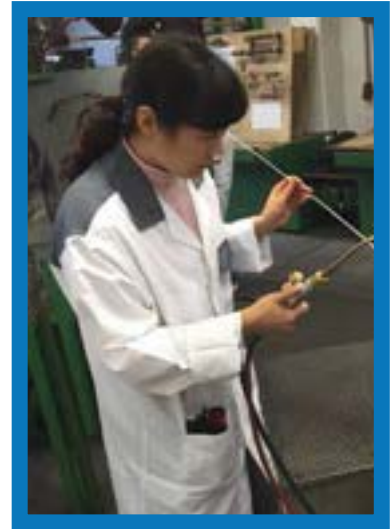
As well as her position of professor at Tianjin University and some IIR expert appointments, Prof. Zhao Yang also serves in the editorial committees of several international and national journals. She has actively been performing her duties as a member of the China National Standardization Technical Committee of the energy system and participated in revising or approving more than 20 national industrial energy efficiency standards. Not only that, but she also serves some academic organizations in this field. Last but not least, she has evaluated some research projects for the State and the Ministry of Education.

Zhou Yanrui

Bad Start, Happy Ending

My name is Zhou Yanrui. I am from China. I will now tell you the story of how I came to work in the refrigeration sector.

Getting into the refrigeration industry was a beautiful mistake for me. When I chose to specialize in refrigeration and cold storage technology at Xi'an Jiaotong University in 1996, I didn't know what 'refrigeration' was, or what I would do in the future. Now, however, I'm a teacher at Shandong Institute of Commerce & Technology. My research field is alternative refrigerant technology. I spent a great deal of time learning how to maintain RAC equipment so I could teach those skills to students and maintenance workers. Because of my excellent performance over the years, I earned the titles of "Outstanding Worker" and "Youth Teaching Expert" and won the "Moon Gardener Award".



"I spent a great deal of time learning how to maintain RAC equipment so I could teach those skills to students and maintenance workers."

In recent years, I have presided over many projects related to new refrigerant technology and submitted a number of papers. I won the second prize for Scientific Advancement in Shandong Province, and the third for Scientific Advancement in China. I participated in R&D for R-404a/NH₃ cascade refrigeration units that were exported to France.

I now work as a technical consultant for many refrigeration enterprises to find an alternative route for refrigerants such as the CO₂/NH₃ cascade system of Shandong Shenzhou Refrigeration Equipment Co., Ltd. I am also a leader at the Training Center of Good Operation for Refrigeration Maintenance Industry, supported by UNEP, which was selected by China's Ministry of Environmental Protection. Our centre has successfully held multiple training courses on new refrigerants for about 900 trainees, inspected by Dr Shamila Nair-Bedouelle, the then director of OzonAction, and Mr Hu Shaofeng, the senior project official, in March 2015, and received high praise.

I love the RAC industry, I love my work and I want to do more for alternative refrigerant technology.



Colombia

- Leidy Natalia Galeano Ortiz
- Liliana Del Socorro Luna Ramírez
- Leidy Marcela Osorio Molina

Liliana Del Socorro Luna Ramirez

My name is Liliana del Socorro Luna Ramirez. I'm 35 years old, I was born in Medellín, and I currently live in the town of Paris with my husband, Carlo Andres, and my 12-year-old son, Jefferson Alejandro. Since I was 15 years old, I have been enterprising and hard-working, and for this reason I do not feel comfortable if I am doing nothing.

I have a diploma in secretarial studies, but I held a secretarial job for only eight months, on account of some personal circumstances which forced me to resign. After this, I worked as a cashier and waitress for six years in different restaurants in the city. During this period, because of the late nights and the constantly changing schedules, I got tired and decided I wanted something different for my life. I started looking for a job in other areas and, thank God, I found out about a vacancy in an industrial company. The vacancy was for the position of production operator, and this is how, with time, I was able to acquire experience in this field.

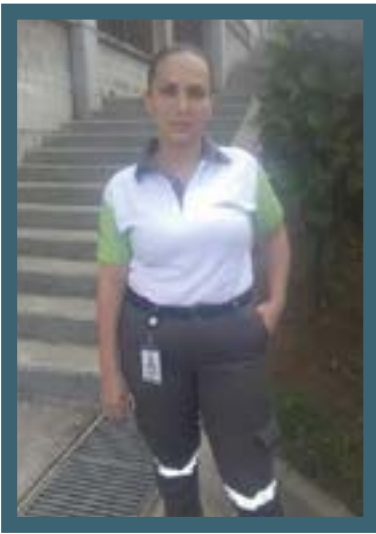
After working for other companies, I finally came to Haceb, where I have been working for the last 10 months. Here, I took on several positions, but to date, the one I have enjoyed most is that in the R-600 gas injection station. I am at ease and happy working on this part of the process because more than just being a simple refrigerant gas, R-600 helps in resolving the environmental problems we have today throughout the planet, something that concerns us all. In terms of composition, this gas has a very low pollution level; and it is good to see that a company like Haceb cares about contributing to the change.

"If men are capable, so are we. If they rise, so should we. So do not belittle yourselves and you will see that society will give you the respect you deserve."

Personally, I get along well with men. I think this is because with women, I've always had some rivalries. At the company, I've never felt belittled or rejected for being a woman. I do not know why, but I think that, currently, there is a greater sense of respect within the company. My message is: if men are capable, so are we. If they rise, so should we. So do not belittle yourselves and you will see that society will give you the respect you deserve.



Leidy Natalia Galeano Ortiz



My name is Leidy Natalia Galeano Ortiz. I am 27 years old and I live in Copacabana, Antioquia, Colombia - more specifically, along El Varado. I have three children, two girls and a boy: Ana Sofía, 9 years old; Jerónimo, 6 years old; and María Ángel, 3 years old. I am a single mother. I consider myself a versatile woman who has faced different changes in life and who will continue to encounter changes in the future. I currently work for Industria Haceb as a production operator in the area of R-600 charging and sealing. R-600 is a gas which requires careful handling and which is usually volatile; however, it is important to note that it is a refrigerant with a very low level of contamination and that its impact on the ozone layer is minimal. It makes me proud to be part of a very good process which contributes something to environmental solutions.

I never worked before joining Haceb. I depended on my husband, and when I separated from him some five years ago, I found myself alone and I realized that I needed to start providing for my family and

securing our future. So I decided to look for a job to get ahead. Thanks to a friend who helped me submit my résumé to Haceb, the company called me in less than a week.

It was difficult in the beginning. I joined the company with 12 other women, while inside the plant there was only one. In addition to joining a very big industrial company and starting to learn everything from scratch, it was also strange that a lot my colleagues were men. However, from the very start, they were all helpful and kind to me by explaining the procedures. Because of this, and with time, I was able to catch up to maintain the work pace, which was quite demanding. We had to keep standardized times and improve production efficiency and effectiveness continuously.

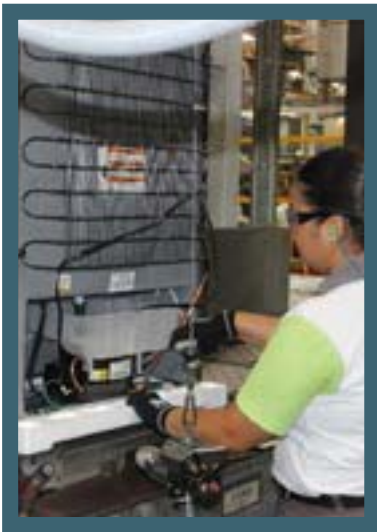
One thing I appreciate about the company is that from the very beginning, it taught me to be adaptable and to work on different tasks in an appropriate way.

As for my children, it was difficult to get them accustomed to the fact that I cannot be with them the whole day, but these are sacrifices necessary for the family's well-being. Initially, I worked for one year without being regularized, but about a month ago I was made a regular employee of the company.

I believe that the fact that I worked amongst men did not cast doubt on my capabilities. My co-workers were never disrespectful towards me, nor was I to them. I believe that is where everything starts: find your place, show respect, and demand equal respect.

“My co-workers were never disrespectful towards me, nor was I to them. I believe that is where everything starts: find your place, show respect, and demand equal respect.”

Leidy Marcela Osorio Molina



My name is Leidy Marcela Osorio Molina. I was born in the city of Medellín, Colombia, 31 years ago, but now I live in the municipality of Copacabana. I consider myself to be a calm, tolerant, and patient woman, but I know that at certain times I need to show that I have a strong personality. In my life, I've gone through various situations that have shown me the difficulties that a woman can experience in a sexist society. However, on the other hand, I have also experienced how marvellous it is to be a woman, an experience which greatly outweighs whatever difficult moments I have gone through up to now or I might go through in future.

I've had three jobs. The first one was as a receptionist. When I was about to get married and have my daughter, an experience which gave me a marvellous feeling of fulfilment as a woman, I decided with my husband to open a store selling plaster moulds. This did not last long because we separated and had to split our common property. I am now a single mother.

After going through this bittersweet moment, I had to immediately find a job, both for myself and for my daughter, who is totally dependent on me. After sending an unbelievable number of job applications for a long time, I thought I would never get an opportunity to work. However, thank God, I received a call from Industrias Haceb, where I have now been working for the last four years. Of course, at that moment, when I received the notification, I was filled with joy; but I knew that this was an industrial company and that the position they offered was for an operator in a refrigeration plant. I was curious to know what it would be like to work in a place where men predominated and, moreover, in a position which is seen as a man's job. There, I performed various tasks, including duties as the operator of an R-600 gas injection station. R-600 is a hydrocarbon used in domestic refrigerators. It is currently one of the least polluting gases there is because of its low environmental impact and excellent thermodynamic properties, although handling it is quite hazardous.

On my first day at the plant, I met six other women. There were only two women who had been working there for less than a month. In the beginning, the biggest challenge was adjusting to working in a male-dominated atmosphere, where I felt my ability to do hard work was underestimated because of the simple fact that I was a woman. I noticed it right away because some colleagues were suspicious and held back information that could help me; it seemed that they were afraid that I would do better than them.

"If you, as a woman, don't have confidence in your abilities, no one else will."

Today, we've overcome these obstacles and stigmas – this applies not only to me, but also to my male colleagues, who now consider me an essential member of the team. Nevertheless, such behaviour is something that does not stop very easily. Even for new operators, suspicion and doubts about their ability is still obvious; however, this is not a job just for men, but a job for all. If you, as a woman, don't have confidence in your abilities, no one else will. For me, the best advice I can give to you is that you have to believe that you are working hard, and more importantly, that you can achieve your goals. You must not belittle yourself. Believe your story as a woman and be strong.

Dominican Republic

- Ana Vanessa Ricardo Acosta

Ana Vanessa Ricardo Acosta

Currently, I work as a specialist in environmental agreements. I have been working five and half years on the Green Customs Initiative, which implements different multilateral environmental agreements (MEAs), including the Montreal Protocol on Substances That Deplete the Ozone Layer. My functions include the training of customs inspectors, who make up the first line of defence in customs. When imports arrive, they are responsible for the inspection of containers, including shipments related to the Montreal Protocol.

I have a master's degree in international trade management, a double degree from the National University of Costa Rica in MEA (including the Montreal Protocol) training workshops, and a diploma in environmental law, among other training certificates.

Throughout this time, I have participated in workshops, including ones

“Times change and trade is not static; we thus need to be alert in order to fight illegal trade and ensure that we have environmentally fair trade.”

held on the border with our neighbouring country, Haiti, where we carried out inter-agency training, which is a shared responsibility. Our relationship with the National Ozone Programme (PRONAOZ), the focal point for the Montreal Protocol under the Ministry of the Environment, is successful. We have worked together to detect the import of prohibited gases from China and India.

A recent case which our office was handling and which attracted attention concerned the detection of an import of refrigerator motor debris from an island in the Caribbean. These motors ran on gases such as R-12. Over the last five years we've dealt with cases of imports of refrigerant mixtures with banned gases from China, among other cases.

We are aware that, together with the controls established by the customs agency and the constant work of PRONAOZ, what will guarantee our continued excellent results is constant education of the surveyors, customs agents, and the public in general, who are concerned with imports of refrigerant gases.

Times change and trade is not static; we thus need to be alert in order to fight illegal trade and ensure that we have environmentally fair trade.



Ecuador

- Rosita Silvia Maldonado

Rosita Silvia Maldonado

Introduction

The current use of refrigerants is a common practice and necessary for the development of society. We see them everywhere, from simple fridges to big freezer or refrigeration units, which is no doubt a very important leap for society's development. However, this has also given way to the arrival of substances used as refrigerants that damage the environment: ozone layer depletion and global warming are the results of the improper use of these substances.

These are sufficient reasons to implement training in good practices for the use of these substances through the Good Practices in Refrigeration training programme for technicians in charge of maintenance and repairs of refrigeration equipment. Today, international organizations such as the United Nations Industrial Development Organization (UNIDO) and the United Nations Environment Programme (UNEP) are dedicated to reducing the environmental impacts of these substances through the implementation of programmes focused on the recovery, recycling, and reuse of such substances, the training of technical personnel, and the provision of equipment. In the end, this will enable countries to comply with their commitments under the Montreal Protocol on Substances that Deplete the Ozone Layer, to which Ecuador is a party.



In 2005, I was an instructor, teaching electricity and electronics, at the Ecuadorean Professional Training Service (SECAP). I became involved in the field of refrigeration and air conditioning. SECAP, a Government institution tasked with training and certification in Ecuador, had me receive training in the management of refrigerant recovery and recycling equipment in Quito as part of the implementation of the Montreal Protocol.

“Through workshops, we are raising technicians’ awareness and training technicians in refrigeration and air conditioning best practices.”

After learning about the importance of the project and our responsibility as a country in contributing to the protection of the environment – not only for ourselves, but also for future generations – I became interested in getting involved in the field of refrigeration.

Through extensive training provided by the Ozone Technical Unit and organizations such as UNIDO and

UNEP, and with refrigeration tools and equipment for conducting workshops, capacity-building for technicians in refrigeration and air conditioning began. It continues to this day. Through workshops, we are raising technicians’ awareness and training technicians in refrigeration and air conditioning best practices, since many of them opened their repair and maintenance shops without adequate technical training. This is knowledge that they can also pass on to their descendants, in many cases in developing countries.

On the other hand, in the city of Cuenca, Ecuador, employees of INDUGLOB, a company that makes refrigeration equipment, were trained in good practices in refrigeration and air-conditioning in 2016 with the same goal in mind. Currently, our goal for the end of 2018 and for 2019 is to train, at the national level, approximately 800 domestic and commercial refrigeration technicians in the use and safe handling of hydrocarbon (HC) refrigerants as a replacement for hydrofluorocarbons (HFCs). HFCs contribute to global warming. This is related to Ecuador’s ratification of the Kigali Amendment to the Montreal Protocol, pursuant to Executive Decree No. 209 of 17 November 2017.

Fiji

- Makelesi Marama Sauturaga
- Akanisi Tevulu Varani

Makelesi Marama Sauturaga



After completing high School, I was motivated by my father, a mechanic by trade, to take up a course in engineering. Being the second eldest of seven siblings, my father was the sole bread winner. So I thought to myself, "Why not pursue a career that will not only help my father, but to which I aspire and in which I can make a difference?"

And so, I prepared to enrol in Mechanical Engineering at the Fiji Institute of Technology without knowing that there was a course on refrigeration and air conditioning (RAC). After much advice from a tutor, I gladly took the RAC course. In 1992, we were required to do internships for a maximum of six months. Initially, I started with Supercool Fiji and then moved on to Pacific Beverages Fiji and, finally, the Warwick Hotel, as a junior RAC technician.

Now, in 1999, because I was so far away from home, I thought of applying for a job in Suva, so I took an application into Rewa Cooperative Dairy in person. After being told there were no positions available, I was noticed by the CEO, who called me in. The next day, I was recruited

into their maintenance and engineering team and was primarily involved in RAC, including mechanical tasks. Regarding RAC jobs, I worked with air conditioning units, compressors, condensers, evaporators, farm refrigeration units, upright coolers and chillers. To complement my trade, I was working with fitters and learning about pumps, valves and manufacturing equipment and servicing boilers with boilermen. I remember when I twice had to attend to the breakdown of milk cooling units, which required me to stay alone all night at a dairy farm milking shed. This was essential in order to get the right temperature, since milk is a very sensitive product and without the right temperature, the milk can be spoilt. In 2009, management assigned me to run a Danish demo machine that converted liquid milk to condensed milk and then to powdered milk. It was a struggle at first, but with my sheer determination and hard work, it eventually turned out to be a success. In early 2012, I was again assigned to operate and maintain one of the new blow-moulding machines (machines that blow bottles into shape) and a juice filling machine. The machines I worked on required me to climb up and even get under the machines for a changeover or a breakdown. In the process, if I was not careful, I could burn a finger or two, get bruises and end up covered in grease and dirt.

"Working in a male-dominated profession has enabled me to develop resilience and determination to continue to strive for the better. "

While I was assigned to these new machines, I did not deal much with RAC unless there were no other technicians available. Towards the end of 2012, I was tasked with managing our maintenance stores and, to be frank, I found it difficult, because I had to deal with administrative work, which I was less used to. However, with the helping hand of the Chief Engineer, I managed to cope. With an open mind, I continued to learn a lot of new things in the different areas of the machine and car parts and civil engineering materials. I also dealt with change such as meeting new sales personnel with their items to sell. Nevertheless, I always have to be prepared to deliver when there no other technicians are available to deal with RAC breakdowns.

Having worked in the industry for a long time, I had always prayed that one day, I would work somewhere where my unique expertise would be recognized. In the latter years of my career, I was interviewed by Fiji's Department of Environment and roped in to serve as one of the assistant ozone depleting substance (ODS) inspectors. The roles expected of me included carrying out inspections (RAC and methyl bromide) to assist the industry with complying with the ODS legislation, monitoring and maintaining records and documentation for permits and licences, conducting inspections of fishing vessels with the Fiji Customs Service and assisting with the promotion of Good Practices in Refrigeration through the Australian Fumigation Accreditation Scheme (AFAS) Workshop and hydrocarbon training.

If anything, I am more than grateful to God for my experiences, because they have brought out the best in me. Working in a male-dominated profession has enabled me to develop resilience and determination to continue to strive for the better. I am continuously challenged not only to treat men and women alike, but to accept the fact that this culture of “male-only” professions is in dire need of a huge paradigm shift, especially in Fiji. As a woman, I continue to respect my male colleagues and it is true that respect is earned and not commanded. Respect is what I have gained at every workplace I have been in. Women should not only be seen as feminine, but as equally strong as their male counterparts – not only physically, but emotionally and psychologically as well. I have also come to a stage where I realize that the only way to change the norm is to have more women join professions such as RAC and continue to be challenged through the mindset that if men can do it, why can't women? In fact, I would vouch for the saying that “If men can do it, women can do it even better”!

Akanisi Tevulu Varani



I obtained a Trade Certificate in Refrigeration and Air Conditioning (RAC) at the Fiji Institute of Technology, now Fiji National University. I was an apprentice for four years before earning a diploma in Plant and Mechanical Engineering. I am currently trying to complete my Bachelor's degree (Hons) in mechanical engineering. In addition, I participated in some training conducted by the United Nations Environment Programme (UNEP). The training was eye opening, showing us a new direction now that we have new alternative refrigerants. It opened up new doors for me – I was invited to be part of a workshop in China. It has motivated me to go in this new direction and become a new version of myself, adapting to change – I am thankful to UNEP for that.

The RAC section at Fiji National University was the first place where I started working after doing a few weeks' interning in one of the local companies. I became a technician, then worked my way up to a tutorial assistant and now an Assistant Instructor. I teach Certificate IV in Refrigeration and Air Conditioning at Fiji National University.

My father was a mechanic, trained by a marine engineer. He did not have any qualifications, but he was good at his work. Being an only child, I dreamed that one day, I would own a garage with my father and that we would work together as business partners. My parents got separated when I was very young. Though I hardly knew either of them, I began to develop a close bond with my father, getting to know him over the years. That bond was broken when I was informed that my father had passed away in hospital. My heart was broken. I was left alone with many sleepless nights, feeling hopeless and thinking of what my future would be without my father. High school friends of mine told me that they had gone to a nearby village on a speed boat and the engine had failed. They had had to float on the sea for several hours until my father came to their rescue, fixed the engine and they continued on their journey. I began to pick up the pieces of my life and move on. That story has motivated me to work hard and give back to the village.

“ The RAC sector is crucial for our health, nutrition and comfort. I am so glad to be part of an important industry that plays an important role in achieving food security and improved nutrition, ensuring healthy lives and promoting wellbeing. ”

When I finished high school, I enrolled at the Fiji Institute of Technology to earn a Trade certificate in Refrigeration and Air Conditioning. It's a male-dominated field and there were certainly challenges. Gender will always be an issue in some countries. Changing my behaviour is not necessary: I just have to be myself. When I hear offensive jokes, I stand my ground and straightforwardly tell the perpetrators that I will not tolerate that behaviour. One of the biggest challenges is getting the skills required and today, I thank my colleagues who have shared

their skills and helped to get me where I am today. Another issue is the lack of female mentors, but we have skilful, able men who have helped me get this far. There are many challenges, but I did not quit. My main focus is on getting the job done. In time, I will earn their respect. I had a passion for this engineering job and a dream to take up my father's legacy. There is a saying that goes: "Success without a successor is a failure". So many people in my village have admired my father's work, but if I didn't take up the baton and complete it, he would be a total failure. My father has given his life to helping people in the village and the money he earned has helped me with my education. There are challenges along the way, but my passion for the job keeps me going. We only get one world to live in, so we get the skill and knowledge that we need to give back and develop our society and our country. That is our human responsibility.

I took scientific subjects in high school, which is why I was accepted for the engineering course. Being a woman is a considerable advantage, since there are only a few of us in a particular field, so we are generally offered scholarships and training.

The RAC sector is crucial for our health, nutrition and comfort. I am so glad to be part of an important industry that plays an important role in achieving food security and improved nutrition, ensuring healthy lives and promoting well being. Now, we are in a transitional period, finalizing the phase out of HCFCs and preparing for the upcoming phase down of HFCs under the Montreal Protocol on Substances that Deplete the Ozone Layer. I have become a new version of myself: out with the old and in with the new. The introduction of the new alternative refrigerant has ushered in new technology. The training course on hydrocarbons has alerted me that I have a responsibility in saving our environment. We are combatting climate change – whether female or male, we have a vital role in saving our environment. The younger generation does not care so much whether you are a woman or a man, nor what race you are. It is more fun when there are people of different genders working together and there is more team bonding. Gender diversity contributes to the positive deployment of skills and also economic growth, as research has shown.



France

- Ina Colombo

Ina Colombo



After obtaining my Bachelor's degree in energy engineering in 2008 at the Raoul Georges Nicolo technical high school (Guadeloupe, a French overseas territory), I decided to continue my academic studies in France and undertook a Higher National Diploma (HND) in thermal and energy engineering. After obtaining my diploma in 2000, I decided to go to England for one year to improve my English. To my great surprise, I found in the United Kingdom a real land of welcome with great cultural diversity and multiple professional opportunities.

In 2001, I decided to complete my previous qualifications with a Bachelor's degree in Building Services Engineering, followed by a Master's degree in Sustainable Energy Systems. In parallel with my Bachelor's degree, I was lucky enough to get an industrial work placement at the House of Commons working as a trainee energy manager of the parliamentary estate. I managed to write my final dissertation on "The Combined Heat and Power Unit in the Houses of Parliament". My role was to understand why the existing CHP plant

installed in the parliamentary estate coupled with an absorption chiller was not working.

After this, I went to work for AMEC as a Building Services Project Manager on Heathrow's Terminal 5, designing and supervising the installation of air-conditioning of baggage control rooms. In parallel, I studied for my Master's and also worked as a sustainability consultant for the Building Design Partnership working on Building Research Establishment Environmental Assessment Method (BREEAM) and Ecohomes assessments, feasibility studies on CHP and as energy manager of the Design Partnership building. In total, I worked for five years as a junior engineer in design offices and contracting companies, and in the field in national and international companies.

"I investigated how to reduce the direct and indirect emissions of supermarkets. The work I did ended up identifying how to reduce CO₂ emissions by 35%."

In 2007, I started a PhD in Sustainable Refrigeration Engineering at London South Bank University (LSBU) full-time. My duties at LSBU involved the development of a novel carbon dioxide refrigeration system starting from the design, supervising the construction and commissioning and undertaking the testing of the experimental prototype. I investigated how to reduce the direct and indirect emissions of supermarkets. I targeted retail stores' energy consumption and carbon emissions using the data from monitoring systems. Furthermore, I worked on innovations in heat recovery for heating, hot water and absorption chilling from a retail application, which were used in Tesco and Sainsbury's as case studies. The work I did ended up identifying how to reduce CO₂ emissions by 35%.

Part of my PhD studies included the project management and development of a new laboratory space, which included the installation of my CO₂ system and a new 30m² environmental chamber at South Bank University.

During my thesis, I disseminated the results of my research at international conferences, in the specialized press and in academic journals. I coordinated the development of two research laboratories and piloted research projects funded by the European Commission and companies. I also taught Applied Engineering and refrigeration at the Faculty of Mechanical Engineering at my university to supplement my income.

After obtaining my PhD, I continued to work for three years in postdoctoral research while being actively involved in the activities of the Institute of Refrigeration (IOR) to promote the refrigeration industry and attract a diverse young audience. For example, I developed and led, with Catarina Marques, the International Institute of Refrigeration (IIR) students' and young researchers' network that takes place every four years during the IIR congress in collaboration with the IOR. The next one will take place at the

25th International Congress of Refrigeration (ICR2019) in Montreal.

In 2013 I joined the International Institute of Refrigeration as the Deputy Director General. Basically, my role is to promote the refrigeration industry worldwide, as well as being responsible for European and internationally funded projects as the dissemination partner of consortiums.

I am the secretary of two IIR working groups: Cold Chain in Hot Countries and Careers in Refrigeration, "CaRe". The CaRe working group led by Dr Catarina Marques aims to make refrigeration and air conditioning more visible to the general public and inspire a young generation to join this exciting field. Another goal is to increase both the cultural diversity and the numbers of women in refrigeration. Since its inception CaRe has had a presence at five international conferences held in Europe, Asia and the USA.

An academic paper on Women in Refrigeration has been drafted and presented at the ASHRAE (the former American Society of Heating, Refrigeration and Air Conditioning Engineers) Winter Conference 2017. This paper highlights the research carried out into the state of women's representation in the industry by collecting information from national refrigeration institutions and associations. I strongly promote the IIR services, publications and activities in developing countries, in particular in Africa. Recently, I was involved in the HCFC Phase out Management Plans (HPMP) Road Show in the Republic of South Africa organized by its Department of Environmental Affairs and the United Nations Industrial Development Organization (UNIDO). My role was to explain the European Fluorinated Gases (F-Gas) Regulations to the attendees from the public and private sectors.

I enjoy making a difference in people's lives, particularly in developing countries. Energy problems in developing countries prevent people from having a fridge, which makes life very difficult. We take this for granted in Europe and forget what it would be like without refrigeration.

One of the great aspects of working in this industry is the opportunity to travel and mix with different cultures. For instance, this year I have been to China, Canada, the USA, Africa and over much of Europe. I never knew I would travel so much when I started out in Guadeloupe.



The Gambia

- Ellen Sambou

Ellen Sambou



I was motivated by one of my uncles, who advised me to study refrigeration and air-conditioning when I completed my high school education in 2009. He was head of an RAC unit in a popular company in The Gambia. I enrolled at the Gambia Technical Training Institute in September 2009, where I did a certificate course and then proceeded to the diploma level in 2010, which I completed in July 2011.

I went on internship at the Medical Research Council Unit The Gambia for six months, where I had a lot of experience working on different cooling systems.

I spent six months on internship with Coca Cola Company The Gambia, where I was employed in the RAC unit of the company. I worked for one year and then left the company for Dakar, Senegal. Since my return I have worked as a field technician.

I have attended training workshops on good refrigerant handling practice as a technician, organized by the Ozone Unit of the National Environment Agency.



Georgia

- Nino Maglakelidze

Nino Maglakelidze

I have always been interested in technical devices since early adolescence. Therefore, after graduating from secondary school I continued my studies at the Tbilisi Trade College, where I graduated in 1981 with a technical qualification in Refrigeration. In the same year I started working for the “Universalservisi” company, where I still work now.

At the beginning I was an engineer-technologist for servicing refrigeration and air conditioning systems, then I became a manager of the workshop, and now I work as Deputy General Director. In 1988 I graduated from the Georgian Polytechnic Institute with a degree in Refrigeration and Compressor machines and installations and gained the qualification of Mechanical Engineer. I love my profession and I have always supported the introduction of new technologies in our company. Especially since the adoption of the Montreal Protocol on Substances that Deplete the Ozone Layer, the reduction in refrigerants emissions into the atmosphere has become an urgent issue in Georgia, which was a part of the Soviet Union at that time. When our country became independent, Georgian specialists became responsible for updating the national RAC sector so that it functioned safely for the environment.



I considered, and I consider now, that it is my duty to contribute to the fulfilment by Georgia of the commitments made in the Montreal Protocol. Therefore along with my main work I spend a lot of time in public work. Since the establishment of a non-governmental, non-profit organization known as the Georgian Association of Refrigerating, Cryogenic and Air Conditioning Engineers (GARCAE) I have been an active member, and since 2010 I have been president of the NGO.

Together with GARCAE I participated in the successful implementation of the Montreal Protocol with projects like the Refrigeration Management Plan (RMP), RMP Update, and the Terminal Phase-out Management Plan (TPMP) managed by the National Ozone Unit of Georgia. At present I am engaged in the use of natural refrigerants in our country. This was also the topic of my doctoral dissertation, for which I received my doctorate in 2016. In addition, I conduct training for trainers and technicians in good practices in Refrigeration as well as training customs officers in the identification of refrigerants.

“We need to actively upgrade the technicians’ skills and consumers’ awareness of the safe use of natural refrigerants.”

