UNEP

International Standards in Refrigeration and Air-Conditioning

An introduction to their role in the context of the HCFC phase-out in developing countries

United Nations Environment Programme

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Acknowledgements

This document was produced by UNEP Division of Technology, Industry and Economics (UNEP DTIE) OzonAction Programme as part of UNEP's work programme under the Multilateral Fund for the Implementation of the Montreal Protocol.

UNEP OzonAction gratefully acknowledges the assistance of the following for reviewing and providing comments on the draft text:

Mr. Urvyn Boochoon – Trinidad and Tobago Bureau of Standards, Implementation Division
Dr. Marissa Gowrie, National Ozone Unit, Trinidad and Tobago
Mr. Douglas Tucker - Mitsubishi Electric US Cooling & Heating

We are particularly grateful to Mr. Daniel Colbourne from Re-phridge Ltd for his invaluable assistance in finalising this document.

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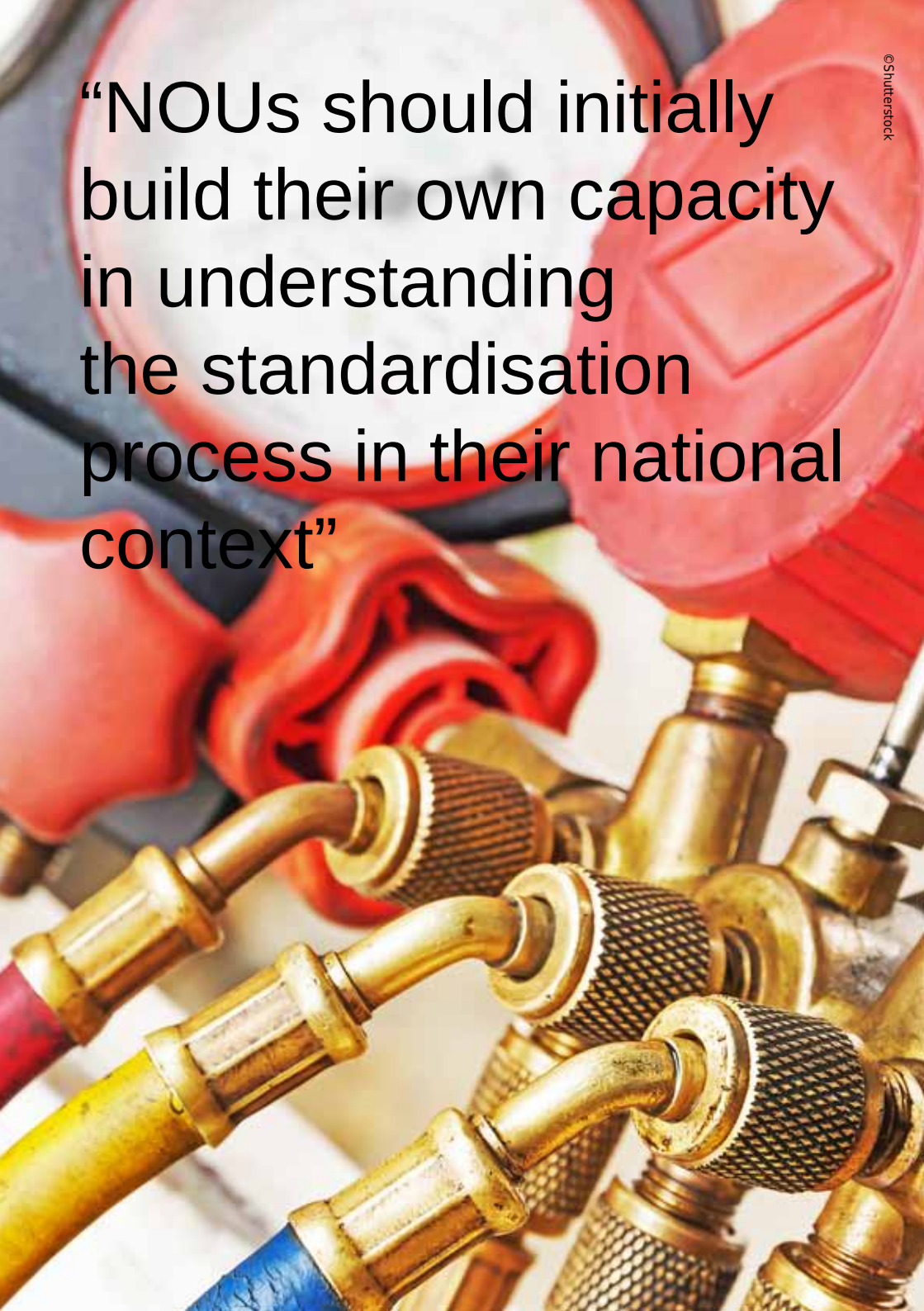
Executive summary

The UNEP DTIE OzonAction Branch in assisting developing countries to comply with their commitments under the Montreal Protocol on Substances that Deplete the Ozone Layer, particularly those related to the phase-out of hydrochlorofluorocarbons (HCFCs). The alternatives to HCFCs include 'ozone and climate friendly alternatives' such as natural refrigerants - hydrocarbons, ammonia and carbon dioxide; and lower global warming potential (GWP) HFCs, both saturated HFCs and unsaturated HFCs (HFOs). In many sectors and individual situations adoption of these alternatives is not completely straightforward, since they exhibit a range of specific properties such as flammability, toxicity and high working pressures which can limit their applicability and require special practices or approaches.

'Standards' can assist with process of application of these alternative refrigerants particularly in developing countries for enterprises that are not necessarily familiar with them and can be very useful tools to assist countries with the introduction of alternatives to ozone depleting substances and related technologies, especially from the point of view of their safe handling and preventing hazards. A 'standard' is a formal document developed by experts to ensure a certain uniform level of products and services. International, regional and national standards can provide an easily accessible mechanism and examples for nationally-applicable requirements which could be adapted/ adopted in countries for alternatives to HCFCs.

It is the responsibility of each country to set up appropriate national legal measures to comply with their commitments under the Montreal Protocol to phase out HCFCs and other ozone depleting substances. Standards can provide the framework and 'insight' as to how alternatives can be adopted with minimal disruption. A national consultation process may be required prior to adoption of a standard to ensure the national context is carefully evaluated in reference to existing standards and that the requirements of all relevant stakeholders are taken into consideration.

Historically in most developing countries the national ozone units (NOUs) have not been closely involved with the issue of standards. As alternatives are considered and adopted better engagement with these processes is becoming increasing important and OzonAction is providing assistance to NOUs to increase their understanding of the standardisation process in general and current standards in their particular national context. Guidance is also being provided in OzonAction network meetings and information materials as to how to establish a dialogue with the relevant national standardisation bodies to ensure that the relevant standards are adopted and that these will be appropriate to the national context and support their efforts to phase-out HCFCs while adopting non-ozone depleting, low-GWP, energy-efficient alternatives.



List of Acronyms

A/C	Air Conditioning
Article 5	Countries operating under Article 5 of the Montreal Protocol, (i.e. developing countries)
ANSI	American National Standards Institute
AREA	Air Conditioning and Refrigeration European Association
AHRI	Air-Conditioning, Heating, and Refrigeration Institute
AS	Australian Standard
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BS	British Standard
BSI	British Standards Institution
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
CFC	Chlorofluorocarbon
DEVCO	The ISO committee on developing country matters
DG	Directorate General
DIN	Deutsches Institut für Normung e.V.
FDIS	Final Draft International Standard
GHG	Greenhouse gas
GWP	Global warming potential
HCFC	Hydrochlorofluorocarbon
HC	Hydrocarbon
HFC	Hydrofluorocarbon
HFO	Hydrofluoroolefin
HVAC&R	Heating, ventilation, air conditioning and refrigeration
IAF	International Accreditation Forum
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
JSA	Japanese Standards Association
NGO	Non-governmental organisation
NOU	National Ozone Unit
NSB	National standardisation body
NZS	New Zealand Standard
ODP	Ozone depleting potential
ODS	Ozone depleting substance
RAC	Refrigeration and air-conditioning
UL	Underwriters Laboratories
UNEP	United Nations Environment Programme
UNIDO	United Nations Industrial Development Organization
WSC	World Standards Cooperation

Foreword

As a result of the ongoing phase-out of hydrochlorofluorocarbons (HCFC) under the Montreal Protocol on Substances that Deplete the Ozone Layer, countries - particularly developing countries are in the process of introducing alternatives to these ozone depleting substances (ODS). The UNEP OzonAction Branch is assisting developing countries to comply with their commitments under the Montreal Protocol, particularly those related to the HCFC phase-out, which involves a range of sectors and approaches.

For the developing countries which UNEP DTIE OzonAction works with it is clear that, at present, the issue of adoption and utilisation of appropriate standards in the refrigeration and air conditioning sector is a relatively new or unknown topic for many of the National Ozone Units (NOUs). Given that many of the low-global-warming-potential (GWP) alternatives to HCFCs may have properties such as toxicity, flammability and high working pressure which the hydrochlorofluorocarbons (HCFCs) and chlorofluorocarbons (CFCs) do not exhibit, adoption of appropriate standards is one important approach that can assist in enabling the uptake of such refrigerants.

This guide is intended to provide an introduction to standards and how they can be useful in supporting the adoption of alternatives in the context of the HCFC phase-out in developing countries. It also includes an overview of existing standards related to HCFCs and their alternatives, barriers to alternatives, the process of the adoption of international and regional standards at the national level, barriers to the adoption and how to overcome them.

While this brief guide is principally designed as an information tool for NOUs, it should also be of interest to refrigeration associations, various government departments, including those working on standardisation issues, and other stakeholders in the refrigeration and air conditioning sector.

As an NOU, armed with an understanding of the types of relevant standards, the general mechanisms and means of adoption of standards, you will be in a better position to start a dialogue with the important standardisation bodies in your country to ensure that the relevant standards are adopted and that these will be appropriate to the national context, will be beneficial and not create any barriers to particular products or practices. I hope you will find this guide interesting and informative in this regard.

We look forward to continue supporting your efforts to phase out HCFCs and adopting non-ozone depleting, non-global warming and energy-efficient alternatives.

Shamila Nair-Bedouelle PhD, HDR
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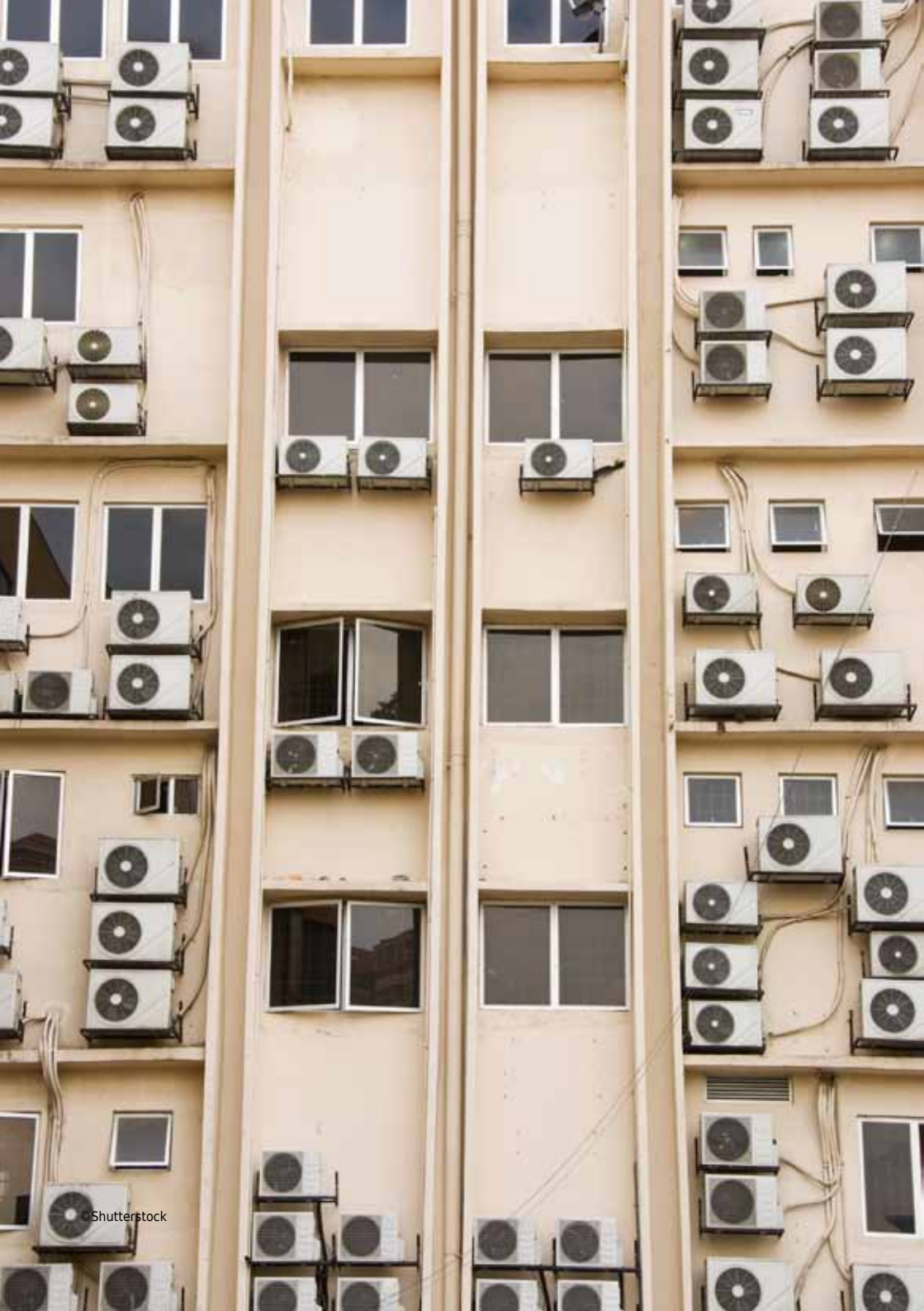
UNEP Division of Technology, Industry and Economics



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1 Introduction

With the phase-out of HCFCs (hydrochlorofluorocarbons) under the Montreal Protocol on Substances that Deplete the Ozone Layer progressing, the introduction of alternatives with not only zero ozone depleting potential (ODP) but also low global warming potential (GWP) and improved energy efficiency is becoming an issue of increasing importance, especially in developing countries.

