Phase out of HCFCs and Promotion of HFC-free Energy Efficient Refrigeration and Air-Conditioning Systems through Technology Transfer in the Russian Federation

GEF ID 3541 - UNIDO GF/RUS/11/001

Contract No. 3000018248

Mid Term Review

Prepared for UNIDO by

Dewpoint Consultants Ltd

December 2013

Introduction

Background

Phase Out HCFCs and Promotion of HFC-free Energy Efficient Refrigeration and Air-Conditioning Systems in the Russian Federation through Technology Transfer – **GEF ID 3541.** This project addresses two major environmental issues: the phase out of ozone-depleting substances and energy efficiency in the refrigeration and air-conditioning sector. Phase out of HCFCs and promotion of HFC-free energy efficient refrigeration and air-conditioning systems in the Russian Federation through technology transfer will eliminate 600 metric tons of hydrochlorofluorocarbons to help the Russian Federation meet its 2015 targets under the Montreal Protocol. Since HCFCs are strong greenhouse gases, there will also be a direct reduction in greenhouse-gas emissions equivalent to 15.6 million tons of CO_2.

Aim of the Mid-Term review (MTR)

The objective of the Mid-Term review (MTR) is to gain an independent analysis of the progress of the project so far (for the reporting period). The MTR will assess progress made towards the achievement of the project objective, identify and document lessons learned, explain the challenges encountered to date, and identify potential constraints during project implementation of the project, and make recommendations regarding specific actions that should be taken to improve the project, if necessary.

The MTR will assess early signs of project success or failure and identify the necessary changes to be made. The project performance will be measured based on the indicators of the project's logical framework indicated in Annex 1 of the project document and using standard tracking tools.

Scope

To review all relevant sources of information, such as the project document, project reports, including Annual APR/PIR, progress reports, project files, Steering Committee reports, national strategic and legal documents, and any other materials that the Project Manager considers useful for this evidence-based review. Most of the documents are in Russian Language.

To study and follow the GEF guidelines for preparation of the GEF Mid-term Evaluations (MTR), and Tracking Tools (TT) and consolidate draft input based on available sources of information.

To liaise and coordinate with project team, UNIDO office in Moscow and key stakeholders for obtaining required input, including financial part for the reporting (assessing financial management of the project, with specific reference to the cost-effectiveness of interventions, including the co-financing monitoring table).

To conduct field visit to project sites, and to To synthesize and consolidate data for finalization of the GEF MTR and TT for UNIDO-GEF project in the Russian Federation.

Methodology

The evaluation was conducted between October 2013 and December 2013.
The progress of the programme has been assessed by an independent consulting firm (DewPoint Consultants Ltd) through desk based review of documentation and correspondence provided by UNIDO HQ, UNIDO Project Management Unit (PMU) Moscow, Ministry of Natural Resources and Environment of the Russian Federation (MENR) and Private Stakeholders. A verification mission was then conducted in October 2013 and all findings were assimilated into the GEF reporting template included below.

Interviews were semi-structured and qualitative, with sufficient flexibility to allow new lines of questioning to be followed where necessary. Interviews were conducted with at least two evaluators present. While maintaining the independence of the evaluation the approach was participatory and open in order to facilitate cooperative and constructive dialogue with all stakeholders.

At the completion of the evaluation mission a presentation of the preliminary findings and conclusions was made to the UNIDO project team in Moscow on 20th October. A draft report was circulated 23 October. Thereafter minor queries and clarifications were dealt with by email and telephone and the final report was completed on 28 November.

Performance Ratings

In line with GEF recommended tracking tools the following ratings system was applied:

Implementation Progress

Highly Satisfactory (HS):	Implementation of **all** components is in substantial compliance with the original/formally revised implementation plan for the project. The project can be presented as “good practice”.
Satisfactory (S):	Implementation of **most** components is in substantial compliance with the original/formally revised plan except for only few that are subject to remedial action.
Moderately Satisfactory (MS):	Implementation of **some** components is in substantial compliance with the original/formally revised plan with **some** components requiring remedial action.
Moderately Unsatisfactory (MU):	Implementation of **some** components is not in substantial compliance with the original/formally revised plan with **most** components requiring remedial action.

Unsatisfactory (U):	Implementation of **most** components is not in substantial compliance with the original/formally revised plan.
Highly Unsatisfactory (HU):	Implementation of **none** of the components is in substantial compliance with the original/formally revised plan.

Global Environment Objective/Development Objective Ratings

Highly Satisfactory (HS):	Project is expected to achieve or exceed **all** its major global environmental objectives, and yield substantial global environmental benefits, without major shortcomings. The project can be presented as "good practice".
Satisfactory (S):	Project is expected to achieve **most** of its major global environmental objectives, and yield satisfactory global environmental benefits, with only minor shortcomings.
Moderately Satisfactory (MS):	Project is expected to achieve **most** of its major relevant objectives but with either significant shortcomings or modest overall relevance. Project is expected not to achieve **some** of its major global environmental objectives or yield some of the expected global environment benefits.
Moderately Unsatisfactory (MU):	Project is expected to achieve of its major global environmental objectives with major shortcomings or is expected to achieve only **some** of its major global environmental objectives.
Unsatisfactory (U):	Project is expected **not** to achieve **most** of its major global environment objectives or to yield any satisfactory global environmental benefits.
Highly Unsatisfactory (HU):	The project has failed to achieve, and is not expected to achieve, **any** of its major global environment objectives with no worthwhile benefits.

Risk ratings

Risk ratings will assess the overall risk of factors internal or external to the project which may affect implementation or prospects for achieving project objectives. Risks of projects should be rated on the following scale:

High Risk (H):	There is a probability of greater than 75% that assumptions may fail to hold or materialize, and/or the project may face high risks.
Substantial Risk (S):	There is a probability of between 51% and 75% that assumptions may fail to hold and/or the project may face substantial risks.
Modest Risk (M):	There is a probability of between 26% and 50% that assumptions may fail to hold or materialize, and/ or the project may face only modest risks.
Low Risk (L):	There is a probability of up to 25% that assumptions may fail to hold or materialize, and/ or the project may face only modest risks.

Recommendations

The final report in GEF compatible format is given in pages 8-33 below, the recommendations below are outside the scope of the standard GEF reporting template but are included here for the consideration of the UNIDO project manager:

Safety issues Relating to Natural Refrigerants

- Working group to engage with relevant ministries and Rostechnadzor to address the over-regulation of R-717 (ammonia) and Hydrocarbons such as R-290 (Propane) which currently inhibits the adoption of this as a non-ODS energy efficient alternative in the commercial refrigeration and air conditioning sectors.
    - EN 378 to be used as the illustration of international good practice to which ideally new/amended Russian safety legislation should converge.
    - Clarification of the likely causes of recent lethal accidents in China and India would be useful, with an expert view as to why these could not occur if EN 378 had been followed.
    - Working group to evaluate syllabi of training courses proposed by "self regulating bodies" (srb's) and ensure the use and handling of natural refrigeration (R-717, hydrocarbons) is adequately covered.