As a teacher at the “Spectri” professional colleges I also teach a new generation of technicians in Georgia’s RAC sector. I want to emphasize that in my work I have always enjoyed great attention and support from my colleagues, at my main workplace and at the GARCAE NGO as well as from staff of the NOU of Georgia. I am very grateful to all of them and I am also grateful to the United Nations agencies – UNEP, UNDP, UNIDO – that help our country to phase out

environmentally harmful refrigerants. In fact, Georgia needs help like many developing countries. This issue has been especially acute since the adoption of the Kigali Amendment to the Montreal Protocol. Georgia should already be preparing for the implementation of the HFC phasing out schedule. But these refrigerants are used very widely in Georgia in all sub-sectors, and their replacement by natural alternatives is complex not only from a financial point of view but also in terms of technical safety and end-user mentality. From my point of view, and many of my colleagues agree with me, we need to actively upgrade the technicians’ skills and consumers’ awareness of the safe use of natural refrigerants through meetings, conferences, training and demonstration projects. I am sure that, together, we will overcome all the difficulties!

Germany

- Monika Witt

Monika Witt

I decided to study mechanical engineering as it offers a wide range of possibilities: from pure research to design engineering, and from project management to the selling or purchasing of technical products. My first interest was rather in ecological engineering (i.e. recovery of soil and water by technical and biological treatment (my Masters' thesis dealt with the de-nitrification of drinking water with bacteria). I applied for a job in applied technology for soil treatment at Messer Griesheim and after my interview ended up as project engineer for air separation systems (a very low temperature process). After working as project and also site engineer for air separation systems in Germany and the USA I returned to Germany and started in the family-owned refrigeration company in its 100th anniversary year. Since 1998 I have been managing director of this company, and responsible for the technical side.



***“Without refrigeration life’s conveniences are not possible.*”**

I found it very rewarding working as an engineer, as women are rather unexpected and this offers many more opportunities than challenges. Men are curious to see whether a woman knows her business, but then impressed and eager to support. Particularly at the construction site, men are very helpful and supportive. Overall, I have never

regretted being an engineer, particularly in the refrigeration industry.

Industrial refrigeration contributes to a good life, as it makes it possible to provide fresh products in a safe manner around the world, and enables numerous technologies, not only for the food industry, but also the chemical and pharmaceutical industries. Without refrigeration life’s conveniences are not possible.

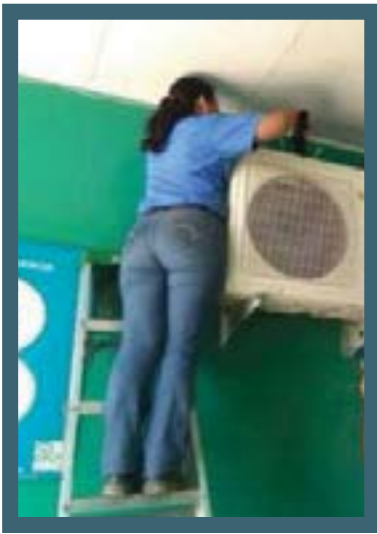
My company produces products for the industrial refrigeration industry, such as refrigerant pumps, high side float regulators, pressure vessels and functional units. From the beginning, TH. WITT has supported natural refrigerants, mainly ammonia, but also carbon dioxide. Even when so called “safety refrigerants” such as HCFCs were introduced, TH. WITT continued to promote natural refrigerants, (although its products were suitable for all refrigerants). TH. WITT has always recognized the energy efficiency of systems operated with ammonia and carbon dioxide.

Due to my position, I have also been active in the German Research Council, the board of directors of the VDMA and at Eurammon, where I served as Chairwoman for more than 10 years.

Honduras

- Diana Michelle Valladares Jacinto

Diana Michelle Valladares Jacinto



My name is Diana and I am 18 years old. I live in the city of San Pedro Sula, one of the most industrialized cities in Honduras and the most developed city in terms of refrigeration and air conditioning, as a result of its agricultural-industrial sector.

I come from a poor family and am an only daughter. My mother was the one who supported me, working as a laundry washer; my father, well, he worked when he felt like it. When I was born, the country was reeling from the aftermath of hurricane Mitch in 1998. During this time, people were going through terrible economic difficulties; my parents lost everything in the hurricane.

Throughout my childhood, I suffered a lot, not because of poverty, but rather because of my father, who was an alcoholic and a rude and violent man. Whenever he came home drunk, he would fight with my mother and insult her, hit the tables and doors, and throw things as I hid in an old closet and watched my mother defend herself somehow.

Thank God that he never beat my mother, but despite that, she would

always cry because of the insults and humiliation she was subjected to.

He never took an interest in me and he didn't care about my education. He would give a small part of the money he earned from working to my mother, and the rest he would spend on alcohol. When there was not enough food, my mother somehow managed to adjust so that everyone still ate.

"What has struck me most in this field are the ways of working and the processes of change."

In spite of all of this, I did not encounter any obstacles to my studies; on the contrary, it was very good. I was particularly obsessed with nature- and history-related subjects. Two years ago, when I took up refrigeration for my baccalaureate, people started criticizing me and telling me: "Seriously, you want to get into this field? This is for men." Others were saying: "A woman can't do heavy work." Some members of my family would even call me "hombrecita – little she-man", and the worst is that sometimes they wouldn't say it to my face, instead telling my mother. Even until recently, my mother started having doubts and believing that I would never find a job because I'm a woman.

I ignored them, and I am even more motivated to continue in this field. I've met many people who motivate me more when they say "when you graduate, you can clean the air" than when they say that I'll be able to lift myself out of poverty and that my mother will see the results of the efforts she has made for me through the years. Right now, I'm involved in a dismantling job at Ramón Villeda Morales airport in La Lima.

What has struck me most in this field are the ways of working and the processes of change; when I started out, I did not have the remotest idea of how refrigerators and air conditioners worked. But what I like most is the subject of refrigerants, since I had never imagined the damage they can do to our planet.

Personally, I already had some knowledge of ozone layer depletion and global warming, and they were among the topics I was obsessed with. This problem is severely affecting my country; in recent years, the climate conditions have become abnormal. There are days where the temperature reaches 40°C and then drops suddenly.

We need to stop the problem. My country is very much affected by the changes in climate due to pollution from more developed countries, which do not realize how Third World countries suffer. There is damage to agriculture, to our forests, to the Honduran jungle, especially to animals, and to the population in general.

India

- Roshini Rebecca Easow

Roshini Rebecca Easow

My interest in RAC began in my undergraduate years, when I carried out a project to produce a “water cooler cum heater”. This was way back in 1976, before the concept of energy efficiency had even been formulated. There were just three girls in the class and two of us did the project by ourselves – we didn’t want boys in our group, because everyone would attribute the success of the project to them!

When I undertook my Master’s degree in heat transfer and thermal power engineering at the Indian Institute of Technology (IIT) in Madras, there were no women in the Department of Mechanical Engineering, not even in the administrative staff.

I have been associated with the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) since 1999, when I established a student branch at the Sardar Patel College of Engineering, Mumbai.

The idea is to get students interested in the RAC industry. Students are usually interested in automobiles or aeroplanes – they didn’t have any awareness of the vastness of the RAC industry or how important it was for the environment, especially since it’s an energy consuming industry. I joined the Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) at the same time and I am happy to say that, due to our efforts, awareness of the RAC industry has greatly increased and students are hoping to get jobs in the industry.

“During my professional career, I have motivated a large number of students to enter the RAC industry. Some have also become entrepreneurs. ”

When I joined ISHRAE and started attending the seminars and workshops, I was the only woman around. It was difficult, but as a mechanical engineer, I was ready to face this challenge.

I was elected as the President of ISHRAE’s Mumbai Chapter in 2012, a proud moment for me, since I was the first woman President in all of the society’s 41 locations since its establishment in 1981.

In 2013, I was appointed ISHRAE’s National Chair of Student Activities, meaning that I had to get the student members to participate in different tasks pertaining to RAC through projects, quiz programmes, scholarships, etc. Students were allowed to attend ACREX, India’s annual international exhibition on air conditioning, heating, ventilation and intelligent buildings organized by ISHRAE and endorsed by ASHRAE. This exhibition is held in the large cities of Mumbai, Delhi and Bangalore. Students from all over India are sponsored to come and visit and volunteer. It gives them a perspective of RAC, so they understand that it’s not just about a domestic refrigerator or a room air conditioner. It’s a vast industry and its efficient functioning is essential for the benefit of the environment.

During my professional career, I have motivated a large number of students to enter the RAC industry. Some have also become entrepreneurs. Through my lectures, I raise awareness of the challenge of finding environmentally friendly refrigerants and the environmental aspects of our lifestyles. For instance, I tell students to drink the healthy coconut water packaged by God, or lemon drinks, or buttermilk, instead of the energy intensive fizzy drinks packaged in tin cans!

Students drink Coke in a can because it’s the “in” thing, never pausing to think about its detrimental effects. They are shocked to realize that our lifestyle is destroying our planet.

I was elected as the President of ASHRAE’s Mumbai Chapter in 2016, after serving as the Student chair. Here again, I found that I was the first woman President among all the chapters in the ASHRAE region at large, which comprises Bangladesh, Dubai, Egypt, India, Nigeria, Lebanon, Pakistan, Qatar, Saudi Arabia, South Africa, Sri Lanka and Turkey. I have attended the Chapters’ Regional Conferences (CRCs) in Cairo



(Egypt), Madrid (Spain), Istanbul (Turkey) and Bangkok (Thailand). This has given me an opportunity to meet people from the RAC community from many countries.

In 2001, my institute gave me study leave to pursue my PhD at the prestigious IIT in Mumbai. I was already 48 years old, but I felt that was just a number – why not fulfil my dream of earning a PhD? I worked on liquid desiccant based air conditioning. My advisor was ten years younger than me!

Let me say something about my personal life here, since it is part of the challenges I have had to overcome. My firstborn child was a boy (I have a daughter, too, who has followed in my footsteps and earned her PhD in Mechanical Engineering) who was diagnosed with Duchenne Muscular Dystrophy, a genetic disorder that leaves the child in a wheelchair by age ten with a life expectancy of 16 to 20. He was completely dependent on me for all his activities, yet I could keep him in a normal school till he completed his tenth year, and I held on to my job at the engineering college. Every day was a struggle. As predicted, he passed away at age 16 in 2000 and it was after that that I went for my PhD.

My PhD research required the fabrication of the liquid desiccant based system, which involved going to workshops to get the system made. We filed an Indian patent and a European patent for the system.

In recognition of my training abilities, I am classified as a Distinguished Lecturer (DL) of ISHRAE. I give talks on energy efficiency, renewable energy, geothermal systems and RAC for beginners.

I am the only woman in the Distinguished Lecturer list.

ISHRAE has an initiative called Women @ISHRAE, in line with Women in ASHRAE. Our aim is to encourage women in the HVAC industry to come forward and be trainers and leaders. I am proud to be one of the role models for this group.

To summarize, in India, with the power and reach of ISHRAE, we have been able to popularize the RAC industry with students, including large number of girls, and inspired their aspirations to enter the industry. Still, we have a long way to go. India has many powerful women politicians, but my concern is that in India, though many girls do opt for engineering, we still need women to come out of their comfort zones and emerge as leaders in the HVAC industry.



Indonesia

- Niniek Dyah Astriani
- Yuniharti Permana
- Vriska Sinaga
- Rinda Pertiwi Wiraadinata

Niniek Dyah Astriani



I am currently one of the active female members of the RAC sector. My name is Niniek Dyah Astriani. I am a civil servant, and more precisely, a vocational instructor in refrigeration techniques at BLK Tanjung, the Tanjung vocational training centre, situated in the northernmost part of south Kalimantan, Indonesia. Before that, I was a vocational instructor in electrical techniques at the same place, from 2012.

The year 2014 represented the height of my involvement with RAC. At the time, I had been shortlisted for vocational skill upgrading in refrigeration techniques at BBPLKLN Cevest Bekasi. This was one of the routine vocational skill upgrades held by INTALA KEMNAKER (Ministry of Manpower of The Republic of Indonesia-Vocational Instructor Directorate). Then, in 2015, I attended AC Training at Panasonic, Jakarta, and got a competency certificate of expertise in refrigeration techniques. Having participated in upgrade and training courses, I am now actively teaching vocational refrigeration, particularly split system AC, at BLK Tanjung.

My teaching and learning activities at the vocational training centre are quite successful – they started in 2015 and continue to this day. Every year, vocational refrigeration, and especially split system AC, consists in around two to four training packages, each totalling 16 participants, financed through both State budget (APBN) and regional budget (APBD) funds.

“Although I am a woman, I can compete with men in my field of work, namely, RAC. ”

There is a corporate social responsibility (CSR) programme set up by companies in the area. My students, whether male or female, are job seekers with backgrounds in senior high school or vocational high school. I provide and equip them with knowledge about AC based on my learning

and understanding. All the scientific and material knowledge that I give them can be applied directly, in the form of best practices, both in and outside the classroom.

The main challenge that I often face in teaching and learning is the scarcity of practical support equipment. The equipment owned by our vocational university is very minimal, so I have tried to add to it little by little, even though I sometimes have to use my personal funds. I ensure that every practice carried out by students continues, even with limited equipment. Up until now, assistance from the central and regional governments with the infrastructure of vocational refrigeration facilities has not received enough attention. However, the existence of these problems has not discouraged me from continuing to provide knowledge to students. I teach the basic theory of AC, AC electricity, AC piping, AC installation, AC commissioning, AC troubleshooting and AC maintenance.

Thankfully, most of my alumni already have jobs, whether they work in industry, the government or are self employed.

There was one source of pride for me along this RAC path: when I attended the RAC instructor competition in 2017. In the regional Kalimantan competition held at BLK Samarinda, the Samarinda vocational training centre, I managed to win the first prize (the only woman among ten competitors). I then represented the Kalimantan region as I advanced to the national instructor competition held at BLKI Semarang, the Semarang industrial vocational training centre (once again, the only woman among 12 competitors). My pride was not diminished by the fact I had to settle for seventh place at the national competition. This was extraordinary and unforgettable for me. Although I am a woman, I can compete with men in my field of work, namely, RAC.

Currently, I am active as an assessor in vocational refrigeration, especially split system AC, at LSP Bekasi, and I am also involved in an RAC Technician Association (Aptu Indonesia DPKalsel). Being part of the association enriched my experience, knowledge and skill. It also helped me build a network of RAC technicians in Indonesia.

Yuniharti Permana



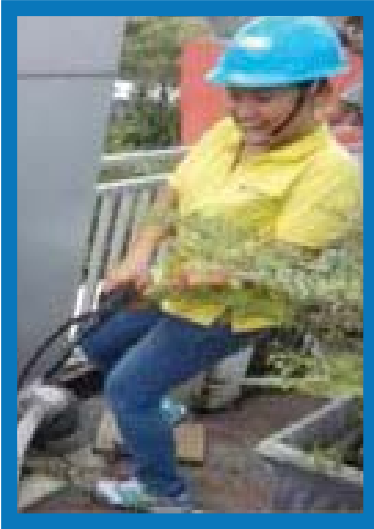
I am a woman interested in a technical field that mostly draws men. I studied mechanics in the RAC department of a polytechnic college in Indonesia. There were only three women in my class: all the other students were men.

I am currently working at PT. Fata Sarana Makmur, an AC manufacturer, as the head of the purchasing department. My job description is mostly ordering spare parts, from both local and international companies. There are some interesting parts in my job: using my knowledge, as well as gaining more knowledge, gaining experience by meeting with many different people, and also being responsible for making hard decisions. Another interesting thing is that I, a woman, am the head of a department, and I have three subordinate members of staff, who are all men. I am really proud of that.

“I am so proud of our achievements in support of the government programme and its implementation.”

Let me share my amazing experience with you. There is a programme in my country to change the use of R-22 to R-407 or R-410. The only reason is that R-22 is potentially damaging to the ozone layer, while R-407 and R-410 are much more environmentally friendly. Because of this issue, all the machines that use this refrigerant have to be replaced. However, that will be funded by the government. And finally, here I am. I am the person who is responsible for changing the machines. I ordered many machines from China, including computer numerically controlled (CNC) punching machines, end forming machines, CNC tube benders and manual expanders. The difficult part is not the ordering process, but how I deal with the handling and import procedure. At the moment, all the machines in the factory are new and working well. I am so proud of our achievements in support of the government programme and its implementation.

Vriska Sinaga



I have been working in RAC since 2011. At the beginning of my journey, I worked in different areas such as a vehicle insurance company in Jakarta and then the launch of my own cargo business. Unfortunately, those did not go well. Finally, I was inspired by my neighbour, who is an AC technician. I heard that many people were asking him about AC servicing and repairing. In a short discussion, we agreed to cooperate. I was thinking about advertising their services, as I had experience in that area. I published some advertisements on the Internet and set up a dedicated website. After that, many clients started calling to use our services. In order to develop this business, I asked my colleagues to participate.

My entrepreneurial instinct pushed me to do more. After about six months, I changed the model to that of a small company with some paid employees. It started out as a small company with a small rented office and four employees. I thought that I had to help my employees, so I provided them with a small living accommodation. However, it was not running as smoothly as I expected. Many things disappointed me such

as the technicians cheating me. Then again, the situation made me realize that I could not stop there. I had to find a better model for my company.

I had the idea of joining the technicians asking clients for direct feedback. That gave me many ideas about how to establish a good model for my company. By doing so and learning many things, I successfully developed my company. In 2013, I had 24 employees, with whom I continue to struggle to provide AC services, until the time came that DAIKIN Compressor Indonesia appointed us a DAIKIN Compressor Corporate Authorized Service.

I realize that this is not the end: my great journey has just begun. Under PT. Padimas Sejahtera, I kept developing my company by becoming a member of RAC APITU Indonesia (RAC Association in Indonesia). We have received many benefits from that decision, both for the company and for the technicians, since they can join many training programmes held by APITU Indonesia.

“ I kept developing my company by becoming a member of RAC APITU Indonesia. We have received many benefits from that decision, both for the company and for the technicians, since they can join many training programmes held by APITU Indonesia. ”

Rinda Pertiwi Wiraadinata



I started my studies at Politeknik Negeri Bandung in 2005, majoring in RAC and earning Certificate III in that field. I graduated in 2008.

After I graduated, I worked as a project estimator for a heating, ventilation and air conditioning (HVAC) contractor in Jakarta. My previous job was calculating the cooling load and designing duct and piping systems for AC units, as well as producing bills of materials and quotes for customers. In 2009, I decided to move from Jakarta due to family issues - my parents were worried about me living alone in a big city. I now live in Cikarang, Bekasi Regency, and work at PT. Fata Sarana Makmur. The company is run by an HVAC equipment manufacturer, and I have been working as a sales engineer. My duties are producing estimates and setting prices for evaporators and different types of RAC units such as condensing, air handling (AHU), ducted split-system and rooftop units.

At the beginning, I faced difficulties designing HVAC equipment such as how to choose and determine the proper size of evaporator and condenser coils for which I could not find the information in the catalogue and so on. I thus needed to design components by myself and I had no knowledge in designing HVAC equipment. This may have happened because the curriculum for my diploma was slightly different and mostly taught me about cooling load and duct design, not, unfortunately, the design of HVAC-R equipment. I gained more knowledge about HVAC-R equipment through a catalogue featuring coil evaporators, coil condensers and thermal expansion valves (TXV). My duties are as follows:

- designing and customizing HVAC equipment for customers.

The Engineering Department and I are in charge of choosing components and designing HVAC equipment (drawing equipment and producing bills of materials), then the Purchasing Department and I determine a reasonable price for each material or component.

- drawing up quotes for customers and negotiating.
- receiving purchase orders from customers.
- conveying sales orders to the Production Planning and Inventory Control (PPIC) and Production Departments.
- informing customers of the availability of the product when it is ready.



Iran

- Mahnaz Sayahi
- Takran Mobared Industrial Company

Mahnaz Sayahi



More than 15 years ago, I started a consultancy project with an old gas refinery, and it was necessary to visit the site in the process. The first time I went to the operational site, at the entrance gate, I found that all the communication tools warned that women could not enter the industrial area! Although I had passed all my safety training and they had a contract with my company to receive consultancy services, they could not allow a woman to enter the site: it was forbidden. It was then that I knew that this was exactly the path I should follow. It was the first, but not the last, situation in which I had to prove myself to the wide world of industry as a competent woman.

My experience of working in the industrial sector started in 2002, when I was working to complete my final thesis on flare gas recovery in petrochemical plants in the industrial zone of South Pars. That experience continued

in several oil and gas refineries and also small and medium sized factories, which provided me with great opportunities for growth and success, in spite of their predominantly male environment.

Challenges for women are not only stereotypes, but also the limited participation of women in many activities. In most of the projects in which I participated, I would be denied access to the industrial area or have to face hesitations to cooperate with me as a consultant at the beginning, because people had reserves as to a woman's competency in this regard. However, at the end of the day, I could always change the game, even when there was little opportunity for me to do so. It showed me that our industry has the capacity to develop its framework to accept cooperation with women. In our traditional and religious society, although women have been entering the industrial sector for several years, they have not been sufficiently involved in challenging and competitive situations. The absence of women in various activities reinforces old stereotypes, and the proficiency of women is either not known or ignored.

We need to practise, too, and I am sure that the industry is open and that there are fields, especially in environmental sectors, just waiting for women to help them develop. We need women who can serve as role models, not only for women, but also for men; women who are active in different areas and have enough skill to challenge the status quo. Role models strongly influence the way people communicate in the workplace.

At the moment, as a National Consultant on the Montreal Protocol Project, I have a professional relationship with several small and medium sized factories and I think it is my responsibility to come across as a confident, competent woman and step forward to balance gender in my country's industry.

“The absence of women in various activities reinforces old stereotypes, and the proficiency of women is either not known or ignored.”

Takran Mobared Industrial Company



More than 40% of the Takran Mobared Industrial Company's employees are women. These women not only work in managerial, administrative and engineering positions,

but also in production lines, along with men engaged in executive and operational operations such as head of production line, assembly operator, welder and so on.

Contrary to what is expected in a religious city such as Qom, where the company is located, women play an equal role to men in the family economy and contribute an important part to the family income. In addition, traditional and religious restrictions have not forced tradeswomen to stay away from the social and occupational worlds, and, contrary to what some politicians are hinting or stating, women are

actively involved in the workplace.

In the Takran Mobared Industrial Company, the presence of women is higher than in the average industrial workplace in Iran, as the board of directors is forward thinking and assesses men and women alike in their creation of added value for the company, in a balanced, equal way.

This is a surprise when it comes to seeing the number of women specializing in the corporate environment on any visit to the refrigeration factory, whether visitors come from government departments or private domestic and foreign companies.

“ In the Takran Mobared Industrial Company, the presence of women is higher than in the average industrial workplace in Iran”



Kuwait

- Fotouh Al-Ragom

Fotouh Al-Ragom



Of four siblings, I am the oldest and the only female. I have enjoyed studying STEM-related subjects, and energy has always been my main area of interest. During high school I joined a new curriculum that was in its third year in Kuwait. In that system, you could select your courses, and so I declared my specialization to be maths (maths and science were the options in STEM-related fields). One subject got my attention and that was RAC. I enjoyed that subject even though my close friends were against taking it as they thought it was a male-oriented subject. I loved learning about DX systems and their parts. Getting the highest mark in that class was the starting point of my future studies in mechanical engineering and my future career in a research institute.

After graduating from high school with a high GPA (that could have allowed me to enter medical school then), I chose to study mechanical engineering. At that time, back in 1985, medical school and engineering had a high demand for high school graduates, yet very little preference was shown for mechanical engineering by either gender. However, I persisted and made it my only selection for Kuwait University, not selecting any other option. During my years at university, while I was encouraged by my parents and professors, I sometimes found it hard to be in classes in which I was the only female. Yet I was determined to excel in this male-dominated field. I felt that this discipline needed more “female brain” to complement the work of our male colleagues. I have been on several training courses related to air conditioning as it was of interest to me and because I live in a hot and arid climate where the temperature can soar to 55°C in summertime, and summer is about eight months long.

“Women can be at the forefront of technological advance if they show the traits of success, mainly in the form of interest, motivation and perseverance.”

During my several training courses, I joined a car dealership to learn about car engines and their A/C systems, and I also joined the Kuwait Institute for Scientific Research (KISR), where I fell in love with my future profession. For two consecutive summers I skipped vacation time with my family; I missed seeing California, the USA and Cyprus for the sake of learning about

energy consumption in Kuwait, and I received training on how to make buildings more efficient to reduce cooling demand in Kuwait. In fact, I still have not been Cyprus! After graduating at the head of my national mechanical engineering class in 1990 (one semester before normal graduation), I applied to join KISR as a research assistant.

Now, 28 years later, I am still working at KISR and proud to be doing so. My work has mainly been focused on energy efficiency, specifically in relation to RAC. I have worked on several jobs that led to adoption of certain measures in the national code of practice for energy. I worked on evaluating the performance of RAC under high ambient temperature and utilization of indirect/direct evaporative coolers.

In 1992, I went to do my master’s degree at Northeastern University in Boston, Massachusetts. I graduated in 1995 after the completion of the course work and a master’s thesis on developing a heat exchanger part of a car ejector type A/C system utilizing R-134a refrigerant. After resuming work at KISR again, I was appointed to be KISR representative at the National Ozone Unit to take part in advising the Kuwaiti Government on RAC issues pertaining to the Montreal Protocol. I served on that committee from 1998 to 2006, when I left to pursue my PhD at the University of Florida, Gainesville. During the years that I worked at the National Ozone Unit, I worked on various programmes including technical and educational. I have also participated in providing general awareness presentations to the general public and kids at school.

I am currently a manager for the Energy Efficiency Technologies (EET) programme of the Energy and Buildings Research Centre (EBRC) at KISR.

The various degrees that I have earned include a Bachelor of Science in Mechanical Engineering from Kuwait University; a Master of Science in Mechanical Engineering from Northeastern University in Boston, and both a Master of Science in Aerospace Engineering and a PhD in Mechanical Engineering from the University of Florida. These degrees are all in what are traditionally viewed as male-dominated fields of study. Yet, while the hurdles are there and at a certain point in time might make a woman doubtful about her capabilities, it is important to know that both genders exhibit different capabilities and both can advance technology in their own way.

As my interest in the field of energy and RAC grew, I continued to further update my technical skills by being an active member of several professional organizations including the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), the American Society of Engineers (ASME), the Association of Energy Engineers (AEE) and the American Association for the Advancement of Science (AAAS). I also joined several women's organizations such as the Society of Women Engineers (SWE) and the Council on Women in Energy and Environmental Leadership (CWEEL). Joining professional organizations can empower any individual whether female or male. Joining women's organizations is indeed important to empower and encourage female professionals. I also take the time to give something back by giving talks (technical or motivational) to professional peers, the general public and students. I participate in programmes that empower women, specifically women in engineering. I joined the Kuwait University programme to encourage women to maintain their specialization in mechanical engineering. I have also joined the University of Florida female students' mentoring programme as a mentor for young students in STEM. Further, I became the first female Certified Energy Manager (CEM) in the Gulf Cooperation Council (GCC) region in 2001. Currently I hold other certifications, the latest being Certified Energy Auditor (CEA) of the Association of Energy Engineers.

In the course of my career I have received several national, regional and international awards, including the 2017 International Professional Development Award from the Association of Energy Engineers (USA) the award for Kuwait's Distinguished Female Engineer from the Federation of Arab Engineers in 2016, and the 2008 Energy Engineer Award category of the Emirates Energy Award (EEA).

I also co-founded the Kuwait chapter of the Association of Energy Engineers (AEE) and am currently serving as its president. I serve on several national and international professional committees, expert panels and technical boards including the AEE Certification Board and acts as Assistant Director for International Membership Development for the Middle East for the AEE.

As a scientific researcher I have worked on several projects and led others in the field of RAC including projects on alternative refrigerants and performance assessment of residential A/C systems using various refrigerants. Currently I'm working on the development of a national testing facility for RAC systems. I still have more to do in my career as a scientist. The challenges that we are facing to commit to sustainable development can be a source of inspiration for technology development. I would like to encourage young female professionals to pursue their career path if they choose such a path in RAC. Women can be at the forefront of technological advance if they show the traits of success, mainly in the form of interest, motivation and perseverance.



Malawi

- Mary Kapete
- Atupele Limbani
- Bridget Tambala

Mary Kapete

I have always had a passion for fixing electrical equipment, and when I realized that the RAC course had no women technicians in our area I took on the challenge of being the only woman doing it.

They were many challenges for me at the school as the only woman in a class full of men who were teasing me and not including me in practical classwork. Furthermore, we were lacking teachers well versed in the course, since many people here in Malawi have never done it, and as women we lacked someone who could be our role model to inspire people like me to greater heights. After obtaining my certificate I went into the industry, where I have continued to face challenges: other people have taken advantage of me at work because I am a woman, and yet others have not believed I could work as a technician. Because of that it's not easy at our company to employ female technicians since they believe women are lazy when it comes to mechanical work, and this has demotivated me. And here in Malawi we don't go further with our education because they



did away with the City and Guilds programme in 2015 because of the lack of practical work, which was a requirement to supplement the certificate. The other challenge has been that when I told my

“Because I believed that I could do it, now I am a role model for other women.”

parents that I was going into this field they weren't happy with the decision because they saw this course as unsuitable for women, discouraging me even further. With these many issues I almost gave up, but I didn't as I believed that I could do it, and so with hard work and perseverance I have managed to defy the odds and make it in this gender-biased field.

I have done two training courses on ozone-friendly gases, in which I learnt the advantages of using gases such as hydrocarbons and ammonia. These gases don't destroy the ozone layer. The only problem with hydrocarbons is that they are flammable, and so we just have to handle them with care. Ammonia is environmentally compatible, it does not deplete the ozone layer and does not contribute to global warming. It has superior thermodynamic qualities, and, as a result, ammonia refrigeration systems use less electricity. Ammonia's recognizable odour is its greatest safety asset – unlike most other industrial refrigerants, which have no odour – and because of that leaks are not likely to escape detection. There is also the fact that ammonia is a natural refrigerant.