HFCs (hydrofluorocarbons), which have a zero ODP but many of which have high GWPs, are still the most commonly used replacement for HCFCs. There are a number of other available replacements. These include 'ozone- and climate-friendly alternatives' such as natural refrigerants - hydrocarbons (HCs), ammonia (NH_3) and carbon dioxide (CO_2); and lower-GWP HFCs, both saturated HFCs (e.g., HFC-161 and HFC-152a) and unsaturated HFCs (sometimes referred to as hydrofluoroolefins, HFOs, e.g., HFC-1234yf, HFC-1234ze). However, these alternatives exhibit a range of specific properties which may prevent them from being unconditionally adopted: flammability, toxicity and high working pressures can limit their applicability and require special practices or approaches for safe handling. Since these characteristics represent a deviation from normal practices, standards can assist with easing the application of these alternative refrigerants for enterprises that are not necessarily familiar with how to do it.

A standard (sometimes called a 'norm'), is a formal document developed by experts to ensure a certain uniform level of products and services. International standards adapted by countries to suit the national situation, or directly adopted into national legislation, bring with them the great advantage of a tool which is agreed by the consensus of participants of national committees, with the aim of achieving high quality and safety. Such standards can be useful tools for the introduction of alternatives and technologies for ozone depleting substances (ODS) especially through specifying safe handling practices and provision of measures for minimising risks.

In the process of the HCFC phase-out, developing countries can take advantage of experiences and lessons learned by the developed countries that have already significantly progressed along the path of HCFC phase-out and in the development and application of such standards.

Since the middle of the last century, especially in developed countries,

several standardisation organisations were established to produce standards - documents based on consensus of group of participants, to ensure a certain uniform level of goods, products and services quality. Development of new standards and their regular revisions reflect general technological progress, the changing needs and requirements of international trade. Through the voluntary use of standards, producers, users and other stakeholders can assure and be assured of comparable levels of quality around the world. International, regional and national standards can provide an easily accessible mechanism and examples for nationally-applicable requirements which could be adapted/ adopted in Article 5 countries for alternatives to HCFCs.

The main international and regional standardisation organisations are the following:

- IEC - International Electro-technical Commission
- ISO - International Organization for Standardization
- CEN - European Committee for Standardization
- CENELEC - European Committee for Electrotechnical Standardization

Some national standardisation organisations have a reach and influence which can be considered as regional or international in operation, for example:

- ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers
- ANSI - American National Standards Institute

This booklet is intended to be a concise guide for National Ozone Units (NOU), as well as for refrigeration associations, government departments, including those working on standardisation issues (but perhaps not familiar with the specific requirements of the Montreal Protocol), and other stakeholders in the refrigeration and air-conditioning sector in Article 5 countries.

During the preparation of this booklet, a questionnaire was distributed to participants in several UNEP OzonAction Regional Network Meetings. The respondents, which were mainly NOUs, were requested to provide feedback related to their national experience with international and regional standards, the level of their cooperation with various institutions, associations and stakeholders and to identify any barriers to the introduction of low-GWP alternatives and technologies in their country.

The responses revealed that the vast majority of NOUs from countries participating in the survey have very little experience at the national level of the use of international or regional standards. The majority of respondents also indicated that they did not have, or were not aware of, any regulations or standards which could specifically impact the adoption and use of low-GWP alternatives. It was also highlighted that existing regulations may not be appropriate to allow for the full range of low-GWP alternatives to be adopted.

Taking into account the responses from the questionnaire, this guide provides a general introduction to standards in the refrigeration and air-conditioning (RAC) sector, including an overview of existing standards related to HCFCs and their alternatives, barriers to alternatives and the process of the adoption of international and regional standards at national level. A general overview and summary of the main relevant standards is provided in Chapter 5. It is beyond the scope of this document to cover in detail all the related standards, particularly the plethora of specific national standards.

The scope of the standards covered in this document can be grouped into four main categories:

- Safety standards - for design, construction and installation of RAC products and systems
- Performance standards - for determining the efficiency and performance of RAC systems and equipment, as well as for refrigerants[1]
- Practice standards - for identifying knowledge and guiding best practices for technicians when handling RAC systems and refrigerants
- Quality standards - these can be general and cover any industry, but can be applied to processes involving refrigerants such as production, accounting, certifying, training, etc.

[1] This could be useful in this context as it is a means of identifying lower indirect CO_2-eq emissions

2 ODS and their Alternatives

The Montreal Protocol

The objective of the Montreal Protocol on Substances that Deplete the Ozone Layer is to protect the ozone layer by phasing-out production and consumption of nearly 100 industrial chemicals known as ozone depleting substances, which include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), halons, methyl bromide, carbon tetrachloride and methyl chloroform. Under this treaty, developing and developed countries have equal but differentiated responsibilities, but importantly, both groups of countries have binding, time-targeted and measurable commitments. As of today, the Parties to the Protocol have phased out 98% of the consumption of ODS. In 2009 the Montreal Protocol became the first treaty to achieve universal ratification by all 197 United Nations Member States. Given all of these factors, the Protocol has been widely praised as one of the most successful multilateral environmental agreements.

At the 20th anniversary meeting of the Montreal Protocol in 2007, agreement was reached to accelerate the Montreal Protocol's phase-out schedule for the production and consumption of HCFCs. HCFCs were introduced in the 1990s as alternative chemicals to CFCs and added to the list of substances controlled by the Montreal Protocol. It was acknowledged at the time that these chemicals, with considerably lower ODPs, were transitional and their production and consumption was also to be phased out under the Montreal Protocol. Moreover, many HCFCs have high global warming potentials (of up to 2000 times that of carbon dioxide). Therefore, the HCFC phase out will result in a significant reduction in ozone depletion as well as in global warming, provided that low-GWP alternatives are adopted. Table 1 shows the phase-out schedule for HCFCs.

The refrigerants which were commonly used in the refrigeration and air-conditioning sectors, such as CFCs and HCFCs, had physical and chemical characteristics that made them particularly suitable for these applications. One of the particular advantages, in addition to the physical characteristics that made them efficient refrigerants, was that these chemicals are generally non-flammable, non-toxic and relatively unreactive. Therefore the refrigeration and air-conditioning systems that were designed to use CFCs and HCFCs did not place great emphasis on safety issues due to the relative benign nature of the refrigerants. With the completion of the phase-out of CFCs and the ongoing phase-out in the production and consumption of

HCFCs under the Montreal Protocol, there are a wide range of zero ODP alternatives which can be adopted. Some of these alternatives are similar in properties to the chemicals they replace (such as HFCs), but others (such as hydrocarbons) have characteristics that are considerably different. Some of these alternatives are flammable, toxic or operate at much higher pressures. Therefore equipment that operate with such refrigerants require a significantly different approach in terms of design, installation, servicing and operation which places a considerably higher emphasis on safety.

Standards can be a useful tool when preparing national legislation and facilitating the HCFC phase-out, especially in such areas where the introduction of alternative substances with particular characteristics (e.g. flammability, toxicity) may be of concern. The implementation of appropriate standards to cover the various aspects of the equipment, chemicals and servicing is thus very important to ensure quality, efficiency and safety. Adoption of existing international or regional standards can be very advantageous to a country so that each enterprise does not need to start from scratch and establish its own

Table 1: The schedule for Article 5 (developing) countries phase-out for production and consumption of HCFCs.

Deadline	Reduction step
By 2013	Freeze HCFC consumption at base level (average of 2009-2010)
By 2015	Reduction of HCFC consumption by 10%
By 2020	Reduction of HCFC consumption by 35%
By 2025	Reduction of HCFC consumption by 67.5%
By 2030	Total phase-out
2030 - 2040	2.5 % of baseline averaged over 10 years (2030-2040) allowed, if necessary, for servicing of refrigeration & air-conditioning equipment until 2040

standard criteria. Standards can be modified at the national level by relevant experts in order to make them more suitable for specific situations. Provision of suitable standards are therefore one important means of assisting enterprises to transition away from HCFCs. However, excessively strict or inappropriate regulations or standards can restrict the adoption of alternatives and prevent the country from benefiting from the range of available alternatives and the benefits these can bring. The standards themselves are voluntary instruments and are consensus-based having been developed by participants in technical committees and working groups. They can be adapted and/or incorporated into national legislation, but otherwise have no legal standing (except in contract law).[2]

Alternatives to ODS

In the context of replacing HCFCs, the alternatives must meet the basic requirement of having zero ozone depleting potential. Additionally it is beneficial, and specifically encouraged by Montreal Protocol Decision XIX/6 which promotes the selection of alternatives to HCFCs that minimise environmental impacts, in particular impacts on climate taking into account global-warming potential, energy use and other relevant factors. However, there is not a single 'one-size-fits-all' option to replace HCFCs: each alternative has its respective pros and cons and several important issues need to be considered, particularly relating to safety.

[2] As in the case in some countries, such as the UK, where it must be followed if previously agreed to.

The most common low-GWP alternatives to HCFCs at present are 'ozone and climate friendly alternatives' such as natural refrigerants - hydrocarbons (HCs), ammonia (NH_3) and carbon dioxide (CO_2); and lower-GWP HFCs including saturated HFCs and unsaturated HFCs which are known as hydrofluoroolefins (HFOs). Historically, natural refrigerants have been used in many applications, particularly in refrigeration, for many decades before the introduction of fluorocarbons.

Table 2 provides an overview and some examples of the current major zero-ODS, low-GWP HCFC alternatives considered in this booklet. This list is not exhaustive.

Table 2: Examples of zero-ODS, low-GWP HCFC alternatives

Natural Refrigerants	HCs (hydrocarbons)	e.g. R-290 (Propane), R-600a (Isobutane), R-1270 (propene)
	Ammonia	R-717
	CO_2 (Carbon dioxide)	R-744
Synthetic HFCs	Saturated HFCs	e.g., R-161, R-152a
	Unsaturated HFCs (known as "hydrofluoroolefins" or "HFOs")	e.g. R-1234yf, R-1234ze

Table. 3: Characteristics of alternatives to ODS

Refrigerant	Natural Refrigerants			Synthetic HFCs	
	HCs	Ammonia	CO_2	Saturated HFCs	Unsaturated HFCs (HFOs)
GWP (100 years)	++	++	++	--*	++
Flammability	--	-	++	++*	-
Toxicity	++	--	+	++	++
Pressure	+	+	--	+	+
Availability	+	+	+	++*	--
Familiarity	+	+	-	++	-

* This refers to conventional, widely used HFCs such as R-134a, R-404A, R-407A, R-410A, etc. Some saturated HFCs such as R-161 and R-152a have low GWPs, are flammable, and may not be as easily available as the common HFCs.

++ - very positive
+ - positive
- - negative
-- - very negative

The safety characteristics of refrigerants are classified according to their flammability and toxicity as defined by international and regional standards (ISO 817:2014 and EN[3] 378-1:2008[4]). The letters 'A' and 'B' are used to classify toxicity. Flammability is classified by the categories: '1', '2', '2L' and '3' (see Table 4 below). The category '2L' is a specific class for 'lower-flammability refrigerant with low flame speed' which was added in the latest update of the ISO standard in 2014 (ISO 817:2014) and is being considered in the revision of EN 378.

