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PROJECT CONCEPT:

DEVELOPMENT OF A 'GUIDE FOR SUSTAINABLE REFRIGERATED FACILITIES AND SYSTEMS', IN COOPERATION WITH THE AMERICAN SOCIETY OF HEATING, REFRIGERATION AND AIR CONDITIONING ENGINEERS (ASHRAE).

(SUBMITTED BY UNEP)

Pre-session documents of the Executive Committee of the Multilateral Fund for the Implementation of the Montreal Protocol are without prejudice to any decision that the Executive Committee might take following issuance of the document.

United Nations Environment Programme
برنامج الأمم المتحدة للبيئة • 联合国环境规划署
PROGRAMME DES NATIONS UNIES POUR L'ENVIRONNEMENT • PROGRAMA DE LAS NACIONES UNIDAS PARA EL MEDIO AMBIENTE
ПРОГРАММА ОРГАНИЗАЦИИ ОБЪЕДИНЕННЫХ НАЦИЙ ПО ОКРУЖАЮЩЕЙ СРЕДЕ

Project Concept:

Development of a 'Guide for Sustainable Refrigerated Facilities and Systems', in cooperation with the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE).

This project proposal concept is provided by UNEP for the information of the Sixty Fifth Meeting of the Executive Committee[1].

[1] As indicated in Para 94. of the Report of the Sixty-Fourth Meeting of the Executive Committee (UNEP/OzL.Pro/ExCom/64/53), an Executive Committee member drew the Committee's attention to collaboration between UNEP and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) on producing a guide that he believed would usefully assist servicing technicians around the world in implementing HPMPs. After discussion, it was stated that the document could be submitted to a future meeting as an information document.

1. EXECUTIVE SUMMARY

UNEP and the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) will collaborate to develop a "Guide for Sustainable Refrigerated Facilities and Systems" (The Guide). ASHRAE is a world-wide leader in energy efficient buildings and HVAC & Refrigeration systems, system start-up advice, energy standards and the adoption of low/no ODP/GWP refrigerants and refrigeration technologies.

Refrigerated systems in the "cold chain" for food and medicine, including refrigerated warehousing and supermarkets, are growing rapidly in A5 countries as their infrastructure responds to growing urban populations. Currently, where these systems exist, HCFC-22 is the preferred refrigerant particularly for small-medium sized enterprises (SMEs). Refrigeration is commonly the largest energy end user for refrigerated warehouses, food processing facilities and supermarkets.

The UNEP/ASHRAE Guide will address the entire range of commercially-available alternative refrigerant options and assess advantages and disadvantages of each, and SME applicability. That assessment will encourage low and zero GWP refrigerant selection and energy-efficient technologies and ways to maximize HCFC phase out climate benefits (Decision XIX/6). The Guide will include methodologies for calculating lifetime facility/system global warming contributions (both direct and indirect emissions). It will describe good product and stewardship practices, including servicing and emissions reduction practices.

The growth of integrated refrigerated storage-cold chain facilities in A5 countries and potential HCFC-22 refrigeration focus in second stage HPMPs makes this project timely. Similar Guides in this sector do not exist today.

The Guide will specifically address large built-up central plants, engineered multiplex "rack" compressor systems, or multiple "split-system" refrigeration units. Nearly all such refrigeration systems are custom engineered and constructed of components, rather than being sold as "packages." The methods and concepts addressed will be practical and actionable, consistent with the questions and options that must be addressed by designers, contractors and operators. The sector's diverse nature makes HCFC phase out particularly difficult.

The Guide will have a global perspective. Facility and system design, refrigerant choice and potential policy options offer a timely opportunity to provide valuable guidance. The Guide will target refrigerated facility and system owners and operators, refrigeration and air conditioning technicians and National Ozone Units in A5 countries.

The Guide will be published electronically (i.e. Excel, CD) and as either a softbound book or in a 3-ring binder, along with analysis methods, tools and sample calculations. Users should be able to practically use the Guide, although an interactive training and certification module could be considered for future development. Tables and spreadsheets will also be provided electronically for increased utility and flexibility.

ASHRAE will provide $150,000 contribution and approximately $75,000 in member equity. The Project will require $250,000 from the Multilateral Fund (*excluding PSC*).

2. BACKGROUND

UNEP and ASHRAE propose to collaborate on developing a Guide for Sustainable Refrigerated Facilities and Systems.