I have always motivated my friends to do what I do and tried to tell them that they should not be afraid of doing courses that people claim to be only for men because it is rare for a woman like me to do this course. When other girls look at me they admire me, and they ask me why I chose this field, as it needs courage: sometimes we use ladders and scaffolds, which is risky, and without courage you cannot do it. I was also motivated because at my house there were a lot of refrigerators that were not working and it was rare to find a technician to repair them; one day we found this male technician who came to do it, and I admired how he did his work. I told myself that I wanted to do it though I was a woman and even my parents were not happy with me when I decided to do this course. But because I believed that I could do it, now I am a role model for other women, and my parents are happy because when we have a refrigeration fault I am the person they can call upon to assist.

I got my tertiary level education at Soche Technical College, where I obtained my Grade 3 and Grade 2 certificates in refrigeration and air-conditioning. Now I am waiting for the results of my Grade 1 in refrigeration, and I wish I could do more with my education. Here in Malawi the highest level is the Grade 1 certificate, but in other countries it is a degree, and so it's my dream to get more advanced knowledge of refrigeration and air-conditioning because I love this field and want to help more women not to look down on themselves by thinking that they can't do this line of work. I want to convince women that there is no work that is for men only; we women can do anything as long as we make the effort and have the support, and it's the world's duty to encourage us into this field.

Atupele Limbani



I joined the Refrigeration sector on 5th of September 2011 with Soche Technical College in the southern part of the nation. The training was not an easy road as we could not study some important topics just because they had no learning materials and no funds to buy such materials. For instance, for air conditioners, we only did the theory part whilst we failed to do the practicals because we had no installation materials which I only learnt at the industry during my internship period.

Through thick and thin I managed to graduate in December 2014, although by then I still had not fully gathered the required skills.

Going through the internship process was a rough road because each passing day we worked out in the field meeting different people with different motives. There were fellow technicians who really showed an interest to help you achieve your goals. They would correct you where you had made a mistake and advise you how to do it next time.

Though there were people who encouraged me to achieve my goals, there were some who took advantage of me. They proposed to me and at times would even threaten me that if I did not have an affair with them my marks would be reduced. By and by I coped and fought for what I wanted to be.

Refrigeration is one of the most challenging courses that I have come across. Going through my secondary years in education, I wanted to pursue what is challenging in nature; a course that will involve me in solving problems not just putting in long hours, but to get involved in problem solving. This happens to be the reason I chose to pursue a career in refrigeration and air conditioning.

“ I wanted to pursue what is challenging in nature; a course that will involve me in solving problems not just putting in long hours ... ”

Though being one of the best courses in our town, our country is still lagging behind, like the world is going digital and our country is still using analogue refrigeration equipment. It becomes so strange when you are called to work on a digital plant, but you do not know how to operate it. The training institutions also need to be upgraded. This includes training staff as well because we are taught some things that have been phased out of the industry and at

times not taught at all because we do not have the training materials.

In conclusion refrigeration is the best course so far, because refrigerators are a 'must-have', as well as air conditioners - both at domestic and commercial level - hence a call for good service technicians.



Bridget Tambala

I work on all refrigerating and air-conditioning devices, and I enjoy working in this field because it motivates me to help the communities around as well as organizations that need my services for their offices and projects. I attended my RAC course at Soche Technical College, where I passed the TEVET (Technical, Entrepreneurial and Vocational



Education and Training) Certificate Level 3 and the Trade Test Grade 2 in refrigeration and air-conditioning. I have received a lot of training

in theoretical knowledge, balanced with practical experience in a busy energy sector: at Nkula Hydro Power Plant (Electricity Supply Corporation of Malawi (ESCOM), now Electricity Generation Company Malawi (EGENCO)) in Malawi, where we were doing plant services at the power station for cooling machines and also domestic work in RAC. Working in this field offers a very challenging environment where the market and positions are male-dominated, and many companies underestimate us ladies. They think we are not capable of doing the job.

“Working in this field offers a very challenging environment ... they think we are not capable of doing the job.”



Mexico

- Marina Josefina Pérez Montiel

Marina Josefina Pérez Montiel

My name is Marina and I am 56 years old. I've been working in the refrigeration and air conditioning (RAC) sector for 26 years. My company is called Refrihogar. My father is a retired refrigeration technician and I obtained a bachelor's degree in economics. My daughter Maria Jose's age, 26 years, is exactly the same number of years I've been in the RAC sector. As a single mother, it was necessary to have a regular income as well as enough time to look after my daughter; and with my father's advice, I decided to open a RAC store.

In the beginning, it was not easy to grow and develop in a sector that was traditionally dominated by men, whether they were suppliers or clients. For them, trusting a woman who didn't have any experience in the area was difficult to accept. Nevertheless, I believe that this obstacle at the beginning became my main motivation for showing that, with training and determination, I can slowly achieve things which, at first, I thought I could never achieve.

After 10 years of working, I met Gonzalo, who was a refrigeration and air conditioning technician, and who eventually became my husband. He joined Refrihogar, managing the servicing department. Through capacity building, I discovered the importance of the sector in which I work; I discovered that refrigeration was essential in sectors such as food, health, tourism, research, and so forth. I also discovered its importance in terms of its impact on the environment.

I regularly update my knowledge of the sector through courses given by my suppliers, and I took one that changed my views on and motivation for continuing in this field. The course was called Good Practices in Refrigeration and Air Conditioning.

This course was a trigger because it motivated me to enrol not only Refrihogar employees, but also all the technicians that I knew through the business. I wanted them to become aware of the importance of our trade and its environmental impact. I wanted them to become aware that it was necessary to prepare ourselves for the changes that we were going face with the phaseout of chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). We reached out to the authorities at the Mexican Ministry of Environment and Natural Resources (SEMARNAT) who organized the course, and they informed us of what we had to do so that the course could be made available in the city of Oaxaca. With their invaluable support, as well as that of the school where the training took place, about 100 technicians were trained in our city.

As I mentioned before, with time, new challenges came and I was invited to take part in the opening of a recovery and recycling (R&R) centre in Oaxaca. I have to say that in the beginning, the desire I had to participate in and to have an R&R centre was very high because it was very difficult. I live in Oaxaca, in the south of the country, which is a state with the richest ancestral traditions and customs. For example, the municipality of San Francisco Lachigoló, where the R&R centre was eventually established, is governed according to traditions and customs. In the town hall, there were only men and no women. The mere fact of asking for permission to put up a centre that handled hazardous waste and industrial land use was a process that involved at least one year of visits only at night, since the service provided by the members is not remunerated and they could only work at night after completing their daily tasks. Convincing them that what we were trying to do was something good for the environment was difficult - even more so because I am a woman, because it was uncommon for women to perform this type of work. Nevertheless, it was gratifying to see that after a time, the municipal office saw that what we were



"We must promote the participation of new generations of women throughout the sector, supporting them and encouraging them to participate in a field of work that is becoming increasingly important."

doing was not dangerous, but in fact, quite the opposite.

We integrated the community into the project, hired people born there, and tried to ensure that the majority of the purchases for construction and maintenance were done in the community. I believe that women's achievements in fields where we did not participate before show us that our capabilities are equal to those of any person, and that we are not less strong, intelligent or capable; I believe that we must strive for equality in work, and for equal recognition of our capabilities in the RAC sector or any other sector in which we take part. We must strive for our empowerment.

Now, Maria Jose, my daughter, is taking over the centre for obsolete-equipment destruction. She has grown by participating equally in our work in the RAC sector. We must promote the participation of new generations of women throughout the sector, supporting them and encouraging them to participate in a field of work that is becoming increasingly important and in which our main goal should be equality and empowerment of women.



Mongolia

- Prof. Enkh Amgalan
- Undram Khosbayar

Prof. Enkh Amgalan

In 1985, I graduated from the Kuban State University of Technology in Krasnodar, Russia, which was then the Soviet Union. My training was in food technology. I started my professional career as a technician, then worked as a design engineer in various food industry related institutions in Mongolia. Since 1988, I have taught at the Commerce College, specializing in refrigeration technology. Even if I do not have in depth training in this field, I understood its importance. It was relatively unknown in my country at the time. The population of Mongolia was only 1.9 million and it was not common to have fridges at home. Only some State-owned dairy and meat producing factories and supermarkets had refrigeration equipment. Most of the servicing personnel, engineers and technicians for such technology were educated in the Soviet Union. Since 1996, I have worked as a lecturer at the Mongolian University of Science and Technology, where I set up a laboratory for food technology, including an operational refrigeration exhibit using an IF-56 compressor. In the 1990s, the Mongolian economy made the transition to a free market economy and many companies and structures collapsed. Only in the early 2000s did the economy start to recover, driving the mining, agri-food and construction and building sectors and creating demand for the engineers and technicians of the refrigeration and air-conditioning (RAC) sector.



“I put forward the proposal to create a course on cold chain refrigeration at the University of Science and Technology. It became official from 2007. Since then, around 57 students, about half of whom were women, have graduated with a degree in refrigeration technology in the agri-food industry. ”

In 2005, I put forward the proposal to create a course on cold chain refrigeration at the University of Science and Technology. It became official from 2007. Since then, around 57 students, about half of whom were women, have graduated with a degree in refrigeration technology in the agri-food industry.

Given the prevalent cold climate in Mongolia, harnessing the natural cold has been always my interest. I completed my PhD on the accumulation of natural cold underground for food preservation with the help of low-temperature resistant heat pipes.

I once attended the workshop on the Montreal Protocol organized by Mongolia’s National Ozone Authority (NOA), and, since then, I have been actively involved in their good practice training for RAC technicians and the strategic integration of zero-ODP and low-GWP refrigerant based RAC technology in Mongolia. I have been one of the organizers and founders of the Mongolian Refrigeration Association (MRA), which is now called the Mongolian Heating, Ventilation, Air Conditioning and Refrigeration (HVACR) Association and includes many people from the industry, including graduates of my course on refrigeration technology.

Undram Khosbayar



From my early years, I have spent most of my time with my cousins. The most interesting fact is that all my cousins are now engineers: an electrical engineer, a geological engineer, a mining engineer, a construction architecture engineer, etc. This might have influenced me, as I became interested in mathematics and physics in high school because I wanted to become an engineer. I was admitted to the Mongolian University of Science and Technology and got a Bachelor's degree in Mechanic Engineering of Food Production in 2015. When I was studying for a course named "Cooling techniques" in third grade, I gained information on cooling systems and cooling equipment. Following that, I did my internship at "APU" JSC, one of the major producers in the Mongolian dairy industry, and worked in the milk production cold chain. During my internship at APU JSC, I took part in installing and assembling freezing systems and full freezing equipment that had been manufactured in Germany for milk and dairy products. I worked under the instruction of senior engineers and experienced specialized staff. During that time, I really felt what it took to be an engineer. It was a valuable experience

and I understood essential parts of my profession.

I have been working as a lecturer for the Food and Technology Polytechnic College of Mongolia for about two years. I teach students specializing in "Repair techniques for the freezing and cooling systems of industrial equipment used for meat, milk, water and drink production". In my course, I cover the use of refrigerants, their proper selection and principles for the structure and operation of the equipment. I also give instructions on workplace safety regulations. Mongolia has been paying special attention to enhancing the skills of teachers and professors in this field and our government has organized a number of workshops to inform experts about new technology and future trends in the cooling market. For example, I recently participated in the "Train the Trainer Workshop on Good Practices in the Handling of R32 and R290 Based Split Air Conditioners and Heat Pumps" organized by the National Ozone Authority (NOA) of Mongolia in collaboration with the UN Environment OzonAction, Mongolia's Ministry of Environment and Tourism and the Mongolian Refrigeration Association, now the Mongolian Heating, Ventilation, Air Conditioning and Refrigeration (HVAC

" When I applied for a job after graduating from university, I often heard the sentence: "Will not hire female engineers!". "

R) Association. Unfortunately, Mongolia still has very few vocational training centres and laboratories with the equipment and tools necessary to provide students from the relevant vocational educational institutions, universities, and technical and vocational education and training (TVET) centres with professional training. I can share my knowledge and education with students in such centres.

On the other hand, most of the students in the field are male.

This year, I had 30 students and all of them were male. This is due to do the fact that employers tend to hire male workers as servicing technicians, repairers and installers for RAC technology. Also, it's a mainstream understanding in society that men have more aptitude in this field and are physically stronger than women. In this regard, I also faced discrimination. When I applied for a job after graduating from university, I often heard the sentence: "Will not hire female engineers!". Through my personal efforts, I worked as an equipment technician for a mining company and water-cooled alcohol producing factory before starting my teaching career. I plan to study for a postgraduate degree in food network and cooling system engineering to prepare skilful human resources in this sector and make my own contribution to its development.



Myanmar

- Kyi Kyi Pyone
- Mie Mie Nyo Win
- Myat Wut Yi

KYI KYI PYONE



I graduated from Rangoon Institute of Technology in 1986, obtaining a Bachelor of Engineering (B.E.) in Mechanical Engineering. I obtained a Master's of Engineering (M.E.) in Mechanical Engineering in 2000. Then, I became a lecturer at West Yangon Technological University (WYTU), teaching RAC systems as one part of the Mechanical Engineering subjects and supervising the theses of fifth year B.E and M.E students. I later joined the public sector, as I had got a government job. In 2001, I was appointed the head of the Mechatronic and Mechanical Engineering Department of Hmawbi Technological University, a government university attached to the Ministry of Science and Technology. I was then transferred to WYTU in 2011, where I still work as a lecturer. I have now taught for over 17 years. During that time, I've taught mechanical engineering subjects and supervised the theses of fifth year B.E. and M.E. students specializing in mechanics. Many subjects and projects are on RAC, and other subjects are linked to the government and private sector.

In 2017, I participated in a survey and collected data on the applications of ozone depleting substances (ODS) and alternative refrigerants in our country to establish the current consumption of ODS alternatives and provide future projections of growth patterns by substance. Before conducting the survey on ODS alternatives, a working committee was formed, gathering the representatives of all stakeholders from both government departments and the private sector. The parties involved were the Ministry of Commerce, Department of Trade, Customs Department, Ministry of Industry, Department of Research and Innovation, Environmental Conservation Department, Ministry of Natural Resources and Environmental Conservation, Ministry of Transport and Myanmar Engineering Society (MES) and other private sector organizations for the importers and distributors of chemicals (ODS & ODS alternatives) and RAC equipment and their respective service companies and end-users.

Without continuous efforts by the members of MES and all the stakeholders, it would have been difficult to conduct the survey and obtain the required information.

Training was provided through case studies of similar projects carried out by the United Nations Environment Programme (UNEP). This was very useful for the survey and analysis. However, due to a lack of time, we didn't reach the goal as we had expected, although we did our best and completed the survey.

I wrote an article entitled "Ozone Depleting Substances (ODS) Alternatives Survey in Myanmar", which was accepted for publication by the International Journal of Scientific and Research Publications (IJSRP) and included in Volume 8, Issue 9, the September 2018 edition. Another paper, "ACMV in Myanmar corresponding to Green Technology", was published at Pyay Technological University on 23 August 2018.

In order to share knowledge, the Air Con and Refrigeration Technical Division arranged training programmes at MES. Courses were completed and a total of 300 participants attended. I also supervised UP2 College, Chindwin TU International College Engineering Exam & Project Presentation. I developed questions for the Professional Engineering Exam (Air Conditioning & Refrigeration subjects and the fundamental engineering topic), the AAE Examination (Association of Southeast Asian Associations – ASEAN), the Inventor award (Ministry of Industry) and so on.

In conclusion, my regular duty and responsibility is to teach engineering students. However, the knowledge and experience I have gained in my training courses, workshops and seminars enable me to provide students with valuable knowledge about working in a real industrial environment and teach them to work as a team to solve technical and management problems. I do this by sharing my experiences and giving

“The knowledge and experience I have gained in my training courses, workshops and seminars enable me to provide students with valuable knowledge about working in a real industrial environment ”

guidance on their projects. Moreover, I volunteer in MES as Joint General Secretary and Secretary of the Air Conditioning and Refrigeration Technical Division. I support the Myanmar NOU in solving challenges. I may participate in training programmes to strengthen the capacities of RAC technicians in following good practices and properly follow and uphold best practices.

Mie Mie Nyo Win



As a woman in the field of engineering, it was not a very trying, but rather challenging, experience to enter the mechanical engineering workforce. My mother worked hard as a civil engineer and she has been very successful. She has greatly inspired me and helped me pursue my career. She also showed me a very good example of how to live and struggle within a challenging culture – that of the engineering field when you are a woman.

As a lecturer, I am currently working at the Singapore-Myanmar Vocational Training Institute (SMVTI), Yangon, Myanmar. In the School of Facilities Management, we teach courses in Building Fixtures and Equipment and Residential Air-Conditioning. The latter is my subject of interest, because air conditioning has become essential in our country and it needs a great deal of advanced technology and skilful technicians. I would like to take part in training such technicians with a view to filling these gaps in my country's development. Thus, I chose the Residential Air-Conditioning course, which includes four modules: Air Conditioning Wiring, Air Conditioning Controls,

Unitary Air-Conditioning System and Split Air-Conditioning System.

Previously, I worked as a mechanical engineering lecturer in three different technological universities. After hearing about SMVTI, which is a joint project between the Governments of Singapore and Myanmar that aims to support the vocational sector of Myanmar's youth and adults, I was interested and joined the institute to train and produce the skilful workers and technicians who will be able to seize the job opportunities offered by Myanmar's different industries. These people are essential for the development of our country. I believe that vocational institutes support the need for human resources, so, I want to play this role as a teacher.

“ I have a strong desire to collaborate widely with many industries and organizations in the RAC sector to strengthen our teaching methods and produce skilful workers and technicians ...”

Regarding education and training, I have completed the pedagogical and technical training (Train the Trainer-TTT) conducted by trainers from the Institute of Technical Education (ITE), Singapore. Furthermore, I attended the TTT Workshop on Good Servicing Practices for the Longer-term, Low-GWP Refrigerants in the RAC Sector provided by UNEP, the Ministry of Natural Resources and Environment Conservation (MONREC) and the Myanmar Engineering Society (MES) in Yangon, Myanmar. Recently, I participated in technical training on the Installation, Servicing and Troubleshooting of Residential Air-Conditioning Systems conducted by Peace Myanmar Electric Holding (PMEH) Company Limited and DAIKIN Air Conditioning Company Limited. I also attended a training course on insulation provided by Cool City Zone Company Limited.

From time to time, I prepare lesson plans with detailed schedules. I give my lectures using PowerPoint presentations with pictures and videos. I train students in the areas of AC installation, maintenance, troubleshooting and servicing. Moreover, I teach students about the installation of wiring systems so they can use that knowledge for air conditioners and other electronic devices. I also train students to work high up using sample scaffolding so they know how to work with heights

and how to safely use Personal Protective Equipment (PPE). The first session of the course focuses on safety awareness.

At the beginning of every workshop session, students must participate in the toolbox meeting, in which I give a short briefing to introduce the topic, safety guidelines and how to prepare the materials. Then, I give students their job sheets with the instructions on what to do, and the explanation of the instructions. A video is shown if necessary.

Occasionally, we invite experts from the RAC industry to share their knowledge about AC tasks such as maintenance, troubleshooting, servicing, insulation and so on. Teachers and students gain more knowledge and good experience from these extremely valuable sessions. Moreover, we visit industries and workshops to discover and learn about the real working world and ask questions.

Students have to take theoretical and practical exams. In their theoretical assessment, their knowledge of the theory is tested with multiple-choice questions. In their practical assessment, for the split AC unit module, each student has to install an air conditioner, purge the air, check for refrigerant leakages, run the system, measure the operating current, refrigerant pressure and air temperature and tidy up. For the AC wiring module, each student has to draw the wiring diagram, install the wiring system, check the continuity, polarity and current leakage and tidy up. I have to assess and score students' activities as they carry them out. After the exam, maybe on the next day, an overall tidying and cleaning operation is performed by students and teachers. This is also our good culture in our institute.

After school, some graduates get a job and work at different industries in the RAC sector. We invite them to come to the school to share their working experiences with the students to motivate them and give them the opportunity to ask the new employees about their working life. We are very proud of their achievements. We collect feedback from both graduates and industries to know graduates' competence and, where appropriate, how much more training they would need to have the necessary work skills. By analysing that feedback, we can adjust our training by preparing the curriculum to align with the industries' needs. Thus, lecturers do not only teach students, they also follow up with students after graduation to improve the standard of teaching.

Even in the educational environment, I have faced some challenges by virtue of being a woman in the RAC sector. Since air conditioning is a male-dominated field in my country, it is difficult for me, as a woman, to train students on AC activities such as servicing, installation and handling and dealing with the machines and accessories such as recovery units, vacuum pumps, gas cylinders, drilling machines, brazing torch sets and so on. However, I try my best. I also have to be more energetic in developing students' skills.

I have also faced some problems when units, tools and equipment are damaged during training due to frequent handling and usage. When that occurs, we service the units and change the tools and equipment. Sometimes, students can service units themselves under my guidance. Sometimes, I call outside service technicians to repair them. On those occasions, I can check and study their work. This is also a type of learning from others. Learning is endless for us. That's why we are continuously studying, so that we will be able to teach our students with confidence.

Another challenge is that some graduates work with different applications to those they studied at school. For example, although students are trained on only basic residential air-conditioning systems at school, sometimes they have to work with commercial air-conditioning systems. That's why we are trying to develop the level of competencies in the curriculum to keep abreast with the industries. For this issue, we need to invite the experts from the RAC sector and discuss the development of the curriculum. We are also currently trying to collaborate with the National Skill Standards Authority (NSSA) to enhance the skills of both students and teachers.

In conclusion, I have a strong desire to collaborate widely with many industries and organizations in the RAC sector to strengthen our teaching methods and produce skilful workers and technicians whose skills are essential to developing our country. As a woman, I would like to encourage other women to enthusiastically work in the RAC sector in the future.

Myat Wut Yi

I am a trainer in residential air conditioning at the School of Facilities Management, SMVTI Vocational Training Institute. I have been working for the school since the Institute was established. I now have over three years' working experience in this school.

Before I worked at SMVTI, I was a lecturer at three different technological universities in Myanmar, each located in a different city. During my time working as a lecturer, I also obtained a Master's degree in mechanical engineering at Yangon Technological University. When SMVTI started recruiting its staff, I applied for a job. At the time, I was interested in providing practical training to students who could not attend the university. I also wanted to train them to become skilful workers and enable them to find a job easily. And then, I was also interested in studying the RAC sector. That's why I chose to train students in RAC at a vocational institute.



“I was interested in providing practical training to students who could not attend the university. I also wanted to train them to become skilful workers and enable them to find a job easily.”

Before opening the Institute, we prepared the things we needed. First, I attended pedagogical training. Then I participated in technical training, both in Singapore and Myanmar. The trainers were Singaporean. During the training, I studied the basics of RAC with my colleagues in the RAC team. I then prepared documents such as lesson notes, lesson plans, PowerPoints and module schedules. I studied so many things to improve myself.

After starting at the Institute, I participated in school events such as orientation for students and parents, interviews to select the students, the orientation programmes, industrial visits and graduation ceremonies. At our school, all training courses take six months. RAC is consequently also a six month course. There are four modules in the RAC course:

Module 1: AC Wiring

Module 2: AC Control

Module 3: Unitary AC

Module 4: Split AC.

Until now, I have taught module 3, unitary AC, in the first three months of the course, and I also teach as a co-trainer in module 2, AC control, in the last three months of the course. Although the name of module 3 is Unitary AC, it is mostly about refrigeration systems. It includes five chapters:

- refrigeration piping systems,
- refrigeration systems,
- leak testing, evacuation, charging and recovery,
- installation of unitary air conditioners,
- selector switches in window units and starting electrical components of compressors.

During training periods, I teach the theoretical background knowledge using pedagogy and then train students in the practical activities with job sheets. First, I instruct them to fabricate the refrigeration piping one by one. Then, I have students form groups of two for the practical activities on refrigeration systems, refrigeration processes and AC installation.

On the first day of training, I introduce the tools and equipment to the new students. I also train them in clearing up. In the next days, I train them in each step of setting up copper piping systems such as flaring, swaging, bending and brazing. After they understand and can set up copper piping systems well, I let them install refrigeration circuits on their training boards. I guide them for the evaporator coil and capillary tube and then these are used in the piping circuit according to the job sheet. Then I train students in the refrigeration processes, step by step and repeatedly until they perform well. During training time, I always answer all the questions asked by students.

After that, I introduce air conditioning and the types of air conditioners. I then train them in the installation of window and casement units and also check how the students do test runs, record data and so on. I also teach them about the control components of window air conditioners such as selector switches, thermostats, capacitors, overload and how to find faults in them.

Part of my work is preparing teaching materials like lesson plans, PowerPoint presentations and so on, thinking up ideas on how to deliver lessons, preparing the tools, equipment and materials for the practical lessons, requesting material from our support staff and delivering the theoretical lessons and practical training. I also need to supervise students when they clean up and maintain the tools and equipment. Then I have to request the required materials for the next batch and condemn damaged tools. I have to do additional duties as instructed by the head of department and participate in school activities and events. I have also been a witness in an internal audit.

I have attended many training sessions supported by our school during vacation weeks. Thus, I am confident in how I improve my personal skills. Sometimes, I study RAC servicing from the technicians and experts of both MOU partner companies and other related areas.

I have faced some challenges because I am not skilled enough to repair RAC systems if there are errors in them - in the control system, for instance. Although I want to complete work experience in an industrial setting, I worry that I am not strong enough, not like a man. However, I believe that I can manage classes and also do well, not only as a trainer, but also as a learner in the RAC sector.



Namibia

- Hilma Panduleni David
- Foibe Kanlenga
- Nendongo Johanna Nangula



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Hilma Panduleni David

I think it important to ensure safe conditions during maintenance, repair, installation and inspection. I also encourage young women to take part in vocational training to update their skills.

I like teamwork because you can gain more skills from others and in the future you can own a company and create job opportunities for others.

I want cooperative education in the field of air conditioning and refrigeration that will challenge and strengthen my education and professional skills.

“I also encourage young women to take part in vocational training to update their skills.”

Foibe Kanlenga

My name is Foibe Kalenga, and I am a qualified technician with a National Technical Certificate (N3) in Refrigeration and Air-conditioning (RAC) that I obtained at the Namibian Institute of Mining and Technology (NIMT). I started my studies in 2010 and finished in 2014. I never had any idea of what RAC entailed until I was deep in the industry. It used to be a big challenge as I very much felt that it was men's work. As a result, at some point I decided to pull out in my second year. However, my mentor and instructor at the NIMT, Mr Karamata, encouraged me by pointing out how advantageous and inspiring it was to be a woman in RAC. His reasoning was that nowadays it does not really matter who is doing what job as long as it's done properly.

During and after my studies I worked for two different air-conditioning and refrigeration companies in Walvis Bay and Swakopmund from 2012 to 2015. These were Atlateck and Walvis Bay Refrigeration, where I was employed as a servicing, maintenance, installer and designer technician. That's where I gained more knowledge in basic and advanced refrigeration. I installed freezer rooms, cold rooms and air-conditioning in the bigger projects which I was entrusted with by my manager and managed the whole site and made sure everything was done as he asked. I am currently working for APM Terminals, and we are contracted by the biggest shipping line in the world, Maersk, in Walvis Bay. I am employed as a reefer container technician running a department with four other people (men) working under me. We specialize in servicing, maintaining



and repairing reefer containers, of which we do more than a hundred a week.

“My biggest motivation is my community at large and people in the RAC industry who see more potential in me than I do myself.”

My biggest motivation is my community at large and people in the RAC industry who see more potential in me than I do myself. When I started my current job I was referred by someone that I met in the industry. He introduced me to APM Terminals management and they didn't hesitate to take me as I had marketed myself enough not to have to introduce myself from a woman's perspective. APM Terminals promoted me to

department supervisor after four months and sent me for reefer training at Cape Town for two weeks. They continued sending me for training locally, and today I can proudly say that I believe in what I do and I can do what men can do.

I have a number of roles in my current job, as departmental supervisor, technician, safety representative, estimator and a mentor to my subordinates. I am also on standby every other week, as we are only two authorized drivers in the department; sometimes I get a call-out at midnight. It's not as easy as it seemed, but I committed to taking it. I love working in the RAC industry, since it requires one to think and troubleshoot before getting to the problem. It's an interesting career as it is mind-challenging. I have learnt how sensitive refrigeration systems can be with moisture and dust. I love what I do and am inspired by it.

In conclusion, RAC is literally the best industry to work in; it teaches you a lot and there is always something new to learn.

Nendongo Johanna Nangula

My responsibilities in RAC involve maintenance, repair, heating, ventilation, cooling and fault-finding. I am a qualified technician from a tertiary institution in Namibia. My field covers residential, commercial and industrial work.

This field motivated me to work on electrical components such as catering equipment and household appliances. In time I developed professionally and also improved my technical skills through work experience.

“In time I developed professionally and also improved my technical skills through work experience.”

I am willing to make a difference through RAC innovation, even though it is a challenge working with heavy items, e.g. carrying units and other heavier material. Also, the field needs updating every year because of changing material and the phase-out of some gases in the industry.





Nicaragua

- Angela Barreto

Angela Barreto

As a freshly graduated architect, I was convinced that I wanted to contribute to a more sustainable future for the built environment. That is why I decided to pursue a master's degree in environmental design and engineering back in 2011.

It was through this course that I became truly aware of the impact that buildings, and especially their heating, ventilation, and air-conditioning (HVAC) systems, have on our global energy demand and greenhouse gas emissions. Therefore, focusing on measures that would improve their energy efficiency became my main interest.

After graduating, I had the great opportunity to work as a consultant in South-East Asia, which allowed me to develop my knowledge of HVAC technologies and design principles. In the beginning, it was quite intimidating for me, as a young female professional, to enter a mostly male-dominated sector. However, thanks to my educational background, strong determination, and great support from my mentors, I soon found myself comfortably collaborating with electrical and mechanical engineers to develop design solutions for high-performance buildings.

“It is also my commitment to encourage female students and young professionals not only to become involved, but also to become leaders in the sector.”