Table 4: Classification of safety characteristics of refrigerants (ISO 817:2014)

	Lower toxicity	Higher Toxicity
No flame propagation (i.e. considered non-flammable)	A1	B1
Lower Flammability	A2L	B2L
Lower Flammability	A2	B2
Higher flammability	A3	B3

Increasing hazard: toxicity

Increasing hazard: flamability

3 European Norm (i.e. European Standard)

4 EN 378 is currently under revision

Barriers to using low-GWP alternatives

In many countries, particularly developing countries due to their differentiated HCFC phase-out schedule, a number of barriers to the adoption of low-GWP alternatives may exist at the national level. In an effort to better understand these barriers UNEP OzonAction prepared a report entitled: "*Barriers to the use of low-GWP refrigerants in developing countries and opportunities to overcome these*[6]." This report, based on the responses of some 250 representatives from more than 40 developing countries, identified about 30 distinct barriers which were classified under the following main areas: technical (refrigeration and safety), supply and availability, commercial, market, information resources, regulations and standards, psychological and sociological. The relevance of each barrier naturally differs according to the country context, as well as the specific details of the facility, equipment and type of refrigerant. In this report, the lack of, or inappropriate regulations and standards was identified as a significant barrier to using low-GWP alternatives.

[6] Available from: http://www.unep.fr/ozonaction/information/mmcfiles/7476-e-Report-low-GWPbarriers.pdf

Significant barriers identified by UNEP survey

General barriers identified by respondents to survey[7]:

- "There are no systems using low-GWP alternative refrigerants available to buy"
- "There is nothing to incentivise enterprises to invest in low-GWP alternative technology"
- "No one is willing to invest in production of systems, parts, components and refrigerants"
- "Consultants developing HPMPs are not recommending low-GWP alternative refrigerant projects"
- "The rules for using low-GWP alternative refrigerants are too restrictive to allow their use"
- "There is a general fear of the safety risks"

Barriers related to standards identified by respondents to survey:

- "There are no suitable rules to direct users how to use the low-GWP alternatives properly"
- "The rules for using low-GWP refrigerants are too restrictive to allow their use"
- "Some stakeholders are unaware of the existence of the rules"

Barriers to implementation of standards

A country may face a number of obstacles or barriers related to implementation of standards for alternatives to HCFCs. These barriers can be generally grouped into four main categories:

Development

Developing a specific national standard requires significant technical resources and expertise with associated financial commitment. Likewise participation in international standardisation organisations requires considerable

[7] Responses to survey from: "*Barriers to the use of low-GWP refrigerants in developing countries and opportunities to overcome these*", http://www.unep.fr/ozonaction/information/mmcfiles/7476-e-Report-low-GWPbarriers.pdf

resources, both in terms of personnel and cost. For developing countries, particularly smaller countries this can present a challenge particularly if the relevant national institutions are not in place. Developing countries might not have at their disposal the technical expertise or resources to actively contribute to the international/regional standard development processes.

Adoption

Barriers to adoption of standards may be related to:

- Time-consuming administrative and procedural issues.
- Lack of awareness or national capacity.
- Requirements that make adoption of certain alternatives difficult
- A lack of the relevant national institutions.
- A lack of formal connections with international/regional standardisation bodies, and/or a lack of cooperation with the relevant national institutions, etc.
- Bureaucracy (in some countries) that hinder the standardisation process especially where incorporation into the national legislation is concerned.
- The associated cost of acquiring international/national standards, which can be an issue for small companies.

Content of standards

The specific content of standards can be a barrier to the adoption of alternatives to HCFCs:

- Without effective planning a newly adopted standard could initially present a challenge for industries and companies in developing countries which need to modify practices to be in compliance with international standards.
- Excessively strict or constrictive measures included in existing standards which may severely limit or prohibit the application of particular HCFCs alternatives or equipment.
- Inappropriate regulations or standards.
- Standards may not be designed in such a way that they can be explained to and understood by small companies and individuals that make up the 'informal sector' of servicing technicians in many developing countries, as well as larger established enterprises and companies.[8]

[8] Pricing is a national decision and should reflect both the value of a standard's content and its affordability. In general these can range, for the standards covered in this booklet, for example, from around US$70 to approximately US$600 for each individual standard sold in Europe

Right: Cindy Liatlatmal, Refrigeration and Air conditioning Engineer, Vanuatu

Industry uptake

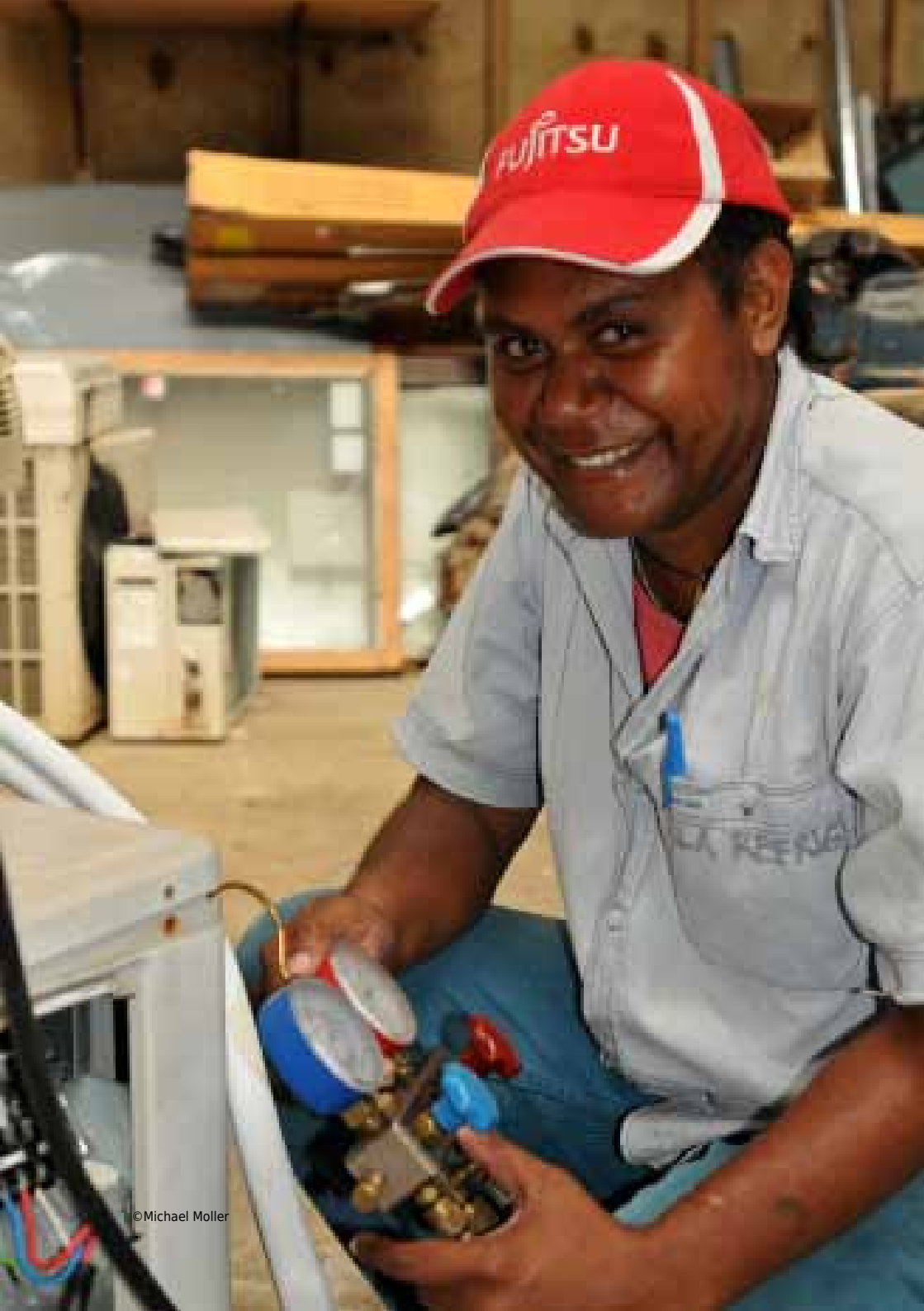
Once a standard is adopted within a particular country there is still considerable work to ensure the standard is implemented and adhered to. In the case of large companies or enterprises this can be reasonably easily addressed, particularly if the enterprise was involved or consulted in the development or adoption of the standard. However, in many developing countries, installation and servicing of refrigeration and air-conditioning equipment is carried out by small companies or individuals. In order to reach these, there is a need to provide simple guidance and support to explain the relevant standards and how they need to be implemented.

There is no general or single measure that can be applied to address such barriers. Initially, the relevant National Standardisation Body (NSB) should establish contact and assure national membership within the respective international/regional standardisation body. In relation to the development or adoption of particular standards the NSB, prior to the adoption of international standards should ensure adequate consultation with relevant national and international experts, including consulting with experts in both HFCs and natural refrigerants to help achieve improvements.

The National Ozone Unit as a focal point for the Montreal Protocol can play an important role in ensuring the relevant NSB is aware of the appropriate requirements in the context of the HCFC phase-out management plans (HPMPs) and working closely with local and regional RAC associations and stakeholders. The standardisation bodies usually offer specific assistance to developing countries.

When developing or adopting a standard it is important to take into consideration the timing of its development or adoption to ensure it is synchronised with other related or interconnected standards and is appropriate for the national context. For example, standards are seldom, if ever, self-standing documents and usually refer to many other standards.

Particularly in case of technical and safety standards it is very important to consider the ‘age’ of standards, which may have impact on the technology transition process. Both standards that are very old or very recent can have a negative impact. The former can result in being locked into legacy systems and the latter can present the country with a considerable challenge to be innovative and an early adopter.



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3 An Introduction to Standards

A standard or “norm” is developed to ensure a certain uniform level of goods, products, and service quality. It is a formal document which requires certain characteristics or behaviour of goods, persons, situations, etc. representing the consensus view of participants in the standards development process. Standards are developed to ensure a certain uniform level of goods, products and service quality. International standards are based on a consensual mechanism with a wide network of national members and stakeholders. In practice however many developing countries have limited engagement in the standardisation process and consequently cannot review, vote and contribute to standards and the process of developing these. Smaller enterprises or non-industry participants can be deterred due to the often high level of fees charged for participation. Standards can be supported by supplementary information and interpretation of requirements, which can be covered by industry guidelines or codes of practice

Main benefits of standards:

- Ensure safety considerations (of products, people, production, use, etc.).
- Enable dissemination and harmonisation of best practices.
- Present a harmonised, stable and globally recognised framework.
- Can support economic growth.
- Can minimise technical barriers for trade.

In the RAC sector, technical standards are becoming increasingly recognised as a key component in successfully transitioning away from reliance on ozone-depleting and powerful global-warming gases. The adoption and utilisation of appropriate technical standards can establish uniform definitions, guidelines, rules, criteria, methods, processes, practices or characteristics for activities and their results.

Standards and regulations

- Many industries, trade associations and governments require products and services to conform to a standard or a regulation prior to being placed on the market to ensure a certain level of quality and safety.
- An international standard does not have any legal force and it cannot supersede national regulations.
- An international standard is not a mandatory regulation.
- A national regulation may refer to a standard or a part of a standard. Standards can be used as a technical reference when developing regulations.

Development of standards

Standardisation bodies are open to participation of experts from industry and manufacturers, academia, governments, consumer associations, non-governmental organisations (NGOs), etc. This varied representation by stakeholders is intended to ensure the quality of the final document including its scope and content. In practice, however, in many countries the vast majority of those participating in the development of standards are from industry.

Within the standardisation organisations (international, regional, national) experts typically work in technical committees focusing on specific issues. More detailed and specific elements within the respective committee can be considered by experts in specialised subcommittees, as shown in the example below on the structure of the ISO Technical Committee 86 on Refrigeration and Air-Conditioning (*Table 1*). Within Subcommittees, *Working Groups* are normally set up to draft documents.

Table 5: Structure of ISO Technical Committee 86 on Refrigeration and Air-conditioning

Subcommittee	Title
SC 1	Safety and environmental requirements for refrigerating systems
SC 2	Terms and definitions- *disbanded*
SC 3	Testing and rating of factory-made refrigeration systems (excluding systems covered by SC 5, SC 6 and SC 7)
SC 4	Testing and rating of refrigerant compressors
SC 5	*'Testing and rating of household refrigeration appliances" was transferred to IEC TC 59, Performance of household and similar electrical appliances, in 2006*
SC 6	Testing and rating of air-conditioners and heat pumps
SC 7	Testing and rating of commercial refrigerated display cabinets
SC 8	Refrigerants and refrigeration lubricants

Procedure of standards development

Formalised procedures are carried out within each standardisation body to develop a standard. The first step which initiates development of a standard is its demonstrated need. The standard development is started by the appropriate committee of the NSB, which is a member of the relevant international or regional standardisation body.