ASHRAE, founded in 1894, is the largest global non-profit member organization related to HVAC&R systems and their use in commercial, industrial and residential buildings, as well as one of the oldest. It fulfills its mission of advancing heating, ventilation, air conditioning and refrigeration to promote a sustainable world through research, development of technical standards, publication and development of educational resources. ASHRAE uses its peer-reviewed, ANSI certified process for over 120 standards and guidelines that are used globally. Each member serves in his/her own capacity and there are no corporate members.

With over 52,000 members, ASHRAE has 175 Chapters in 30 countries and members present in 130 countries, including more than half of the A5 countries. Over 10% of ASHRAE's members and 20 Chapters are in Article 5 countries. ASHRAE has long established relationships with more than 50 technical societies around the globe, including those from the largest Article 5 countries, through its Associate Society Alliance. Annex I provides more information on the ASHRAE Associate Society Alliance Members ASHRAE's impact reaches far beyond these numbers though; when one of the 100 ASHRAE technical committees develops a new standard many governments evaluate whether it should be adopted into their national regulations or laws.

ASHRAE's Distinguished Lecturer (DL) program supports local chapters. The DL's speak on many topics including refrigeration and air conditioning technology. The DL program could support UNEP's regional Article 5 efforts with this Guide, promoting appropriate methods and practices for use of all refrigerants.

3. PROJECT OBJECTIVE

The proposed Guide is expected to assist the HCFC transition but, as significantly, provide proper product and environmental stewardship practices, covering all refrigerant alternatives.

The Multilateral Fund has provided significant support to Parties making transitions away from ozone depleting refrigerants, primarily CFCs to date. Historically, that support has been primarily provided through NOUs and refrigeration servicing technicians, including through UNEP training seminars. The Guide will address multiple issues present within refrigerated facilities and other refrigeration end users, and will target facility owners, operators and designers.

This tool does not currently exist, nor do similar documents that target the user level, and it will be implemented only if the Multilateral Fund provides the requested support. The collaboration between UNEP and ASHRAE could lead to sector specific supplements or supplements for new refrigerants as needed. Commercialized technology evolves at a rate that such updates would be required infrequently. Any update or supplement would be based on an analysis of developing country needs, at the facility level, including target audience needs.

This collaboration between UNEP, ASHRAE and the Montreal Protocol could create a dynamic relationship directly linking with designers, manufacturers, industry and technicians in this sector in many countries. This new effort would strengthen the efforts of all countries to address the Montreal Protocol HCFC reductions. ASHRAE's contribution would include detailed technical input, the authority of the worldwide recognized standard setting society, oversight as the Guide is developed and its technical review process. ASHRAE will also provide $75,000 member in-kind contribution in addition to $150,000 cash.

4. PROJECT APPROACH AND ACTIVITIES

This project will be implemented under the framework of the existing ASHRAE-UNEP Memorandum of Understanding. The cooperative MOU provides for professional technical services to refrigeration and air conditioning stakeholders (governments, private and public sector) and ensures up-to-date technical information and standards are properly introduced. UNEP will provide overall guidance, quality review and dissemination.

Distribution of the guide will occur through ASHRAE's 175 global chapters, ASHRAE's Associate Society Alliance members and through UNEP's Information Clearinghouse and Regional Networks. ASHRAE's Distinguished Lecturer program will also support the distribution.

The guide will be written in English initially. Since translation will be crucial for global outreach, the guide will be concise and the text limited in quantity.

ASHRAE will provide its well respected, peer–reviewed, American National Standards Institute (ANSI) certified process. ANSI provides the US linkage to the International Organization of Standardization (ISO) and the International Electrotechnical Commission (IEC). To ensure widest support for the proposed guide, additional external experts will be invited to participate in a Review Panel, to provide comments at the design and implementation stage, and to perform the final quality review. The membership in the review panel will be jointly agreed by ASHRAE and UNEP.

5. OVERVIEW OF GUIDE

The Guide will compile, explain and provide examples of the existing knowledge and methodologies concerning refrigeration system and facility design concepts, cooling loads, equipment design choices and performance modeling, within the framework of sustainability and facility life-cycle.