Throughout my professional experience in South-East Asia, and now in Central America, ASHRAE standards have been my main guidance when it comes to performance criteria for HVAC systems and energy efficiency, thermal comfort, air quality, and refrigerant management. It was therefore a logical decision for me to become an ASHRAE member.

Motivated by the way entering the HVAC and energy efficiency world helped me broaden my professional skills and outreach, I moved back to my home country of Nicaragua in 2017 with a mission: to encourage other young professionals to develop a career in these fields. I gave presentations at the main private and public universities in the country and ultimately managed to gather 35 students to create Nicaragua's first ASHRAE student branch. The main objectives of this group were to foster interaction and collaboration between future professionals with architectural and engineering backgrounds, to introduce them to the HVAC industry, and to provide them with relevant literature and up-to-date knowledge through specialized presentations and activities. Unfortunately, because of Nicaragua's ongoing sociopolitical crisis, the student branch activities have had to be put on hold for now.

Nonetheless, I have continued with my work as a consultant. I am currently coordinating the sustainability and energy efficiency strategies for the new building of a high-profile regional institution in Managua that aims to become the country's first certified green building. My scope of work includes energy modelling for the adequate selection and sizing of its HVAC systems.

Additionally, I have carried on with my voluntary work for ASHRAE, which gave me the honour of being one of its representatives at the Twinning Workshop on Energy-Efficient and Climate-Friendly Refrigeration and Air Conditioning: Latin America, which took place this year in Guatemala. As a follow-up activity, I have contributed to the review of Kigali Cooling Efficiency Program (K-CEP) window 3 applications by providing technical insight on behalf of ASHRAE.

It is my commitment, from my position as a professional and educator, to continue working for the sustainable development of the refrigeration and HVAC industry in my country and in my region. It is also my commitment to encourage female students and young professionals not only to become involved, but also to become leaders in the sector.



Niger

- Mardiya Issoufou Addou

Mardiya Issoufou Addou



In 2007, during my eighth year in school, a repairman came to our house one day to repair my mother's refrigerator. After five minutes he handed her a bill for 36,000 francs. A week later, the fridge broke down again and a cousin who worked as a refrigeration technician came over and repaired it in less than 20 minutes. He explained to my mother that the other repairman had just swindled her. That day I promised my mother that in the future I would be the one to repair our fridge.

The urge to repair an air-conditioning unit, a job long considered the domain of men, came while visiting a sick aunt at the Issaka Gazoby Maternity Hospital, where the unit in her room had broken down and the repairman was on holiday. Her room was indeed very hot, and I had to use wet towels to bring down the temperature.

In 2010, while attending the Issa Beri technical school, I was offered seven different professional fields during a career guidance session. I chose a field that now brings me pride: refrigeration and air-

conditioning (RAC).

The challenges began with training, where for three years there were only two girls surrounded by 23 boys. I obtained my first qualification, a vocational training certificate (BEP), in 2012 and my second, a vocational baccalaureate in RAC, in 2013. I then spent the next two years as the only girl among 36 boys at the Ziniaré Vocational Training Reference Centre (CFPR/Z) in Burkina Faso, where the field of training is considered to be for men only. I met the challenges and finished at the top of the class. A big graduation ceremony was organized, attended by several notable personalities, where I was handed my third qualification, a technician's diploma (BTP), by the minister from Taiwan. Despite the looks and remarks that my work uniform elicits, I am proud to wear it all day long.

My experience encourages me to face the challenges, which can sometimes be an obstacle to obtaining the assistance I request from different financial institutions.

"I promised my mother that in the future I would be the one to repair our fridge."

From 24 August to 25 September 2013 I attended training on refrigeration and automobile mechanics for young people from ECOWAS Member States at a reference centre in Burkina Faso.

From 4 March to 5 April 2014 I did a practical internship at the Société nigérienne du charbon (Sonichar) in Anou-Araren. It consisted in monitoring and maintenance of refrigerated and air-conditioning units.

From 1 to 31 August 2014 I did a practical internship at the Operational Equipment Maintenance and Repair Service (SERMEX) of the Ministry of Public Health.

In 2015, after completing my academic curriculum and obtaining my degree, I was offered a contract as manager of the refrigeration and air-conditioning department responsible for monitoring, installing, servicing and maintaining all cooling appliances in the buildings of the Ministry of Foreign Affairs and Cooperation. The Issaka Gazoby Maternity Hospital also approached me in 2017 to hire my services for the hospital's permanent cooling system. On top of this experience, my servicing skills have been greatly improved through numerous household service calls.

Nigeria

- Esther Bamiwo Funmilayo
- Dr Charity Maeleera Kpabep

Esther Bamiwo Funmilayo

Educational background

I attended St John's Anglican Primary School in Oba-Ile (Akure) between 1977 and 1983 and had my secondary school education at Ejioba High School in Oba-Ile between 1983 and 1990. I then went on to the government technical college in Owo (Ondo State) to study refrigeration and air-conditioning between 1991 and 1994, passing Federal Labour Trade Test 2 & 3 and the Federal Craft Training Certificate in 1994. I also passed Trade Test 1 in 1998. In my quest for further education I took the National Examinations Council (NECO) examination in 2005 and the NABTEB (National Business and Technical Examinations Board) Ordinary Level examination in 2010, which then enabled me to obtain a National Diploma (ND) in Mechanical Engineering at Osun State College of Technology (Esa-Oke) in 2011, and because of my unquenchable passion for education I further gained a Higher National Diploma (HND) in the same field, mechanical engineering (plant & maintenance), at the same college in 2014.



Motivation and reasons

My childhood ambition was to become a nurse or medical auxiliary because I love doing things that bring comfort to others, but the first admission that came my way was for technical college, and the initial course I wanted to put in for was electrical/electronics. When I got to the college I saw some students dressed in white coats, very tidy, and that reminded me of my medical ambitions; I also noticed that most of them had cars. I immediately enquired about them and was told they were students of the Refrigeration and Air-Conditioning Department. There were 65 students and only two of them were female. I was led to understand that their head of department was a woman, who had just returned from overseas, where she had been attending a seminar workshop. Then I decided to switch my course to study refrigeration and air-conditioning (RAC) and have never regretted it.

Incentives

The thing that most motivates me about the profession is how my fellow women tend to admire me whenever I am on duty installing and servicing air-conditioning units. Moreover, among the female colleagues with whom I graduated, I am the only one that has a workshop.

Refrigeration and air-conditioning services cut across so many areas: households, hospitals, railways, aeroplanes, plastics, ships, etc. This also motivates me about the profession.

There were five instructors all with blue aprons on the staff of the department, but I saw a woman wearing a white apron who happened to be their head, and all the other instructors accorded her respect as she was putting them through how some instrument was to be used (e.g. a psychrometer to measure the relative humidity of the atmosphere, an anemometer to read air flow, etc.).

Working in the sector has brought me so many opportunities; as a member of NARAP (Nigeria Association of Refrigeration and Air-conditioning Practitioners) I've been able to meet people who have helped me positively and very resourcefully by adding value to my life and professional career.

- Working in the RAC sector has also helped me to further my education as well as sponsor and cater for my family.

“Working in the sector has brought me so many opportunities ... I've been able to meet people who have helped me positively and very resourcefully by adding value to my life and professional career.”

- As a woman in the RAC sector I feel so proud and honoured because other women give me respect and admire me.

Working experience

My first work experience was during my industrial training, which I did under the supervision of Engineer Akinsiku of Ondo State Radiovision Cooperation back in 1993, and our main fieldwork was at Stanmark Cocoa Processing Company Limited in Ondo (Ondo State), where we worked as contract staff in charge of the company's refrigerators and air-conditioners; through my working time there, I was able to see industrial air-conditioners and chillers face to face. Our job then included servicing, repair and installation.

Also, immediately after finishing technical college, I did a two-year internship training programme at Bayak Technical Services and Oguntoyinbo's technical company in Akure, where I was able to gain additional knowledge of installation and repair of refrigerators and air-conditioners.

At present I am working as a high-tech officer with the Federal Ministry of Trade and Investment; my job description includes servicing, repair and installation of refrigerators and air-conditioners both domestic and industrial.

Challenges

The major challenge of any profession in Nigeria is power (electricity). Power failure has become a great threat to the RAC profession as it slows down the pace of work.

- The issue of fake and adulterated products and materials (e.g. refrigerants, pipes and oil, etc.) makes work a bit difficult.
- The lack of (in-house and external) training, capacity-building and workshops on new technologies also contributes greatly to the challenges facing the sector and profession at large.
- Unavailability of equipment, most of which is very expensive, also poses a great threat, while others may include fake equipment, which wears quickly.
- There is not much capital to purchase most of the work tools.

Suggestions

The following suggestions are my personal opinion and I feel would help the women and men in the RAC sector to perform well in the profession.

- The Nigeria Association of Refrigeration and Air-conditioning Practitioners (NARAP) ought to organize periodic training for its members to upgrade their skills.
- Producer and international bodies in the RAC sector should give loans and grants to its members to support their work/businesses.
- Refrigerator and air-conditioner producers should organize seminars and workshops for RAC professionals whenever new products are produced.
- It's also necessary for producers and NARAP to set up a committee that would check items sold on the market so as to flush out fake and adulterated materials.

Dr Charity Maeleera Kpabep



My career in refrigeration and air-conditioning began when I gained admission to the Federal Technical College Yaba in Lagos and subsequently passed the West African Examinations Council examination in (technical) refrigeration and air-conditioning in 1986.

I was employed by the Rivers State Government to teach refrigeration and air-conditioning theory, science and practical in the Government Technical College, Port Harcourt, from 1987 to 1989. In 1989, I gained admission to study mechanical technology, which embraced refrigeration and air-conditioning. After graduating, I was employed in 2004 by Rivers State Polytechnic, Bori, to teach refrigeration and air-conditioning. During my employment here, I was given the opportunity to further my education. Hence I did an MSc in Industrial Education (Mechanical Option) and a PhD in Industrial Education (Mechanical Technology). From 2004 to the present I have been teaching refrigeration and air-conditioning at the polytechnic level.

I have supervised several student projects in refrigeration and air-conditioning, a few of which include design and fabrication of an ice block making machine, design and fabrication of a mobile cold room, design and fabrication of a fruit preservative refrigerator, and design and fabrication of a dual-powered refrigerator.

From 1996 to 2000 I also served as external examiner in refrigeration and air-conditioning for the National Business and Technical Examinations Board (NABTEB). My passion for refrigeration and air-conditioning motivated me to register as a maintenance contractor. Consequently, I was given the opportunity to maintain the oil movement central air-conditioner in the Port Harcourt Refining Company at Alesa-Elеме on several occasions. I also maintained split and window air-conditioners for hotels. One of the repairs carried out at the Port Harcourt Refining Company indicated that the unit was abandoned because of the level of contaminant in the system. However, because of my expertise, I was able to rehabilitate the central air-conditioner.

“I have supervised several student projects ... which include design and fabrication of an ice block making machine, a mobile cold room, a fruit preservative refrigerator, and a dual-powered refrigerator.”

I participated in a good practices refrigeration workshop in 2006 and served as a member of the committee that compiled the Training Manual on Good Practices in Refrigeration. I also took part in a hydrocarbon refrigerant workshop and a recovery and recycling training workshop in 2007 and a hydrocarbon refrigerant technology workshop in 2013. All participants in the above workshop were drawn from polytechnics in Nigeria and were given training equipment for training refrigeration practitioners in Nigeria. This training lasted from 2009 to 2010. A total of 11,000 technicians were trained in the country. An assessment of training centres was conducted for quality of training and I won the Best Trainer Award in 2010.

I was motivated by that award and consequently wrote a proposal through my Rector in 2011 to the Environment Commissioner in Rivers State for the creation of recovery centres to enable the trained technicians in Rivers State to fully install, repair and commission refrigeration systems without emission of ozone-depleting refrigerants into the atmosphere. The result was that the Permanent Secretary of Rivers State Ministry of Environment requested that I should train the environmental inspectors in the Ministry of Environment. With the assistance of Rivers State Polytechnic (now Kenule Beeson Saro-Wiwa Polytechnic, Bori), I was able to train 35 inspectors who were expected to do a follow-up on the technicians when the proposed recovery centres had been established. Unfortunately, my dream of the recovery centres was never realized.

Papua New Guinea

- Jodie-Marie Lavu
- Geam Sam

Jodie-Marie Lavu



New Day, New Challenge, New Experience....

I became an air conditioning technician without knowing anything about air conditioning or refrigeration. My name is Jodie-Marie and this is my story.

Going from working as an accounts clerk under the chief accountant of a renowned Papua New Guinean logging company to becoming an AC technician was an exciting but challenging transition in my life.

Today, I have worked in the field for just over six years and nothing excites me more than facing the challenges of each day at work. And just so you know, challenges are not only in the workplace if you're a female technician in a developing country. These challenges are not only physical, but emotional, mental and spiritual. Speaking of challenges, I personally think that to be a female technician in the RAC field, you have to possess the strength of a warrior to literally get through the day. My typical day starts at 5 o'clock in the morning and the challenges actually start at home, where I have to carry out my responsibilities as a wife and mother. After a normal eight hour shift at work, or longer, if needs be,

when I am attending to breakdowns, I have to again fulfil my duties at home such as preparing dinner, washing up, doing the day's laundry, cleaning up my children's mess and helping my eldest son with his school homework, etc., finishing my day at around 10 or 10:30 p.m.

The challenges I face at work are mind blowing. I encounter men who underestimate me just because I'm a woman and men who cannot work with me because it's a traditional taboo for them to work with women. I am ridiculed in the workplace by men who still believe women don't belong in the field. There are also men who cling to me and offer me anything and everything because I, as the only woman at my workplace, am the centre of attention. The job and its tasks themselves present physical and mental challenges, which can be overcome by working not so much hard as intelligently, with determination and, above all, a willingness to learn from others. I can improvise, adapt and thus overcome a situation. I believe the RAC trade belongs to a more sophisticated field than most people would believe. I find it more and more interesting every day. Every new day starts with a challenge, a new experience is encountered, and you keep learning and learning each and every day.

“ Just so you know, challenges are not only in the workplace if you're a female technician in a developing country. These challenges are not only physical, but emotional, mental and spiritual.”

You're probably still wondering how an office person in short skirts and heels become an AC technician in protective clothing and work boots. Well, to cut a long story short, back in 2011, I applied for a TVET scholarship to study information & communication technology (ICT). The confusingly interesting part was that my application was successful, however, the course name on the acceptance letter from the Institute was unfamiliar to me. It listed "Certificate II in Air Conditioning Split-Systems". I was struck with confusion, but had hope that this must be a mistake or typing error. Goodness, I wanted to cry upon confirming with the scholarship coordinators that it was not a mistake: I was listed under that course with ten other scholars and streaming into the courses was done by the Institute, not them. I was advised to sit in for a week when I mentioned lodging a conflict of interest letter with the Institute to my dad so that, if it was possible, I could register under the course I had initially applied for. Years down the line, I'm glad I took that advice and I have no regrets about this amazing transition.

Today, I am completing my "Certificate III in Refrigeration and Air Conditioning" and proud to say that I am one of the first groups of Stage 3 at the erstwhile Australia-Pacific Technical College, now the Australia-Pacific Training Coalition (APTC). Its motto is "Creating Skills for Life" and it is an Australian project to

help the people of the Pacific Islands. It is a privilege I will forever be grateful for. Moreover, I am enjoying every bit of this career path. I hope to be a trainer in this field sometime in the future so I can impart my knowledge and skills to young, aspiring RAC technicians, and especially women, so I can share my experiences with them and encourage them to continue in their career as RAC technicians, as most tradeswomen in our country tend to leave their job once attached or married. There are various reasons for that such as domestic violence from jealous partners, the salary, physical challenges at work or harassment in the workplace, to name but a few.

Geam Sam



My name is Geam. I come from Papua New Guinea (PNG) and my mixed parentage links me to three different provinces: Morobe, Oro and Central. I started to gain technical knowledge by embarking on a two year RAC course at one of the vocational training schools in PNG, Badili Vocational Training Centre, Port Moresby, from 2004 to 2005. While attending Badili Vocational Training Centre (BVTC), I was chosen to do my on the job training (OJT) with DAIKIN Air Con Engineering Company for three months. The company was interested in recruiting female apprentices during my training, so the company offered me the opportunity to continue my OJT till November 2005. I graduated from Badili Vocational Training Centre with a trade certificate and the DAIKIN Company had given me a certificate of completion for completing my on the job training. I worked for

“The more I throw myself into the job, the more quickly I get attached to it and I make the men’s world my world.”

DAIKIN for four years, as an RAC trade assistant from 2006 to 2008.

I signed my contract with the company and became the first female apprentice the company recruited in 2006. I worked for DAIKIN, Port Moresby, for four years and then transferred to the company’s other branch in Lae, where I currently reside. From 2010 to 2014, I worked as an RAC Service Estimator doing RAC service quotes. In 2014, I resigned in order to pursue further studies.

Motivation and reasons

To be honest, I knew nothing of the RAC trade, but my father, a tradesperson himself, was my role model. He is more specialized in the trade of carpentry and joinery. He always said that people who graduated from vocational centres and technical schools were very skilled and that companies mainly wanted to hire hands on recruits with experience and technical skills. That is why I found myself interested in taking up a technical trade. When I entered the technical centre, I found out I was one of the few ladies to have applied for the RAC course. With time, I find myself amongst only men in the trade I was learning. RAC is not like any other trade, from what I have experienced doing what men generally do – installing AC units, changing compressors and motors and servicing all types of RAC units and all other related jobs. Something new and different comes up every day while I train and work. I challenge myself to equal the men in my trade. Every day, learning new things, I find myself putting a great deal of time and effort into doing what must be done to prove to my male colleagues that I’m capable of doing what they can do. That is one of the challenges I have faced in my experience as a female RAC technician. I have a positive mindset. Every time I do a job, I say to myself, “If a man can do it, I can do it”, and that is what has brought me this far. Working in a male dominated field is very challenging, but I find myself flexible with my work colleagues: being part of a man’s world is not an issue anymore. The more I throw myself into the job, the more quickly I get attached to it and I make the men’s world my world. I gain the confidence to work amongst men, and not just confidence, but respect and trust, bestowed by everyone. I am also treated with honesty. I love my job and what I am doing. I’m proud of what I do and who I am today and I’m looking forward to achieving my goal of becoming an RAC Tradeswoman in the future.

About my studies

Through the media, I found out that the Australia Pacific Training Coalition (APTC) was hosting a two-day programme to recruit new applicants. I was one of the several applicants to apply and I was given the opportunity to sit the entry exam. After a year, I received an email from APTC informing me that I had been accepted. I was speechless and so excited. It was like a dream come true for me – I had always wanted to study at APTC. I'd always waited for that moment and now I was lucky enough to have the opportunity to further my knowledge and learn new things.

Being here at APTC is a privilege. My studies are interesting, I have been learning new things for the past two months, about the proper way to handle tools and the standard Australian RAC operations. In my training, I also learn computer skills. When it comes to writing and submitting RAC reports, it helps to understand how to go about doing it.

In my country, I'd heard that only men could work in the RAC trade. I thought to myself that only men could do this job, because they were men and they were strong enough to carry and lift machines. I told myself to give it a go.

If my country can have other women do men's work in other big industries, I feel positive about moving forward and not worrying about people saying the job is too hard for women. Some ladies work in the automobile sector, becoming mechanics and welders and so on. I chose the RAC trade because all the men I spoke to said RAC was quite a hard job for women. I find the RAC trade very interesting. In my working days, I was one of two ladies. We were the first female apprentices to be recruited as RAC technicians.

In the future, I believe APTC is the key to my future and, even currently, doing my studies here at APTC, APTC is creating skills for life and I feel that my future has already begun.

Peru

- Karla Magdalena Arguedas Sánchez
- Marlene Estefa Huaman Huanaco
- Iris Milagros Vegas Valverde

Karla Magdalena Arguedas Sánchez

Since I was small, I have loved repairing things at home: the electric stove, the iron, radios, and so on. When I was asked what I wanted to be when I was older, I would say I wanted to be an electrical engineer. I was sure God gave me a gift, as I was able to repair things without having studied how to do this.

My mother did not understand this and would always reprimand me because I loved doing “men’s stuff”. She insisted that I should focus on work for women, and so she enrolled me in sewing and teaching courses, which I ended up dropping because of a lack of motivation.

I relentlessly persevered with my mother, and with my father’s help, I was able to enrol at an institute in Cañete Province, where we lived, and I signed up to study technical electronics. At the time, my father worked as a farmer, but as a result of the El Niño phenomenon, he incurred heavy losses and was forced to find a job in the city of Lima to be able to support us.

Things changed while my father was in Lima. For the first few months, he needed a lot of money to get settled and the little he sent us was only enough for my siblings’ schooling, food, and household expenses. My mother had to find a way to pay for the transport fare for my older sister and me. That is why my mother sent me to join my father as soon as his situation in Lima improved. Moving to Lima was a great opportunity. My father asked me to choose to study at either an institute or a university. I did a lot of research on electronics degrees and chose the National Service for Industrial Labour Training (SENATI). I enrolled in the refrigeration and air conditioning course because I was told much about



“Over time, I have learned and gained experience, and today I can say that there is nothing impossible for us women. When you love what you do and you work hard for it, everything is possible!”

its electronics module. The more I studied the modules, the more I liked everything I studied – electricity, welding, machining processes. When it was time to take the famous electronics module, it turned out to be only a basic module which lasted 15 days. However, I was not disappointed because I was about to finish my degree and I was delighted with everything I had studied.

Studying for the degree was not easy, and I did not mind my classmates’ behaviour towards me, but I would wonder, “why do they do that?” They would hide my work, take my food, hide my backpack, or when I would start welding, they’d throw a rag soaked with thinner at me. There was one classmate with whom I always had problems, and so one day, my cousin, tired of the stories I would tell him, went to SENATI and waited for this person at dismissal time to give him a firm warning. This made things worse for me. This person was the head of the group, and soon afterward, nobody was talking to me anymore. My friends were guys from another specialty. But as the saying goes, nothing lasts forever. I joined a football competition at SENATI, and one day, my team came looking for me when I was in class, about to take a quiz. The teacher allowed me to leave to play football, but the other students started complaining. The teacher closed the door and asked if everyone wanted to take the quiz; obviously, they all shouted “no”. So he said: “This is what we’ll do. If Karla scores a goal, everyone is exempted from the quiz. If not, everyone gets a failing score at the end of the game.” I remember that it was then that, for the first time, I was treated nicely by my classmates and that everyone cheered for me throughout the entire game. We were all given a passing grade for the test because that day I scored three goals.

Since then, I have gotten along well with every one of my classmates, but I still thank them for how they treated me in the beginning because this prepared me for what life later had in store for me. When I left SENATI, I encountered many obstacles in my career, but I always held on to my beliefs.

Over the years, I've always applied what I learned during my time in school to help me in my professional career: universal welding (course completed), electrical studies (course completed), and specialty refresher courses at universities.

In my work as a technician, my supervisors always doubted me at first. I remember one company, where I was hired with five other technicians and the male technicians were paid more than me. I told myself that even if they did not value me, I was there to learn and get experience, which is more valuable than money. After some time, I became the team leader, and those who had started with me were now under my supervision. Obviously, I was given a raise because I had more responsibilities. I stayed at this company for five years, and it was there that I also met the man who became my husband and the father of my daughter. Unfortunately, I was forced to resign, as I had a risky pregnancy.

After I gave birth, my bosses asked me to return, but my husband and I decided to start our own business. Starting the business was not at all easy. When he left for work and I had to travel, it was my mother who stayed with my daughter. The first time I had to travel, my baby was only 15 days old, and I still remember the pain and guilt I felt for leaving her. It was a time of great sacrifice, but I always thought the sacrifice was worth making in order to have something in life and to ensure that in the future my daughter can be proud of her mother.

In business, as in life, there are ups and downs, but I have always made it a point to have a positive outlook. My husband and I eventually divorced, and now, my company has been in business for about nine years. I've inspired my brothers, who now are also in the refrigeration and air conditioning (RAC) profession. They used to work as technicians in automotive mechanics. We are now all working together in the family company. Over time, I have learned and gained experience, and today I can say that there is nothing impossible for us women. When you love what you do and you work hard for it, everything is possible!

Marlene Estefa Huaman Huanaco

When I was a little girl, I remember my father painting refrigerators for work, and as an innocent four-year-old, I would help him sand the fridge surfaces with my little hands. This is how I got started in the world of refrigeration. I grew up surrounded by refrigerators, compressors, tubing, refrigerants, and the like. In the summertime, which was the high season for our repair shop, we had lots of equipment that needed repairs or maintenance work; as the eldest sister, I helped with purchasing spare parts, sorting out the budget and invoices, or taking calls from clients. We all helped at the repair shop – my younger brothers and nephews, as well as my mother.

At the repair shop, I knew all the tools, and there were even occasions where I had to refill some units with refrigerants myself, while they were being tested. There were also times when I had to do in-home repairs of some equipment. Some clients doubted whether I was able to do repairs, while others were surprised to see me use my tools, but I was just doing my job. There were times when I would



check a system and the compressor didn't have labels or electric circuits because another technician had removed them. I therefore had to find out on my own, by contacting the suppliers, exactly which spare part was needed, and I had to get the original parts, such as controls, sensors, and other parts.

After finishing my secondary studies, I applied to university, but unfortunately, I was not accepted. Discouraged, I applied to the National Service for Industrial Labour Training (SENATI), and when I received my admission documents, I was surprised to learn that there was no other female student in the programme – everyone was male. I was the only girl in my group, and despite thinking that I would have problems or issues with the other students, I was mistaken. I found a great group of friends, and in my two years of studying at SENATI I learned a lot about air conditioning and industrial refrigeration equipment under the guidance of my teachers. Of course, I was already more familiar with the tools, but I never told my classmates.

***“My boss would always tell me:
“When you come to do maintenance
work on a unit, everything around
you should be as you found it once
your service work is done”***

It was not easy to get into the company where I did my apprentice training. They tested me for several weeks, but I showed them, through my work, that I could handle it. During my time at the International Potato Center, I met good colleagues and had excellent bosses. I learned a lot from them. We did everything from repairs to preventive maintenance to the adjustment of

refrigeration and air conditioning (RAC) equipment. We had all kinds of tools; we even had a refrigerant recovery unit. This was in 2005, and we were still using R-141 to clean the circuits. We also performed washing and then flushing with nitrogen, and even with the same refrigerant from the unit – R-22; we'd request a spare part and they'd bring it to us. The units cannot stop functioning. When our intervention was completed, my boss would always tell me: “When you come to do maintenance work on a unit, everything around you should be as you found it once your service work is done. If there is something requiring improvement, communicate it, then do the necessary work. Never leave things half done.”

Later on, I decided to work as a freelance technician and to return to our family repair shop. Through the years, our list of clients has grown to include minimarkets, restaurants, cafés, ice-cream shops, and other businesses that call upon us for the RAC services we offer. My younger brother has become my right-hand man, I also work with my sisters, and my father, with all his experience, is still at the head of the company. Currently, I go out to check on RAC units, loading my backpacks with the necessary tools, showing that we continue to learn more each day with honesty and respect – because there is no such thing as big or small customers, we must treat all customers equally.

Iris Milagros Vegas Valverde

My story began in the 1980s, when I started studying industrial refrigeration at the National Service for Industrial Labour Training (SENATI) in the city of Chiclayo, Peru. There were 12 of us (10 men, two women), and it was a struggle to be accepted in the group, which we eventually succeeded in doing.

Over time, I began considering the course as precision mechanics, and each day, I continued falling in love with what I was studying because it dealt with subjects from the simplest to the most complex. I always referred to it as my “magic thingy”.

Years went by, and I completed the course and started working in shops repairing refrigerators and cold chambers; with time, I continued to acquire experience in refrigeration.

I then began working in sales and technical consultancies for a leading refrigeration company in Lima. Over time, I fell in love and had a child, who has become my reason to live. However, the company did not accept people with children because it seemed to the people in charge that they are not as productive as those without children, and therefore not as profitable.

“Leaving the company to have my child was very painful because I felt I brought much to my team at work. However, instead of lamenting my fate, I let this push me to go forward and to never give up.”

Leaving the company to have my child was very painful because I felt I brought much to my team at work. However, instead of lamenting my fate, I let this push me to go forward and to never give up.

I’ve gone through many experiences, including having a partner opposed to my work because he saw that I worked with so many men. However, this did not stop me and, on the contrary, I pushed on and grew professionally.

I then worked for an NGO, where I taught young people with low-income backgrounds, especially women. We trained many young people in refrigeration, and a great number of them continue to work in the sector up to this day.

I kept working with this “magic thingy”, and my expertise helped me start my own small family business. My son, who has been immersed in this environment since he was small, is now part of this venture.

In the world of refrigeration, you make many friends and many of them are men. Today I am the vice-president of the Peruvian Refrigeration, Air Conditioning, and Ventilation Association, where we organize capacity building for technicians and people working in the refrigeration sector, and I personally address women to empower them in the air conditioning environment.

Thanks to my profession, I have managed to keep a spot in this market and help colleagues through technical consultation and training.





Philippines

- Raquel Dumayas
- Maria Yzabell Angel Palma

Raquel Dumayas

Why I enrolled in a RAC technology course

Before I started college, my parents considered sending me to the University of Southeastern Philippines (USEP), a State university in our region where the tuition fee is affordable for an average income family. My first choice was to enroll in the College of Education, but since there were no slots for me in any of its courses, I tried to enroll in the Philippine College of Technology (PCT). It so happened that the only course available was the Bachelor of Industrial Technology, with a major in RAC Technology. That is where my journey started.

What motivated me to pursue the course

During my first semester, I started to appreciate the beauty of the course and the opportunities it offered. Semester after semester, I fell in love with the course until I successfully finished it, excited about the opportunities that awaited me. Out of the 14 students enrolled in the course, only five of us graduated on time. I graduated with a Bachelor's degree in Industrial Technology-Technology Teacher Education major in Refrigeration and Air-Conditioning Technology. During the Licensure Examination for Teachers, I was one of only two graduates in our class to pass. This simply shows that when you enjoy your learning, you will end up happy, successful and fulfilled.