The new standard is proposed to the relevant technical committee, which usually sets up a working group consisting of industry representatives and other experts. The working group prepares a draft standard and provides it to the technical committee for approval. The draft standard is then distributed to all members of the standardisation body. In the case of an international or regional organisation, the draft is shared with the national members. Once consensus

is reached, the final draft is sent to all members of the standardisation body for a vote. The standard is only published if a sufficient number of votes in favour of the standard is received. The process from the acceptance of a standard proposal to its publication can take, on average, two to four years, although in some cases this can be considerably longer. Existing standards are regularly revised and amended.

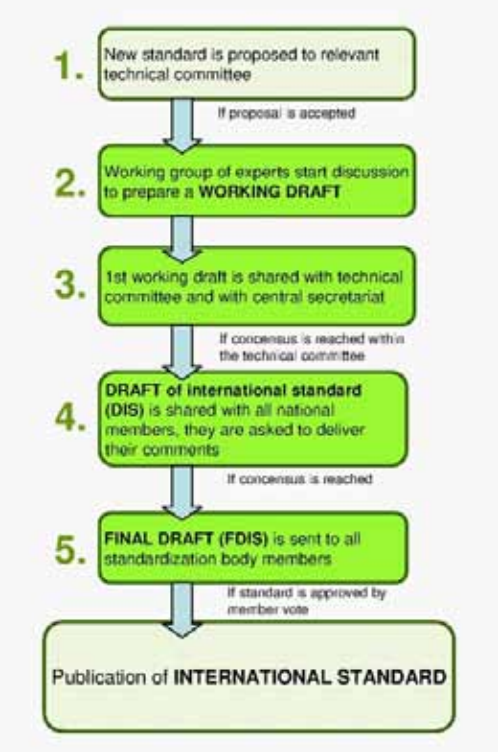
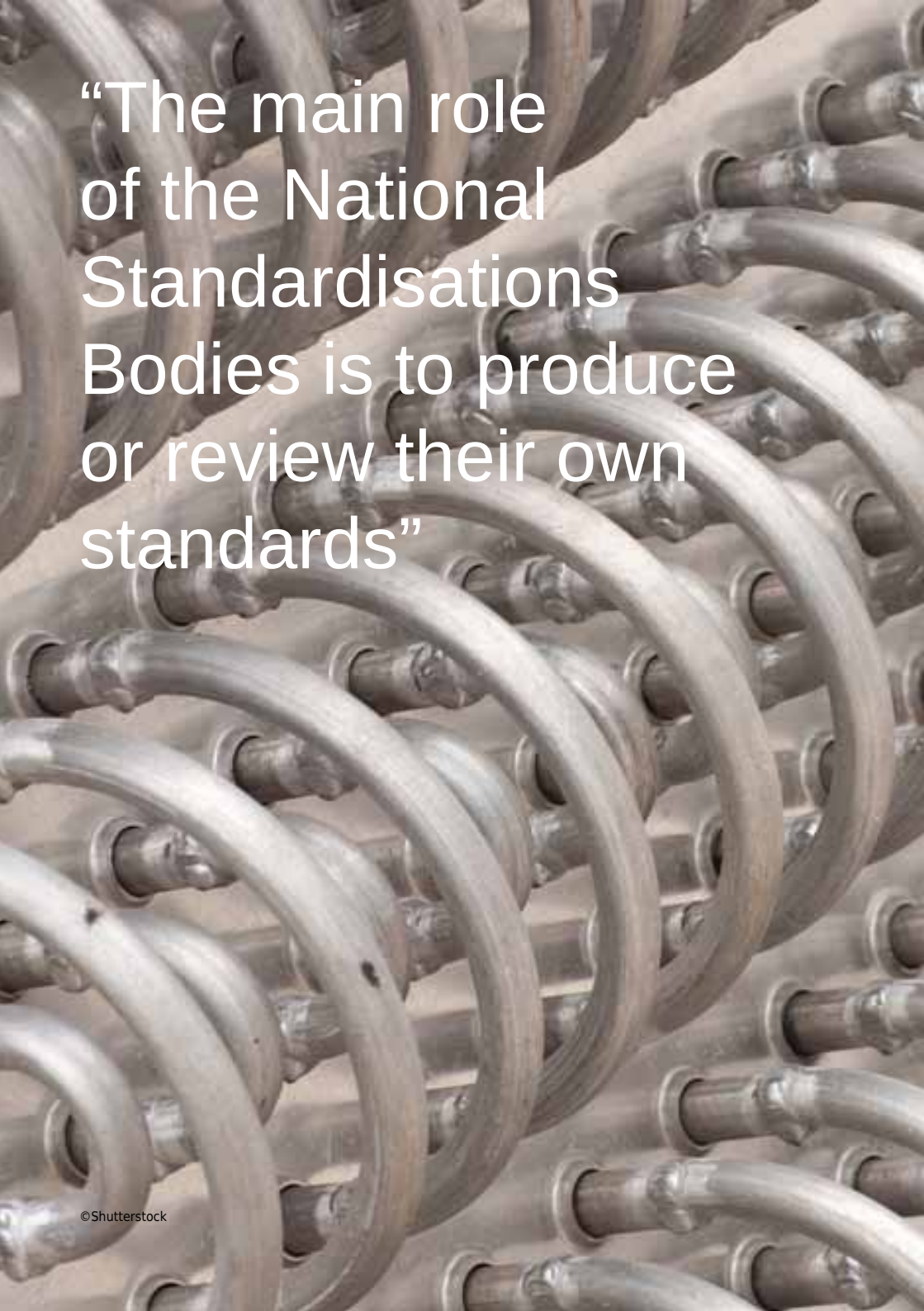


Figure 1: Process of international-regional standard development (based on ISO example).



‘Levels’ of standards

Standards are developed at the international, regional, national and other levels[9] by a variety of organisations. These organisations are independent of governments, industry, associations and the private sector. Chapter 4 provides an overview of the main standardisation bodies relevant to the refrigeration and air-conditioning sector.

At the national level, many countries have their own national standardisation bodies. Usually these national standardisation bodies are the contact points for the regional and international organisations developing standards. The main role of the national standardisations bodies is to produce or review their own standards. Bodies can be independent or linked to the national government. Standards issued at the national level generally have priority over the regional or international standards.

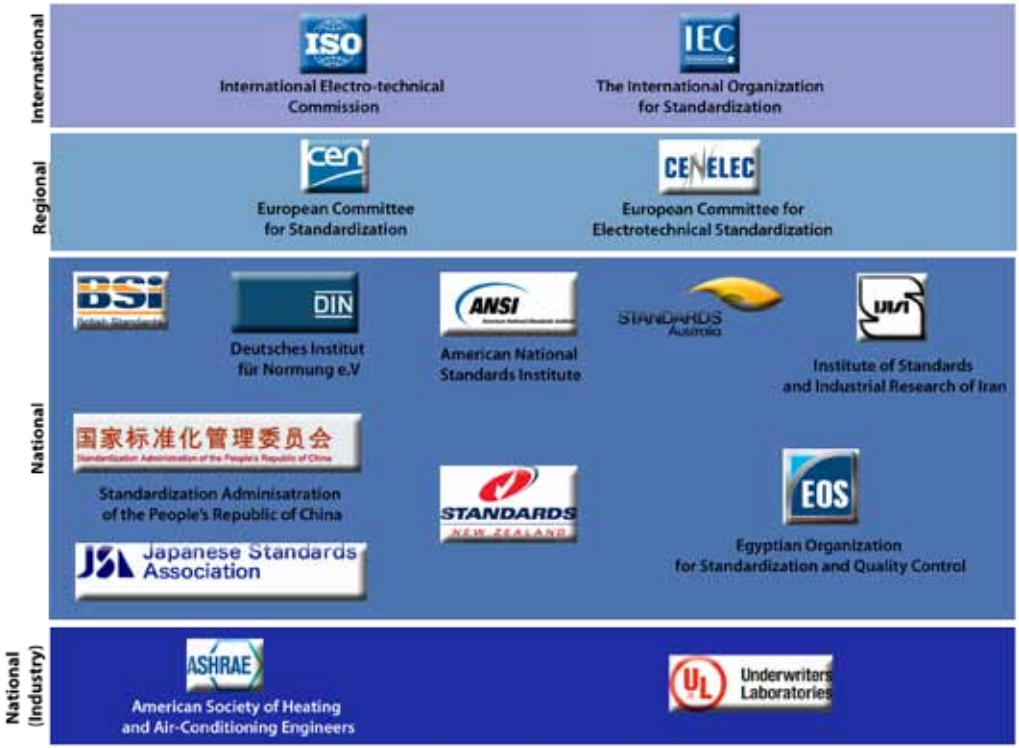
It is a common practice that international and regional standards are adopted at the regional and national levels. During this procedure, standards can be modified to suit the best local demands and conditions. In some cases a contrary approach can be applied and the standard from the national or regional level may be adopted for the regional or international level.

[9] e.g. by a private company for private use.

4 The Main Standardisation Organisations

There are several principal organisations developing standards related to the refrigeration and air-conditioning sector. Figure 2 below, summarises the main international standardisation organisations and provides some examples of national and regional standards organisations.

Figure 2: Standardisation organisations



International level

Of the international standardisation organisations, the two main bodies which are principally involved into the development of standards related to the RAC sector are the ISO (International Organization for Standardization) and the IEC (International Electro technical Commission). A formal agreement between these organisations aims to prevent overlap and potentially contradictory standards.

The International Organization for Standardization (ISO)
ISO is the largest standardisation organisation in the world with 162 member countries (the complete list is available on ISO website: http://www.iso.org/iso/home/about/iso_members.htm) and with more than 19,500 standards issued which were developed by some 300 technical committees.
The Technical Committee TC 86 on Refrigeration and Air-conditioning is crucial for the RAC sector. Its structure is presented in Chapter 3.

The International Organization for Standardization (ISO)
Website: www.iso.org

ISO standard nomenclature:
ISO 14001:2004 Environmental management systems

ISO Number	14001
Year	2004
Name	Environmental management systems

International Electro technical Commission (IEC)
IEC is primarily focused on safety issues of electrical and electronic technologies, devices containing electronics, using or producing electricity. IEC has 82 member countries (national committees). The list of countries is available from the IEC website (http://www.iec.ch/dyn/www/f?p=103:5:0##ref=menu).

Standards related to the RAC sector are developed by experts of the technical committees:
- TC 59 on Performance of household and similar electrical appliances (http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:1275).
- TC 61 on Safety of household and similar electrical appliances (http://www.iec.ch/dyn/www/f?p=103:7:0::::FSP_ORG_ID:1236).

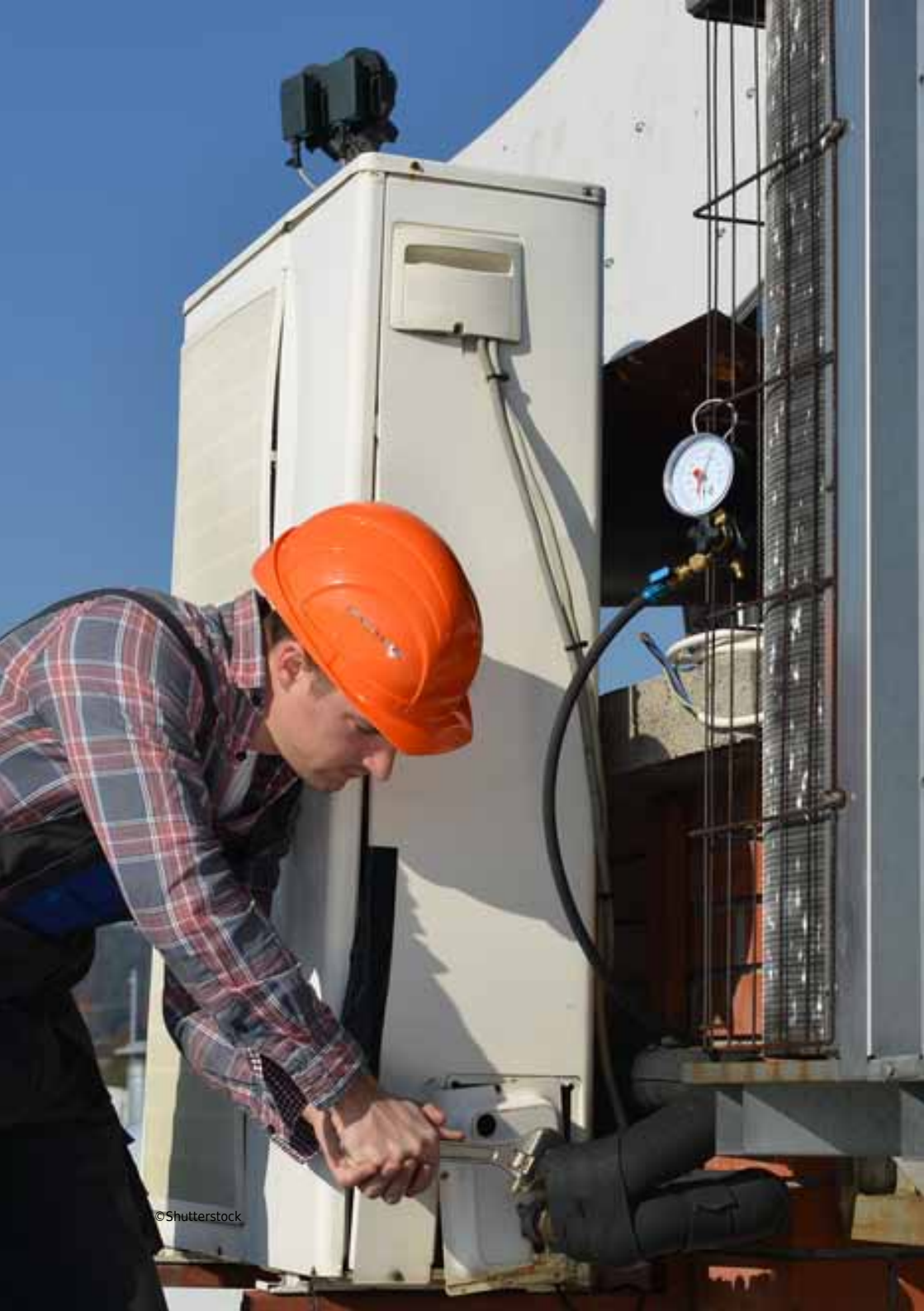
International Electro-technical Commission (IEC)
Website: www.iec.ch