Activities under Component 6 (Energy efficiency)

- Identify potential energy efficiency demonstration projects in the commercial and air conditioning sector, and potential technology partners.
- It is understood that initial contacts have been made with companies such as Oleks holdings, Ostrov and others involved in commercial refrigeration in Russia.
- Some notes on how comparative energy testing can be carried out are appended.

Improving speed of Project implementation

- Ensure customs clearance and related issues are clarified in a document to assist future funding recipients in receiving their equipment in a timely fashion.
    - This should incorporate input from Pozis and other entities that have already negotiated this process.

Destruction and Recycling

- Provide minutes of March 2012 meeting (MNRE, working group and UNIDO) dealing with destruction and recycling of refrigerant.
- Identify the five companies that claim to be operating recycling facilities.
- Regarding the reclamation centres (Kemerovo, Ekaterinburg and Pyatigorsk Torgtechnikas) and recycling centres set up under the 2002 World Bank project, their current situation should be investigated and a definitive report provided on their ability to form a part of the proposed refrigeration collection, reclamation, recycling and destruction network.

Gas Analyzers

- It is understood that the Federal Customs Service want to develop their own gas analyzers for reasons that are unclear, and it is intended to allocate those intended for them to College #19.
- This egregious situation should be clarified as soon as possible. The change of use needs to be approved and, more significantly, the ability of the Federal Customs Service to enact the legal requirements of refrigerant control in the Eurasian customs union in a timely fashion would seem to be in jeopardy.

Stakeholder list
Knowledge of the foaming sector could be improved. The following is recommended:

A complete list of users of HCFCs should be prepared as a spreadsheet table. Against each enterprise the following information should be given:

- Name and address
- Status with respect to project, either:
    - Not eligible – foreign owned
    - Originally on list but removed (e.g. because ownership changed)
    - Currently on list
    - Potentially on list. *The working group should note that state ownership is not a requirement. The key criterion is ownership. The enterprise must be 100% Russian owned.*

- HCFC Consumption
  - Consumption of blended polyol (indicate whether purchased in Russia or imported)
  - Direct consumption of HCFC 141b

From this table it should be possible to sum the quantities of HCFC141b used, either directly or as a component of blended polyol. This should be reconciled with the total declared by the Russian government.

UNIDO PROJECT MID-TERM REVIEW REPORT
Fiscal Year (FY) 2013 (1 July 2012 – 30 June 2013)

Date: 14/11/2013

1. Project Information

General Information	**Project Title**	TT-Pilot (GEF 4):Phase Out HCFCs and Promotion of HFC-free Energy Efficient Refrigeration and Air-Conditioning Systems in the Russian Federation Through Technology Transfer
	GEF ID	**3541**
	UNIDO ID (SAP Grant Number)	GFRUS11001
	Region	ECA
	Country(ies)	**Russian Federation**
	GEF Focal Area(s)	Multi Focal Area
	Co-Implementing Agency(ies)	**UNIDO**
	Project Executing Partners	- Ministry of Natural Resources and Environment of the Russian Federation; - The Ministry of Foreign Affairs of the Russian Federation; - The Ministry of Internal Affairs of the Russian Federation; - The Federal Customs Service of the Russian Federation; - The Federal Agency on Technical Regulating and Metrology of the Russian Federation; - National Cleaner Production Centre; - Vocational Schools and institutions of higher education; - HVAC&R associations.
	Project Size (FSP, MSP, EA)	**FSP**
Milestone Dates	**Project CEO Endorsement/Approval Date**	12/08/2010
	Project Implementation Start Date (PAD Issuance Date)	22/02/2011
	Original Expected Implementation End Date (indicated in CEO Endorsement/Approval document)	31/12/2014
	Revised Expected Implementation End Date (if any)	1/06/2015
Funding	**GEF Grant (USD)**	18,000,000
	GEF PPG (USD) (if any)	180,000
	Total GEF Grant Disbursements as of 11 September 2013 (USD) **Total Expenditures = Commitments + Payments)**	5,377,910.60
	Co-financing (USD) at CEO Endorsement	40,000,000
	Materialized Co-financing at Mid-term (USD)	11,950,000
	Total Project Cost (USD) **(GEF Grant + Co-financing at CEO Endorsement)**	58,000,000
Evaluations	**Mid-term Review Date**	19/10/2013
	Planned Terminal Evaluation Date	01/06/2015
	Tracking Tool Date[1]	19/10/2013

[1] For FSPs the Tracking Tool (TT) date should be the same as the MTR date. For MSPs, the TT date should reflect the Expected Implementation End Date.

2. Main Findings of the Mid-term Review

The progress of the programme has been assessed by an independent consulting firm (DewPoint Consultants Ltd) through desk based review of documentation and correspondence provided by UNIDO HQ, UNIDO Project Management Unit (PMU) Moscow, Ministry of Natural Resources and Environment of the Russian Federation (MENR) and Private Stakeholders. A verification mission was then conducted in October 2013. The main findings of the review are summarised below.

The programme has started effectively and both public and private stakeholders are actively engaged in both the technical and institutional activities and objectives of the programme.

Appropriate and necessary legislation is now in place at the federal level (Federal Laws 30.09.2013 No. 752 and 23.07.13 No. 226) and government and project stakeholders are working to develop the detailed regulations (governmental resolutions) which will form the mechanism for enforcement of the appropriate federal laws. These regulations will take effect on 1 January 2014. At which time a robust enforcement mechanism will be in place for the control of the import, movement and consumption of ODS will be in place, with a range of punitive measures including imprisonment for serious offences.

The progress in implementing a robust legal framework for the control of HCFCs has significantly accelerated the prioritization of HCFC phase out across the foam and refrigeration sectors and some foreign owned enterprises have already converted to non-ODS technology voluntarily ahead of the legal obligation communicated by MNRE and UNIDO.

The implementation strategy that has been developed by government with the assistance of the project team is to bypass the adoption of HFCs, by encouraging and facilitating the adoption of Low GWP solutions. Great emphasis is being placed on natural refrigerants such as ammonia and hydrocarbons, used in appropriate applications supplemented by the use of HFOs which currently in the development phase.