The Guide will have a global perspective, recognizing the rapid growth of the "food chain" in developing and recently developed countries. In addition to local industry growth, these countries are often a focus for expansion by major multi-national food firms and retailers. In many cases, these new facilities and systems are a new concept creating significant opportunity to provide valuable guidance.

Large energy savings and corresponding Climate Change impact reductions are possible through improved system design throughout the equipment life cycle. Advanced control strategies incorporating performance monitoring to achieve continuous energy improvement throughout the equipment's life cycle also provide energy savings and climate benefits. There are potential cost/energy savings of up to 20-40% in refrigerated warehouses and retail food store refrigeration systems, compared to current practices. The Guide will combine all these subjects in a document focused on improving refrigeration systems.

6. SCOPE AND OBJECTIVES

Refrigeration systems generally operate year-round and must maintain design storage or product temperatures at all times and in all conditions. The resulting large safety factors often result in inefficiencies during "average" operation. Increasingly urban populations in developing countries create additional refrigeration demand. This demand is often met through expanded, modern "cold chains." The Guide will describe state-of-the-art design techniques, examine the performance modeling tool use, address benchmarking and performance measurement methods to maximize energy efficiency and focus on maintenance practices to maintain performance.

Refrigeration system and refrigerated facility design is commonly performed by design-build contractors or owner staff and a small number of specialized engineers. Existing codes in countries and regions primarily address safety and not system energy efficiency. This is fundamentally different from commercial buildings and HVAC design, with its large professional community and extensive code-prescribed design framework. The Guide will analyze methods and metrics for net-zero-energy design. Case studies will be included to provide context.

The Guide will provide design and analysis. It will include reduced charge system examples, indirect fluid use such as glycol or phase-change CO_2, and natural or low GWP non-traditional systems. Evaluation of alternative refrigerant direct (leakage) and indirect (energy use) global warming impacts will be included.

The Guide will be suitable for engineering programs and training courses, particularly those supporting owners. The content will be valuable to students studying refrigerated facility and system design, interactions and performance. Design and improved safety of global food sources are two highly interesting topics, attracting many engineering students. Moreover, new engineers view computerized simulation and analysis methods as a natural (and necessary) part of the design process.

Refrigeration facility and system design needs to consider:

- facility orientation, building site use and work-flow options,
- building design including insulation, door design and locations,
- infiltration management and reduced internal cooling load methods,
- cooling system design options including refrigerant choice, system configuration (two-stage, single-stage, split-systems, “rack” systems, indirect options, etc.),
- condenser and evaporator selections, including part-load optimization and system balance topics,
- control systems for energy efficiency and load management,
- on-site energy and resource options such as photovoltaic (PV) generation,
- water re-use and heat recovery,
- other operational topics.

The means to analyze and compare above options will be addressed, with life-cycle cost and GHG impact evaluation.

It is proposed that The Guide will consist of five primary sections:
1. Refrigerated Facility Design and Cooling Loads
2. Refrigeration System Components and System Design
3. Controls and Control Strategies
4. Energy Modeling and Performance Analysis
5. Commissioning, Operations and Benchmarking

The Guide can be used to design new facilities, for expansions and for remodels, and to provide guidance on improvements and operating methods that may also be applicable to existing facilities.

The HCFC phase-out and potential HFC phase-down will result in increasing alternative refrigerant use including CO_2, hydrocarbons, ammonia, water and air, along with low-GWP HFOs. The most appropriate refrigerant choice may be guided by overall global warming contribution including both direct and indirect GHG emissions during the facility/system lifetime. The Guide will include examples of energy-efficient system alternatives, minimizing energy consumption. The technology options evaluated would also include not-in-kind technologies such as absorption technology using waste heat, geothermal or renewable energies or free cooling systems. Specifically, renewable energy options will be discussed.

The Guide will provide a conceptual framework, specific analytical methods and examples to encourage technical advancement in several areas:

- Use of mass flow based refrigeration system design and system balance calculations, both for complex industrial and for commercial systems (e.g. supermarkets and food outlets).

- Accurate methods for, for example, productive and non-productive superheat impacts

- Understanding system balance at off-design and part load conditions.

- Identifying research opportunities for eventual future funding

- Emphasizing system operation throughout the year and incorporating annual energy modeling in design decision-making. This enhances consistency in fundamental design and component options as part of life-cycle analysis

- Examining heat recovery from refrigeration systems and use of engineered heat pumping systems, by providing analytical methods to evaluate high-lift refrigeration and heat pumping cycles as an alternative to conventional heating plants, evaluating both site and source energy.