IEC standard nomenclature:

e.g. IEC 60335-1:2012 Household refrigerating systems used for cooling and heating – Safety requirements

IEC Number	60335
Number[10]	1
Year	2012
Name	*Household refrigerating systems used for cooling and heating – Safety requirements* Environmental management systems

[10] The first number (60335) refers to the number of the standard. The second number (1) refers to the particular part of the standard which may consist of several parts. This standard 60335 consists of more than 100 parts.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Regional level

Good examples of regional standards include two European Committees for standardisation: CEN and CENELEC whose approved standards are automatically valid within the member countries.

European Committee for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC)
CEN and CENELEC are recognised European standards organisations independent of governments, European institutions and each other. These European standards organisations cooperate with each other and with the European Commission to harmonise their work and prevent contradictions.
Members of CEN and CENELEC are national standardisation bodies of all EU member countries and some other European countries (33 countries in total, see http://standards.cen.eu/dyn/www/f?p=CENWEB:5:::NO:::).
Implementation of European Standards as national standards is the responsibility of the CEN/CENELEC national member country.
Standards directly related to the RAC sector are developed by Technical Committee CEN TC 182 on Refrigerating systems, safety and environmental requirements (http://www.cen.eu/cen/Sectors/TechnicalCommitteesWorkshops/CENTechnicalCommittees/Pages/default.aspx?param=6163&title=CEN/TC%20182).

CEN and CENELEC
Websites: www.cen.eu, www.cenelec.eu

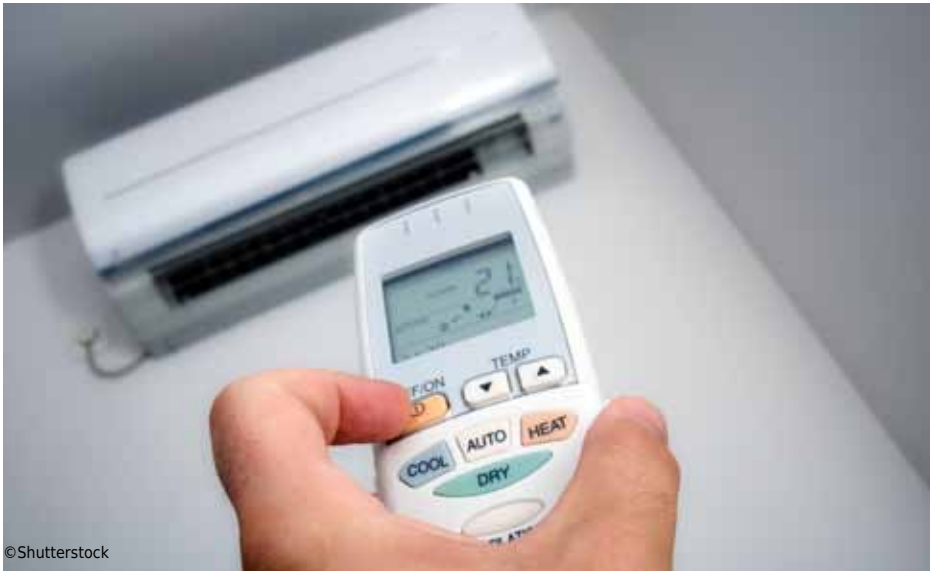
IEC standard nomenclature:
e.g. ***EN 13313:2010 Refrigerating systems and heat pumps – Competence of personnel***

EN Number	13313
Year	2010
Name	*Refrigerating systems and heat pumps – Competence of personnel*

Harmonised and non-harmonised European standards

The European Standardisation organisations develop harmonised and non-harmonised standards:

- Harmonised standards are based on an official request made by the European Commission. Their scope is to support EU Directives and Regulations. Harmonised standards are very useful as they provide a presumption of conformity to the relevant directive or regulation (users are deemed to meet requirements of directive or regulation).
- Non-Harmonised standards are not linked to directives or regulations, thus producers are obliged to develop methodologies and interpretations to achieve conformity to directives and regulations independently.



National level

At the national level, the majority of countries have a national standardisation body (NSB) or several bodies. These institutions can produce their own national standards or adopt international/regional standards. Depending on the country, national standardisation bodies can be independent or linked to and be responsible to the government.

A comprehensive list of NSBs is available on the ISO website: http://www.iso.org/iso/home/about/iso_members.htm and NSBs for IEC can be found here[11]: http://www.iec.ch/dyn/www/f?p=103:5

Some national standardisation organisations can have a reach and influence which can be considered as regional or international in operation (e.g. ANSI, ASHRAE).

Some examples of national standardisation bodies:

AHRI (Air-conditioning, Heating, & Refrigeration Institute), http://www.ari.org/standards.aspx
ANSI (American National Standards Institute), www.ansi.org
ASHRAE (American Society of Heating and Air-Conditioning Engineers), www.ashrae.org
BSi (British Standards Institution), www.bsigroup.com
DIN (Deutsches Institut für Normung e.V.), www.din.de
EOS (Egyptian Organization for Standardization and Quality Control), www.eos.org.eg
IJISI (Institute of Standards and Industrial Research of Iran), www.isiri.org
JSA (Japanese Standards Association), www.jsa.or.jp
NZS (Standards New Zealand), www.standards.co.nz
Standardization Administration of China, www.sac.gov.cn
Standards Australia, www.standards.org.au
UL (Underwriters Laboratories), www.ul.com

[11] Some NSBs may be linked to ISO whilst those linked to IEC may be different (e.g., in Germany), whereas the NSB in some countries (e.g. UK) is the same for both.

Membership of standardisation organisations

Members of standardisation bodies should play an active role in the development of standards and of current and future work plans of technical committees and the standardisation body itself. Generally, the main standardisation organisations (ISO, IEC, CEN, CENELEC, ANSI/ASHRAE) have two distinct levels of membership:

- Full members: these have access to all the technical and managerial activities and functions of the organisation, they can be directly involved in development and review of standards, attend committee meetings, sell and adopt standard at the national level, and have voting rights.

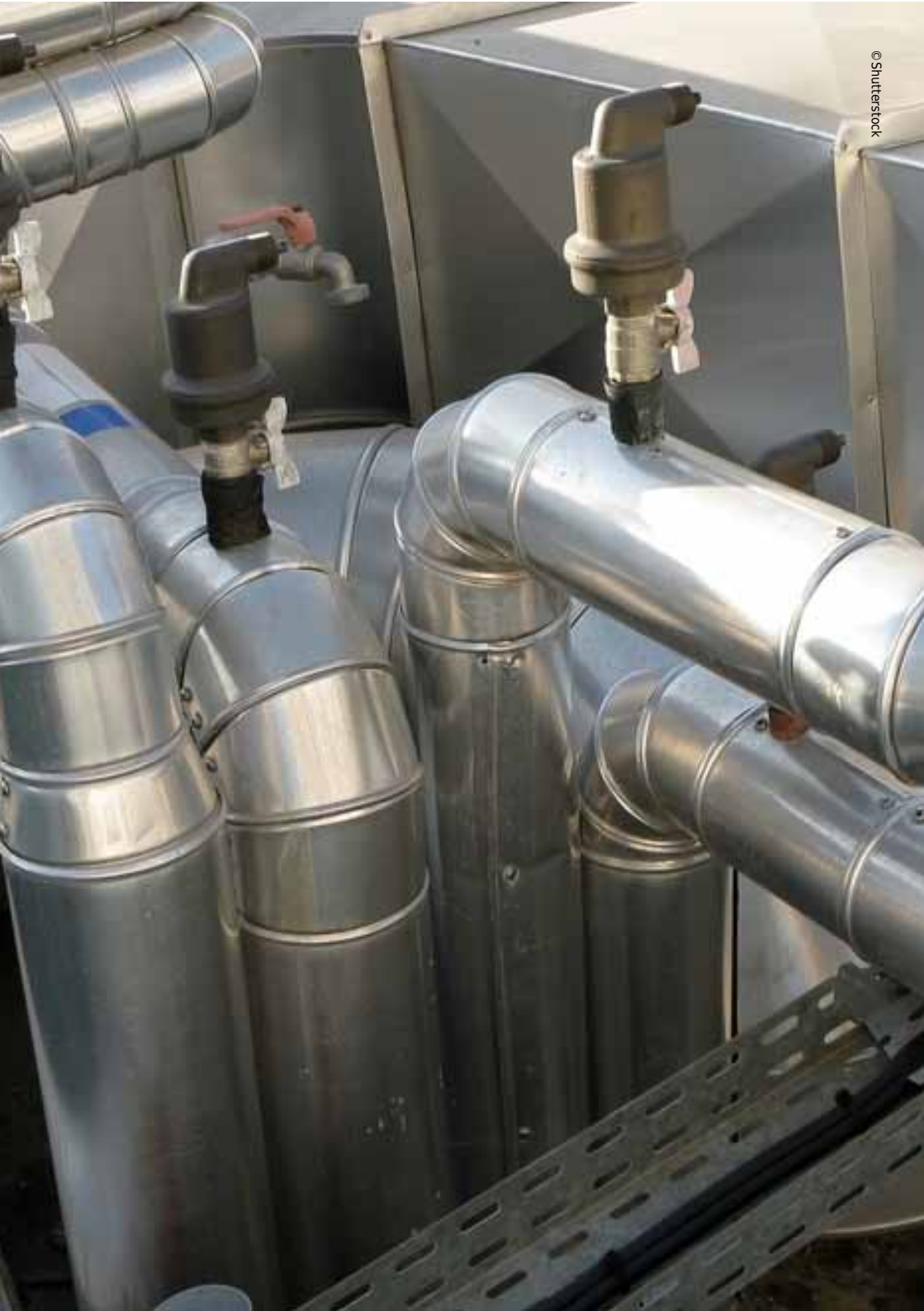
- Associate/correspondence members: these have limited rights and they can only observe standards development, can attend committee meetings as an observer and have very limited or no voting rights.

Depending on the organisation, other types of membership also exist (e.g. associates, affiliates, partners, counsellors, etc.).

Advantages of membership in a standardisation organisation

- Opportunity to influence technical content of standards to ensure they reflect specific needs.
- Early access to information and technological knowledge.
- Wide source of know-how, good access to knowledge and resources.
- Experience in international standardisation work can help build national infrastructures.
- Improvement of access to global markets.
- Development of the international trade by meeting defined characteristics of products and services.

Before accession to the international or regional standardisation organisation, it is necessary to also evaluate the availability of national technical experts and resources to be able to actively and meaningfully contribute to the content of the international standard.



Cooperation between standardisation organisations

Cooperation between standardisation organisations developing standards at various levels and with legislative bodies is the common practice. This process eliminates double work, overlap and contradiction.

ISO and IEC are members of the World Standards Cooperation, which was established in 2001 (WSC, http://www.worldstandardscooperation.org/). The main scope of the WSC is to promote adoption and implementation of international consensus-based standards worldwide to ensure cooperation in the technical work of member standardisation bodies in a transparent way to avoid duplication, overlap and potential conflict. One of the results achieved is the synchronisation of terms used in standards regarding technical requirements.