This strategy appears to be supported by the chemical manufacturing sector, which does not currently produce most popular HFC Refrigerants or Foam blowing agents and is keen to avoid a widespread adoption of technology dependent on foreign imports.

Some progress has been made in stimulating the adoption of more energy efficient refrigeration technology, for example there is a high level of engagement from refrigeration technicians and designers and a technical training centre has been established in Moscow with support of the leading industry players to train technician and promote energy efficient refrigeration technology.

However the nature of the market has made it more difficult to get stakeholders to prioritize energy efficiency without the any legal or financial imperative to change. The project strategy is

therefore to first create the legal imperative to phase out HCFCs, then to demonstrate the potential energy (and operating cost) savings that can be achieved by efficient natural refrigerant and foaming agent designs.

The programme is now at the point where such a legal framework is in place and it is becoming much easier to engage stakeholders in the discussion on energy efficiency.

During the initial stage of the project the methodology and the normal complications related to the specification, procurement, co-financing and supply of equipment under investment activities have been resolved and there is now an established methodology for the conversion of foam manufacturers.

Conversion at Pozis (Zelenodolsk) is nearing completion and the anticipated production start of January 2014 is entirely feasible. Conversion activities at several other foam manufacturers are now underway as indicated below.

The main achievements of the project up to the time of the mid-term review are summarised below

- Changes to the Russian legislation: ban on import of equipment containing ozone-depleting substances (ODS); criminal liability for ODS smuggling; limitation of the number of checkpoints through which ODS import is permitted; Federal law on fulfilment of obligations under the Montreal Protocol. Law 30.09.2013 No. 752
- With the assistance of private sector and manufacturer representatives, UNIDO has prepared proposals for detailed regulations (by-laws) designed for the implementation of that Federal Law. These are due to come into force on 1 January 2014.
- Government sponsored Federal level communications and public awareness activities including a diverse range of mechanisms from stakeholders meetings to a national art competition to encapsulate the objectives of the project in pictures with the title “Protect the Ozone Layer and the Earth’s Climate”.
- Conversion of foam manufacturing to cyclopentane at the Pozis refrigerator factory in Zelenodolsk, Tatarstan.
- Development and adoption of improved energy efficiency designs based on R600a at the Pozis refrigerator factory in Zelenodolsk. Products are now the equivalent of the European A+ energy rating.
- Conversion activities underway to replace HCFC-141b with cyclopentane in the manufacture of foam and introduce high efficiency R600a technology at Sepo in Saratov and Polus in Yoshkara Ola in the manufacture of domestic and commercial refrigeration equipment.
- Short list of counterparts for further investment, technology transfer and energy efficiency demonstration projects compiled and detailed project specifications being developed at time of review.

- Trials and feasibility underway for the conversion of production of blended polyol foam systems using methyl formate blowing agent at Vladipur and Dow Isolan, Vladimir.
- HCFCs have been specifically excluded from the range of goods that can be freely traded within the Eurasian Customs Union, to allow control of HCFC trade with Kazakhstan, which has not ratified the Beijing Amendment.
- Ministry of the Interior of the Russian Federation and the Federal Customs Service agreement established to ensure control of ODS movements within Russia.
- Customs officers have been trained and equipped with refrigerant analysers ahead of the enforcement of new regulations from 1 January 2014.
- The Microclimate, Energy Efficiency and Building Automation Centre established with support of the leading industry players to promote high efficiency refrigeration systems and train refrigeration technicians
- Special website dedicated to the ozone issues launched: www.ozoneprogram.ru, specifically to promote public events, raise awareness of the importance of HCFC phase out, provide updates on new environmental friendly technologies, and act as primary communication tool between the programme and stakeholders.

The main project challenges that have been encountered so far are as follows:

- There was a conflict between the need of the project for Russia to control the import and use of HCFCs and the stipulations of the Eurasian Customs Union which includes Belarus and Kazakhstan. This created complications the updating of the Federal Law on ODS.
- The refrigeration service sector is unstructured and lacks a sufficiently well patronized industry association to coordinate training and awareness activities related to HCFC-22 phase out and energy efficiency improvements.
- Private sector stakeholders were originally reluctant to engage in the development of new Russian Laws and detailed regulations. UNIDO project management has had to pays considerable attention to creation of the private sector-government interaction model.
- It has emerged recently during engagement with the refrigerant sector is the relative over-regulation of ammonia use compared with European standards and practice. The stringency of the operating regime, documentation and inspection requirements creates a financial disincentive, which offsets the potential savings in energy consumption.

3. Rating of Project Implementation Performance

Please indicate the project's progress made in achieving the outcomes against key performance indicators' targets specified in the project's M&E Plan/Log-Frame at the time of CEO Endorsement/Approval. Please expand the table as needed. Definition of ratings can be found in the AMR 2013 Guidelines and Definitions Annex.

Outcomes by Project Component	Indicators	Target Level	Progress To Date	Independent Rating*
Component 1: Building institutional capacity				
1. Accelerated HCFC phase out and reduction of HFC consumption; 2. Understanding of the level of residual demand for HCFCs; 3. Good communication between and coordination of cross-functional Stakeholders; 4. Improved awareness of environmental policies and associated HCFC phase out legislation amongst users and stakeholders; 5. Improved understanding and performance of	HCFC consumption under control and reducing; Actively engaged cross sector Stakeholders; Improved awareness of government and non-government stakeholders of educational information and environmental management systems	HCFC legislation in place and cross-functional stakeholders proactively communicating and enacting HCFC controls	From January 1, 2013, import of HCFC and HCFC containing equipment in the territory of the Customs Union (Russia, Belarus, and Kazakhstan) is prohibited. Criminal penalties for ODS smuggling are in place. The Chairman of the Government of the Russian Federation signed a number of directives with regard to acceleration of the ODS phase out, elaboration of the Federal target programme for 2015-2020, incentives for use of non-ODS substances and equipment and limitation of the number of checkpoints through which ODS import is permitted. Work has been initiated on the development of a programme for the destruction of ODS containing equipment in regions of the Russian Federation; on revision of norms and standards applied in the respective area, and on elaboration of a number of normative documents of the Government of the Russian Federation. With support from UNEP, cooperation between the licensing authorities and customs services of Russia and China has been implemented. ODS analysers have been purchased for the Ministry of the Interior of the Russian Federation and the Federal Customs Service. Creation of internet portal www.ozoneprogram.ru has made a significant contribution to the institutional support and dissemination of all relevant information and documents regarding the progress and achievements of project and on the specific relevant topics, meetings and events. This is the first Russian portal dedicated to ozone issues, containing complete information on the Russian ozone legislation, collection of documents and video records, a large number of translated documents describing world experience in the area of HCFC phase out, information on events, trade journals, codes of practice and other information, news, and articles addressed to representatives of federal executive bodies, industrial	**HS**