The Guide will provide system modeling methods including an energy code performance option. Building codes are beginning to incorporate refrigerated facility and system requirements. Codes typically begin with mandatory requirements and eventually evolve toward performance criteria (i.e. where the building meets or is better than a minimum simulated "energy budget") as technical information and methods allow. Owners, contractors and engineers generally prefer a performance path, allowing trade-offs between various design choices, particularly for large, complex systems.

Analysis methodologies, analysis tools and sample calculations will be provided electronically (i.e. Excel) or on a CD provided with the Guide. Users will be able to gain immediate and practical use without additional training. As an example: An engineer or supermarket chain could specify that their refrigeration systems be designed by their system vendors (or consulting engineers) following the "ASHRAE mass-flow based design methodology," based upon an example and explanation in the Guide.

7. TARGET AUDIENCE

The Guide will serve designers, contractors, owners and operators of refrigerated facilities and industrial and commercial refrigeration systems. This Guide is also expected to have broad interest to educators, utilities and policy makers. Refrigeration systems will be evaluated to seek high efficiency performance and certification, rather than simply the sum of the individual parts. Efficiency regulations, adoption of "green" codes by Parties, states or local jurisdictions, and corporate adoption of sustainability policies requires design techniques from expert "rule of thumb" to life-cycle optimization based on modeling or actual performance.

The Guide will include a significant amount of guidance, examples, case studies and simplified "how to" tools. Individuals involved in refrigeration, particularly in developing and recently developed countries, will find the Guide extremely useful.

8. TIMEFRAME:

The timeframe for the project would be 24 months.

9. BUDGET:

The project is expected to cost a total of US $475,000, which includes in-kind contributions by ASHRAE of US $75,000 (approximately) and direct ASHRAE co-financing of US $150,000. ASHRAE's Research Committee has approved this project and reserved the funding.

The total request from the Multilateral Fund is therefore US $250,000 (excluding project support cost).

ASHRAE will also provide its well respected, peer–reviewed, ANSI certified process.

Annex I

ASHRAE Associate Society Alliance Members

LOGO	ACRONYM	ORGANIZATION NAME	SOCIETY WEB ADDRESS	COUNTRY
	ASURVAC	Asociacion Uruguaya de Refrigeracion, Ventilacion, Aire Acondicionado y Calefaccion		URUGUAY
	AAF	Association of Air Conditioning and Refrigeration of Argentina Learn More	www.aafrio.org.ar	ARGENTINA
	OEKKV	Austrian Air-conditioning and Refrigeration Society Learn More	www.oekkv.at	AUSTRIA
	TECFRIO	Assoc Nacional Capitulo Tech ASOFRIO		VENEZUELA
	AIRAH	Australian Institute of Refrigeration, Air Conditioning and Heating	www.airah.org.au	AUSTRALIA
	ABRAVA	Brazilian Association of Refrigeration, Air Conditioning, Ventilation and Heating Learn More	www.abrava.com.br	BRAZIL
	ACTECIR	Catalan Association of Technology, Energy, Air Conditioning and Refrigeration Learn More	www.actecir.cat	SPAIN
		China Committee of HVAC		CHINA
	CAR	Chinese Association of Refrigeration Learn More	www.car.org.cn	CHINA
	ACAIRE	Columbian Association of Air Conditioning and Refrigeration Learn More	www.acaire.org	COLOMBIA
	DITAR	Cooling and Air Conditioning Technical Division of Chile		CHILE
	DANVAK	Danish Society of HVAC Engineers	www.danvak.dk	DENMARK