My Work Experience

As I was seeking career opportunities to practise what I had learned at school, I arrived in General Santos City, where I was hired as a trainer in RAC technology at the General Santos National School of Arts and Trades (GSNSAT). GSNSAT is a Technical Education and Skills Development Authority (TESDA) administered school that offers training in trade skills. TESDA is a government agency tasked with managing and supervising technical education and skills development (TESD) in the Philippines. My experience as a trainer at GSNSAT enabled me to become a more productive worker in the field of RAC technology. I was sent to different enhancement courses in different companies such as DAIKIN and Gesellschaft für Internationale Zusammenarbeit (GIZ) to be exposed to new technology in the heating, ventilation, air conditioning and refrigeration (HVAC R) sector. My exposure to those companies broadened my perspective in regard to the significance of this sector as we move forward to a highly industrialized country. Thus, I have more of an appreciation for advancements in green technology.

Challenges in my career

The more I enhance my trade, the more I love my career in the field of RAC technology. I believe that I can give more to the community and lend a great deal of assistance to women on the same career path as mine and those who are considering being or aspiring to be one of us. This desire led me

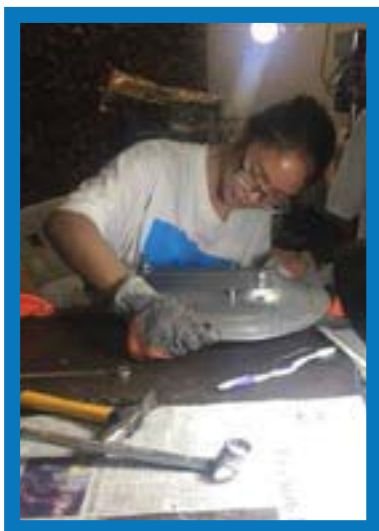
“I believe that, like men, women can conquer any challenge, because women are innovative problem-solvers who are relevant in the world of industrial technology.”

to further my studies by enrolling in a Master's degree in vocational education at the University of Southeastern Philippines (USEP), Davao City. While I was considering the topic of my dissertation, as I was especially driven to inspire and motivate women wishing to work in this field, I considered some of the difficulties women might encounter during this kind of career. As a trainer in RAC technology, I came up with a dissertation proposal to design and produce a “snap-on hand-type pinch-off tool”. This is a device used to help women working in the RAC servicing industry, a field that is usually dominated by men. The device started as a prototype and was then developed to make pinching operations requiring tight seal pressure easier for women. Before I graduated from my Master's studies, I was able to successfully invent the device. This success was driven by my deep desire to contribute in this kind of industry. The invention was already registered for a patent at the Intellectual Property Office of the Philippines on 11 April 2014, under application number 1 2014 000119. This breakthrough promotes



gender equality in the workplace, especially since the technology used in the industry is typically operated by men. I finished my Master's degree with a deep sense of fulfilment, knowing that in one way or another, in pursuing a career in the RAC industry, I had been able to inspire women. I believe that there are many ways to inspire people in any career path they could take, and this is the kind of inspiration I could give them. I believe that, like men, women can conquer any challenge, because women are innovative problem-solvers who are relevant in the world of industrial technology.

Maria Yzabell Angel Palma



The welfare of those living on Earth is perilously endangered; the possibility of extinction is even becoming an everyday challenge for different lifeforms. I support the hypothesis that these threats come from the emission of greenhouse gases (GHGs), and primarily that of CO₂, initially believed to be caused by the massive burning of fossil fuels by the world's economies.

More alarming, a greater threat is now arising from the use of chemical refrigerants in the RAC sector. As the findings of scientists proved that the likes of the "Freon" refrigerant deplete our planet's ozone layer, the United Nations' Montreal Protocol subsequently and successfully banned the production of such chemical refrigerants. As the chemical refrigerants in question have been phased out, it has been discovered that one kilogramme of the now widely used hydrofluorocarbons (HFCs) is roughly equivalent to as much as 20,000 kilogrammes of CO₂ in terms of global warming potential (GWP). In monitoring the production of air conditioners, the Japan Refrigeration and Air Conditioning Industry Association (JRAIA) reported that in 2016, world demand amounted to

more than 100 million units, and was increasing annually. In another study, world demand is estimated to reach 700 million units by 2020.

The United Nations Kigali Amendment to the Montreal Protocol requires the phase-out of HFCs.

The International Federation of Inventors' Associations (IFIA) published an article about my invention on 12 August 2018, entitled: "AirDisc: A Timely Response to Global Warming". Likewise, I have received various awards, mostly gold medals, from different countries. I was personally invited to present my "AirDisc" invention in Geneva, Switzerland, by the President of IFIA on the occasion of the federation's fiftieth anniversary, but I was not able to attend due to school requirements for my graduation. I was conferred high honours and the Philippine Science High School System's Excellence in Leadership Award. In Naga City, Philippines, where I live, I was also awarded the most prestigious youth award, entitled "Jesse M. Robredo Youth Award" on 16 June 2018. Recently, I have been invited to attend BIXPO, an international conference and invention fair in South Korea organized by the Korea Electric Power Corporation. Presently, I am very busy accepting media interviews from different media outlets. I have applied for a provisional patent, which has been approved by the United States Patent and Trademark Office (USPTO). I also plan to apply for an international patent with the Patent Cooperation Treaty (PCT) within the prescribed timeframe. I have formed a team to help me confer with different air conditioning companies so that I can also have enough time for my school requirements as a freshman of De La Salle University under the College of Engineering– Mechanical Engineering programme.

" I consider myself a researcher and, now, inventor for our planet. I am seriously concerned about the dire state of our Earth with respect to climate change. "

As my invention, the AirDisc (air conditioning technology), which uses the air that we breathe as a cooling medium, is an effective substitute to chemical refrigerants, I have already encouraged many women to take interest in my invention and in the fields of science and technology. They are particularly interested

because my AirDisc will use only 150 watts of electric power, as opposed to chemical refrigerant air conditioners, which need 1200-1500 watts. For the information of the public through the Philippine-based OzonAction and this very publication ("Women in the Refrigeration and Air conditioning (RAC) Sector"), a group of women has been encouraged to form an organization, which they have done, named STEMGirlsPH, to promote women's empowerment, especially in the field of air conditioning, science and technology.

When I made my courtesy call to Ms Elsie Ferrer, Campus Director of PSHS-Bicol Region Campus, to thank her for all the support she had given me and her encouragement to join international contests with my invention, she told me that one direct result of media coverage was that students in my beloved alma mater had been so encouraged that they had started to approach her for information on how to join international contests in which I had participated. In fact, she has already received projects for international competitions from grade 9 students (freshman year for other countries). She is expecting more students to submit projects in the upcoming months. As for me, I always try to encourage women to save people from climate change through their own small or big ways and actively participate in endeavours or activities that will, hopefully, negate the negative effects of climate change.

Romania

- Nina Stan

Nina Stan



I can say, without being accused of lack of modesty, that I am a good engineer. I like what I do, I like the RAC sector, I like the challenges. I am a responsible person you can rely on. Already, I have said it all: I am a woman in the RAC sector - a field dominated by men.

Yes, it's a male-dominated area because it is about a clean technique, a very specialized one, even, where you have to combine different types of technical knowledge. It is an area where women do not venture. There were countless times in my discussions with clients when I was treated in the beginning as a kind of secretary to the men, until the moment I opened my mouth and was actually involved in the discussion. Since that moment, the distrust has completely disappeared and the approach has changed, usually to admiration. At least that's how I perceive it.

Often, answering the phone number displayed on our website www.frigmania.ro, I would be asked to transfer the call to a colleague (that is, a man) to discuss a technical problem. After some initial amusement,

I would have a very technical discussion and I don't think the callers were disappointed. There are prejudices and stereotypes around, but by being ourselves and striking at them, we can overcome them.

It really amuses me when I see a preconceived approach because I know I'll overcome it in a few seconds. I make a plan for how to deal with the problem, but I know I have to be prepared for it to go wrong.

I have been lucky enough to work in several areas of the economy, following the RAC field where it has taken me.

I have been working in the RAC field since 1989. Until 1997 I worked in a milk industrialization company, and I managed to maintain five large refrigeration systems with ammonia refrigerant. I accumulated other management functions within the company, too. I was involved in the operation of some old refrigerated appliances, designed according to the rules I learned in school. For me, working with these facilities represented putting into practice the principles learned in school, and entering the heart of a refrigeration plant taught me things I did not learn at school. That's where I first came into contact with ammonia, the refrigerant closest to my heart. Sounds very bizarre, right? Who ever heard of that? But that's the way it has been. Now that ammonia is less used in the RAC field, I have been asked to engage in various activities: decommissioning ammonia installations, using my expertise in ammonia refrigeration plant, and dealing with ammonia discharge in some plants. I would not have had those skills without that start-up period in 1997-2012, when I worked in a company specializing in the design, execution, installation, commissioning and service of ammonia, HFC and even CO₂ refrigeration installations as a designer, project manager, and technical director.

“Now that ammonia is less used in the RAC field, I have been asked to engage in various activities: decommissioning ammonia installations, using my expertise in ammonia refrigeration plant, and dealing with ammonia discharge in some plants.”

There too I learned a lot, building on what I had learned until then. Importantly, I knew what a customer wanted from a provider of such services, as until then I had been a client myself. I can say that this dual status of recipient and service provider gave me a substantial advantage in what I went on to do later.

In 2014, after another job at a small refrigeration equipment company (showcases and freezers), I decided to start my own business, of course in the same field: RAC. We built the specialized website www.frigmania.ro, which I originally saw as a doorway to a new company in this field. Subsequently the site started to develop, and in parallel to that, the company now makes cold rooms, commercial and industrial refrigeration plants and refrigeration containers, and provides maintenance and service. I'm

directly involved in designing, the stabilization of technical solutions in various projects, diagnostic care and management.

My achievements, however remarkable, still require a lot of effort:

- Building the specialized site www.frigmania.ro that is growing from year to year, although ours is a very narrow sector;
- Creating a team around me, in which the person responsible for the technical management of the site is also a RAC woman;
- Doing work that cannot be performed by ordinary firms, involving technical expertise in ammonia installations; optimization of technological processes using cold; design of industrial installations, etc.



Rwanda

- Valerie Mukandayisenga
- Marthe Nikuze
- Flora Niyonzera

Valerie Mukandayisenga

My motivation and the reasons why I decided on this sector:

- As a professional technician in RAC, it is good to help others get a good life.
- I will raise public awareness about the refrigerants which are being phased out and their toxicity.
- I will go into all areas using refrigerants and check if they are still using the toxic ones, and I will tell the directors to remove those old components and buy the new which use good refrigerants.
- I decided to work in this sector because I'm a professional technician in RAC and I need to help everybody by teaching them about the environmental and human health impact of refrigeration and air-conditioning.

“I need to help everybody by teaching them about the environmental and human health impact of refrigeration and air-conditioning.”

- I will help my country in its task of removing toxic refrigerants and using the good, new refrigerants.

- I'm very happy to be in this sector because I'm a woman and because many people have hope in women and human life.

- It will help me to teach them about air-conditioning and refrigeration.

I will teach people that saving Mother Earth means not releasing refrigerants and chemicals into the atmosphere but recovering the refrigerants to reuse.



My training and education

School	Year	Qualification
Higher education: Kicukiro College of Technology (IPRC Kigali)	2009-2012	Advanced Diploma in Mechanical Engineering/ Air-Conditioning and Refrigeration
E.T.O Muhima	2005-2008	Professional Certificate of Secondary Education Level A2 / Mechanical Engineering
Secondary education: Groupe Scolaire Officiel de Butare	2003-2005	Ordinary Level

Challenges and successes

- When moving damaged compressors as I was working with other technicians not trained in air-conditioning and refrigeration, they cut the pipes without keeping the refrigerant, which they put into the atmosphere.
 - Telling them that it was not good to remove any component in an air-conditioner or fridge without keeping the refrigerant and it was not good to let out the refrigerant as it damaged the atmosphere and human life.
 - Teaching them every day about toxic refrigerants.

- Not enough equipment in some areas/companies for doing maintenance and repair.
 - Telling the directors to remove those old components and buy new ones which used good refrigerants.
- In many areas, there are many kinds of refrigerant which are being phased out or toxic.
 - Teaching everyone every day about the evils of toxic refrigerants.
 - Telling them the advantages of refrigerants which are not toxic.

Experience

EKAL Company Ltd Jan. 2012 - March 2013

Maintenance Director

- Installation of new air-conditioners in Parliament of Rwanda (offices of deputies and senators)
- Repair and maintenance of air-conditioners in Parliament of Rwanda
- Repair and maintenance of air-conditioners in Ministry of Justice (Rwanda)
- Removal of old air-conditioners and installation of new air-conditioners in Ministry of Justice (Rwanda)
- Repair and maintenance of air-conditioners in Rwanda Development Board (RDB)
- Installation of new air-conditioners

Kigali Serena Hotel April 2013 - June 2014

Room & Maintenance - Tech Desk Attendant

- Generating daily, weekly and monthly reports to the managers through Outlook
- Repairing, replacing and maintaining technical spare parts (air-conditioners, fridges, electricity, plumbing)
- Planning schedule and coordinating work of other technicians
- Servicing and cleaning air-conditioners, fridges, cold rooms and water dispensers

EKAL Company Ltd June 2015 - present

Maintenance Technician

- Organizing routine servicing schedules of air-conditioners and fridges (Rwanda Development Board)
- Installing new air-conditioners
- Fixing faults or arranging for replacements to be installed
- Keeping production managers informed of progress
- Organizing teams to make sure 24-hour cover is available
- Making scheduled checks on machinery and parts
- Finding and fixing faults and recalibrating instruments
- Oiling and cleaning machinery and parts
- Overhauling and replacing parts according to schedule

Marthe Nikuze



1. Education: Advanced Diploma in Biomedical Engineering.
2. Working experience: From 2016 to the present as air-conditioning and refrigeration technician and customer supporter in charge of customer problems concerning RAC machines.
3. Training: I have completed training in general maintenance, biomedical workshops, air-conditioning, heating equipment and refrigeration.
4. I was motivated to work in the RAC sector because it was my first job and I found it very interesting. It helps me to meet new people and I like to be close to the environment. I would like to increase my knowledge in this field to help protect the ozone layer and the environment from the negative effects of refrigerants. I also wish to be able to train other technicians in the future.

“I would like to increase my knowledge in this field to help protect the ozone layer.”

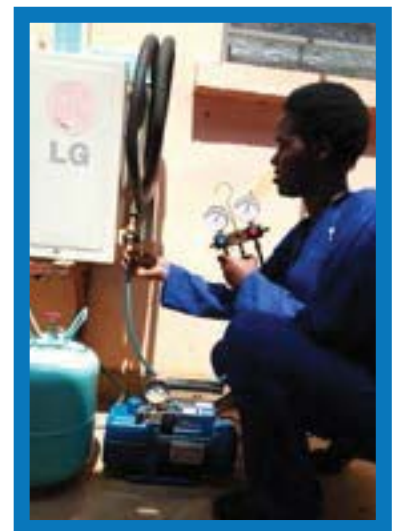
5. But we have challenges for ozone protection because we don't have much knowledge on it and some technicians don't even care about the effect of refrigerants on our future, and we also still have fake refrigerant on market, and so I need to keep working in this field to help protect our environment and the ozone as well.

Flora Niyonzera

I decided to work in the RAC sector because I wanted to make my contribution to the development of my country by reducing ozone pollution and encouraging women to work in RAC.

“I wanted to make my contribution to the development of my country by reducing ozone pollution and encouraging women to work in RAC.”

I have had training on ozone layer protection from the Rwanda Environment Management Authority (REMA), as well as training in servicing and general maintenance, which has included testing, diagnosis and repairing of refrigerators in different fields at Kabgayi Hospital and six months of professional training in car air-conditioning at the Kabgayi Garage Company Ltd.



I completed my Advanced Level in Motor Vehicle Mechanics at IPRC West (ETO Kibuye) and my university studies at Rwanda Polytechnic (RP) IPRC Kigali in the field of air-conditioning and refrigeration technology.

The challenges have been that most people do not understand the importance of ozone protection and why we need to reduce atmospheric pollution. Also, I was the only girl in the class.

I have installed new air-conditioners in different offices and done servicing and general maintenance of older air-conditioners as well as testing, diagnosis, repair and charging of the refrigerant in different laboratory refrigerators and in Kabgayi Hospital as a refrigeration and air-conditioning technician.

Senegal

- Sokhna Fall

Sokhna Fall

After studying in the Physics and Chemistry Department of Cheikh Anta Diop University in Dakar, I passed the admissions test for the CEDT (Entrepreneurship and Technical Development Centre), where I obtained my advanced technician's certificate in refrigeration and air-conditioning (RAC) in November 2000 after three years of study. The subject of my thesis at the end of the programme was "Compressor scaling for meat lockers".

I chose this profession for two reasons. Firstly, I realized that refrigeration and air-conditioning are present in all the key areas of our lives: in homes and offices, agriculture, fisheries, the food industry, hospitals, etc. Secondly, I found that working as a refrigeration technician also allows you to acquire knowledge in other areas such as electricity, plumbing, welding and mechanics. It was a great challenge for me to succeed in a profession practised mostly by men. My passion for refrigeration has been my strength, allowing me to create my own business without help or funding and competing with men in the market.

"I found that working as a refrigeration technician also allows you to acquire knowledge in other areas such as electricity, plumbing, welding and mechanics."

I have also done maintenance, repairs and installation of air-conditioning units, cold stores, refrigerated containers and central air-conditioners. I've worked in hotels, supermarkets, the Port of Dakar, government buildings such as the Ministry of Environment, private residential villas and private households.

I've been a member of IIR (International Institute of Refrigeration) since 2015 where I regularly receive information on current news and development in the refrigeration sector around the world.

I am also a founding member and president of RENAFF (national network of female refrigeration technicians in Senegal). My goals in this association are to encourage female technicians towards entrepreneurship as well as to provide training, for those who need it, in mobile air-conditioning, which is a sector hitherto dominated by male technicians. With this in mind, I organized a training for 20 female technicians on automobile air-conditioning at the Liberté 6 Reference Centre in August of 2018.

I am a member of APROFIC (Industrial Refrigeration and Air-conditioning Professionals' Association), and I am the organization's secretary and officer in charge of educational affairs.

In 2002, the year I was named best refrigeration technician for protection of the ozone layer, I joined Senegal's National Ozone Committee. I am also a national consultant and trainer in good refrigeration practices in Senegal's ozone programme.

In November 2018, with the help of GIZ, I participated in a training on using hydrocarbons as refrigerants in refrigeration and air-conditioning organized by the ACRA Institute (Air-Conditioning and Refrigeration Academy) in Johannesburg, South Africa for which I obtained a certificate in Safe Handling of Refrigerants.

Today, my professional life is divided between my workshop, conducting training in MAC and good refrigeration practices and taking part in Senegal's ozone programme activities and the work of the refrigeration associations.



Serbia

- Nevena Aksic
- Željka Vuković

Nevena Aksic



When I was 13 years old I wanted to be a physicist. I was in love with theoretical physics and I was good at it. At the time, I worked in the laboratory at the Institute of Physics at Kragujevac, in the centre for talented students. My father always supported my science work and at that point he had his own company, engineering and installing Cold Storage systems.

When I was 15 my father asked me if I would like to come with him to one of the construction sites to see how industrial refrigeration worked. It was love at first sight. That day I knew I wanted to make my scientific dreams in research come true in Industrial refrigeration. Next day I started working with builders on installing sandwich isolation panels, learning from scratch. I wanted to know the soul of the systems, so I worked for three years before I started my university studies, doing all sorts of manual jobs: installing and assembling compressor units, and servicing systems.

When I started studying for my Bachelor's degree I knew I wanted to work in the field of energy and process sciences. My professors saw my passion, so they started giving me higher expectations and more literature. Today I'm in my final year of Bachelor's studies, preparing the final essay on an industrial refrigeration topic, which is my own startup business.

Last year the dreams started to become real; my idea was to save F-gases from being banned, but also to make it impossible for them to leak from systems. This started as laboratory research, and very soon I won my first awards for student research (even though I was the youngest). Then everything started to happen by itself. I started developing a business, and won the first prize in a national competition for green business ideas and the chance to represent Serbia in the global competition, where my idea reached the finals. I won five more awards for Innovative Green Business ideas.

“When I was 15 my father asked me if I would like to come with him to one of the construction sites to see how industrial refrigeration worked. It was love at first sight.”

Only my father believed that a really young girl from Serbia could do big jobs in the Refrigeration industry globally, and he was right. My first application of an innovative solution will be this October in Vigo in Spain. But it has also brought me work in my own country. Cold storage owners have come to see me as fresh and innovative, and from thinking that construction sites are not for young girls, they now say I am the one they trust.

I won't stop developing my knowledge of industrial refrigeration until I make my name in the history of refrigeration.

Željka Vuković

I graduated in 2004 in the Department of Thermo Techniques at the Faculty of Mechanical Engineering at Belgrade University.

I began to work in the field of RAC in 2004. My first experience was in the production of compressor racks, condensing units, mono blocks and chillers with HCFC. In 2006, at the International Fair of Technique and Technical Achievements, the compressor rack with two temperature modes suitable for supermarkets that I constructed as an employee of Soko Engineering received the first prize.

After experience in production, I designed central refrigeration installations with HCFC for supermarkets, cold stores and cold rooms for cooling and freezing food. In order to obtain more complete experience in the field of refrigeration, I followed the implementation of cooling installations in the facilities and I put the cooling systems into operation. For most installations I set up and put into operation a system for monitoring and managing the operation of cooling installations, working together with the installers.



Through attending congresses, lectures and exhibition fairs in developed countries, reading scientific journals in the RAC field and informing myself about the trend towards eliminating Freon (even HCFC) in refrigeration installations generally, I began to explore the current state of cooling installations in our country (type of system, type of refrigerant, Freon leakage rate, etc.). In 2010 and 2011 I collected recorded data for refrigeration installations in 46 existing supermarkets in Serbia showing the amount of supplementary refrigerant used in refrigeration systems. The study determined the amount of refrigerant that was leaking out of the systems. This research showed that Freon leakage rate in Serbia was significantly higher in comparison to more developed countries. Following that research, as a team of technicians, engineers, installers and repairers, we worked on reducing the amount of Freon released from the system into the environment. We applied many constructive design solutions, whereby the Freon leakage rate was reduced to the average level in more developed European countries.

“I felt motivated to further reduce the negative impact of cooling systems on the environment. The result has been the development of a system with natural refrigerants for use in new cooling installations.”

After the success achieved in reducing the amount of Freon released from the existing systems into the environment, I felt motivated to further reduce the negative impact of cooling systems on the environment. The result has been the development of a system with natural refrigerants for use in new cooling installations.

Nine years ago, we started research and development of a cascade refrigeration plant with CO₂, and eight years ago we created a small refrigeration installation project for three cold rooms. This type of mixed system with flooded and direct expansion (DX) systems is suitable for supermarket refrigeration systems, where two temperature levels are required. This system was developed, manufactured, tested and put into operation in the Soko Engineering factory.

During my work in the RAC field I have designed reconstructions of large cooling systems in distribution centres. This was a challenge owing to the size of the systems, their age and the fact that the cooling fluid in these systems is ammonia, which is inflammable and explosive.

In the past few years, the construction of large distribution centres in Serbia has begun. All the investors in this area have a green profile, and refrigeration installations in these distribution centres should be environmentally friendly. During this period, I have designed large cooling systems in distribution centres. From the point of view of environmental protection, energy efficiency and investment value as an optimal solution, we chose an ammonia refrigeration system in cooperation with the investor. After a long period of several decades, these were the first major projects in Serbia to involve ammonia

refrigeration systems. With a team of engineers, I designed an ammonia refrigeration system for a 78,000 square km. distribution centre, of which 22,000 square km. was cooled. We also designed an ammonia cooling system for a 46,000 square km. distribution centre, with 14,000 square km. cooled. These systems are designed in accordance with the latest knowledge in the field of refrigeration, with special emphasis on human safety and environmental protection. The size of the cold stores and the available time frame made it a challenge to finish them on time. These projects were successfully completed on time, and now they are running to the owners' satisfaction.

In addition to design and implementation of refrigeration systems for supermarkets, cold stores and cold rooms for food, I have designed and supervised the implementation of refrigeration systems for cooling machines in the food and plastic products industry. Designing such systems is a challenge since they are all custom-made. They are demanding because they have very variable operating parameters, and the quality of the final product depends on the quality of the design and adaptability of the cooling system.

The latest development project I have worked on is for Trans Critical Cooling Systems with CO₂. At the Soko Engineering factory we started development of Trans Critical Cooling Systems with CO₂ for supermarkets. We have completed the pilot project and are currently in the process of procuring equipment for this project. We plan completion and commissioning of this project for the beginning of September this year.

At the same time, we designed a Trans Critical Cooling Systems with CO₂ for the supermarkets of large retail chain in Serbia. Work on this project and commissioning of the facility will be completed by the end of 2018.

I am also a member of the Serbian Chamber of Engineers and the Serbian Society for HVAC (SMEITS). I have presented my experience and the Soko Engineering experience in the field of air conditioning, heating and cooling at several international congresses. The papers I wrote were published in international scientific journals, as well as in the proceedings of some of the international congresses.

Sierra Leone

- Hannah I. Kamara

Hannah I. Kamara

I enrolled in the Refrigeration and Air-conditioning Department at the Government Technical Institute in 1998 and graduated in 2002. I was sent on job training at the Sierra Fishing Company from 2003 to 2004. Later I gained permanent employment as an RAC technician in this company in 2005 and have remained there.



Two people motivated me to choose a technical field. In my village I saw a Chinese lady who was working as a builder and another woman who was working as a welder, and I admired them greatly. One day I said to myself, "I can do what those ladies are doing", and I decided to enrol for refrigeration and air-conditioning at the Government Technical Institute and I completed the course. I find that working in this field is so exciting. Nevertheless, I found it difficult during my course to get learning materials such as textbooks and practical materials.

"In my village I saw a Chinese lady who was working as a builder and another woman who was working as a welder, and I admired them greatly. One day I said to myself, 'I can do what those ladies are doing.'"

The key challenges in my work life are sexual harassment from male supervisors and lack of tools and spare parts to carry out my work smoothly.



Solomon Islands

- Elizabeth Joan Billy

Elizabeth Joan Billy



I commenced my working career as an apprentice electrician for four different companies. I completed my apprenticeship and worked for SBS Electrical as a competent electrician, one of a few female trades in Solomon Islands.

To gain more experience, I worked for a few electrical companies before deciding to work in the RAC sector. As most electricians are required to wire air conditioning systems, I felt that I should also know how they work and was interested in the sector. To strengthen my knowledge and skills, I attended a basic RAC course with Powerit RAC (PRAC) at the National Trade Training and Testing (NTTT) building in Kukum Campus, Solomon Islands, in early 2015.

Once I had graduated, I commenced a career in the RAC sector with a small company. My roles were commissioning and installing split air conditioning systems. HKL Logistics came to Solomon Islands to assist the Australian Federal Police with the Regional Assistance Mission to Solomon Islands (RAMSI) project. I started with them in 2015 and was given the opportunity to correctly learn the basic installation of

domestic and commercial RAC appliances. They also provided extra in-house training, which broadened my knowledge base relating to RAC appliances. It was a challenging role, especially with my sex, as female workers are not seen to be as competent as male workers. I did not have many opportunities to perform substantial roles, unlike other team members, and I was instructed what to do step by step, rather than allowed to use my skills. Moreover, I was always assigned as the "tool lady", who packed up the tools at the end of the job. However, gender issues could also be seen as individual perception, as some team members did treat me equally. Following a consultation with my boss, I was assigned to work with another good team. Always remember, ladies, that whenever there is a problem, there is a solution. After a couple of years, I left this company to pursue my next career as an electrical lecturer at Solomon Islands National University (SINU).

Becoming a female trainer was another big challenge for me, as most of the office staff are men. Although most of my colleagues are kind and treated me fairly, the challenges I faced as a woman persisted, as the capacity and knowledge of a female lecturer in the electrical sector was in doubt. I had to be strong and prove that I was capable of being an electrical lecturer. Another challenge is, when delivering a lecture in class, students do not pay full attention to the lecturer. I must find ways to make the lecture attractive so that they can understand the topic and find it interesting. As a trainer, I need to be flexible and treat them fairly and with respect, but, at the same time, I have to maintain principles and restrictions.

I still do private service, maintenance and installation work to keep my practical skills and knowledge to date regarding new technology. With my roles in the RAC sector, I was asked to be secretary of the Solomon Island Refrigeration & Air-Conditioning (SIRACS) to maintain the gender balance. I have been involved in discussions with the members and stakeholders to explore the approach to introducing licensing and legislation for the country's RAC servicing sector and thus ensure the safe handling of refrigerants, including fake refrigerants. Refrigerants are imported from other countries and can be fake, with negative implications for the system, such as a shortened lifespan. It is essential to have a plan and work toward addressing these challenges.

My advice for all ladies who might be thinking of coming on with me on this trip is that it will be very challenging, but never give up, look ahead. Challenges will always be there to make you strong and give you more courage. If I can do it, why can't you?

"My advice for all ladies who might be thinking of coming on with me on this trip is that it will be very challenging, but never give up, look ahead. Challenges will always be there to make you strong and give you more courage"

South Africa

- Joyce Chifamba
- Ilana M. Koegelenberg

Joyce Chifamba

Working in the HVAC industry was the best choice I ever made. Training in Zimbabwe was hard, but I managed to sail through. I had trainers who were so patient; I appreciate all their effort. I was taught to do all my jobs alone so that I didn't have to depend on someone.

My husband's brother was the person who encouraged me to do refrigeration and air-conditioning. I just liked the way he was working and his lifestyle, and so I just had to do it.