			sectors, educational institutions and mass media. Various pubic media events have been successfully implemented including outreach activities and awareness programmes (available at the website www.ozoneprogram.ru.)	
Component 2: HFC and HCFC life cycle performance analysis				
1. Implementation of a sustainable phase out strategy for different HCFC consuming sub sectors; 2. Capacity to adapt to developing phase out scenarios, international climate agreements and technology developments.	HFC and HCFC life cycle performance analysis used in the selection of HCFC phase out alternatives	Climate impact benchmark data for the Russian Federation Clear selection parameters for alternative technologies ODS and climate impact	A consulting company was contracted to prepare recommendations on guidelines for the use of life cycle performance analysis in the selection and operation of refrigeration and air-conditioning systems in the Russian Federation. Field research in Moscow and the regions has investigated the operation and performance of different types of systems and equipment in a range of applications. The results of technical investigations have been combined with research into current operating conditions and barriers to the adoption of more energy efficient systems. The study indicates that there is clear potential for the use of lifecycle analysis using simple modelling and calculation techniques, but that significant barriers exist in terms of corporate policy towards energy efficiency. The Final technical Report was provided at the end 2012 and the recommendations have been fed into climate policy discussions at the Federal level. The MTR team has recommended that specific demonstration projects are quickly identified to demonstrate the effectiveness of life cycle analysis and that these could easily be combined with energy efficiency demonstration projects.	**S**
Component 3: Phase out of HCFC consumption in the key consuming sectors of Foam and Refrigeration				
1. HCFC consumption within Montreal Protocol phase out obligations; 2. Clear understanding of the technical capacity to phase out within each sector; 3. Phase out of 600 ODP tonnes HCFC	Reduced consumption in Refrigeration and foam Manufacturing; Reduced requests for import Permits.	600 ODP Tonnes of HCFCs; The direct GHG emissions reduction resulting from the phase-out of HCFCs will be approximately 15.6 MMT CO_2.	The process for developing the technical specifications, agreeing co-financing and setting up customs clearance for specified projects and equipment has been rather complex and time consuming. A number of enterprises have withdrawn from the project due to the co-financing ratio stipulated in the project. However the methodology has now been established by the project team in cooperation with MENR and other institutional stakeholders and the conversion of refrigerator factories is now fully underway. Equipment has been installed and the conversion at Pozis is nearing completion.	**S**

(22,141b,142b) (Direct phase out 60% and 40% by replication); 4. Reduction of direct and indirect GHG emissions through HCFC phase out and improved energy efficiency of replacement technology.			Staff at Pozis have assisted other counterparts with aspects of the specification and co-financing process. Civil work for the installations of bulk storage tanks is underway at Sepo and cyclopentane foaming equipment has been purchased. The delivery of equipment is expected in the 4rd quarter 2013. Terms of reference have been agreed for two further enterprises; Polus Company, Yoshkar-Ola and Marikholodmash, Yoshkar-Ola, and preparation of tender documentation is completed. Procurement is due to commence soon. Preparation of project proposals is in progress for the remaining enterprises (Orsk plant household applience, Orsk, cyclopentane; Biryusa, Krasnoyarsk, cyclopentane; Polair (Sovitalprodmash), Volzhsk, cyclopentane; Vladipur, Vladimir, methyl formate; Daw Izolan, Vladimir, methyl formate)	
Component 4: Development of ODS destruction facility and supporting recovery network				
1. Technical and commercial understanding of the feasibility of operating ODS destruction Facilities; 2. Strategy for the provision of ODS destruction across the Russian Federation; 3. Reduction of ODS Banks; 4. Consistent Monitoring, Inspection and Verification procedures applied across federation; 5. Annual destruction of CFC-1,163 MT and CFC-1,294.5 MT	The design and installation of destruction facility and appropriate foam processing equipment; Analysis of alternative funding mechanisms including CDM; The proposed destruction activities will provide annual destruction of 63 MT of CFC-11 and 94.5 MT of CFC-12 (Total 157.5 ODP tonnes)	Detailed analysis of destruction requirements and selection of the most appropriate technology to provide adequate destruction capacity for all recovered ODS	MENR and UNIDO have facilitated various meetings and consultations with regional executive bodies and industry stakeholders. After the consultation round the Chairman of the Government of the Russian Federation has now signed a directive to initiate work in this area and activity is planned to commence in the first quarter of 2014. Preparation and introduction of alterations to technical regulations of the Customs Union which will form the basis of the establishment of a standard package in Russia, Kazakhstan and Belarus has been done.	**S**

which are equivalent to 157.5 ODP tonnes 6. The total impact is equal to 1,062,009 t CO2e.				
Component 5: Stimulating market growth for energy efficient refrigeration and air conditioning equipment				
1. Increased market share of more energy efficient refrigeration and air conditioning equipment; 2. Greater consumer and user awareness and increased demand for energy efficient technology.	Take-up of new designs and energy efficient practice by manufacturers and installers Increased awareness by consumes of impact of poor energy efficiency and use of high GWP refrigerants	Energy efficiency marketing campaign (demand drivers)	Public awareness material published and broadcast in the run up to the ban of equipment containing HCFCs, highlighted the importance climate impact as well as Ozone Layer protection in the selection of new equipment. The ban of equipment containing HCFCs has facilitated an increase in more up to date energy efficient equipment from a range of international suppliers. But more needs to be done to discourage HFC based equipment. The Chairman of the Government of the Russian Federation has issued an instruction to develop and market low GWP refrigeration equipment including small-scale ammonia as part of the federal target programme, a unique information portal, was created for this development. The stakeholder engagement in the development and marketing Low-GWP systems has gained considerable momentum in 2013. The MTR team has recommended that piloted projects in this area (possibly combined with TT transfer) are prioritised in 2014 in order to meet the objectives of the programme. Widespread celebration of the International Day for the Preservation of the Ozone Layer as well as on the occasion of the 25th anniversary of the Montreal protocol with participation of secondary schools, secondary and higher vocational institutions and federal executive bodies was organized.	**MS**
Component 6: Technology transfer				
1. Technology Transfer of non-HFC alternatives to HCFC applications; 2. More higher efficiency RAC	Increased awareness of technology alternatives	Centre of excellence established Technology transfer projects completed;	So far, the equipment for the Centre of excellence has been partially provided and first training on the use of hydrocarbon refrigerants in air conditioners was conducted on September 3–7, 2012.The first training course on equipment conversion to ozone-safe refrigerants was elaborated. Currently, tenders on development of a training course for officials of the Federal Customs Service and Ministry of the Interior	**S**