Cooperation of the European standardisation bodies with ISO has been established at the technical level so European and international standards are developed in parallel. Around 30% of standards under CEN are identical to ISO standards. In such cases the standards are called “EN ISO”.

Further information:

International standardisation bodies organise trainings and provide technical and financial assistance to developing countries. Specific information is available on their respective websites:

- **ISO**: DEVCO (Committee on developing country matters), http://www.iso.org/iso/home/about/iso-and-developing-countries/devco.htm
- **IEC**: IEC Affiliate Country Programme, http://www.iec.ch/affiliates/?ref=menu

5 Existing Standards

In general the standards related to the ozone depleting substances and their use are concerned with four major areas:

- Standards for the substances themselves such as specifications for refrigerant gas and refrigerant designation (e.g ISO 817).
- Standards for systems, equipment and components; including, for example, safety requirements for refrigerating equipment, codes/ guides for refrigeration & air-conditioning systems (e.g. ISO 5149), and refrigerant recovery/ recycling equipment (e.g., IEC 60335-2-104), and equipment charge size.
- Standards for refrigerant containers, including content of recovery cylinders (AHRI), colour codes, and pressurized cylinders standards.
- Other related standards such as foam final products, content and fire retardant requirements, buildings codes (which for example could prohibit the use of flammable refrigerants), energy efficiency labelling programmes, installations, and practice.

Safety issues, such as safety in construction and installation, use, service, maintenance, leak prevention, dismantling and recycling of technologies and substances are of particular importance, and in general standards aim to maximise operational safety and minimise hazard and risk.

There are several technical international ISO and IEC standards as well as several regional and national standards particularly from the European Union (e.g. CEN, CENELC) and the United States (e.g. ANSI/ASHRAE, UL) relevant and applicable to ozone-depleting substances and technologies relying on them.

In the context of the HCFC phase-out and requirement for non-ozone depleting, low-GWP alternatives, there is a requirement that existing standards are updated and/or new standards created to cover the use of these substances. Some important relevant standards, published several years ago have recently been revised and updated (e.g ISO 5149, ISO 817) or are currently under the process of revision (e.g EN 378). The previous version of standard ISO 5149 on 'Mechanical refrigerating systems used for cooling and heating – Safety requirements' which was issued in 1993 essentially prohibited the use of flammable refrigerants which are now widely applied in many sectors.

Because many of the lower-GWP refrigerants are flammable, RAC equipment must conform to the requirements of any standards for *flammable atmospheres*. In most countries these standards have a higher status than the general refrigeration standards. For example, the UN has "*A Common Regulatory Framework for Equipment Used in Environments with an Explosive Atmosphere*", to which a large number of developed and developing countries are signatories.

Although the general refrigeration standards include provisions for flammable refrigerants, they are not considered to provide adequate guidance for how to safely apply them. In this regard, the design, construction and evaluation requirements for achieving safety of equipment using flammable refrigerants must be sought in the relevant standards (such as EN 1127-1 and the IEC 60079-series in the European Union).

The most important standards which have a role in supporting the HCFC phase-out and standards related to the low-GWP alternatives and alternative technologies are listed below. Full details of all the related standards can be found in the catalogues of standardisation organisations and bodies.

Main technical standards relevant to the HCFC phase-out and low-GWP alternatives

International Organization for Standardization

ISO 5149:2014 Mechanical refrigerating systems used for cooling and heating – Safety requirements

- Recently revised from 1993 version
- Includes requirements for new classification on low flammability (2L) for refrigerants
- Specifies the requirements relating to the safety of persons and property for the design, construction, installation and operation of refrigerating systems and puts an emphasis on minimising the leakage of refrigerant to the atmosphere
- Specifies classification of the refrigeration systems
- Specifies monitoring of leakage; i.e., refrigeration concentration in the machine room - a special requirement for ammonia
- Applicable to all types of refrigerating systems in which the refrigerant is evaporated and condensed in a closed circuit

ISO 817:2014 Refrigerants – Designation and Safety Classification

- Provides a clear system for numbering and assigning composition-designating prefixes to refrigerants (e.g. for chlorofluorocarbons the prefix CFC is used)
- Refrigerant safety classification (flammability, toxicity)
- Refrigerant concentration limits
- Is intended to be used with other relevant safety standards such as ISO 5149, IEC 603352-24 and IEC 60335-2-40

ISO 17584:2005 Refrigerant properties

- Specifies thermophysical properties of several commonly used refrigerants and refrigerant blends
- Applicable to the refrigerants R-12, R-22, R-32, R-123, R-125, R-134a, R-143a, R-152a, R-717 (ammonia), and R-744 (carbon dioxide) and to the refrigerant blends R-404A, R-407C, R-410A, and R-507
- Includes specifications of several properties, including the following: density, pressure, internal energy (total energy contained by a thermodynamic system), enthalpy, entropy, heat capacity at constant pressure, heat capacity at constant volume, speed of sound and the Joule-Thomson coefficient

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

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

International Electrotechnical Commission

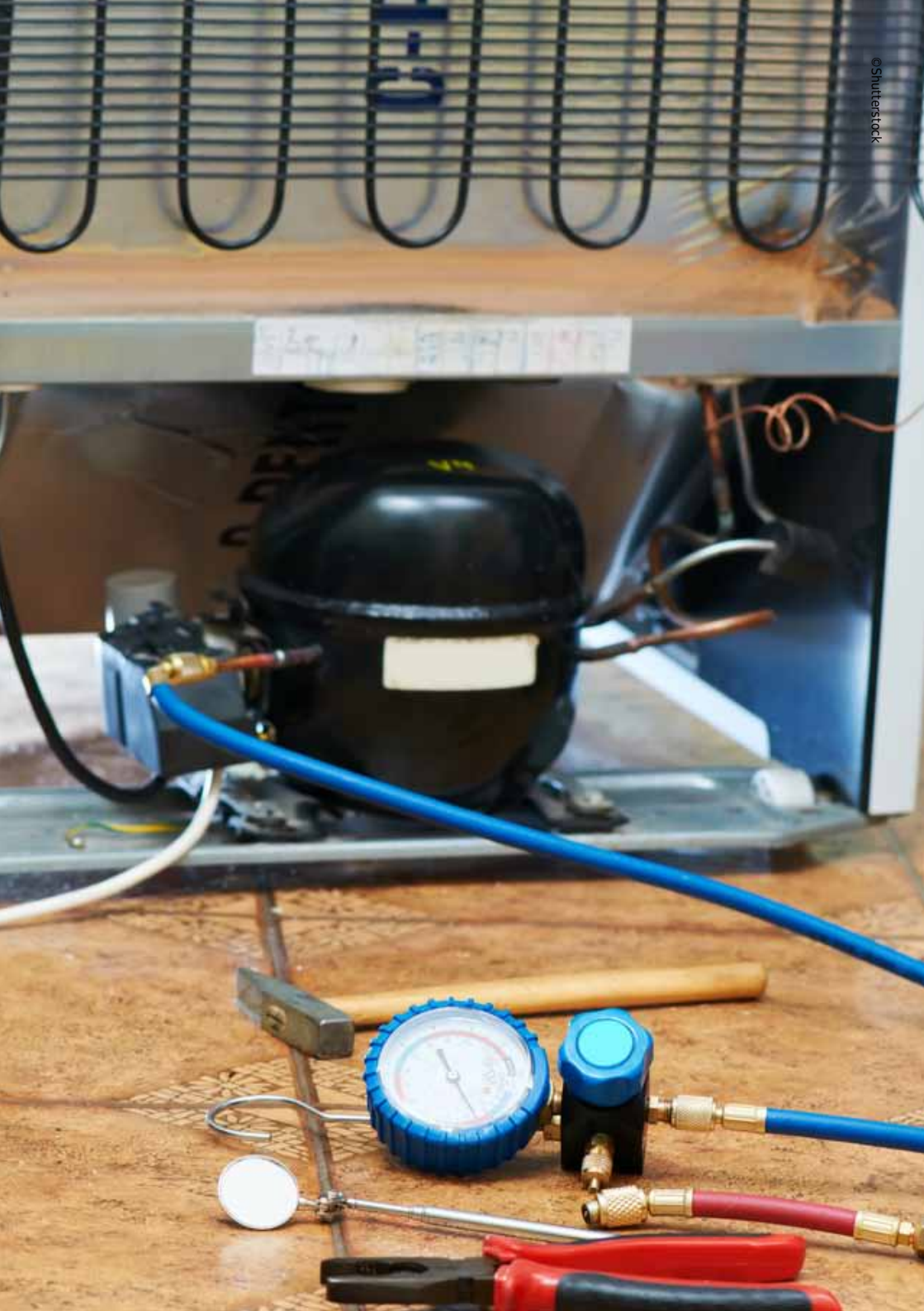
IEC 60335-1:2012 Household and similar electrical appliances – Safety, general requirements

- The basis for a series of more than 100 parts covering broad variety of requirement and appliances including non-RAC systems
- The most relevant are:
  - IEC 60335-2-24 Particular requirements for refrigerating appliances, ice cream appliances and ice makers
  - IEC 60335-2-40 Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers (currently prohibits HC use)
  - IEC 60335-2-75 Particular requirements for commercial dispensing appliances and vending machines
  - IEC 60335-2-89 Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant unit or compressor
  - IEC 60335-2-104 ed1.0 Particular requirements for appliances to recover and/or recycle refrigerant from air conditioning and refrigeration equipment incorporating open drive or motor-compressors

European Committee for Standardization

CEN: EN 378:2008 Refrigerating systems and heat pumps - Safety and environmental requirements

- Consisting of 4 parts (amendments were approved in 2012):
  1) Basic requirements, definitions, classification and selection criteria
  2) Design, construction, testing, marking and documentation
  3) Installation site and personal protection
  4) Operation, maintenance, repair and recovery
- Main scope is to reduce the number of hazards to persons, property and the environment, caused by refrigerating systems and refrigerants
- Applicable to almost all refrigeration systems
- Covers almost every phase of the design, construction and operation of a refrigerating system
- References several other European standards



CEN: EN 13313:2010 Refrigerating systems and heat pumps – competence of personnel

- Specifies procedures for achieving and assessing the competence of persons who design, install, inspect, test and commission, maintain, repair and dispose of refrigerating systems and heat pumps with respect to health, safety, environmental protection, and energy conservation requirements
- Requirements for training, assessment, and maintenance of competence
- Certification set up in F-gas regulation is based on the requirements of this standard

CEN: EN 1127-1:2011 Explosive atmospheres — Explosion prevention and protection Part 1: Basic concepts and methodology

- Provides basic risk assessment and risk reduction methodology for any equipment using flammable substances (including refrigerants)
- Guidance of level of protection for sources of ignition
- Guidance on tightness of systems

IEC and European Committee for Electrotechnical Standardization

CENELEC: EN 60335-1:2012 Household and similar electrical appliances – Safety, general requirements

- Consists of a series of more than 100 parts
- This CENELEC series corresponds to the IEC standards. Some modifications were carried out to conform to the European context
- The most relevant are:
  - EN 60335-2-24 Particular requirements for refrigerating appliances, ice cream appliances and ice makers
  - EN 60335-2-40 Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
  - EN 60335-2-75 Particular requirements for commercial dispensing appliances and vending machines
  - EN 60335-2-89 Particular requirements for commercial refrigerating appliances with an incorporated or remote refrigerant condensing unit or compressor

CENELEC: EN 60079 Electrical Apparatus for Explosive Gas Atmospheres

- Consists of a series of parts
- Covers different requirements for construction safety, protection and training for electrical systems in potentially explosive gas atmospheres
- EN 60079 series consists of more than 20 standards most of which are harmonised with the EU Directive on Explosive Atmospheres (including flammable substances in the form of gases, vapours, mists or dust)

American National Standards Institute/ American Society of Heating, Refrigeration and Air-Conditioning Engineers

ANSI/ASHRAE 15-2013 Safety Standard for Refrigeration Systems

- Establishes safeguards for life, health, and property and prescribes safety requirements of persons and property on or near the premises where refrigeration facilities are located
- Specifications for fabrication of tight systems but does not address the effects of refrigerant emissions on the environment
- Specification of the safe design, construction, test, installation, operation and inspection of all refrigeration and stationary A/C applications
- Modifications and replacements of parts or components and substitutions of refrigerants having a different designation
- Safety classifications of ASHRAE Standard 34 -2010 used to provide safety guidelines for the design and installation of refrigerating systems

ANSI/ASHRAE 34-2010 Designation and Safety Classification of Refrigerants

- System of referencing refrigerants and classification of refrigerants based on toxicity and flammability
- Definition of permissible concentration limits allowed by ASHRAE standard 15-2010