My challenge was getting a job when I moved to South Africa. I had no experience because immediately after my training my husband didn't want me to work. I had to stay at home for a year. By the time I moved to South Africa I didn't have the confidence, but I had to work for my family because my husband was out of work as well. Besides, in South Africa the HVAC industry is white and male-dominated. So it was also a challenge for me to get a job. There was a time I decided to buy tools so that I could do the small jobs that I could find and that was my breakthrough. I met my first employer. It didn't last for other reasons, but anyway now I'm working for a bigger company. I'm at one of their sites which is a government complex. I maintain their chillers, air cons, heat pumps and refrigeration units. I also do their fans and air handling unit.

My challenge here when I started was my assistance. I work with four men who are all older than me. In South Africa it's not easy for a black man to submit to a woman, let alone a foreigner. We had to sit and talk on many occasions. Some people advised me to ask for another team from my boss, but I believe in giving people second chances and now we are working just fine.

When I repair something that a man couldn't, I feel so proud of myself. I also enjoy when a man is holding a ladder for me while I'm doing the job. I like it even more when people notice.



“ I was taught to do all my jobs alone so that I didn't have to depend on someone.”

Ilana M. Koegelenberg

I landed in the RAC industry by pure chance. After a two-year stint as an agricultural journalist, I was eager to move to the big city and answered a job advert for a “senior journalist” in Johannesburg.



At that point I had never given much thought to the RAC industry – my education was purely journalism-based. The company (Interact Media) was looking for a senior journalist, and at that point I didn’t even know which magazines I would work on. I was given Refrigeration and Air Conditioning Africa (RACA) Journal and Cold Link Africa – titles I had never even heard of previously. I was 24.

I started on a Wednesday, and the publisher informed me that by the Monday I had to submit two project site visit articles and a 2,500-word feature on compressors! Needless to say, I was in way over my head. I knew about trade and technical publications, but the sector was new to me. But I made it work.

It was incredibly tough at first. Being female and under 30 really put me at a disadvantage. Initially I came up against many stubborn engineers and consultants who challenged every question I asked with, “What do you even know? You’re not an engineer.” I still get that today, but now I can hold my own and I’m no longer as intimidated as I was when I started.

It was supposed to be a temporary job but the industry sucked me in.

“I’m that girl who drives around with a hard hat in her car boot and spends more time in plant rooms than at her desk.”

I worked my way up to assistant editor and eventually editor, taking on the responsibility of both magazines, complete with their accompanying online platforms and social media accounts. RACA Journal is a monthly 120-page printed magazine – so it really is no small task to put this together single-handedly. I have a few contributor writers I manage, but, other than that, the whole magazine falls in my lap.

I spend my life running around the industry, attending events and climbing up ladders to check out chiller plant rooms. I travel a lot to the international shows like Chillventa and recently came back from Mostra Convegno in Milan. In between I work long hours and most weekends to make sure the South African industry (and beyond) stays up to date with the latest and greatest in HVAC&R news. (I don’t think I’ve taken a lunch break since 2013.)

Starting with no background at all, I’ve grown myself and my knowledge to a point where I’ve been to presentations at events on the state of the industry, and even the official local associations send international queries my way to answer instead. I never pass up an opportunity to learn and better my knowledge, asking as many questions as it takes for me to get the real story.

It’s still difficult being female in such a male-dominated industry. I either have to defend myself and my position, justifying why I’m even there – or I have to fend off inappropriate advances during events when some guys have had too much to drink. Most meetings I have with first-time clients/readers always start off with me first having to prove myself and my knowledge before they are willing to entertain my questions.

But I’m passionate about the industry and what I do. I’ve worked hard to elevate the publications and the South African RAC industry. I don’t stand back for anyone, no matter their age, education or gender – I will fight for my titles, always. I pride myself on not merely reporting on the industry but being part of it. I sit on the policy-making committees for the refrigerant phase-down regulations, and I’m very involved in promoting WorldSkills and education in general. We’re not just a publishing house; we create communities.

You have to understand... I grew up in a very small town called Clanwilliam in the rural area of the Western Cape. I couldn't speak proper English until I went to university (I was raised and educated Afrikaans-speaking), and I was 19 the first time I even got on a plane or saw Johannesburg. Everything has been a very steep learning curve, but I was incredibly ambitious and determined to get to the top.

I've fallen in love with the RAC world since. Even if my friends find it incredibly boring when I point out HVAC equipment to them when we go to movies and nobody appreciates my lame jokes about "cool" things, I wouldn't want it any other way. I'm that girl who drives around with a hard hat in her car boot and spends more time in plant rooms than at her desk – but it's so exciting!

I'm currently involved in organizing the local FRIGAIR Expo (our own mini version of the trade shows) and putting together the three conferences: three ASHRAE workshops, the first shecco ATMOSphere Africa event, and the SAIRAC association free-to-attend seminars. It's all about educating and uplifting the industry in Africa and the excitement is truly contagious.

On an international level, I have regular contact with my peers and have especially close ties with the ASHRAE Journal, JARN and the IIR.

All the people I studied with are working as news journalists on other, more well-known, consumer publications. But I'm happy with my choice. Why be one of a hundred journalists covering a story when I can be THE ONE?

It may not be the most glamorous career path, but it definitely is super interesting! Now if anything even remotely RAC-related happens in South Africa, I'm the one they call.

Sri Lanka

- Pathmi Dayarathne

Pathmi Dayarathne

I am Ms Pathmi Priyangani Dayarathne, employed by the Ceylon German Technical Training Institute (CGTTI) as a training instructor in refrigeration and air conditioning (RAC).

“This is a highly technical profession that is a challenging job for a woman. I am extremely happy to rise to this challenge.”

After completing my secondary education at a government school, I entered CGTTI to follow a three and a half year RAC course. I successfully completed my academic career at CGTTI in 2012.

I was offered employment as an instructor in electrical engineering by Wayamba (North-Western) Technical College, Kurunegala. After working at the technical college for four years, in 2016, I moved to CGTTI to take up my present position as RAC instructor.

This is a highly technical profession that is a challenging job for a woman. I am extremely happy to rise to this challenge and my aim is to perform my profession for the wellbeing of the RAC Sector in Sri Lanka.



Switzerland

- Dolaana Khovalyg
- Janet Ludert

Dolaana Khovalyg



I grew up in Siberia and my hometown, Kyzyl (in the Tuva Republic of the Russian Federation), is very far inland, so the climate there is harsh continental. As a result, the air temperature can drop to -50°C in winter. I remember walking to school in the early mornings: despite layers of heavy clothing, the cold still penetrated to the bone, and my nose and ears got frostbitten from time to time! Nevertheless, I was captivated by the beauty of the frosty winters in Tuva and wanted to learn about the nature of cold.

After graduating high school in Kyzyl and spending three days on the Trans Siberian Railway to Moscow, I successfully passed the entrance exams and enrolled in the Low Temperature Physics Department at the Moscow Power Engineering Institute, where I completed my BS and MS degrees with honours. During the final year of my MS studies in Moscow I started to work in a HVACR engineering firm with minor duties such as updating technical brochures. Within two years I was a RAC Project Engineer with lots of responsibilities: my duties included

sizing RAC equipment and drawing projects for cold storages, food processing facilities, distribution centres, industrial kitchens, and supermarkets in accordance with Russian Federal construction codes. For instance, I designed a project for industrial shock freezing of bread products, which enables the storing of bread for up to 18 months without loss of texture or nutrients.

“The fact that I came from a remote place, and that I am a female who has paved her own way into the RAC field, have not stopped me in my endeavours; indeed, the challenges I have faced have made me grow and push my boundaries each time.”

The tremendous importance of long-term food preservation via refrigeration bolstered my interest in RAC, and my fascination with the capabilities of cooling equipment to generate cold mechanically for various other industrial applications kept growing.

Despite my seemingly considerable progress, my job experience was not entirely smooth, since my working environment was not woman-friendly. RAC is traditionally a man’s field, especially in Russia. I used to meet male technicians to discuss projects and to present RAC solutions, and I recall seeing bored and giggling faces of men thinking that “females don’t

have enough brain power to handle complex technical projects, and even to suggest to them what to do”. That was the reality of the profession that I have chosen following my childhood curiosity, and almost every day I have had to encourage myself not to pay attention to such attitudes, but stay strong, work hard and be ready to face all the challenges and push my boundaries.

Through numerous interactions with men in RAC, I discovered “the secret weapon” against the doubters: if you are more knowledgeable and confident than they are, they will eventually accept you into their men’s club. Therefore, I decided to go back to school and deepen my knowledge by pursuing a PhD degree – not in Russia, but rather abroad to gain international experience. In 2011 I was awarded a scholarship by the Fulbright Foundation that provided an opportunity for advanced studies in the USA at a leading RAC research centre, the Air-Conditioning and Refrigeration Center (ACRC) at the University of Illinois at Urbana-Champaign. My PhD work focused on flow boiling of refrigerants in compact microchannel heat exchangers (MCHX). MCHXs are lightweight aluminium heat exchangers that allow reduction in the volume of the necessary refrigerant, and the use of MCHXs aligns with the global goal of reducing the use of HFCs in RAC systems.

During that time, I was awarded an opportunity to participate at the Global Young Scientists Summit in Singapore, a premier event bringing young researchers and prominent scientists together from all over the world. My proposal on “Net-Zero Energy Air-Conditioning and Dehumidification” was one of the finalists in the “Sustainable and Liveable Cities” challenge held at the Summit. Brainstorming the

proposal for that challenge sparked my interest in the sustainable and liveable indoor environment, which has significant importance nowadays.

HVAC systems have a key role in achieving a higher standard of living by providing a comfortable indoor environment all year around. However, HVAC systems face major challenges since they are also a major source of energy consumption in buildings. With CO₂ emissions causing temperatures to break record after record, the need for sustainable energy systems to combat climate change is now greater than ever. Driven to improve both the global warming situation and the quality of life of people, I came to realize that I can contribute to developing better energy-efficient and novel HVAC solutions for comfortable living environments by pursuing a career in academia.

Currently I am employed as an Assistant Professor in Energy and Building Systems Engineering at École Polytechnique Fédérale de Lausanne (EPFL, Switzerland), one of the leading technical institutions in the world. My laboratory, Thermal Engineering for the Built Environment (TEBEL), focuses on minimizing energy use for thermal conditioning of buildings, and the performance enhancement of building services such as cooling, heating, ventilation, and hot water supply. Presently I advocate for coupling heat pumps with renewable sources, and for the widespread use of CO₂ heat pumps for hot water supply.

Presently I teach two courses – “Building Energetics” and “Thermodynamics of Comfort in Buildings” – that cover the topics of thermal management in buildings, and analysis of the efficiency of building services such as HVAC.

I am truly blessed to be able to contribute to both the local and global community through my teaching, and to shape the future of the field through my research. The fact that I came from a remote place, and that I am a female who has paved her own way into the RAC field, have not stopped me in my endeavours; indeed, the challenges I have faced have made me grow and push my boundaries each time. Looking back, I would say that my path so far is less about luck, and more about hard work, persistence, and commitment. I feel proud to be a female in the RAC sector and to serve humanity through my research and teaching.

Janet Ludert

In my 20-year career in the fluorochemicals and RAC industry, I have never experienced such an exciting time as now! The RAC sector is playing a critical role in making a positive contribution to curbing the effects of climate change and I am proud to be in an industry where challenges can become opportunities – from business or regulatory to personal and professional ones, too. Throughout my career, I’ve learned a lot from the RAC industry about teamwork, resilience, and perseverance (among other lessons) and am happy to pass on a few of my experiences to other women aspiring to work in this dynamic and exciting field.

“I value the critical function that refrigeration and air conditioning plays in our society. Without RAC, needed medicines and food supplies, for example, might not be available to those who need them most.”

I started my journey in the RAC sector after graduating from the University of Virginia in the United States with a degree in Chemical Engineering. After leaving my hometown near Washington, D.C., my professional career began in 1998 in Texas with DuPont’s Fluorochemical business – a leader in RAC refrigerant technology. I started from the ground up in a technical role as a process engineer, working at a plant manufacturing one of the key raw materials



used in making fluorinated refrigerants. I was only one of a few women on the team, tasked with leading and working with a group of mostly senior men. However, I learned a lot during those years, especially from the excellent group of operators and mechanics who taught me not only about the plant operation but also life in general! From them, I learned how to put safety first, how to solve problems, manage through the night shift and how to make the best chilli you've ever tasted. These seasoned professionals had seen it all and personified teamwork. Working with them helped me realize that everyone's role in the RAC industry is important to achieve common goals – from the CEO to the operator; from the design engineer and contractor to the end-user; from the legislators to the consumers; and of course, from men AND women.

In 2003, I had the great opportunity to transition to a sales role – interacting with customers in the RAC sector and helping their businesses succeed. As a young salesperson in tough negotiations, again in a male-dominated environment, it was difficult to hear “no” for an answer. But, as is often the case in the RAC industry, where there is a will, there is a way. I learned that understanding the needs of the person on the other side of the negotiating table was key. Creating a connection led to trust and this opened the doors to many win-win outcomes. This also applies to the RAC industry. Regulators and legislators need to understand the needs of their constituencies. Suppliers, contractors and manufacturers all need to understand the needs of their customers. And vice versa. With this approach (coupled with resilience), the win-win solutions are possible.

In 2007, I took the leap to move from the United States to Europe. Even though I had travelled to Europe before and spoke several languages, everything seemed new – new job, new city, new challenges in the RAC sector. Since then, I've had the opportunity to work on launching key low-global warming potential (GWP) products, on understanding new regulations (like the Mobile Air Conditioning (MAC) Directive and the F-Gas Regulations) and their impact not just on my company (now Chemours, a spin-off of DuPont), but more importantly on our customers and the RAC industry at large. All this while contributing to improving and protecting the environment. During these years, perseverance has been the name of the game. Implementing anything new takes time and patience – sometimes you take two steps forward and one step back. But you move forward, nonetheless. The RAC industry knows this first-hand, as it balances compliance with new regulations (like the F-Gas regulation) with the needs of business, consumers, stakeholders and the environment. It has been through many transitions over the past decades and, together as an industry, I am confident it will rise to conquer future challenges as well.

This leads me to today. Currently, I lead the Marketing efforts for the Europe, Middle East and Africa (EMEA) Refrigerants Business at Chemours – working to promote our Opteon™ portfolio of low-GWP refrigerants that have already made a big difference to helping RAC customers meet the requirements of the F-Gas regulation and transition to more environmentally-friendly refrigerant technologies. Alongside an exceptional team, I've been happy to share my expertise in the F-Gas regulation with all levels in the RAC value chain to provide solutions to their refrigerant needs. I've given speeches, written articles, hosted webinars – all opportunities for professional development afforded to me in the RAC industry.

Above all, I value the critical function that refrigeration and air conditioning plays in our society. Without RAC, needed medicines and food supplies, for example, might not be available to those who need them most. I'm proud to be in an industry that makes that kind of a difference to society.

All the lessons I've learned in the past are relevant today – teamwork, resilience, perseverance – and the RAC industry reflects these and other positive traits. My journey in this sector hasn't always been easy, but I wouldn't change anything about the path I've chosen. I've travelled the world and met amazing people. I've grown professionally and personally – all thanks to a varied career in the RAC industry. If young women are up for the challenge and ready to define their own lessons and make a difference, the RAC industry is a great place for them to shine!

Other info: I was born in the US in 1976 to South American parents. I've lived in Geneva, Switzerland, since 2007 and work for Chemours – a leading supplier and innovator of refrigerants. I speak Spanish, French and English. I enjoy dancing, singing karaoke, travel, trying new foods and volunteering.

Togo

- Yawa Mawuli Agbavor

Agbavor Yawa Mawuli

In 2004 I enrolled at the CRETFP (regional centre for technical education and vocational training) to receive training in refrigeration and air-conditioning (RAC) and two years later obtained my qualification. These two years of training were not easy for me because my family considered this field of work to be only for men. After my training I was fortunate enough to experience first-hand the realities of the RAC sector on the ground in two companies – TTSI and Interdis – based in Togo and run by French managers. Through this employment I was able to obtain a training scholarship in technical maintenance of HVAC installations at the AFPI Rhodanienne in Lyon (France), where I received my certificate (the scholarship was financed by the French Development Agency (AFD)).

After my training, several clients of my former employer were impressed by the quality of my work. I therefore decided to create my own company, Timef, which I had registered in the trade register in Togo on 20 June 2010 so that I could work with companies that were requesting my refrigeration services and, in particular, gain experience lawfully.

“I would also like to further increase interest in working in RAC among women, who are practically absent from this field and think that this sector is only for men.”

individuals. Under the verifiable tax and VAT systems adopted by my company at the start of the year, we are now able to obtain public contracts.

Considering the competition in the market, I intend to keep promoting the latest techniques in RAC through the professionalism and the quality of services we provide. I would also like to further increase interest in working in RAC among women, who are practically absent from this field and think that this sector is only for men.



Today, I manage Timef's administration, which includes accounting and secretarial services, and a technical team of nine technicians declared with the tax and social security offices, as well as three trainees.

Timef also accepts interns sent by the national training centres (CRETFP and CFMI in Lomé), and our clients consist of companies and

United Arab Emirates

- Shima Ali Gamal

Shima Ali Gamal

Currently I am working with Alfa Laval in their Dubai office. I work as a technical sales engineer and support the air heat exchanger division. Some of my tasks are to understand customer requirements/scope and prepare techno-commercial proposals, to select optimum HVAC-R equipment, to liaise with the production and design team to resolve issues and to support sales to achieve targets for the MENA region. My immediate objective at work is to minimize the consumption of refrigerant quantity and energy by not overdesigning the equipment. This helps to improve TEWI/LCCP numbers.

Overall, I have around 10 years of working experience in industrial refrigeration, commercial refrigeration, and air-conditioning. I graduated in 2006 with a bachelor's degree in mechanical engineering from Khartoum University, Sudan. I had various internships/workshops in Sudan as part of my extracurricular activities.

My inclination towards mathematics and physics had led me to pursue a career in techno-industry. My experience at LG in Sudan was the main reason for my interest in the RAC sector. The pursuit of my career led me to look beyond Sudan. Being a girl from a conservative society it was not an easy decision on my part. Also, it was not easy for my family to let me go alone to a different country. However, I found the UAE to be one of the safest countries for women and a land with equal gender opportunities.



“Working in the RAC sector allowed me to express my talent and vision. It is the “ambition to learn and contribute” that motivates me to continue my career in this sector, and especially the contribution towards making the world an environment-friendly place.”

Working in the RAC sector allowed me to express my talent and vision. It is the “ambition to learn and contribute” that motivates me to continue my career in this sector, and especially the contribution towards making the world an environment-friendly place by supporting and implementing green technologies based on ozone-free and low-GWP refrigerants. I am a staunch supporter of sustainable and energy efficient technologies (e.g. VFD, VAV, inverters, micro-channels, adiabatic cooling, renewable energy, etc.). I believe a lot of work needs to be done to spread this awareness to developing countries where they still use CFCs/HCFCs coupled with overdesign and less efficient systems.

The RAC sector is predominantly a man's sector; tasks like commissioning, fabrication, installation, servicing and maintenance are carried out mostly by men. However, there is more to the RAC sector than the above-mentioned tasks, and women can perform various other tasks as efficiently as men in this field. I continually work hard to gain more knowledge and expertise. I would like to convey this knowledge and expertise to other women who are bereft of such opportunities owing to lack of funding, availability or for other reasons, to empower them and motivate them to pursue a career in RAC.

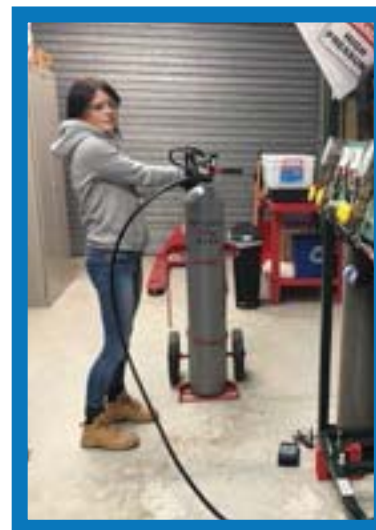
I had my own share of struggle – working without pay for months, laid off due to cost-cutting, dealing with customers with various attitudes, etc. However, I never let these challenges distract me from my goals and visions.

United Kingdom

- Hayley Ann Billson
- Jacinta Caden
- Ana Catarina Marques

Hayley Ann Billson

I started my career in the refrigeration and AC industry in 2011 when I became a Trainee Sales Engineer for the North of England. I still work for "Beijer Ref UK". My father, who for as long as I can remember has always enjoyed working in the same industry, is the one that gave me the motivation to join him. I first qualified with a National Vocational Qualification (NVQ) level 1 & 2 in small commercial refrigeration in December 2011. Among other things, once passed, that was a big milestone and part of the qualification to become a Sales Engineer. I then moved into branch management and later into sales management. This entailed training Trainee Sales Engineers and coaching them during their training period. Today I work as a Group Product Manager, a challenging and rewarding role taking products into the business from concept to market leadership. From the initial market analysis I prepare the sales strategy, and roll it out throughout the business.



All my roles in the industry have been challenging, but manageable.

The most challenging to date has been obtaining recognition by the industry of the need for refrigerant solutions for the medium and long term as we work through a phasedown situation. I often wonder what our industry would be like if we had continued to use CO₂ as a refrigerant as we did in the 1850s!

One of my main motivators is the daily opportunity to make contacts and inform the industry through internal and external communications of the changes happening now. To explain the damaging effects that CFC and HFC refrigerants have had and continue to have. To inform people about the harm that were seen as ideal refrigerants in the 1930's are causing to our environment. Also to inform the industry that by using history we can find a long-term solution now, and make the natural choice that is CO₂. The retail sector of our industry is already on board with natural refrigerants, and has been since 2005. Unfortunately though, the commercial refrigeration sector is a little more dubious. It is my job to inform customers that there is a choice today. I am working to take away the mystique that surrounds the pressure differences when using carbon dioxide (R744) compared to traditional options.

This industry is seen from the outside as not very exciting. Wow, how wrong perception can be. This is the most exciting industry ever, we actually change the world!

"I am very fortunate that I can pursue my full time career in the Refrigeration & Air Conditioning industry while being a loving mum to my boys."

Every day is different for me, I am based in Sutton Coldfield, in the Midlands but far from grounded. I cover the country from the tip of Scotland to Lands End, visiting people throughout our supply chain. I also often visit our suppliers' manufacturing plants in Italy, which I love doing.

I have been a member of the Institute of Refrigeration since I started in the industry and I have contributed to the Institute by being secretary of the local Newcastle Upon Tyne committee and the London Dinner Committee. More recently I have joined the membership committee, which I really enjoy.

I am also the mother of two young boys aged three and two. I am very fortunate that I can pursue my full time career in the Refrigeration & Air Conditioning industry while being a loving mum to my boys.

My job is the best for daily learning, researching, sharing knowledge through networking, and fun too through socializing. Who could want for more?

Jacinta Caden

For over 50 years my family has had refrigeration, electrical and haulage businesses so I was surrounded by RAC, as well as mechanics, from my earliest memories. Albeit normal for me, I now realise I was fortunate to be exposed at a young age to elements of life that I was instinctively interested in. My sisters and I spent many happy hours growing up playing games like “shop” with endless sorts of commercial and domestic equipment. I also spent a lot of my spare time immersed in the business of service and maintenance of trucks and trailers when they were not on trips. I just remember never being bored, not happy until I was somehow “stuck in”. I was always given jobs by mechanics and the like, which made my day! Exploring, observing, learning and asking questions freely as a child I think cemented my natural enthusiasm, which helped facilitate my transition into the real world and into an industry which I very much enjoy today.



I moved to Dublin after I left school at 17, to spread my wings and to avoid falling into the easy trap of continuing with a “hobby” (although getting paid for it was appealing) surrounded by my family who were sheltering me from the real world. I would likely never have learned independence. I would also have less life experience than I do today. Instead, complacency, expectation and dependency were the messages I would probably have absorbed. In addition, anything I have or haven’t accomplished is all my own doing, which is empowering for me.

“RAC is a trade most take for granted or are unaware of. There will always be requirements for temperature control, so it can only be rewarding for anyone involved.”

Once settled in Dublin I eventually decided on pursuing an apprenticeship in RAC, where I officially learned my skills hands-on with a RAC contractor. Working on a combination of RAC equipment/applications was necessary to progress in RAC. I studied in institutions in Cork and Dublin over a four-year period for the off-the-job phases of my apprenticeship, and subsequently qualified as a refrigeration engineer. The ceremony was held at Croke Park in Dublin, Ireland’s national Gaelic Athletic Association stadium, and it was a wonderful occasion to be presented with my qualification by the Minister of Adult Education in front of my peers and family, and also see the many other students who did so well representing other apprenticeships and trades.

Yes, I was the only female doing an apprenticeship in RAC at the time, but as I say, RAC for me was a natural environment, therefore I never gave this statistic a second thought. Throughout my career my upbringing meant I have never felt “rare”, so I never assumed I would elsewhere. In hindsight, many people over the years have commented on this.

When doing air conditioning installations for example, I did not always get the lightest side of a condenser to lift. Depending on the situation some of my colleagues would offer me the lightest side but I never asked for it, also it was an ongoing joke as to who would get the heavy side!

During my apprenticeship I also found the time to get my official driving licence for articulated trucks and coaches, allowing me to get paid for a big passion if I ever wanted to in the future. Again, these were my toys as a child, so it felt natural to want to do this.

There were some aspects of being a hands-on engineer that I did not like too much, and an opportunity arose for me to become office based. For ten years I worked at a RAC wholesaler as a Technical Sales Engineer, designing and specifying equipment for RAC applications, providing technical support on products etc. I worked in Dublin before moving to the UK to support the Manchester and Preston branches during this period. The opportunity to move within a company was also ideal for me.

I accepted an exciting opportunity after that job and for 18 months I was the Area Manager (UK & Ireland) for an Italian manufacturer in the close control air conditioning sector, predominantly offering

our niche equipment to consultants and contractors in the data centre and clean room/operating theatre sectors. This was a new area for me, which was rewarding as this aspect of the AC industry proved to be a crucial technical element of our daily lives.

Today I work in the Industrial Refrigeration & Critical Environments division of Integral as the Business Development Manager. I research, source and develop new and existing business, predominantly in the food production/processing, manufacturing, pharmaceutical, brewing, storage, logistics, life science and critical industries. We deliver comprehensive solutions to the industrial and commercial refrigeration, spiral freezer and heating, ventilation, air conditioning and refrigeration (HVAC) sectors of these markets. We provide reactive service, planned preventive maintenance (PPM), sales, design and installation functions. Having a background in RAC is obviously advantageous to my understanding of our business. I am fortunate to work among some of the best people in their respective fields, which also allows me to flourish and perform. This is an important element to be considered during one's career.

The RAC industry is ever-changing: whether in terms of global warming, or legislation and with Brexit also on the horizon, there are interesting times ahead. Every day, everywhere I go I see refrigeration new and old. I am always intrigued and sometimes surprised about how RAC is utilized. This makes me proud to be part of an industry that will never die, an industry that everyone needs.

I am currently a member of the Women's Engineering Society (WES) council, a Member of the Institute of Refrigeration and a member of the steering group for Women in RACHP Refrigeration, Air Conditioning and Heat Pumps). Although RACHP is not always a popular choice for women, there are many women involved in all levels and types of important roles in our sector. The career opportunities, people, companies and technology out there are fantastic. Like anything else, RAC is a trade most take for granted or are unaware of. There will always be requirements for temperature control, so it can only be rewarding for anyone involved. The skills you can develop can take you anywhere in the world too.

Ana Catarina Marques



My career in Refrigeration shows just how thriving this industry is, with many opportunities for personal and professional development.

My first degree in Food Science and Engineering was completed in 2005 at the Polytechnic Institute of Coimbra in Portugal, my native country. The degree/training programme included two internships abroad. The first internship took me to Berlin where I spent three months at the Technical University working on a beer fermentation project that employed a yeast immobilization technology to reduce the fermentation time from three weeks to 24 hours. This internship was funded by the European Erasmus programme. The second internship was undertaken at the Federal University of Viçosa in Brazil in their dairy pilot plant. Here I developed a new yoghurt flavour and tested consumer acceptance using sensory analysis.

My introduction to Refrigeration started with an internship at the Food Refrigeration and Process Engineering Research Centre (FRPERC), a former department of Bristol University. The 2006 placement was funded by the European Leonardo Da Vinci programme. At FRPERC I participated in the air cycle project, a system for integrated, rapid heating and cooling of processed foods, where I measured and calculated the heat transfer coefficients of the system.

At the end of 2006 I began working for Adande Refrigeration as their Test Engineer. Adande is a manufacturer of commercial refrigerators that are sold into Michelin starred restaurants and fast food restaurant chains. It is an innovative company with several patented technologies in Refrigeration, so it was an exciting company to work for. The role consisted of testing and optimizing professional refrigerators and new concepts for the household and retail markets. The work included design and

planning of tests, fault diagnostics, prototyping, data analysis and report writing. I gained a very good understanding of capillary expansion circuits, airflow and refrigerant charge optimization. One of the most interesting projects was converting all Adande refrigeration systems from HFC to hydrocarbon refrigerant with low GWP, and achieving an energy reduction of 19%. I still fondly remember setting up a test and coming to work excited the following day to see if my improvement idea had worked!

Drawing on my knowledge in food science, I also organized several food quality and safety trials to demonstrate the ability of the Adande patented drawer system to extend food shelf life over conventional refrigeration systems.

“Refrigeration, unlike other fields, does not have a clear path, but in my experience is a unique industry to be in ... where your work can make a significant contribution towards a more sustainable planet.”

In 2008 I started a full-time industrial CASE award PhD that was funded by the UK Engineering and Physical Sciences Research Council and Adande Refrigeration. The PhD with London South Bank University was undertaken while still working for Adande Refrigeration, so it combined the best of both worlds: academic research and working in the industry.

The PhD investigated the design and operation of a thermal storage domestic refrigerator. A phase change material (PCM) was employed to store energy and then used to cool the compartment. In essence the PCM acted as a thermal battery that extended the refrigerator off-cycle period from minutes to hours, thereby improving its energy efficiency. The PhD allowed me to present four papers at international conferences and publish two papers in peer-reviewed journals, and I won the Ted Perry award, which is given by the UK Institute of Refrigeration for outstanding research in refrigeration. The research was also shortlisted for the London Mayor's Low Carbon prize.