systems in use across the Russian Federation; 3. Increased Private sector energy efficient design capacity; 4. Increased use of high efficiency manufacturing equipment.		GHG reductions	of the Russian Federation as well as for preparation of certified courses for HVAC&R specialists and technicians. The Centre of excellence was established with support of the Ministry of Natural Resources and Environment of the Russian Federation, Russian Energy Agency, Centre of environmental certification GREEN STANDARDS and 11of the largest manufacturers of environmentally safe equipment.	
Component 7: Feasibility study to determine the best and most integrated strategy for dealing with HCFC production closure				
1. Stakeholder facilitation to agree production closure strategy 2. Reduction of 1,840 metric tons of HCFCs closed.			Consultations with stakeholders have started and international and national experts have been engaged to develop strategy. Agreements in principle with Russian HCFC producers with regard to cooperation in this area have been achieved. HCFC Manufactures have endorsed increased control and regulation of HCFC use, including improved practice in the service sector. Detailed work will commence in Q1 2014	**S**

**assessed by independent consulting firm*

4. Overall ratings and assessment of progress made towards achieving "Global Environment Objectives/Development Objectives" and "Implementation Progress"

Definition of ratings can be found in the AMR 2013 Guidelines and Definitions Annex.

Project Performance Ratings	
Overall Global Environment Objective/Development Objectives Rating	**HS**
Overall Implementation Progress Rating	**S**
Ratings: HS=Highly Satisfactory; S= Satisfactory; MS=Marginally Satisfactory; MU=Marginally Unsatisfactory; U=Unsatisfactory; HU=Highly Unsatisfactory	

4.1 ***Narrative assessment of factors justifying the rating on progress towards achieving "Global Environment Objectives/Development Objectives" (DO):***

The Global Environmental / Development Objectives have been reviewed and assessed by the independent consultants recruited to carry out the MTR. They are considered to be challenging as indicated in the FSP, but achievable. There are a number of factors supporting the achievement of these objectives.

The government of the Russian Federation has committed to a reduction of 40% overall energy use by 2020 compared to 2007. The portion of overall electrical energy use accounted for refrigeration and air conditioning equipment is difficult to assess. The EU average is estimated at 15%, and the reviewers agree that the situation of Russia is unlikely to be very different. The savings sought in this project will therefore make a significant contribution to the government's energy reduction target, and as such there is good support for the initiatives with the programme.

The commitment by the Russian Federation under the Montreal Protocol to phase out HCFCs is also clear and demonstrable and the reviewers have observed a robust and cohesive attitude to phase out has been developed between the institutional stakeholders; MNRE, UNIDO, NGOs, and Industry Associations. There is also a clear and growing mind-shift amongst private sector manufacturers and consumers, which acknowledged the need to phase out ODS and the potential competitive advantage to be gained through adopting new technology. For example many stakeholders interviewed during the MTR mission commented on their ambition to produce goods that would have the environmental credentials to allow them to export to Europe.

Overall therefore the reviewers consider that programme has started well. Completion of the first half has seen the establishment of a solid legislative basis for HCFC phase-out and the control of HCFC trade through the Eurasian Customs Union. HCFC producers as well as air conditioning and refrigeration industry stakeholders have participated actively in project activities.

The reviewers consider that the progress in relation to the promotion of more energy efficient systems has been more challenging than in the area of ODS phase out. However they also accept that this is because it has been necessary to first build relationships between institutional and private stakeholders on the basis of clear regulations and directives from Government which has taken time to put in place. That said, the communications and discussions emanating from institutional stakeholders are clearly aimed at avoiding HFC solutions to ODS phase out and there has been considerable progress in recent months in introducing the energy efficiency agenda in relation to the use of natural refrigerants.

Given the nature of the market and the regulatory process in Russia the reviewers conclude that the project is in an excellent position to fully achieve its stated environmental and development objects as long as activities in the energy efficiency and technology transfer areas

are now prioritised in the next year of implementation. The MTR team has made a number of recommendations to UNIDO in this respect.

4.2 *Narrative assessment of factors justifying the rating on progress made towards achieving "Implementation Progress" (IP):*

The MTR team has reviwed the documentation provided by UNIDO and other stakeholders as well as infromation obtained by desk research. The team also conducted a series of meetings and interviews with institutional and private stakeholders during a review mission to Russia. In the view of the review team the following activities have been completed or are at the advanced stage of preparation and can be cited as justification for the ratings given above.

A national project team was established and a detailed plan has been developed, there is a good shared understanding of the plan and its objectives and the team meet and comunicate regularly.

Key legislation came into force in 2013 in the shape of the Federal Law 226 enacted on 23rd July 2013. This extends existing Russian legislation on substances controlled by the Montreal Protocol to HCFCs. The law covers the production and consumption of HCFCs and introduces bans on the design and construction of equipment containing them. The law establishes requirements for the management of ozone-depleting substances, including their production, use, transportation, storage, recovery, recycling and disposal, as well as their entry into the Russian Federation and export from the Russian Federation. Discussions are under way between relevant ministries regarding the preparation of legislation enabling the provisions of Law 226 to be put into practice, and the harmonisation of this with existing legislation. Earlier legislation made import of HCFCs and equipment containing them into the Eurasian customs union illegal from January 2013.

Procurement of equipment for one of the factories in the foam sector has been completed and the expected delivery is by end 2013. The civil work is on-going. The inspection team found that all major equipment items had been delivered to site. Some pump sets and safety equipment was still awaited. These had been paid for and delivery was imminent. The team felt that the enterprise was likely to achieve its target date for production conversion of the first half of January 2014.

Refrigerant analyzers for use by the Ministry of the Interior of the Russian Federation, Federal Custom Service and a training institute had been delivered. Only the training institute can currently use the 10 units it was allocated. A "Train the trainers" type course will be held in November 2013 for around 18 participants.

Analytical equipment for MOI's laboratories to perform chemical analysis of ODS and afford proofs of illegal trade to the court will be delivered in the latter half of 2013.

Training courses in use and handling of hydrocarbon refrigerants have been prepared and are being delivered at College #19, with the active participation of Daikin and other leading manufacturers who have provided equipment including a number of split air conditioners operating on R-290 (Propane). The school provides both full time training and refresher courses and graduated about 200 part time refresher course students in 2012 and have currently about 170 full time students. These activities will be integrated into the traditional Russian vocational training structure where they will form part of standard HVAC and Refrigeration training courses accessible by larger numbers of students. As well as refrigerant handling these courses deal with retrofitting of HCFC-22/HFC-410A air conditioners with Propane (R 290), based on a Masterclass given from 3-7th September 2013 by a foreign expert provided by UNIDO. Some excellent training material and videos have been produced and are available on the Project website www.ozoneprogram.ru.