Underwriters Laboratories

UL 207 Refrigerant-Containing components and Accessories, Nonelectrical
UL 250 Household Refrigerators and Freezers
UL 471 Commercial Refrigerators and freezers
UL 474 Dehumidifiers
UL 484 Room Air Conditioners
UL 984 Hermetic Refrigerant Motor-Compressors
UL 1995 Heating and cooling equipment
UL 60335-2-40 Safety of Household and Similar Electrical Appliances Part 2-40: Particular Requirements for Electrical Heat Pumps, Air-Conditioners and Dehumidifiers

- UL standards are focused on setting of complex requirements for devices stated in the title of respective standard
- Reliance on other regional or national standards is always specified in the scope of the standard

Australian Standard/ New Zealand Standard

AS/NZS 1677.2 -1998 Refrigerating systems part 2: Safety requirements for fixed applications

- Specifies requirements for the safety aspects, in terms of the design, construction, installation and inspection of refrigerating appliances, systems and ancillary equipment intended for use or installation in institutional, public assembly, residential, commercial and industrial occupancies
- Applies to new refrigerating systems, to extensions and modifications of existing systems and to used systems being reinstalled and operated at another site
- Also applies in the case of the conversion of a system for use with another refrigerant. It does not apply to household refrigerators

AS/NZS 2022 – 2003 Anhydrous Ammonia – storage and handling

- Specifies requirements for the design, construction, location, and operation and testing of systems for the storage and handling of anhydrous ammonia.
- Requirements for the management of emergencies involving anhydrous ammonia and for the fire protection of any associated facilities are also specified

Air-conditioning, Heating, & Refrigeration Institute

AHRI 700-2012 Specifications for Fluorocarbon Refrigerants

- Important specification to assist in avoidance of use of mislabelled, low-quality and/or counterfeit refrigerants

Complete lists of international and regional standards

Usually each standardisation body has a ‘catalogue’ or ‘store’ available on their respective websites where all standards and other publications developed by the organisation are listed.

Examples of catalogues and stores include:

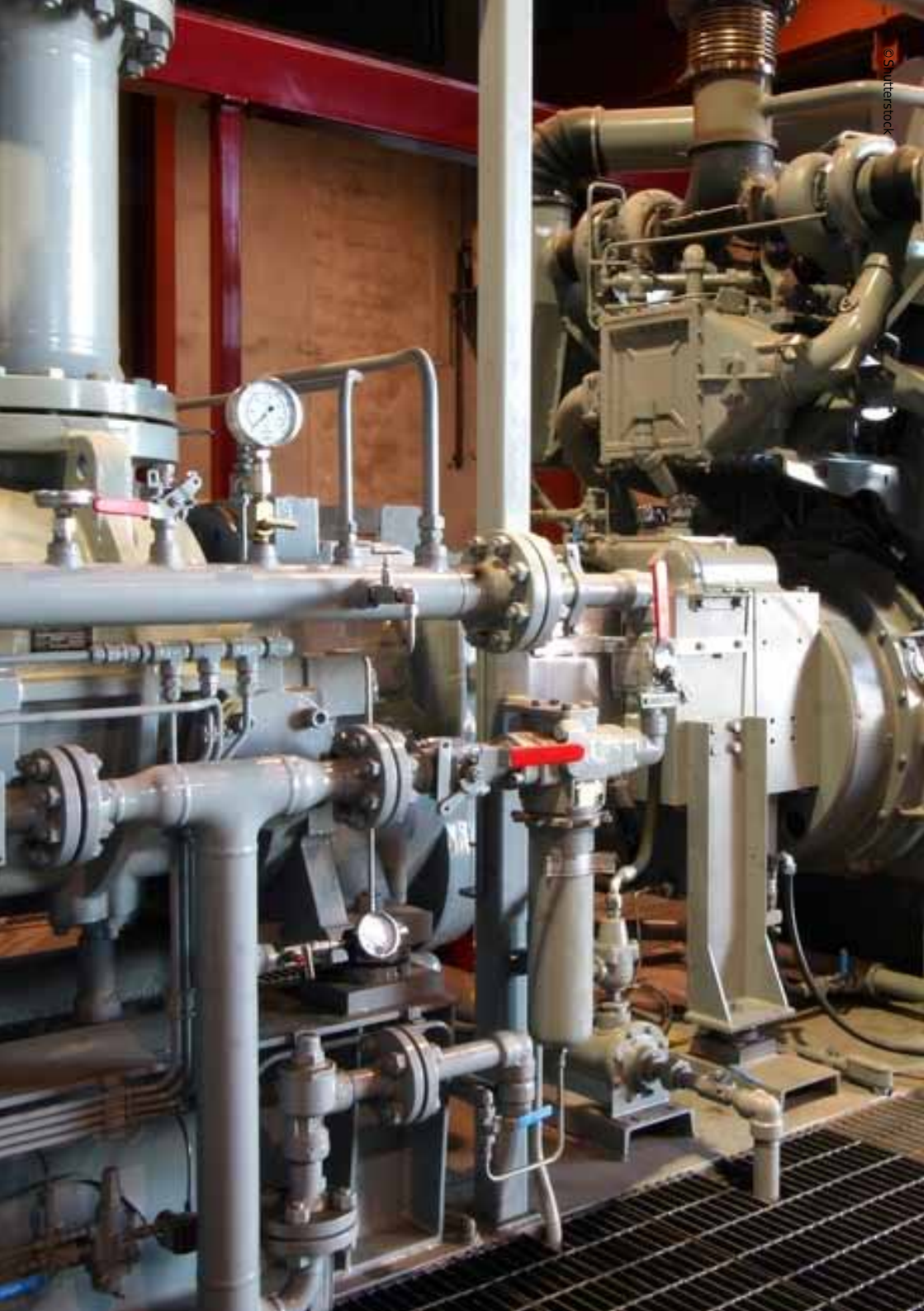
ISO Standards Catalogue: http://www.iso.org/iso/home/store/catalogue_ics.htm

IEC webstore: http://webstore.iec.ch/?ref=menu

CEN Standard database http://esearch.cen.eu/esearch/

ANSI Standards store: http://webstore.ansi.org/default.aspx

A database of standards and technical regulations is available from Perinorm www.perinorm.com (registration required).



6 Adoption of International Standards at the National Level

It is the responsibility of each country to set up appropriate national legal measures to comply with their commitments under the Montreal Protocol to phase out HCFCs and other ozone-depleting substances. In the context of the phase-out, it is the responsibility of the country to select alternative technologies and substances to those ozone-depleting substances which are being phased out. In the case where these alternative substances are significantly different from those they replace and have certain properties that the various sectors are not familiar with, standards can provide the framework and 'insight' as to how these substances can be adopted with minimal disruption. International and regional standards can be adopted at the national level or they can be used as guidance and as examples in the preparation of national legislation. A comprehensive national consultation process may be required prior to adoption of a national standard to ensure the national context is carefully evaluated in reference to existing standards and that the requirements of all relevant stakeholders are taken into consideration.

In the process of successfully adopting national standards, the cooperation of NOUs with NSBs, national RAC associations and other institutions is key, with each institution having its own role, different tasks and mandates.

National standardisation bodies

National Standardisation Bodies are the focal points of the international and regional standardisation bodies. They typically carry out several functions; including:

- Coordination and organisation of the work at the national level related to all stages of standard development.
- Information, training, sales, and promotion of standards.
- Adoption of international and regional standards at the national level.
- Coordination of national , regional, sub-regional, and international cooperation.
- Ensure and arrange the national expert participation at the technical committees, subcommittees and working group meetings.
- Ensuring conformity and assessment of implementation (testing, calibration, inspections, product, and system certification).

The NSB is involved in the process of development and review of standards as member of its relevant technical committee, depending on the country membership in the international/regional standardisation body. Member countries of the international standardisation bodies can adopt international standard as the national standard. It can be adopted directly or the standard can be modified by the NSB to best suit the national situation. The resulting national standard is named accordingly.

Example: BS ISO 817 on *Refrigerants – Designation* system is the ISO 817 adopted at the national level of the United Kingdom as the British Standard (BS)

"At the regional level in Europe, the NSBs of members of CEN, CENELEC and EU Member States are responsible for adopting European standards as national standards. The European standard adopted at the national level is named according by the country.

Example: DIN EN 378-1 on *Refrigerating systems and heat pumps - Safety and environmental requirements* is the European standard EN 378-1 adopted in Germany.

Cooperation of standardisation bodies enables the adoption of international standard through regional standards at the national level.

Example: DIN EN ISO 14001 on *Environmental management systems* is the international ISO standard adopted as the regional European EN standard and also adopted at the national level in Germany.[12]

Usually national standardisation bodies liaise with ISO, IEC and at the European level with CEN and CENELEC. In cases of a national standard conflicting with a regional or international standard, the national standard is usually withdrawn.
Example: Since the EN 378:2000 some national standards had to be withdrawn: e.g. NPR 7600 in the Netherlands, DIN 7003 in Germany, BS 4434 in the UK.

A comprehensive list of NSBs which are ISO members is available on the ISO website: http://www.iso.org/iso/home/about/iso_members.htm
NSBs which are IEC members (sometimes different from ISO NSBs) can be found here:
http://www.iec.ch/dyn/www/f?p=103:5

National Ozone Units

National Ozone Units (NOUs) are the focal points for the Montreal Protocol, responsible for implementation of the Protocol's requirements at the national level and responsible for the national compliance with the Protocol and its targets. While it is not recommended that NOUs become directly involved in the standards setting process, as this is most likely beyond their mandate and role in most countries, they nevertheless have an important part to play.
Ideally the NOUs should remain appraised of the status, development and review of international standards and can provide input on the nationally-relevant context. NOUs can play an important role in promoting dialogue between the appropriate actors on the issue at the national level, for example with the relevant Energy agency, Safety agency and Standards organisations.

[12] In Europe the EN must be adopted "as is" except when there is a conflict with national legislation

Recommendations for NOUs:

- Learn about which types of standards could affect the adoption of alternatives in the context of the HCFC phase-out in key sectors in their country.
- Review the country's national standards (Substances, Systems/ Equipment/ Components, Containers, other related standards) and determine whether the country has adopted the latest international standards related to the HCFC phase-out.
- Identify and make contact with the different national authorities responsible for standards, and educate them about Montreal Protocol developments and the HCFC phase-out.
- Consider areas where there are gaps with standards and take up dialogue with standard setting authorities on how they might be addressed.
- Understand the process of adopting existing standards as part of national legislation.
- Explain the process of adopting standards to relevant stakeholders within the country.
- Promote awareness to national industry and the government about the importance of standards to HCFC phase-out and the latest developments about international standards.
- Consider whether and how the standards issue might be addressed during the HPMP implementation process (e.g. it could be part of the legislation and policy component of HPMPs).

Accreditation bodies

Accreditation bodies are used to ensure that the application of the national, regional or international standards is correctly achieved by organisations that provide certification, testing, inspection and calibration services. A list of national accreditation bodies can be found on the International Accreditation Forum (IAF) website: http://www.iaf.nu/articles/IAF_Members_&_Signatories/4

National RAC associations

National RAC associations are technical bodies and are contact points for the technicians. Frequently they are responsible for training and certification of technicians. They can provide useful input to the National Standardisation Bodies, as well as having an important role to play in ensuring standards are implemented and adhered to and can provide guidance and support to explain the relevant standards to their members

The process of adoption of international standards

A standard is usually initially proposed by a national standardisation body and developed by the working group of the respective technical committee of the relevant standardisation organisation. An NSB can develop the standard itself, but more often it is carried out by a national institution on technical standardisation or relevant expert. It is the responsibility of the NSB to prepare a guideline on development, maintenance and layout of the national and adopted international standards based on the requirements and general principles elaborated by the international or regional standardisation bodies.

Before the adoption of an international/regional standard or its implementation into national regulation it is important to ensure that the objective will bring about the anticipated benefit, will not present any unforeseen barriers and will not duplicate or be in conflict with any existing regulations. This may involve a comprehensive national open and transparent consultation and process of monitoring and evaluation.

Approaches for standards adoption

Several approaches are possible to adopt an international or regional standard as a national standard. International and regional standardisation organisations set up rules and guidelines for adoption of their standards at the national level. These rules are obligatory and are available from the respective standardisation organisations.