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After completing the PhD in 2012 there was an opportunity to do a knowledge transfer project (KTP) with the university in Acoustics, to reduce the noise of the Adande commercial refrigerator. This was a new field that involved diagnostic testing of noise sources, noise and vibration control techniques and sound quality. That is the beauty of engineering: it allowed me to move seamlessly from food science to refrigeration to acoustics.

Because I enjoyed so much working simultaneously in industry and academia, I wrote a successful application for another two-year knowledge transfer project. KTP projects are funded by Innovate UK and provide management training for the research associates. The project was focused on developing a new product for the food service market, and the tempering unit was specifically designed to both chill and rapidly warm up food ingredients. It provided controlled and consistent tempering times for food condiments, addressing a key operational issue in restaurants. A tool was also developed to identify new products that obtain a better return on investment, and a stage gate process was tailored to evaluate project progress. The outcome was an accelerated development of new products from concept to launch. The KTP allowed me to combine my knowledge in food science and refrigeration and was so successful that I won the 2015 Innovate UK Business Leader of the Future award.

Another experience that proved worthwhile, and taught me about negotiation, was becoming a technical expert on a working group of the European Committee for Standardization (CEN TC44 WG2). I was one of the UK experts nominated by the British Standards Institution. The working group drafted two European standards for professional refrigerated storage and blast cabinets. These standards underpinned the testing requirements for compliance of professional cabinets with two key European directives: ecodesign requirements and energy labelling.

In my current role as Engineering Manager at Adande, I am responsible for leading the development of new products and the continuous improvement of the existing product range. I am supported by a team of five: Designers, Test Engineers and a BoM technician. In the past two years we have developed and certified three products for North America, and brought to market an A+ rated commercial refrigerator, which won the 2017 Refrigeration Product of the Year at the UK National ACR Awards.

Above all, the most rewarding work I do is promoting refrigeration as a career to a younger generation.

It all started in 2013 when I began chairing the UK Institute of Refrigeration (IOR) RAC Young Engineers network. The network was the brainchild of Ina Colombo, who is now the Deputy Director General of the International Institute of Refrigeration (IIR). The objective was to bring together students and young engineers who have an interest in refrigeration and air-conditioning and help them build their professional network. This was achieved by organizing speed networking events where students meet senior representatives from the industry and leading academics.

This experience led to chairing an event for Students and Young Researchers at the 24th IIR International Congress of Refrigeration, held in Japan in 2015. Another key event at the conference was the first "Women in Refrigeration" workshop, which highlighted key barriers influencing the uptake of refrigeration as a career. These two events stimulated the creation of a new IIR working group: CaRe – Careers in Refrigeration, in 2016. The working group aims to make refrigeration and air conditioning more visible to the general public and inspire a young generation to join this exciting field. Another goal is to increase both the cultural diversity and the numbers of women in refrigeration. Since its inception CaRe has had a presence at five international conferences held in Europe, Asia and the USA. The IIR has carried out research into the state of women's representation in the industry by collecting information from national refrigeration institutions and associations. This research has been presented at conferences and is followed up by workshops. The response has been incredibly positive, as people in the industry recognize the value of inspiring the next generation and fostering career development opportunities. CaRe is developing its social media presence on LinkedIn, Twitter and Facebook as the need to reach a wider audience is paramount. Personally, it has been an incredible experience chairing the CaRe working group. I have met incredible people, gained new skills and, more importantly, the initiative can help rebrand the industry to make it more attractive to young people, thus addressing the predicted shortage of engineers. The next CaRe event was held at Chillventa in Germany in October 2018 in partnership with Karlsruhe University and the European Partnership for Energy and the Environment (EPEE).

Another steering group that I participate in is the UK IOR "Women in RACHP". It has a synergy with CaRe, while focusing more on mentoring women in the industry through events with hands-on training in refrigeration and personal development activities.

Refrigeration, unlike other fields, does not have a clear career path, but in my experience is a unique industry to be in. It combines knowledge of mechanical design, electrics and electronics, physics, chemistry and food science to solve real technical challenges. Because it has both a direct (refrigerant leakage) and indirect (energy use) impact on climate change, this is an industry where your work can make a significant contribution towards a more sustainable planet.

I have had the opportunity to present at conferences and industry events, and share my career experience with graduates at the Institution of Mechanical Engineers and teenagers at the Big Bang careers fair. I have worked on interesting projects around the world and was invited to a networking event at the House of Lords, just to name a few opportunities in this amazing industry.

United States of America

- Erica Gallant
- Lilit Gevorkyan
- Katherine Hammack
- Sheila Hayter
- Julia Keen
- Sarah Maston
- Lauren Roberts

Erica Gallant



As a young engineer, I rarely noticed heating, ventilation and air conditioning (HVAC) equipment, and I certainly never considered the industry for its professional possibilities. However, for the past decade, my career has been dedicated to chillers – the massive, heavy-metal machines that tend to reside in the bowels of high-rise buildings and basement district-cooling facilities. As a thermal systems engineer at Trane in La Crosse, Wisconsin, my primary goal is to make cold water. I am fortunate enough to work for a company that places incredible emphasis on sustainability and environmental commitment, and today, we are making cold water more sensibly than ever.

My path to this role has not been without some unique encounters. When I was hired by Trane over a decade ago, I was among only a handful of women in a building of 400 employees. The odds were awkward, but certainly did not intimidate me. As a female graduate student in mechanical engineering and during the time I spent in the automotive industry, I was accustomed to being part of the minority

gender. It was commonplace for my work to be unduly questioned and routine for me to be mistaken for the administrative assistant instead of assumed to be the engineer. It was no surprise that my new colleagues were a bit uncertain about how my presence might change the dynamic of their comfortable, male-dominated cubicle culture.

“My affiliation with the HVAC industry began merely because of available employment in a geographically suitable location. The passion that I have developed for designing HVAC equipment, however, is rooted in my desire to change the outlook for our global climate, even just one chiller at a time.”

The approach I took to thrive in such a setting was to demonstrate to my colleagues where I could succeed, not where I lacked skill or HVAC experience. Since throughout my education and early career I had been exposed to a range of laboratory testing functions, I felt relatively comfortable in Trane’s extensive test facility. I spent hours each day in the lab, asking questions and working with the laboratory technicians on all types of commercial

HVAC equipment. The technicians became my most valuable source of HVAC training. Several of them recognized my genuine interest in learning their trade and my dedication to quality test data, and they were willing to go out of their way to bring me quickly up to speed on our products and on the basics of HVAC. It was these laboratory technicians who helped me build the tools and confidence I needed to interface more effectively with my engineering peers during my first several months on the job.

As I became more familiar with the industry and the products at Trane, I explored different engineering roles and tapped into the technical experts’ knowledge of our various components and subsystems. I became more versed in the mechanics, thermodynamics, and systems integration of our centrifugal chiller products. Eventually, I positioned myself to be part of the chiller new product development department, where I would work directly on meeting the challenges of more stringent worldwide efficiency standards and refrigerant phase-out directives for commercial chillers. In the past three years, Trane has successfully launched four new centrifugal chiller products that are designed for next-generation, low-global-warming-potential refrigerants. I have been able to participate in the design, modelling, testing, and building of three of these machines.

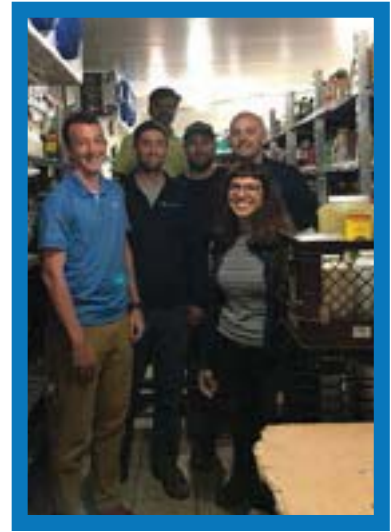
My day-to-day activities vary as chiller projects move from the conceptual stage to the product launch. During the early stages of a project, the majority of my time may be spent talking with marketing engineers to understand and define customer needs. A significant part of early development includes physics and mathematical modelling of components and systems to predict overall performance and

function. I work directly with our drafting and design team to specify and develop the individual parts and features so that they meet the requirements for function, manufacturability, and cost and comply with regulations. The process continues with the construction and testing of a prototype, during which 100 per cent of my time may be spent in the fabrication shop and laboratory, helping to assemble the unit and monitoring chiller performance as it is exposed to a range of rigorous tests. The analysis of this data leads to engineering discussion and revisions before a final design can be released to the factory for production. The variety associated with my job keeps me engaged throughout the development process and seeing an environmentally friendly chiller leave the factory to be delivered to a job site provides a great sense of satisfaction.

My affiliation with the HVAC industry began merely because of available employment in a geographically suitable location. The passion that I have developed for designing HVAC equipment, however, is rooted in my desire to change the outlook for our global climate, even just one chiller at a time.

Lilit Gevorkyan

It has been a little over a year since I graduated from the University of Texas at Austin with a bachelor's degree in electrical and computer engineering. Shortly after graduation, I was hired at Lennox International as a full-time test engineer for the Controls Team. I was excited about this new opportunity and about facing the challenges that were to come, but I was also a bit nervous because I didn't know what to expect. As part of my educational background, I have experience working in a lab environment and, of course, working with teams to complete challenging projects involving critical thinking. But the refrigeration and air conditioning (RAC) environment is something that I did not have any experience in; I didn't know what goes on in the attic of a house or even think about the complications of the cooling and heating process - or the actual design involved in keeping food cool in a refrigerator. Not only that, but since my degree programme was predominantly male, I had a bit of an expectation that this would be the case in my career as well. It was definitely intimidating coming into a field where most people had years of experience.



I began learning about residential projects, trying to grasp the concept of the design of the indoor and outdoor unit and how the systems communicated with each other. You can imagine that this was a lot of new information to take in, but with the help of my co-workers and training videos, I was beginning to understand the basic structure of heating, ventilation, and air conditioning (HVAC) systems. With the resources that Lennox provided - whether training material, product manuals, visual lab equipment, physical units, or fellow co-workers - understanding and learning these new concepts were becoming much easier.

The primary project I began working on involved the refrigeration units that are placed in convenience stores and grocery stores. This was a new project being developed at Lennox with control boards incorporated into refrigeration systems. I studied the specification document for this design and gathered as much information as possible from teammates working on this project. I developed test cases regarding the system and began testing scenarios on trainer boards. The trainer boards helped

“By dismissing the thought of failure, I have been able to interact with co-workers that can teach me certain skills and concepts, as well as helping me realize my full potential.”

me understand the algorithms and basic functionality, but it was still a bit challenging picturing the full functional system. After a few weeks, we received units to use for testing and I assembled the set-up in the lab with the units to be tested. Fast forward to a few months later, and I had the opportunity to go to an actual field trial site to help set

up this system for field testing. This experience gave me the chance to see how field technicians interact and work with each other, the challenges faced on site, and a whole other side of the business which I don't partake in. I learned how the typical installation process is implemented. Not only did I discover the behind-the-scenes process of technicians, but I also became more aware of the work that I was putting into this project. Going inside a convenience store and grabbing a bottle of cold water or an energy drink, you don't necessarily think about what is keeping your drink cold. I was able to imagine the impact that my work would be making on a bigger scale.

Throughout the past year at Lennox, I have learned that the fear of failure is something that can stand in between success and what you want to achieve. By dismissing the thought of failure, I have been able to interact with co-workers that can teach me certain skills and concepts, as well as helping me realize my full potential. I have learned to take full advantage of the resources offered and learn from people with different backgrounds who were more experienced in the field. While there is still a lot to learn about refrigeration and air conditioning systems, asking questions and seeking help when needed from others has been very beneficial. My personal approach to understanding the refrigeration system has been to

take in valuable information and allow the visual equipment in the labs to provide a strong foundation for understanding the cooling cycle. Realizing that RAC systems are incorporated into elements of daily life (such as vehicles, dwellings, airplanes, hospitals, restaurants - the list goes on) makes the achievements in my work much more significant and relevant to the betterment of this world.

Katherine Hammack



Background

I come from a family of engineers, so becoming an engineer was very natural. I learned as much as I could about the profession, taking internships during my summer breaks in college: one involved working for an electric utility company and the other, working as a test engineer at a shipyard.

After receiving my bachelor of science degree in mechanical engineering, I started my career as a product manager working for United Technologies' Carrier Air Conditioning corporation. I went on to get my master's degree in business administration, with a focus on marketing.

Much of my career has been spent communicating engineering concepts to non-engineers. After working in manufacturing for several years, I went back to the electric utilities industry, working on energy efficiency and the deregulation of the utility.

“From personal experience, I have found that I needed to “prove myself” in every job I have had by working harder and more effectively than my male counterparts.”

My next career move was into business consulting with Ernst & Young (EY). My focus was still energy efficiency, but it had evolved into a focus on sustainability and climate change. I was with EY when I received a call from the White House, asking me to join the Obama Administration.

I spent the last seven years as a presidentially appointed, Senate-confirmed Assistant Secretary of the United States Army. My responsibilities were policy and oversight for all Army bases worldwide – with a focus on energy, environment, and infrastructure. With the change in the presidential Administration, I left the US Federal Government and returned to EY to focus on performance improvement.

My favourite work while in the Army was the development of the Net Zero programme. Providing guidance and direction, with great collaboration with pilot projects, has resulted in a road map for net-zero energy, net-zero water, and net-zero waste on Army bases. The Net Zero strategy is all about resiliency. When net zero is achieved, the base, buildings, and operations are more resilient. Resiliency is cost-effective, enabling better responses to climate change and enhancing the quality of life for all. Today's technology enablers and thoughtful design strategies are changing our world. I found public service to be a humbling and awesome experience. I worked with phenomenally dedicated and thoughtful people, many of whom have spent their whole career working to ensure the men and women of the US Military Services have the support they need so that they can focus on their missions.

I am currently back at Ernst & Young, focusing on resiliency and smart cities.

Early on in my career, I met like-minded individuals who were struggling to define “green” in the built environment. We went on to found a non-profit organization, the US Green Building Council (USGBC). We worked closely with talented innovators and developed the Leadership in Energy and Environmental Design (LEED) certification programme for high-performance green buildings. Now, over 25 years later, the organization is still working to improve the built environment by providing leadership and guidance. I continue to be involved as the USGBC works to develop resiliency certifications for the built environment.

I joined the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) originally as a student member while in college. At Carrier Air Conditioning, involvement in ASHRAE was strongly encouraged. Job opportunities have taken me all over the US, but I have kept my ties with ASHRAE, where I am now on the Board of Directors as a Director-at-Large.

Thoughts and Challenges

Engineering is not often considered a field for women; neither is military service. Science, technology, engineering, and mathematics have long been considered more difficult fields of study. Women have not felt as welcomed in these fields as in other areas. From personal experience, I have found that I needed to “prove myself” in every job I have had by working harder and more effectively than my male counterparts. The engineering profession needs to be more welcoming, encouraging, and inclusive. It is diversity in thought and experience that makes projects better. Project leaders also need to consider that their clients want to see providers that reflect their diversity.

It is hard to point to any one person who mentored me during my career journey.

The women who were called into service during the labour shortages of World War II, when America’s aeronautics industry was in dire need, the women highlighted in the book and movie *Hidden Figures*: they demonstrated the curiosity and drive to make a difference.

Nelson Mandela has been quoted as saying: “I learned that courage was not the absence of fear, but the triumph over it. The brave man is not he who does not feel afraid, but he who conquers that fear.”

The Bible (Luke 12:48) says: “To whom much is given, of him shall be much required: and to whom men have committed much, of him they will ask the more.”

These are all things I live by and communicate to those I mentor. Take your curiosity and make something of it. Conquer your fear of making a difference. Take the God-given skills you have and put them to good use!

Personal

A general I once worked with in the Army called me an adrenaline junkie. I enjoy skydiving and scuba diving. With my two grown sons, I have been on a camel-back safari across the Australian Outback, and hiked across Victoria Falls in Zimbabwe. With my sons, we ventured into the high mountains of Tibet, climbed the Great Wall of China, and went on safari in South Africa.

I believe in working hard and playing hard. I believe that this is a great world full of amazing sights and amazing people. When we incorporate that diversity of thought, experience, gender, and race into our project teams, we always have better results!

I have returned to EY, the company I was with before I was in the US Army. I want to continue to work with teams and clients, to make the world a better place. To be a listener and encourager of those starting their careers. To know that our work makes a difference.

Sheila Hayter

My buildings industry career has truly been an exciting adventure filled with opportunities and success, as well as my fair share of disappointments. I cherish every one of these experiences, as they all provided valuable learning opportunities and helped me be better prepared for the next challenges ahead.

Throughout my career, which started when I was an undergraduate student in mechanical engineering during the 1980s, I have been driven to find a path where I feel I can give back, protect our energy and natural resources, and make the world a better place for all. Both my volunteer roles in ASHRAE and my career at the United States Department of Energy's National Renewable Energy Laboratory (NREL) help me meet these goals in two very different ways. ASHRAE is a global buildings industry organization with nearly 57,000 members and a presence in more than 130 countries. NREL is a research institution that focuses entirely on advancing energy efficiency and renewable energy technologies. While NREL has me looking constantly to the future – working in the buildings industry to find opportunities to advance cutting-edge research and make our new energy future a reality – ASHRAE keeps me firmly planted in the now. My ASHRAE colleagues work with current realities in our profession every day, while my NREL colleagues work every day to dream up a better future for all of us.



My ASHRAE experiences have connected me with buildings industry professionals from around the world, people whose expertise and careers are as varied as the places they are from. This network helped me grow as a young professional as I learned how to be a better buildings engineer – helping me explore solutions which make building systems as efficient as possible and connecting me with boots-on-the-ground practitioners, equipment manufacturers and suppliers, researchers, policymakers in energy, and corporate decision makers. These experiences developed my appreciation for the important responsibility those of us in this industry have to create healthy, comfortable, and productive environments, and for the role refrigeration and air conditioning play in achieving this goal.

As my career progressed, my ASHRAE network evolved and expanded as well. It continuously provided me with friends and colleagues whom I contacted when I needed answers to technical questions, advice on steps forward to address problems I faced, and strategies for growing new technical or business opportunities. My volunteer ASHRAE roles evolved over time as well, providing me with increasingly greater management, team-building, and strategic leadership roles. Because of my ASHRAE involvement, I expanded my technical knowledge of refrigeration, air conditioning, and all aspects of energy use in buildings, as well as learning to become a leader in our industry.

“These experiences developed my appreciation for the important responsibility those of us in this industry have to create healthy, comfortable, and productive environments, and for the role refrigeration and air conditioning play in achieving this goal.”

Every day at NREL, I am surrounded by highly creative and inquisitive thinkers who are asking questions about what our energy future will be and finding answers to those questions. Working at NREL is a humbling experience, as I can easily let myself feel how hard it is to keep up with the pace of innovation that surrounds me. But working in this environment is also invigorating. It drives me to continuously seek ways that I can contribute to, and be a valuable part of, the teams that are working to understand the problems of tomorrow and finding solutions to those problems today.

I joined the NREL buildings research team only a few years after completing my undergraduate degree in mechanical engineering. In essence, I have grown up at NREL just like I have grown up at ASHRAE. Early

on, my NREL role was to be the “doer,” the person on the team who crunched the numbers and searched high and low for a piece of information. It was not long before I was also leading project work to develop new tools for identifying and evaluating opportunities for energy savings in buildings. In addition, I was leading project work to explore technical and non-technical solutions which encourage decision makers to incorporate energy-efficiency and renewable-energy technologies into buildings systems. During the past nearly 10 years, I have been a line manager for a team of technical and clean-energy policy experts, as well as the partnership development manager overseeing the business development activities for a team of 80 people. So how do I contribute to supporting those incredibly creative and innovative colleagues with whom I work at NREL? My role as a manager has been to enable others to accomplish great things, and my role as a partnership development manager has been to facilitate the formation of relationships that lead to exploring new challenges with a range of stakeholders. All the while, I have continued to lead activities that connect experts from the Laboratory to stakeholders who benefit from their expertise. I have also continued to help those stakeholders define and implement strategic directions for addressing the challenges they face.

As I look back on my journey, I see that I have followed my desire to grow professionally and personally, that I have a passion to make the world a better place, and that I am willing to reflect when things go right or wrong in order to realize what I have learned and do better next time. All this has led to being selected by my peers in the buildings industry to become this year’s ASHRAE president. Through this journey, I have always felt a desire to give back and to show my appreciation to those around me who have helped me become who I am. I believe this is what will continue to be my motivation through the rest of my career as I work towards finding new ways to contribute to our new energy future and facing the challenges yet to come.

Julia Keen

I have been working in the heating, ventilation, air conditioning, and refrigeration (HVAC&R) industry since graduation from college. I pursued an education and career in the building design and construction industry because I had a passion for buildings. Following college, I took a job working as a consulting engineer designing mechanical, electrical, and plumbing systems in many different types of new buildings and renovations. I found this career exciting, challenging, and very rewarding.

It was not until I was a professional that I understood the impact that the career path I had selected had on peoples' quality of life, welfare, and safety. People spend most of their lives inside the built environment, and they expect that they will not only be thermally comfortable, but also safe. Air conditioning in buildings enables comfort even in the harshest environments, some of which may otherwise be deemed uninhabitable. As a direct result of this comfort, people are more productive and satisfied. Providing comfort is very satisfying, but even more rewarding is the ability to provide environments that enhance welfare – surgical suites that maintain conditions (temperature and humidity) to promote better patient prognoses, refrigerated warehouses for food and medical storage, and so on.



“I find tremendous satisfaction in knowing that I can help promote and advance good design practices.”

Seven years into my career, I made the decision to move from the design side of the profession to an academic appointment at Kansas State University. This career choice allows me to still be engaged in the industry, but instead of doing design full-time, I have the opportunity to educate and influence the next generation of designers. In this role, I am able to communicate the importance of what they are studying to practice. I also have the chance to train

professionals in the basics of HVAC&R through an ASHRAE professional development course. I find tremendous satisfaction in knowing that I can help promote and advance good design practices.

My career has been greatly influenced by my involvement in ASHRAE. The interaction and networking with HVAC&R professionals afforded to me by ASHRAE is invaluable. I have access to professional experts, allowing me to ask questions and collaborate, advancing my personal knowledge. To advance the HVAC&R industry, I can also share my skills: participating in the development of technical resources and leading efforts to create opportunities for distributing knowledge, such as partaking in research, lecturing, and writing of articles.

Sarah Maston

After graduating from Rensselaer Polytechnic Institute (RPI) with my bachelor of science degree in mechanical engineering, I did not enter the heating, ventilation and air conditioning (HVAC) field right away. It was after I had been in the workforce for a few years and was not exactly thrilled with my first job that I stumbled upon an ad for an HVAC engineer. I met with the owner of the small company, and we hit it off. I was a little concerned that I didn't know much about the field, but he said that he would teach me all I needed to know. So, for the next year, I and another young engineer that had recently been hired went to work an hour early two days a week to learn HVAC principles. My boss was patient and an excellent teacher, and the material we covered was directly related to the work we were doing.

A few years later, I moved on to a larger mechanical, electrical, plumbing, and fire protection (MEPFP) engineering firm, again working as a design engineer, to try designing HVAC systems for different building types. After a few years at the larger firm, I felt stuck – like I wasn't learning anything new.

One day, I was talking to the group leader for the firm's commissioning group about what commissioning was all about. I was intrigued by the idea of working for the building owners and being on site to see the building being built. This was more exciting than sitting in my cubicle all day. Soon I switched groups and fell in love! I was fascinated as I watched the HVAC equipment installation and start-up. I started writing the sequences of operations and failure modes for the equipment tests. I met many people, from manufacturers' representatives to mechanical contractors, and of course, owners. I enjoyed being a member of the team and helping to solve problems as they arose.

“Being involved in ASHRAE has been a vital part of my career, allowing me to collaborate and network with people of different technical backgrounds and from every corner of the globe.”

Commissioning is a process that is dependent on good documentation and clear communication - skills I excelled at. My group leader was a real mentor for me, introducing me to other decision makers along the way, and engaging our entire commissioning team in the marketing and business of commissioning. We were all project managers, managing our own budgets and forecasting new business. We each helped to write proposals and to interview for new projects.

This manager also introduced me to ASHRAE. The company encouraged its employees to be active at the local level, but my manager belonged to a technical committee (TC) that was responsible for editing chapters in the ASHRAE Handbook. So my first ASHRAE job was Handbook revision. After working on a chapter for over a year, I was invited to go to the winter meeting where the TC was going to vote on my revised chapter. I was so excited! I went to New York City for the conference and met members of the TC. I was giddy with anticipation and a tad nervous - what if they didn't agree with my changes? What if they challenged some of my content? But I need not have worried. All the chapter revisers were asked to stand and be acknowledged, and then the chair said: “Let's vote on the proposed revisions to these five chapters. All in favour?” All voting members answered “aye”, and it was over in two minutes. From there, though, I springboarded into involvement in the Building Commissioning TC, where I met many other commissioning practitioners from all over the world, and in the Conferences and Expositions Committee, where our team of volunteers created the technical programme for the biannual conferences. Being involved in ASHRAE has been a vital part of my career, allowing me to collaborate and network with people of different technical backgrounds and from every corner of the globe.

As things have turned out, my manager would be proud. Four years ago, I started my own commissioning firm. It's only me, but I'm okay with that. I have many ongoing projects for our local hospital campus. I enjoy the projects and the people I work with. I enjoy working for myself and building my business, but also having the flexibility to be there for my children. I'm not on the school board anymore and my kids are playing high-school sports, so I am not coaching, but I do lead a Girl Scout troop, as I try to encourage another generation of girls to be whatever they want to be. I really do enjoy going to work every day.



Lauren Roberts



My grandfather co-founded a business, cfm Distributors, in 1969, and my father followed in his footsteps, working in various capacities within our company until 2001, when he became president. When I was in college, I was studying for a business degree but working outside the industry. In 2004, I was asked to join the family business by cfm's then controller. He planned to retire in a few years and thought I might want to learn how to do the job and potentially take over. I started as an accounting assistant and soon learned that I needed more interaction with people. Next, I moved to the marketing department and became a marketing assistant. I worked my way up to the post of Marketing Manager after a while, then moved up to Director of Marketing, then Vice-President of

Marketing and Customer Experience, then Executive Vice-President, and then, in 2018, to President/Chief Executive Officer.

“Being involved in the Women in HVACR organization has given me a network of other women at all levels of the supply chain with whom to share ideas and challenges and who have mentored me.”

I am excited and passionate about my work and the overall industry because we are at a really exciting point in time: there is a huge generational change and there are tonnes of new technology advancements and great people to work with. With all that, there is never a dull moment and there is plenty to work on and change in our industry.

Throughout my career, I have experienced the best professional and personal growth by being involved in different committees through Heating, Air-conditioning and Refrigeration Distributors International (HARDI), the board of directors for Women in HVACR, and other local industry associations. The ideas and best-practice sharing, the personal and professional growth, and the personal friendships that have come out of such involvement have made my career far better than it would have been at this point had I not been involved.

As a woman in the heating, ventilation, air conditioning, and refrigeration (HVACR) industry, I have found it challenging. I have been fortunate enough to have several male sponsors who helped give me opportunities for growth and have given me a voice in meetings and activities to help me showcase my abilities. Also, being involved in the Women in HVACR organization has given me a network of other women at all levels of the supply chain with whom to share ideas and challenges and who have mentored me. I highly recommend that women in our industry join Women in HVACR to get the same kind of network and great support that has helped many women like me flourish in our industry.

Vanuatu

- Cindy Liatlatmal
- Indy Michael

Cindy Liatlatmal



I grew up doing what I do today because I wanted to be different. During my early years in school, I had already decided to take up the study of electrical engineering. In early 2000, I was offered a sponsorship award by the Australian Agency for International Development (AusAID) to fund my education at the Vanuatu Institute of Technology. I chose their electrics programme.

As part of my studies, I did an internship with the Vila Refrigeration & Air Conditioning company during my holidays. At the time, I was basically just a helper for senior staff and learned a lot during these internships. However, things changed later in the course of a summer break when the manager gave me a new toolbox as a gift, showing the company's appreciation to me for being part of the team during that busy time.

At first, I had no idea about refrigeration, because it was different from my electricity studies. However, as time went on, my interest grew and I became more and more familiar with the basic concepts of the job. In 2001, I was employed by the company on a full time basis.

For over seven years, I worked from experience, with no proper training in refrigeration, until 2008, when I was accepted for on the job training in Samoa with the Australia Pacific Training Coalition (APTC). Two years later, I graduated in refrigeration and was promoted to supervisor, which has been my position to this day. I achieved all this success through many years of hard work and patience. Although I faced many challenges in school being the only girl in my class, I managed to succeed with the help of my tutors and support from my parents and family. At times, my male colleagues can be very hard with me concerning my workload and position, but I am always fair and patient.

“ This industry is a very challenging business for me as a woman, yet it is very rewarding and it would be good to see more women and girls in this sector. ”

This industry is a very challenging business for me as a woman, yet it is very rewarding and it would be good to see more women and girls in this sector. I would thus like to encourage other ladies out there. If I can do it, then you can do it too! You just need to have strong self-esteem and live your dream.

Indy Michael

My journey began after an early departure from primary school, when I decided to take up an IT programme at the Vanuatu Institute of Technology. However, due to limited places in that programme, I had no choice but to enrol for the next option, which was electrical wiring. It was really difficult at times to study for a course that was not part of my future plan.

“I am happy with being the only woman in the company in my current job and would like to reassure other girls and women to trust and think highly of themselves because, although we are women, we can also pursue careers that only men used to do.”

Though I was the only girl in class, I managed to graduate with a basic certificate and was ready to continue my studies abroad. Once again, things did not turn out as planned, since my parents could not afford for me to continue my studies. It was then that I decided to apply to Vila Refrigeration & Air Conditioning to pursue a career as an RAC technician.