Proposals for incorporating stringent professional training in refrigerant handling and retrofitting have been made that will be administered by the independent trade bodies (SPOs) which control technician licensing in Russia. These will not however be made compulsory, according to a Presidential edict stating that the list of professions requiring compulsory licensing should not be increased. The effectiveness of this system will depend, as in all EU countries on improving awareness among end-users.

Engagement with all HVAC and refrigeration industry sectors has been excellent. Clear evidence of this was the conference on the use of ammonia as refrigerant organised on 16th October 2013 in Moscow and attended by members of the MTR review team. A large number of technicians from all levels and sectors took part, and a variety of presentations by Industry, Government and independent experts elicited lively responses. A draft summary of the meetings conclusions was discussed and a submission to government is being prepared containing a consensus of views around measures required to promote the use of ammonia as a refrigerant. Much of this will centre on the apparently excessive safety regulation surrounding ammonia use in Russia and the way this inhibits its wider use.

Research studies on “The Phase out of HCFCs at enterprises of the chemical sector of the Russian Federation in 2013–2014 and 2015–2020” and “On the Need for ban on expendable transportation and storage non-refillable containers in the Russian Federation” were prepared and submitted to the Ministry of Natural Resources and Environment of the Russian Federation. A ban on the use of disposable canisters containing HCFCs will be in force from January 2015. This will reduce illegal imports and enhance the ability of the government to control HCFC use and circulation in the Russian Federation.

The Ministry of Natural Resources and Environment of the Russian Federation, Ministry of Education and Science of the Russian Federation and UNIDO held a competition entitled “Protect the Ozone Layer and Earth Climate” supported by the Russian Government and organized as part of official events of the Year of the Environmental Protection. The response

was quite extraordinary and a wide selection of the best contributions was displayed at the 16th October conference on Ammonia use. The number and quality of these suggests that public awareness activities are being effective.

A training course for Customs officers and Ministry of the Interior of the Russian Federation officials is planned for November 2013 on implementing refrigerant controls and the use of gas analyzers. A contractor has been hired to provide this training and a comprehensive 300 page manual prepared. About 18 personnel will be trained on a "Train the trainer" basis. Regarding the use of the analyzers, question marks remain on their use as described above in section 4.1

Consultations with the stakeholders have started and an expert is currently being recruited to develop a production closure strategy.

The PR and public/stakeholder outreach activities have been particularly successful as is evidenced by the response to the ozone day competetion and the number of "hits" registered on the website at www.ozoneprogram.ru.

A number of supporting activities have also been carried out including Publication of the UNIDO HCFC phase out guide
"Preparing for HCFC phase-out:Fundamentals of uses, alternatives, implications and funding for Article 5 countries" (a UNIDO publication) in Russian; Organization of a PR campaign for promotion of HCFC phase out in the Russian Federation and communicating the progress of the UNIDO/GEF project to the public during 2012.

The core of this has been the creation of the project website. This has been supplemented by a programme of information dissemination to the press, responding to queries from the public, and sponsoring the publication of articles in the press, and radio and television interviews. The website currently has about 800 hits per day, a considerable number considering the subject. Significantly this rate has increased steadily over the last 10 months suggesting that the PR and other outeach activities undertaken by the Project have had a significant impact.

Specific events sponsored by the project include a conference organized by UNIDO, GEF and the Russian Ministry of Natural Resources and Environment of the Russian Federation as part of "The World of Climate 2012" Exhibition, on 14 March 2012 in Moscow (attended by more than 21,000 visitors), and the celebration of the International Day for the Preservation of the Ozone Layer which has been held every year since the project started.

On September 17, 2012 at the Institute of Refrigeration and Biotechnology of the Saint-Petersburg National Research University of Information, Mechanics and Optics, a competition entitled "Protect the Ozone Layer" was held as part of an international scientific conference held to celebrate the 25th anniversary of the Montreal Protocol and prizes were awarded for the best scientific contributions. As part of the same celebrations a series of lectures on ODS

destruction and conversion of refrigeration systems to ozone friendly refrigerants was delivered at educational establishments throughout Russia.

In addition to the highly successful stakeholder conference on 16th October 2013 in Moscow already described, attendance of key stakeholders at the following events was sponsored by the project:

- the international conference on ammonia use in Ohrid, Macedonia, 9-11 May 2013.
- the UNIDO ATMOsphere Technology Summit co-organized by UNIDO and Shecco from 3-4 June 2013, Vienna.

Overall the MTR team have concluded that implementation progress is satisfactory with elements being highly satisfactory. Furthermore the team concludes that with concerted effort in a few areas the project should be able to attain an overall highly satisfactory implementation score in one year's time. The MTR team have made a number of suggestions and recommendations in this respect.

4.3 ***If the project received a sub-optimal DO and/or IP rating(s) (MU, U, or HU) in FY 2012 (1 July 2011 – 30 June 2012) report, please provide a detailed progress report on actions taken to rectify the rating(s) and improve the overall performance of the project:***

N/A

5. Risk Management

Please provide the overall risk rating of the project. Definitions of the risk ratings can be found in the AMR 2013 Guidelines and Definitions Annex.

Project Risk Ratings	
Overall Risk Rating	**L/M**
Ratings: H-high; S-substantial; M- moderate; L- low	

5.1 Please indicate project's progress made in **managing risks, identified in the project document at the time of CEO Endorsement/Approval**:

Risk	Progress made in managing risk
One of the key barriers to project implementation is the scale and complexity of the HCFC production and consumption situation in the Russian Federation. Geographically the Russian Federation is the largest country in the world. Implementation of legislative frameworks required enactment across 9 federal states. There is a risk that the number and variety of stakeholders to be actively engaged will result in lower	The scale and complexity has definitely found to be an issue, however prioritization of communications and engagement activities at the outset of the programme, including elements such as the "ozoneprogram" website have significantly reduced this risk for the second half of the programme.