Considerations for the adoption of a standard at the national level

1. Adoption by translation

- A national cover page and national foreword must be added
- Translation cannot substantially change the content of the document
- Translation is carried out from the English original in case more languages are available
- The national translation can be accompanied by nationally relevant annotations, or an annex to provide more information
- National annex of informative character may accompany the document

2. Adoption by acceptance of the original version

- The standard text remains in the original version, in the original language and layout
- A national cover page is added, and a national foreword and national annex can also be added

3. Adoption by the NSB official announcement on standards' approval

- Carried out through an official announcement by the NSB (no other actions are done as in the two previous options on standard adoption)
- Standard is approved for direct application
- This is the usual practice for regional European CEN/CENELEC standards

4. Adoption by modification to suit the best the national needs

- Adoption of the international/ regional standard adapted by the NSB or by an expert/experts secured by the NSB to best suit national needs.
- Standard draft containing clearly marked national modifications including their explanation is disseminated for comments to all relevant participants. After settlement of all comments, final draft of the standard adapted to the national needs is finalised.

7 Final Remarks

This booklet was developed to introduce standards in the refrigeration and air-conditioning sector and to show how they can be useful in supporting the HCFC phase-out in developing countries. While the booklet has focused on the refrigeration and air-conditioning sector, it is worthwhile to point out that there are some other sectors and areas in which standards relevant to the implementation of the Montreal Protocol also apply, for example transport refrigeration[13] and foams. It is not possible in a booklet of this nature to cover all aspects and considerations of these standards and the aim has been to focus on the most relevant information. Links to further reading have been provided and it is recommended to contact national standardisation focal points for more information, as appropriate.

From the country perspective, successfully transitioning away from reliance on ozone depleting chemicals is required under the Montreal Protocol and is an historic opportunity to, at the same time, avoid reliance on powerful global warming gases. The adoption and utilisation of appropriate standards in the refrigeration and air conditioning sector can facilitate this process.

While historically in most developing countries NOUs have not been closely involved with the issue of standards, as alternatives are considered and adopted better engagement with these processes will be of increasing importance. It is therefore recommended that NOUs should initially build their own capacity in understanding the standardisation process in general and standards in their particular national context, and this booklet should assist in this objective. It is then recommended to start a dialogue with the relevant standardisation bodies in their country to ensure firstly that the relevant standards are adopted and that these will be appropriate to the national context, and secondly that any national standards in place or in development will be beneficial and not create any barriers to particular products or practices supporting their efforts to phase-out HCFCs and adopting non-ozone depleting, low-GWP, energy-efficient alternatives.

- Standards are voluntary tools, they have no legal standing themselves unless adopted into national legislation.
- Standards are, in general, commercial products available for purchase.
- The cost of a standard is a national decision which can reflect the value

[13] For more information, see: “Risk assessment and standards survey for use of flammable refrigerants in transport refrigeration applications” by H. König and T. Enkemann (2nd IIR International Conference).

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of the content of standards.

- Most developing countries are 'standards takers' not 'standards setters' - the standards setting process is highly technically, procedurally complicated, resource intensive, and can take considerable time.
- Typically standards are reviewed and updated every five years or so.
- The National Standardisation Body in most countries will be the relevant focal point and will be the national representative to any international or regional standards organisation of which the country is a member.
- Standards adopted at the national level should be nationally appropriate and not cause any unnecessary barriers to the adoption of alternatives to HCFCs.

Further Reading and References

STANDARDS ORGANISATIONS:

- European Committee for Electrotechnical Standardization, CENELEC: www.cenelec.eu
- European Committee for Standardization, CEN: www.cen.eu
- International Organization for Standardization, ISO: www.iso.org
- International Electro-technical Commission, IEC: www.iec.ch

- American National Standards Institute, ANSI: www.ansi.org
- American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE: www.ashrae.org
- British Standards Institution, BSi: www.bsigroup.com
- Czech Office for Standards, Metrology and Testing: www.unmz.cz
- Deutsches Institut für Normung e.V., DIN: www.din.de
- Japanese Standards Association, JSA: www.jsa.or.jp
- Standards Australia, AS: www.standards.org.au
- Standards New Zealand, NZS: www.standards.co.nz
- Underwriters Laboratories, UL: www.ul.com

NATIONAL STANDARDISATION BODIES

List of NSBs (ISO)

http://www.iso.org/iso/home/about/iso_members.htm

List of NSBs (IEC)

http://www.iec.ch/dyn/www/f?p=103:5

LISTS OF INTERNATIONAL AND REGIONAL STANDARDS

Examples of catalogues and stores:

- ISO Standards Catalogue: http://www.iso.org/iso/home/store/catalogue_ics.htm
- IEC webstore: http://webstore.iec.ch/?ref=menu
- CEN Standard database http://esearch.cen.eu/esearch/
- ANSI Standards store http://webstore.ansi.org/

A database of standards and technical regulations is available from Perinorm www.perinorm.com (registration required).

STANDARDS DEVELOPMENT – RULES OF VARIOUS STANDARDISATION BODIES:

- ASHRAE: https://www.ashrae.org/standards-research--technology/standards-forms--procedures
- CEN, CENELEC: http://www.cen.eu/work/ENdev/Pages/default.aspx, ftp://ftp.cen.eu/BOSS/Reference_Documents/IR/CEN_CLC/IR2_E_AD.pdf
- IEC: http://www.iec.ch/standardsdev/?ref=menu
- ISO: http://www.iso.org/iso/home/standards_development.htm

ASSISTANCE FOR DEVELOPING COUNTRIES

International standardisation bodies organise trainings and provide technical and financial assistance to developing countries. Specific information is provided on their respective websites:

- IEC: IEC Affiliate Country Programme, http://www.iec.ch/affiliates/?ref=menu
- ISO: DEVCO (Committee on developing country matters), http://www.iso.org/iso/home/about/iso-and-developing-countries/devco.htm

GENERAL GUIDANCE AND INFORMATION ON STANDARDS

- CEN guidance document Implementation of European Standards - ENs not corresponding to national standards on a one-to-one basis: http://boss.cen.eu/reference%20material/guidancedoc/pages/impl.aspx
- CEN guidance document National Regulations – Possible Conflict with CEN work (and A-deviations): http://boss.cen.eu/reference%20material/guidancedoc/pages/nationalreg.aspx
- Corberán, J., M., Seguardo, J., Colbourne, D., Gonzálvez, J. (2008): Review of standards for the use of hydrocarbon refrigerants in A/C, heat pump and refrigeration equipment. International Journal of refrigeration 31, p. 748-756
http://www.sciencedirect.com/science/article/pii/S0140700707002496
- Goetzler, W., Burgos, J., Hiraiwa, H., Sutherland, T. (2010): Review of regulations and standards for the use of refrigerants with GWP values less than 20 in HVAC&R applications. Air-conditioning and refrigeration technology institute, INC, Arlington, USA
http://www.ahrinet.org/App_Content/ahri/files/RESEARCH/Technical%20Results/ARTI-Rpt-09001-01.pdf
- ISO / IEC directives http://www.iso.org/iso/standards_development/processes_and_procedures/iso_iec_directives_and_iso_supplement.htm
- ISO/IEC guide 21-1(2005): Regional or national adoption of International Standards and other - International Deliverables.
Part 1: Adoption of International Standards. Available from: http://www.iso.org/iso/iso_iec_guide_21-1_2005.pdf
- ISO, UNIDO (2008): Fast Forward. National Standards Bodies in Developing Countries. ISBN 978-92-67-10477. Available from http://www.iso.org/iso/fast_forward.pdf and http://www.unido.org/fileadmin/user_media/Publications/documents/fast_forward.pdf

INFORMATION ON ALTERNATIVE REFRIGERANTS

- AHRI Low-GWP Alternative Refrigerants Evaluation Programme, http://www.ahrinet.org/ahri+low_gwp+alternative+refrigerants+evaluation+program.aspx
- AREA (2012): Low GWP Refrigerants. Guidance on minimum requirements for contractors' training & certification. Available from: http://www.area-eur.be/system/files/Documents/AREA%20-%20Guidance%20training%20Low%20GWP%20refrigerants%20%282012%29.pdf
- AREA (2011): Low GWP refrigerants. Guidance on use and basic competence requirements for contractors http://www.area-eur.be/_Rainbow/Documents/AREA%20-%20PP%20Low%20GWP%20refrigerants%20(110629).pdf
- Ammonia 21, everything natural: http://www.ammonia21.com/
- Australian Institute of Refrigeration. Natural Refrigerants case studies. Air Conditioning and Heating: Australian Government, Department of Environment and Water Resources. (2007) Available from: http://www.environment.gov.au/atmosphere/ozone/publications/refrigerants-guide.html

• British Refrigeration Association (2012): Guide to flammable refrigerants http://www.feta.co.uk/uploaded_images/files/BRA%20Guide%20to%20Flammable%20Refrigerants%20-%20Issue%201%20-%20Oct%2012.pdf
• British Refrigeration Association (2012): Guidance. Service of Hydrocarbon Refrigerant Equipment in a Retail Environment. Available from http://www.area-eur.be/system/files/Documents/Service%20of%20Hydrocarbon%20Refrigerant%20Equipment%20in%20a%20Retail%20Environment%20%282%29.pdf
• Everything R744, http://www.r744.com/
• Hydrocarbons 21, everything natural: http://www.hydrocarbons21.com/
• GIZ Proklima (2011): Operation of split air conditioning systems with hydrocarbon refrigerant. A conversion guide for technicians, trainers and engineers. GIZ Proklima, Federal Ministry for the Environment, Nature Conservation and nuclear Safety, Eschborn. http://star-www.giz.de/fetch/5kPE5X001s00g71a0Q/giz2011-0610en-air-conditioning.pdf
• GTZ Proklima (2010): Guidelines for the safe use of hydrocarbon refrigerants. A handbook for engineers, technicians, trainers and policy-makers – For a climate-friendly cooling. GIZ Proklima, Federal Ministry for Economic Cooperation and Development, Eschborn. http://star-www.giz.de/fetch/3SQ00p3Xa0001Jgk6g/giz2013-0686en-hydrocarbon-refrigerants.pdf
• GTZ Proklima (2008): Natural Refrigerants. Sustainable Ozone – and Climate-Friendly Alternatives to HCFCs. GTZ Proklima, Federal Ministry for Economic Cooperation and Development, Eschborn. http://star-www.giz.de/fetch/6Y06X01J00pgEJ00Qj/giz2013-0684en-natural-refrigerants.pdf
• Underwriter Laboratories (2011): Revisiting Flammable Refrigerants. Available from http://www.ul.com/global/documents/library/white_papers/UL_WhitePaper_FlammableRefrigerants.pdf

BARRIERS TO LOW-GWP ALTERNATIVES

• UNEP: Barriers to the use of low-GWP refrigerants in developing countries and opportunities to overcome these. (2010) ISBN: 978-92-807-3124-8: http://www.unep.fr/ozonaction/information/mmcfiles/7476-e-Report-low-GWPbarriers.pdf

FURTHER READING:

• Executive Committee - Discussion paper on minimizing adverse climate impact of HCFC phase-out in the refrigeration servicing sector (decision 68/11). Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol, document 70/53 (2013). http://www.multilateralfund.org/70/English/1/7053r1.pdf
• Montreal Protocol - Meeting of Parties of the Montreal Protocol on Substances that deplete the Ozone Layer: Decision XIX/6: Adjustments to the Montreal Protocol with regard to Annex C, Group I substances (hydrochlorofluorocarbons)
http://ozone.unep.org/new_site/en/Treaties/treaties_decisions-hb.php?dec_id=614
• UNEP Guide for National Ozone Officers (2013) ISBN 92-807-2674-9.
http://www.unep.org/ozonaction/Portals/105/Files/7659-Guide_NOU.pdf

About the UNEP DTIE 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. One hundred ninety seven governments have joined this multilateral environmental agreement and are taking action.

The UNEP DTIE 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.

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About the UNEP Division of Technology, Industry and Economics

The UNEP Division of Technology, Industry and Economics (DTIE) helps governments, local authorities and decision-makers in business and industry to develop and implement policies and practices focusing on sustainable development.

The Division works to promote:

> sustainable consumption and production,
> the efficient use of renewable energy,
> adequate management of chemicals,
> the integration of environmental costs in development policies.

The Office of the Director, located in Paris, coordinates activities through:

> The International Environmental Technology Centre - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.

> Sustainable Consumption and Production (Paris), which promotes sustainable consumption and production patterns to contribute to human development through global markets.

> Chemicals (Geneva), which promotes sustainable development by catalysing global actions and building national capacities for the sound management of chemicals and the improvement of chemicals safety worldwide.

> Energy (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.

> OzonAction (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.

> Economics and Trade (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

UNEP DTIE activities focus on raising awareness, improving the transfer of knowledge and information, fostering technological cooperation and partnerships, and implementing international conventions and agreements.

For more information
see **www.unep.org**

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This guide provides an introduction and simple overview of the issues related to international standards in the refrigeration and air-conditioning sector and how they can be useful in the context of the phase-out of hydrochlorofluorocarbons (HCFCs) in developing countries as required by the Montreal Protocol on Substances that Deplete the Ozone Layer.

DTI/1805/PA