I attended a training course on Good Practices in Refrigeration in 2016. I learned about the different techniques that can be used to prevent gases such as R-22 from leaking. The course enhanced my understanding on the topic.

I was a little nervous at first, because a lot of my daily tasks included heights, of which I am rather afraid. However, bit by bit, I came to overcome my fear of heights! Having faced that fear every day, it has now become one of my strengths. Working with heavy tools is also one of the challenges that makes my job even harder at times, but I am happy that my male counterparts are continuously near to support me.

The good thing about being a female technician in the RAC industry is the appreciation and recompenses received from clients for the decent work I do. Then again, at times, it can be frustrating when clients raise concerns over my not meeting their expectations on a job.

However, I am happy with being the only woman in the company in my current job and would like to reassure other girls and women to trust and think highly of themselves because, although we are women, we can also pursue careers that only men used to do.





Zambia

- Jane Lubi
- Annie Macheba
- Clara Nakalonga
- Judith Jilinu Nsakashalo

Jane Lubi

I am a Zambian lady aged 42. I graduated from Northern Technical College in 1998 with a certificate in refrigeration and air-conditioning and then worked in the industry for two years before joining the training sector, where I have been training students for the past thirteen years.

I work for Northern Technical College, which is the biggest technical training college in Zambia.

My job involves training students in refrigeration and air-conditioning practice and theory. The trainees consist mainly of beginners from secondary schools.

I am also involved in short courses in which we train people from industry. These people are trained in new refrigeration practices, such as basic refrigeration for those with a different technical background who want to improve their skills, and also refrigerant management, where we train people how to handle refrigerants so that they don't release them into the atmosphere – in order to protect the ozone layer.

In our country the RAC sector is male-dominated, and I am the only woman in the training sector. I decided to join the refrigeration and air-conditioning training sector so that I could encourage women to take up that trade.

“I decided to join the refrigeration and air-conditioning training sector so that I could encourage women to take up that trade.”

Refrigeration has been my passion for the past 20 years. It's one of the fastest-growing industries in Zambia and a good contributor to the growth of the economy.

I encourage our graduates to open their own companies. Most of my former students are now company owners employing others.



Annie Macheba

I am a Zambian lady aged 38, born on 27 November 1980. I completed my education at Namwala Secondary School in the southern part of Zambia.

I attended my RAC course at the Northern Technical College (Nortec) in Ndola in the Copperbelt from 2002 to 2005. I did my attachment at the Wanaz Refrigeration company in Kitwe. When I was allowed to join them after completion, I worked there from 2005 to 2009 as a technician and at the same time as workshop supervisor.



As for my work, it was interesting because of what I learnt at school and what I actually experienced. At school we were told about recovery and recycling, but when we arrived in industry it was the opposite because very few people could afford to have all the equipment owing to the high cost of living in our country.

We attended LC2 certification in 2007 and 2013, where we learnt about gases being changed and replaced in our country because people were looking for high profits. Few people are aware that all they consider is high profits and too much corruption is allowed at the borders.

The challenges are so many, but to mention just two: workers are supposed to be motivated by good salaries and secure jobs, but because

“I am inspired by women who can make their own demands.”

of too many people with no jobs they do cheap work just to earn a living; technicians don't care about the methods and tools they use – all they are interested in is having food on the table.

As women, we are not really given any consideration, even though we can contribute, but are mostly left at the workshop to take care of internal issues instead of being involved in industrial work. But, as a woman, I think we should wake up from the delusion that only men can do it. As for me, because of my education and difficulties, just paying school fees was a problem. I value my work. I feel my work is my mother or father.

I was also privileged to work in the mines but had some bad contractors who didn't even pay me after I had been working for the company for so long. They take a woman for granted because she is a woman. Some even take women as their girlfriends so that they can take care of their businesses. I am inspired by women who can make their own demands, not really waiting for a man to do everything for them. As a woman, I pity women who end up leading wrong lives, e.g. doing prostitution because they don't have anyone to help them.

Some measures should also be taken to give women work security. If anything happens or jobs are to be lost, women will be considered first. Now with this theme of gender we are in trouble. Some measures should be considered for bosses who offer jobs to women on certain conditions (giving up the first salary or paying before you are given the employment). As women we encounter problems.

Clara Nakalonga



I completed my secondary school education in 1997. My parents owned a flower, spice and cake shop and this was my main motivation to study refrigeration and air-conditioning. I wanted to know how to repair and maintain cooling systems for the shop.

Later I enrolled at the Northern Technical College and studied refrigeration. Upon graduation, I was employed by Zambeef, a major agribusiness company dealing with beef, fish, pork and dairy products.

My job is mainly to repair, service and maintain refrigeration units such as freezer rooms, meat displays and chillers.

As a woman, I face some challenges. One of the challenges is that men do not accept me as a technician. They believe that technical jobs are

not meant for women. Currently I am a supervisor leading a group of 11 men and some cannot accept being headed by a woman. In some cases I face sexual harassment from certain men.

“One of the challenges is that men do not accept me as a technician. They believe that technical jobs are not meant for women.”

Judith Jilinu Nsakashalo

I graduated from the Northern Technical College in 1999 with a technician's certificate in refrigeration and air-conditioning.

I worked for Zambia Telecommunications Limited as a service technician for ten years. The job involved installation, servicing and maintenance of split-type air-conditioners and central air-conditioning systems.

“The challenges faced by female technicians are that menfolk underestimate the capabilities of women to do the job. There are also cases of sexual harassment by men.”

I am currently working with fellow technicians running a refrigeration and air-conditioning business which we set up in 2010.

The challenges faced by female technicians are that menfolk underestimate the capabilities of women to do the job. There are also cases of sexual harassment by men.

I was motivated to work in this sector because there are few women working in it, and I wanted to prove to the menfolk that women can also do engineering tasks.



Zimbabwe

- Yolanda Dembedza

Yolanda Dembedza



It is not always easy or even possible for a woman to choose a career in a male-dominated field. One thing I have learnt is never to underestimate yourself; you can be who you want to be as long as you stay positive because the sky is the limit.

My name is Yolanda Dembedza, and I am a Class One refrigeration and air-conditioning technician. Becoming an HVAC (heating, ventilation, air-conditioning and refrigeration) technician was the greatest decision I have made in my life. The fact that the industry was growing and needed more refrigeration and air-conditioning technicians motivated me to choose the trade as a great career. If you look around, everything needs to be refrigerated. Buildings, ships, planes, refrigerated trucks and almost every modern car have air-conditioners. All this inspired me to join the trade because it was broad, meaning more job opportunities. Another thing is that after training you can work on your own, starting your own business.

I did apprenticeship training for four years. This involved one year of theory training and three years' practice. In my first year I went to Bulawayo Polytechnic for the theory. At college I got to know the principles and basis of refrigeration. College work was not a challenge, though engineering drawing was a bit difficult for me. Fortunately, I was the best student, with five distinctions and five credits. On graduation day I was awarded the best-student certificate and the national certificate.

I also attended the training course on safe use of hydrocarbon refrigerants and environmentally friendly practices held at Kwekwe Polytechnic by the National Ozone Unit. For the other three years after college I was on attachment at Frigquip Refrigeration in Kwekwe. The practical training was more hands-on, doing work in the field, working directly with customers and systems. Most of the duties were troubleshooting, making mechanical and electrical repairs, and maintenance and installation of refrigeration and air-conditioning equipment. I learnt the necessary skills to work

“As a woman working in an exclusively male environment, I have faced gender-related challenges ... including sexual harassment from teachers, supervisors and classmates.”

with domestic, commercial and industrial systems. On completion of the attachment I was trade tested for Class One journeyman and I did well.

As a woman working in an exclusively male environment, I have faced gender-related challenges. These include sexual harassment from teachers, supervisors and classmates. Some of my male workmates see me as intimidating; they undermine my potential, looking down on me as a woman and saying it's a man's job.

The trade is physically demanding; a man's strength is needed to lift some equipment. It was difficult for me to lift heavy materials without men's assistance. I am scared of heights and so installing air-conditioners in tall buildings was also a challenge for me. The other thing is female dressing versus working conditions. Once you join the trade there is no more female dressing in the workplace. At work I dressed like a man for the sake of safety: work suit and safety shoes to avoid injuries. In one incident, the gas exploded while I was working on a fridge and I had burns on my face and hands. The work schedule was also a challenge; sometimes I had to work on weekends. In the summer season, because of the pressure, I would finish work late in the evening, thus making it difficult for me as a woman to perform other duties at home.

At times I might meet customers who would not want me to repair their refrigerators or air-conditioners until I could prove that I could do better than men. Social views and attitudes at first

affected me because some people had no faith in me as a woman doing a man's job. To be an expert it takes time: the trade requires a lot of on-the-job experience. Hard work and dedication really pays off because the work experience I had has made it easier for me to scale new heights in my career. The time I spent being an apprentice was a valuable experience since it gave me the opportunity to think through problems and solve them. New situations with different challenges kept me busy and eager to learn new things every day, using both my hands and my head to do good work.

Because of the country's economic problems, I haven't got a full-time permanent job. At the moment I am working on my own responding to customers by appointment and in their homes, doing services and repairs. In a nutshell, refrigeration and air-conditioning is one of the best fields for women who want to pursue a career in industry. If you are mechanically inclined, energetic and competent, the career is very exciting. The most important thing is to work hard because the more dedicated you are as a woman technician the more respect, knowledge, experience and income you will gain.



GLOSSARY

Adiabatic cooling	The process of reducing heat through a change in air pressure caused by volume expansion
AIRAH	Australian Institute of Refrigeration, Air Conditioning and Heating
Air conditioning	The process of controlling temperature, humidity, composition and distribution of air for the purpose of human comfort or for special technical needs in an industrial process (pharmaceutical, textile, etc.) or other application
Anemometer	An anemometer is a device used for measuring wind speed and is also a common weather station instrument
ASHRAE	ASHRAE is a global society whose members focus on building systems, energy efficiency, indoor air quality, refrigeration and sustainability within the air conditioning and refrigeration industry. In 2012, as part of a rebranding, ASHRAE began doing business as “ASHRAE” vs. using its full legal name of the American Society of Heating, Refrigerating and Air-Conditioning Engineers to reflect the Society’s worldwide membership and global services.
APTC	Australia-Pacific Technical College to the Australia-Pacific Training Coalition
Cascade refrigeration system	Two or more independent refrigeration circuits where the condenser of one system rejects heat directly to the evaporator of another
CFCs	See chlorofluorocarbons
Charging	Transferring a refrigerant from the refrigerant source (a new or recycled refrigerant cylinder) into a system, usually according to a specified weight, amount of sub-cooling, or evaporating pressure. Charging is normally carried out using a dedicated charging machine (e.g. in a production area) or using a cylinder connected to the system via a manifold or hoses. The cylinder is disconnected from the refrigeration system after the refrigeration system has been completely charged with the new refrigerant
Chillers	Chillers are centralised air-conditioning systems that remove heat from a liquid via a vapor-compression or absorption refrigeration cycle
Chlorofluorocarbons (CFCs)	Halocarbons containing only chlorine, fluorine and carbon atoms. CFCs are both ozone depleting substances and greenhouse gases
Climate change	Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcing, or to persistent anthropogenic changes in the composition of the atmosphere or in land use. Note that Article 1 of the Framework Convention on Climate Change (UNFCCC) defines climate change as “a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability, observed over comparable time periods.” The UNFCCC thus makes a distinction between “climate change,” attributable to human activities altering the atmospheric composition, and “climate variability,” attributable to natural causes

CO₂	Carbon dioxide
Cold chain	A cold chain is a temperature-controlled supply chain. An unbroken cold chain is an uninterrupted series of refrigerated production, storage and distribution activities, along with associated equipment and logistics, which maintain a desired low-temperature range
Compressor	A device for mechanically increasing the pressure of a refrigerant vapour.
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DX systems	Direct expansion system (the evaporator is located in the space to be refrigerated)
ECOWAS	Economic Community of West African States
EPEE	European Partnership for Energy and the Environment
F-gases	Fluorinated gases ('F-gases') are a family of man-made gases used in a range of industrial applications. Because they do not damage the atmospheric ozone layer, they are often used as substitutes for ozone-depleting substances. However, F-gases are powerful greenhouse gases.
FECO	Foreign Economic Cooperation Office, Ministry of Environmental Protection (China)
Freon	Freon is a registered trademark of The Chemours Company, which uses it for a number of halocarbon products. It is commonly used as a generic term when referring to any fluorocarbon refrigerants.
Fluorocarbons	Halocarbons containing fluorine atoms, including chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons and perfluorocarbons.
Gas chromatography	Gas chromatography is a common type of chromatography used in analytical chemistry for separating and analysing compounds that can be vaporized without decomposition.
GCC region	The Gulf Cooperation Council (GCC) is a political and economic alliance of six countries in the Arabian Peninsula (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates)
GEF	Global Environment Facility
Global warming potential (GWP)	An index comparing the climate impact of an emission of a greenhouse gas relative to that of emitting the same amount of carbon dioxide. GWP is determined as the ratio of the time integrated radiative forcing arising from a pulse emission of 1 kg of a substance relative to that of 1 kg of carbon dioxide, over a fixed time horizon
Green Customs	The Green Customs Initiative, is a partnership of international organisations cooperating to prevent the illegal trade in environmentally-sensitive commodities and substances and to facilitate the legal trade.

Greenhouse gases (GHGs)	The gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation within the spectrum of the thermal infrared radiation that is emitted by the Earth's surface, by the atmosphere and by clouds. This property causes the greenhouse effect. The primary greenhouse gases in the Earth's atmosphere are water vapour, carbon dioxide, nitrous oxide, methane and ozone. Moreover, there are a number of entirely anthropogenic greenhouse gases in the atmosphere, such as the halocarbons and other chlorine- and bromine-containing substances that are covered by the Montreal Protocol. Some other trace gases, such as sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons, are also greenhouse gases
GWP	See global warming potential
Halon	Halon or haloalkanes are a group of chemical compounds derived from alkanes containing one or more halogens used primarily as flame retardants and fire extinguishants (now phased out by the Montreal Protocol except for some exempted uses)
Halon-1211	Bromochlorodifluoromethane
Halon-1301	Bromotrifluoromethane
HTOC	Halon Technical Options Committee, one of the specialised subsidiary bodies of Montreal Protocol Expert Panels
HC-290	See R-290
HC-600a	See R-600a
HPMP	HCFC Phase out Management Plans
HCFCs	See hydrochlorofluorocarbons
Heat exchanger	A part of the refrigerating system used for transferring heat across a boundary, including the condenser, evaporator, and intercoolers.
Heat Pumps	A heat pump is a device that transfers heat energy from a source of heat to what is called a heat sink. While air conditioners and freezers are familiar examples of heat pumps, the term "heat pump" is more general and applies to many heating, ventilating, and air-conditioning (HVAC) devices used for space heating or space cooling.
HFC	See hydrofluorocarbons
HFC-32	Difluoromethane
HFOs	See hydrofluoroolefins
High pressure side	The part of a refrigerating system operating at the pressure level of the condenser or gas cooler
HVAC	Heating, ventilation, and air conditioning
HVAC&R/ HVAC-R	Heating, ventilation, air conditioning and refrigeration
Hydrocarbon (HCs)	Chemical compounds consisting of one or more carbon atoms surrounded only by hydrogen atoms.
Hydrochlorofluorocarbons (HCFCs)	Halocarbons containing only hydrogen, chlorine, fluorine and carbon atoms. Because HCFCs contain chlorine, they contribute to ozone depletion. They are also greenhouse gases

Hydrofluorocarbons (HFCs)	Halocarbons containing only carbon, hydrogen and fluorine atoms. Because HFCs contain no chlorine, bromine or iodine, they do not deplete the ozone layer. Like other halocarbons they are potent greenhouse gases
Hydrofluoroolefins (HFOs)	hydrofluoroolefins, also called “unsaturated HFCs”. Molecules of carbon, fluorine and hydrogen that include a double-bond between 2 carbon atoms. All recently introduced HFOs have a GWP below 10
IIR	International Institute of Refrigeration
JARN	Japan Air Conditioning, Heating & Refrigeration News
K-CEP	The Kigali Cooling Efficiency Program
Kigali Amendment	The Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer was adopted by all Parties to the Montreal Protocol in October 2016. The Amendment brings the future production and consumption of hydrofluorocarbons (HFCs) under the control of the Protocol and will make a major contribution towards the fight against climate change. Control of HFC production and consumption will add to the climate benefits already achieved by the Montreal Protocol through the phaseout of ozone depleting substances (ODS) including CFCs and HCFCs
LCCP	Life Cycle Climate Performance is an evaluation method by which HVAC&R systems can be evaluated for the global warming impact over the course of their lifetime. It is calculated as the sum of direct and indirect emissions generated over the lifetime of the system. Direct emissions include all effects from the release of refrigerant into the atmosphere during the lifetime of the system. This includes annual leakage and leakage during the disposal of the unit. The indirect emissions include emissions from the manufacturing process, energy consumption and disposal of the system
MAC	Mobile Air-conditioning - systems installed in cars to keep drivers comfortable and cool.
MAC Directive	To reduce emissions of fluorinated greenhouse gases from mobile air-conditioning systems (MACs), the European Directive on MACs introduces a gradual ban on these gases in passenger cars
Maintenance	All kinds of work that may be performed by a maintenance technician, primarily related to ensuring the continued good operation and working of refrigeration systems, as well as record-keeping
MEAs	Multilateral Environmental Agreements
MENA region	Referring to the Middle East and North Africa region
Methyl Bromide	Methyl bromide is an odorless, colorless gas that is a powerful ozone-depleting substance, used to control a wide variety of pests in agriculture and shipping, including fungi, weeds, insects, nematodes (or roundworms), and rodents. It is controlled under the Montreal Protocol
Montreal Protocol on Substances that Deplete the Ozone Layer	An international treaty designed to protect the ozone layer by phasing out the production and consumption of numerous substances that are responsible for ozone depletion

Multilateral Fund	Part of the financial mechanism under the Montreal Protocol. The Multilateral Fund was established by a decision of the Second Meeting of the Parties to the Montreal Protocol (London, June 1990) and began its operation in 1991. The main objective of the Multilateral Fund is to help developing countries (Article 5 parties) to the Montreal Protocol to comply with the control measures of the Protocol
National Ozone Units	National Ozone Units (NOUs) are the government units in developing countries that are responsible for managing their national programmes to comply with the Montreal Protocol on Substances that Deplete the Ozone Layer
Natural Refrigerants	Natural refrigerants are naturally occurring substances, such as hydrocarbons (e.g. propane, iso-butane), carbon dioxide and ammonia. These substances can be used (amongst others) as refrigerants in various kinds of refrigeration and air-conditioning systems. The key characteristics of these refrigerants are that they do not contribute to depletion of the ozone layer and have no or only a negligible global warming impact.
NH₃	Ammonia
Ozone Depleting Potential (ODP)	A relative index indicating the extent to which a chemical product may cause ozone depletion compared with the depletion caused by refrigerant R-11. Specifically, the ODP of an ozone depleting substance is defined as the integrated change in total ozone per unit mass emission of that substance relative to the integrated change in total ozone per unit mass emission of R-11.
Ozone depletion	Accelerated chemical destruction of the stratospheric ozone layer by the presence of substances produced by human activities.
Ozone Depleting Substances (ODS)	Substances known to deplete the stratospheric ozone layer. ODS controlled under the Montreal Protocol and its Amendments are chlorofluorocarbons, hydrochlorofluorocarbons, halons, methyl bromide, carbon tetrachloride, methyl chloroform, hydrobromofluorocarbons and bromochloromethane.
Ozone layer	The layer in the stratosphere where the concentration of ozone is greatest. The layer extends from about 12 to 40 km. This layer is being depleted by anthropogenic emissions of chlorine and bromine compounds. Every year, during the Southern Hemisphere spring, a very strong depletion of the ozone layer takes place over the Antarctic region. This depletion is caused by anthropogenic chlorine and bromine compounds in combination with the specific meteorological conditions of that region. This phenomenon is called the Antarctic ozone hole.
Phase-out	The ending of all production and consumption of a chemical controlled under the Montreal Protocol
PPE	Personal protection equipment; safety equipment
Psychrometer	A psychrometer measures the relative humidity in the atmosphere through the use of two thermometers: a dry bulb thermometer, is used to measure the temperature by being exposed to the air. a wet bulb thermometer, measures temperature by having the bulb dipped in a liquid.

R-12	Dichlorodifluoromethane (CFC)
R-134a	1,1,1,2-tetrafluoroethane (HFC)
R-141	Dichlorofluoroethane (HCFC)
R-161	Fluoroethane (HFC)
R-22	Chlorodifluoromethane (HCFC)
R-290	Propane (hydrocarbon)
R-32	Difluoromethane (HFC)
R-407	Refrigerant blend/mixture containing Hydrofluorocarbon (HFC)
R-407C	Refrigerant blend/mixture containing Hydrofluorocarbon (HFC)
R-410	Refrigerant blend/mixture containing Hydrofluorocarbon (HFC)
R-415A	Refrigerant blend/mixture containing Hydrofluorocarbon (HFC) and Hydrochlorofluorocarbon (HCFC)
R-415B	Refrigerant blend/mixture containing Hydrofluorocarbon (HFC) and Hydrochlorofluorocarbon (HCFC)
R-418A	Refrigerant blend/mixture containing Hydrofluorocarbon (HFC), Hydrochlorofluorocarbon (HCFC) and Hydrocarbon (HC)
R-600	Butane (Hydrocarbon)
R-600a	Isobutane (Hydrocarbon)
R-744	Carbon dioxide
RAC	Refrigeration and air conditioning
Reefer container	A refrigerated shipping container used to store or transport frozen or cold goods, perishable items or goods that require temperature control.
Refrigerant	A fluid used for heat transfer in a refrigerating system. This fluid absorbs heat at a low temperature and a low pressure and rejects heat at a higher temperature and a higher pressure, a process that usually involves changes of the state of the fluid.
Refrigerant oil	Refrigerant oil reduces friction on metal parts, reducing wear on the compressor and prolongs the life of the refrigeration system. The refrigerant oil must also have the appropriate miscibility and solubility characteristics to interact with the refrigerant.
RMP	Refrigerant Management Plan (Montreal Protocol national ODS phase-out project)
SAIRAC	South Africa Institute for Refrigeration and Air Conditioning
SENAI	Serviço Nacional de Aprendizagem Industrial, Portuguese National Service for Industrial Training: a network of not-for-profit secondary level professional schools established and maintained by the Brazilian Confederation of Industry.
Servicing	All kinds of work that may be performed by a service technician, from installation, operations, inspection, repair, retrofitting, redesign and decommissioning of refrigeration systems to handling, storage, recovery and recycling of refrigerants, as well as record-keeping.
SGS	Synthetic greenhouse gases

shecco	shecco is a market development organisation working within the HVAC&R sector specialising in the natural refrigerants CO ₂ , hydrocarbons, ammonia, water, and air.
Spiral freezer	A particular type of freezer design usually built to preserve space and minimize the freezers footprint
TAFE	Technical and further education
TVET	Technical Vocational Educational Training
TEWI	Total Equivalent Warming Impact - A measure of the overall global-warming impact of equipment based on the total related emissions of greenhouse gases during the lifetime of the equipment, including its manufacture and the disposal of operating fluids and hardware at end-of-life. TEWI takes into account both direct emissions and energy-related emissions produced by the energy consumed in operating the equipment. TEWI is measured in units of mass of CO ₂ equivalent.
TPMP	Terminal Phase-out Management Plan (Montreal Protocol national ODS phase-out project)
Trans Critical Cooling	A refrigerating cycle whose compressor discharges refrigerant at a pressure above the critical point.
UNDP	United Nations Development Program – an implementing agency of the Multilateral Fund for the Implementation of the Montreal Protocol
United Nations Environment Programme (UNEP)	Established in 1972, UNEP is the specialised agency of the United Nations for environmental protection and is an implementing agency of the Multilateral Fund for the Implementation of the Montreal Protocol.
UNIDO	United Nations Industrial Development Organization - an implementing agency of the Multilateral Fund for the Implementation of the Montreal Protocol
VAV	Variable air volume - allows different volumes of air into a space to provide better control of the room temperature and air flow.
VFD	Variable frequency drive - based on demand, a VFD adjusts the speed of an HVAC fan or pump motor, saving energy and prolonging equipment life.

UN Environment Programme Law Division and its OzonAction Branch

About the OzonAction Programme

Under the Montreal Protocol on Substances that Deplete the Ozone Layer, countries worldwide are taking specific, time-targeted actions to reduce and eliminate the production and consumption of man-made chemicals that destroy the stratospheric ozone layer, Earth's protective shield.

The objective of the Montreal Protocol is to phase out ozone depleting substances (ODS), which include CFCs, halons, methyl bromide, carbon tetrachloride, methyl chloroform, and HCFCs. And with the adoption of the Kigali Amendment in October 2016, hydrofluorocarbons (HFCs) have been added to the list of substances controlled under the protocol. One hundred ninety eight governments have joined this multilateral environmental agreement and are taking action.

The UNEP Law Division OzonAction Branch assists developing countries and countries with economies in transition (CEITs) to enable them to achieve and sustain compliance with the Montreal Protocol. With our programme's assistance, countries are able to make informed decisions about alternative technologies, ozone-friendly policies and enforcement activities.

OzonAction has two main areas of work:

- Assisting developing countries in UNEP's capacity as an Implementing Agency of the Multilateral Fund for the Implementation of the Montreal Protocol, through a Compliance Assistance Programme (CAP).
- Specific partnerships with bilateral agencies and Governments.

UNEP's partnerships under the Montreal Protocol contribute to the realisation of the Millennium Development Goals and implementation of the Bali Strategic Plan.

For more information about these services please contact:

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About UN Environment Programme Law Division

The Law Division is the lead division charged with carrying out the functions of UN Environment Programme that involve the development and facilitation of international environmental law, governance and policy. To fulfill its mandate, the law division focuses on:

Strengthening National Environmental Laws

Laws designed to prevent and minimize different forms of pollution and prevent the exploitation of natural resources are the backbone of sound environmental governance. No form of sustainable development is possible without well designed environmental laws. We work with governments and organizations in the design of model laws for replication and application by states. We build the capacity of judges to make more informed rulings on cases of an environmental nature and improve cooperation between law makers the world over working on our behalf to safeguard the environment.

Supporting Environmental Treaties

International environmental treaties set benchmarks and standards for states to meet their obligations to their citizens and to neighboring states, and through them technical and legal support can be provided to support implementation of environmental policies. We provide support to countries for the coherent planning and implementation of the biodiversity, chemicals and waste, and climate conventions.

Strengthening Institutions

Through strong institutions, environmental laws can be enforced and more effective management of natural resources assured through the provision of environmental services, gender equity and risk mitigation. We work with governments and organizations to strengthen and streamline institutional arrangements and capacities for tackling environmental issues. We strengthen capacities to enforce environmental laws and encourage trans-boundary cooperation. We help build national capacities, and support awareness raising and communication with regard to environmental laws and regulations.

Advancing Environmental Rights

Promoting, respecting and protecting environmental rights is key to sustainable development. We work with state and non-state actors to strengthen institutional capacities to develop and implement policy and legal frameworks that protect environmental rights effectively and inclusively. We encourage businesses to respect environmental rights by helping them to better understand what their environmental rights obligations are, and we support the dissemination of information on environmental rights to the public, and implement a media training curriculum on environmental rights in all major regions.

Achieving the Global Goals

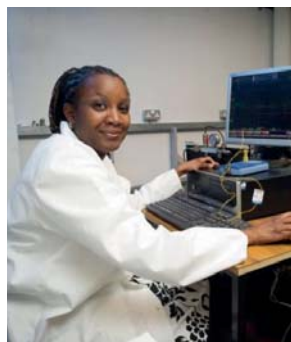
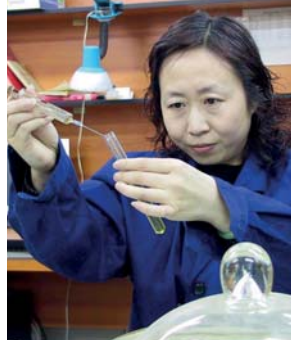
We promote synergies in the multilateral system by strengthening the capacities of countries to coherently implement internationally agreed environmental goals, including the Sustainable Development Goals and the Paris Agreement. In order to achieve the internationally agreed environmental goals and the implementation of the 2030 Agenda we work with state and non-state actors to enable institutions to better address the environmental dimension of the Sustainable Development Goals by supporting the development of national policies that promote poverty eradication and environmental sustainability.

About UN Women

UN WOMEN IS THE UN ORGANIZATION DEDICATED TO GENDER EQUALITY AND THE EMPOWERMENT OF WOMEN. A GLOBAL CHAMPION FOR WOMEN AND GIRLS, UN WOMEN WAS ESTABLISHED TO ACCELERATE PROGRESS ON MEETING THEIR NEEDS WORLDWIDE.

UN Women supports UN Member States as they set global standards for achieving gender equality, and works with governments and civil society to design laws, policies, programmes and services needed to implement these standards. It stands behind women's equal participation in all aspects of life, focusing on five priority areas: increasing women's leadership and participation; ending violence against women; engaging women in all aspects of peace and security processes; enhancing women's economic empowerment; and making gender equality central to national development planning and budgeting. UN Women also coordinates and promotes the UN system's work in advancing gender equality.

Refrigeration and air-conditioning is crucial for our health, nutrition, comfort and well-being. From prevention of food wastage to preservation of vaccines, from air-conditioning in hospitals to our homes, we increasingly rely on the advances that refrigeration has brought us. However, all around the world the sector has always been a largely male-dominated work environment. The fast-growing sector can offer a wide variety of interesting and fulfilling careers for women as well as men. UN Environment Programme (UNEP), OzonAction, in cooperation with UN Women, has compiled this booklet to raise awareness of the opportunities available to women and to highlight the particular experiences and examples of women working in the sector and to recognise their successes. Being aware of these experiences and the opportunities available can encourage and inspire other women to consider similar careers and support girls to seek to follow a career path in this fast growing and important sector.



UN environment
United Nations
Environment Programme

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