than predicted speed of implementation or lower than anticipated replication across the Federation.	
Complexity and scale of programme might make it difficult or slow to establish and agree roles and responsibilities across a wide ranging stakeholder group.	Roles and responsibilities have been established and well communicated. The project Steering committee is established and well attended and there is evidence of a good working relationship between UNIDO Project Management Unit (PMU) and MNRE. The UNIDO PMU has established good visibility in the sectors amongst public and private stakeholders.
Inadequate national support to enhance the related legislation	MNRE has been very supportive of the project, the PMU works in close cooperation with MNRE.
The complexity of interrelated technical, commercial and the legislative problems to be addressed may be underestimated.	There is definitely a complexity issue, but the approach of dealing with issues in a systematic way seems to be managing this risk at this stage. The time taken to achieve progress is potentially an issue and the review team recommends continued prioritisation of engagement of stakeholders.
The scale and complexity of the HCFC production and consumption situation in the Russian Federation may crate resistance to change and closure of production facilities	This risk does not seem to have been significant so far. The great majority of stakeholders appear to be very willing to change, subject to the appropriate support and institutional approval.
A number of elements of the programme are based on initial discussions with potential counterparts and technology suppliers. Whilst potential suppliers have agreed in principle to collaboration with the project, there is a risk that when the full details are negotiated there may be logistical or commercial reasons that would prevent a technology supplier from collaborating.	This has not found to be an issue to date. However the risk must be monitored, particularly in relation to activities planned in the second half of the programme.
The direct phase out of HCFCs will be achieved partly through the implementation of capital investment projects within the duration of the project. However the final phase out of all HCFCs and the on-going adoption of energy efficient non HFC technology in the affected sectors requires longer term commitment and activity.	The prioritisation of institutional activities in the first half of the programme seems to have achieved a very good level of buy-in by the great majority of institutional stakeholders. This is evidenced through the development of professional standards and codes of practice in the refrigeration sector which take specific account of new regulations and objectives to stimulate the adoption of energy efficient non HFC technology
There is a risk that the market will be considered too "risky" for manufacturers to take up the opportunity to develop and market higher energy efficiency products which might have a higher initial cost even if lifecycle costs are lower.	New HCFC regulations in conjunction with Energy Efficiency Regulations and other project such as the GEF Energy Labelling project have effectively reduced this risk however more work is recommended in the second half of the programme to demonstrate the benefits of a lifecycle approach to equipment selection and design.
There is a risk that latest technology might be perceived as too recent or insufficiently supported or established within Russia or in general thus creating a barrier to adoption.	This continues to be an issue, particularly in relation to hydrocarbon and CO_2 refrigeration systems. However the on-going engagement activities appear to be adequate at this stage.

5.2 Specify additional/new risks internal or external to the project which affect implementation of the project and prospects of achieving project objectives:

It has emerged recently during engagement with the refrigerant sector is the relative over-regulation of ammonia use compared with European standards and practice. The stringency of the operating regime, documentation and inspection requirements creates a financial disincentive, which offsets the potential savings in energy consumption. This issue was discussed at the recent conference on the use of ammonia held on 16 October 2013. The review team recommends that the issue is raised as a priority at the next Project Steering Group Meeting.

The removal of customs checks at the boarder of Russia and Kazakhstan due to the implementation of the Customs Union presents a potential risk in the control of imports of HCFCs and equipment containing HCFCs. MNRE and UNIDO will therefore have to liaise closely with the newly created ITPO offices in Belorussia, Armenia and Kazakhstan to mitigate possible risks.

5.3 ***If the project received a sub-optimal risk rating and was perceived to be at risk in FY 2012 (1 July 2011 – 30 June 2012) report, please provide a detailed progress report on actions taken to rectify the rating and improve the overall performance of the project:***

N/A

6. Implementation Issues

Please indicate any project implementation issues experienced by UNIDO as the Implementing Agency of the project during FY 2013.

A complication has arisen in that the Federal Customs Service wish to develop their own design of analyzer, and according to its own rules the Ministry of the Interior of the Russian Federation is unable to use new analytical equipment without a qualified operator. The reason for the Federal Customs Service's decision to develop its own equipment is unclear and is being investigated.

7. Execution Issues

Please indicate any project execution issues identified by Project Executing Partners, Project Management Unit (PMU), Project Steering Committee (PSC) and other relevant stakeholders during FY 2013 and indicate actions that were agreed upon to rectify these issues.

The time taken to establish the methodology for customs clearance of equipment required for factory conversions for HCFC phase out was somewhat longer than expected. The local customs

officers in Tatarstan were unfamiliar with this type of project. However a model for implementation has been established and agreed by MNRE and PMU.

8. Lessons Learned

Please indicate key lessons learned identified to date, which would be of relevance to any future projects and initiatives in the same area.

Efficient implementation of programmes such as these required strong cooperation between the private sector and government; it is particularly important to consider the private sector's interests when amending laws and developing Government Directives. UNIDO has been able to facilitate this cooperation through the extensive engagement efforts made by the PMU and national experts are beginning to pay dividends as private stakeholders now see UNIDO and MNRE as trusted partners and supporters.

The relationship between the public and private sectors in Russia and aspects of the prevailing business culture, have an impact on the speed and order of in which programme activities can be implemented. Many stakeholders are wary of engaging in activities or discussions until the activity is official mandated by Government edict. This means that by the time an activity officially starts a certain period of time has already elapsed, which could have been used for initial discussions, analysis or feasibility studies. Whilst ongoing engagement and coordination may well reduce the impact this issue has on implementation timescales, it should be taken into account when planning future projects.

At the beginning of the project there was a low public awareness regarding the ozone protection issues and relative ambivalence towards the climate benefits of energy efficiency. Communications campaigns and stakeholder engagement activities have made a significant impact but it is very clear that this area requires continued effort.

The "Centre of excellence approach" (Microclimate, Energy Efficiency and Building Automation Centre) shows potential as a way of engaging grass roots stakeholders and building in climate and energy efficiency issues into basic training and education of technicians and school leavers. Having a physical space dedicated to demonstration and training in certain technology also provides a useful vehicle for cooperation between public and private stakeholders. The centre established in Moscow is partly sponsored by Samsung and supported by the Russian Energy Agency, Ministry of Energy of the Russian Federation and the Environmental Certification Centre for Green Standards.

9. Co-financing and Additional Leveraged Financing

Please indicate the level of materialized co-financing from the sources indicated at CEO Endorsement level. If new sources of co-financing have been identified during project implementation, please indicate those. Please expand the table as needed.

Sources of Co-financing[2]	Name of Co-financer	Type of Co-financing[3]	Amount Confirmed at CEO endorsement / approval	Actual Amount Materialized at Midterm	Actual Amount Materialized at Closing
Private Sector	Pozis	In kind / cash	4,000,000	6,500,000*	
Private Sector	Sepo	In kind / cash	4,000,000	4,350,000*	
Private Sector	Samsung/Daikin	In Kind / Guarantee		1,100,000	
		TOTAL		**11,950,000**	

*subject to project completion and final cost analysis

10. GEF Grant Disbursement Summary

Please provide a summary of all GEF grant disbursements as of 11 September 2013 (total expenditures of the project=commitments + payments).