	Learn More		
	German Society of Refrigeration and Air-Conditioning Engineers		
DKV	Learn More	www.dkv.org	GERMANY
	Dutch Society for Building Services		
TVVL	Learn More	www.tvvl.nl	NETHERLANDS
ESME	Egyptian Society of Mechanical Engineers		EGYPT
ETE	Epitestudomanyi Egyesulet		HUNGARY
	Finnish Association of Heating, Piping and Air-Conditioning Societies		
FINVAC	Learn More	www.finvac.org	FINLAND
AICVF	French Association of Heating and Ventilation Engineers		FRANCE
	Indian Society of Heating, Refrigeration and Air-Conditioning Engineers		
ISHRAE	Learn More	www.ishrae.org	INDIA
	Institute of Refrigeration, Heating and Air-Conditioning Engineers of New Zealand		
IRHACE	Learn More	http://www.irhace.org.nz/MainMenu	NEW ZEALAND
	Israel Society Heating, Refrigeration and Air-Conditioning Engineers		ISRAEL
AICARR	Italian Association of Air Conditioning, Heating and Refrigeration	www.aicarr.it	ITALY
	Latvian Association of Heat, Gas and Water Technology Engineers		
AHGWTEL	Learn More	www.lsgutis.lv	LATVIA
	Japan Society of Refrigerating and Air-Conditioning Engineers		
JSRAE	Learn More	www.jsrae.or.jp	JAPAN
	Lithuanian Thermotechnical Engineers Society		
LITES	Learn More	www.ktu.lt/LISTIA	LITHUANIA

AMERIC	Mexican Association of Companies in the Industry of Building Installations Learn More	www.americmx.com	MEXICO
NORVAC	Norwegian Society of HVAC Engineers		NORWAY
OEA	Order of Engineers & Architects Beirut Learn More	www.oea.org.lb	LEBANON
OEA	Order of Engineers & Architects Lebanon	www.mouhandess.org	TRIPOLI
	Pakistan HVAC&R Society Learn More	www.hvacr.org	PAKISTAN
PSVARE	Philippine Society of Ventilating, Air-Conditioning and Refrigerating Engineers		PHILIPPINES
PZITS	Polish Association Sanitary Engineers and Technicians	www.pzits.org.pl	POLAND
EFRIARC	Portuguese Association of Industrial Refrigeration and Air-Conditioning Engineers Learn More	www.efriarc.pt	PORTUGAL
AGFR-AIIR	Romanian General Association for Heating, Refrigeration, Air Conditioning, Sanitary and Electrical Engineering Learn More	www.agfro.ro	ROMANIA
KNVVK	Royal Dutch Association of Refrigeration		NETHERLANDS
ATIC	Royal Technical Society of Heating, Ventilation and Related Technology Industry	www.atic.be	BELGIUM
ABOK	Russian Association of Engineers for HVAC, Heat Supply and Building Thermal	www.abok.ru	RUSSIA

	Physics		
	Learn More Serbian Society of HVAC&R		
KGH	Learn More Slovak Society of Environmental Technology	www.kgh-kongres.org	SERBIA
P			SLOVAKIA
	Slovenian Society of Heating, Refrigerating and Air-conditioning Engineers – SITHOK		
SITHOK	Learn More Society of Air-Conditioning and Refrigeration Engineers of Korea	http://lab.fs.uni-lj.si/sithok/	SLOVENIA
SAREK	Learn More Society of Building Services and Energy Engineers	http://www.sarek.or.kr	SOUTH KOREA
LIVI			FINLAND
	Society of Environmental Engineering		
STP		www.stpcr.cz	CZECH REPUBLIC
	Society of Heating, Air-Conditioning and Sanitary Engineers of Japan		
SHASE		www.shase.org	JAPAN
	South African Institute of Refrigeration and Air Conditioning		
SAIRAC	Learn More South Brazilian of Refrigeration, Air Conditioning, Heating and Ventilation Association	www.sairac.co.za	SOUTH AFRICA
ASBRAV	Learn More Spanish Technical Association of Air Conditioning and Refrigeration	www.asbrav.org.br	BRAZIL
ATECYR	Learn More Swedish Society of Heating and Air-Conditioning	www.atecyr.org	SPAIN
SWEDVAC		www.emtf.se	SWEDEN

	Engineers	Learn More		
SWKI	Swiss Society of Heating and Air-Conditioning Engineers	Learn More	www.skwi.ch	SWITZERLAND
TEE	Technical Chamber of Greece - TEE	Learn More	http://www.tee.gr/	GREECE
ICVAC	The Icelandic Heating, Ventilating and Sanitary Association			ICELAND
IOR	The Institute of Refrigeration	Learn More	www.ior.org.uk	UNITED KINGDOM
TTMD	Turkish Society of HVAC and Sanitary Engineers		www.ttmd.org.tr	TURKEY
ATEAAR	Asociacion Tecnica Ecatoriana de Aire Acondicionado Y Refrigeracion		www.ateaar.org	ECUADOR