Total Expenditure as of 11 September 2013	
Budget line	**Total expenditures US$**
International Experts/Consultants	**106,331.02**
National Experts/Consultants and travel	**628,767.00**
Subcontracts and Equipment	**4,495,016.79**
Workshops and miscellaneous	**147,795.79**
Total	**5,377,910.60**

[2] Sources of Co-financing may include: Bilateral Aid Agency(ies), Foundation, GEF Agency, Local Government, National Government, Civil Society Organization, Other Multi-lateral Agency(ies), Private Sector, Other
[3] Type of Co-financing may include: Grant, Soft Loan, Hard Loan, Guarantee, In-Kind, Other

11. Updated project work plan and budget for the remaining duration of the project

Please provide an updated project work plan and budget.

Ref	Current UNIDO work plan as of 8 October 2013
1	Unification of the legal and regulatory framework of the member countries of the Customs Union in the area of control over ODS and ODS-containing equipment import and export.
2	Contribution to adoption of the Federal law on amending certain legislative acts with regard of fulfilment by the Russian Federation of its commitments under the Montreal Protocol; assistance to concerned federal executive bodies in development of the system document package (draft decisions/decrees of the Government of the Russian Federation, technical regulations, standards, orders of ministries and agencies, etc.) with regard to establishment of the state system for regulation of ODS and ODS-containing equipment.
3	Continuation and completion of the scheduled work on Russian enterprises' transition to manufacture of non-ODS containing products.
4	Elaboration of the new UNIDO/GEF project on HCFC production phase out on the territory of the Russian Federation by 2020.
5	Establishment of the federal recovery, reclamation and environmentally safe destruction programme for HCFCs and other ozone-depleting substances and greenhouse gases (HFC) in the Russian Federation.
6	Strengthening of institutional potential through organization of training and professional development of federal and regional officials, representatives of the Federal Customs Service, Ministry of the Interior and Federal Service for Supervision of Natural Resources.
7	Creation of the certification system for HVAC&R service and repair technicians and entrusting the respective coordinating functions on the Centre of excellence.
8	Establishment of a Russian unified training and professional development system for HVAC&R repair and service technicians on the basis of the Centre of excellence.
9	Continuation and expansion of PR activity and educational projects that facilitate promotion of environmentally safe substances and technologies in the Russian Federation.
10	Creating conditions for Russia's and Customs Union's market promotion of energy-efficient and ozone and climate-safe technologies and products as well as incentives for development of respective production in Russia.

Current Project Budget as of 11 September 2013

Project components	Budget available for the remaining duration of the project
1. Building institutional capacity	502,581
2. HFC and HCFC life cycle performance analysis	49,044
3. Phase out of HCFC consumption in the key Consuming sectors of foam and refrigeration	2,099,999
4. Development of ODS destruction facility and supporting recovery network	2,300,000
5. Conversion of production facilities and stimulating market growth for energy efficient refrigeration and air conditioning equipment	4,699,622
6. Technology Transfer	2,450,000
7. Feasibility study to determine the best and most integrated strategy for dealing	225,206

with HCFC production closure	
8. Project management	295,638
Total available funds	**US$ 12,622,090**

12. Feedback from National Operational Focal Points (OFPs)

Please provide any feedback submitted by the national OFP.

The independent review consultants met with the National Operation Focal Point to discuss the status and progress of the programme. The OFP stated that UNIDO had provided excellent support and that there was a very good working relationship between UNIDO PMU and MNRE.

The OFP stated that this is very important project and the Government and it wishes to continue cooperation on this and other environmental projects. It also noted that it is keen to support preparation of Phase 2 under the GEF, as a successful continuation of this ongoing project.

13. Feedback from Co-financiers and Other Partners/Stakeholders

Please provide any feedback submitted by co-financiers and other partners of the project.

Representatives of the companies and other project partners interviewed by the MTR consultants stated that cooperation with the implementing agency had been excellent and that the financial support provided by GEF was instrumental in facilitating activity.

Most parties feel that the project provides excellent added value and would like to thank GEF and UNIDO for the opportunity to take advantage of project support.

One company originally cited as a project counterpart, decided that it could provide the level of co-financing required by GEF and has withdrawn from the project

14. Please indicate the name of the Focal Area Tracking Tool(s) attached to this report

Instructions and links to the relevant focal area tracking tools are provided in the AMR 2013 Guidelines and Definitions Annex.

Climate change tracking tool.

15. Additional Supporting Information and/or Documents

Please provide any additional information and/or attach relevant supporting documents (E.g. relevant technical reports, PSC meeting minutes, project websites, photos, video links, publications, flyers, etc.).

- Changes in the Russian ozone legislation
- http://www.ozoneprogram.ru/novosti/uzhestochenie_ozonovogo_zakonodatelstva/
- Competition “Protect the Ozone Layer”, Moscow
- http://www.ozoneprogram.ru/meroprijatija/16092012/
- Anniversary celebration in Saint-Petersburg
- http://www.ozoneprogram.ru/meroprijatija/17092012/
- Workshop on conversion of air conditioners to propane
- http://www.ozoneprogram.ru/meroprijatija/03092012_master_klass/
- The Microclimate, Energy Efficiency and Building Automation Centre established with support of UNIDO
- www.проф2.рф
- Customs activity coordination meeting in Saint-Petersburg
- http://www.ozoneprogram.ru/meroprijatija/soveshhanie_sp/
- Information on the present status of the Russian legislation with regard of issues of the ozone layer protection and ODS use regulation
- http://www.ozoneprogram.ru/ozonovoe_zakonodatelstvo/np_dok_rf/
- Various publications
- http://www.ozoneprogram.ru/biblioteka/publikacii/
- Various video–materials: http://www.ozoneprogram.ru/biblioteka/videomateriali/

Annex: AMR 2013 Guidelines and Definitions

1. Definition of Ratings

Implementation Progress Ratings

Highly Satisfactory (HS): Implementation of **all** components is in substantial compliance with the original/formally revised implementation plan for the project. The project can be presented as "good practice".

Satisfactory (S): Implementation of **most** components is in substantial compliance with the original/formally revised plan except for only few that are subject to remedial action.

Moderately Satisfactory (MS): Implementation of **some** components is in substantial compliance with the original/formally revised plan with **some** components requiring remedial action.

Moderately Unsatisfactory (MU): Implementation of **some** components is not in substantial compliance with the original/formally revised plan with **most** components requiring remedial action.

Unsatisfactory (U): Implementation of **most** components is not in substantial compliance with the original/formally revised plan.

Highly Unsatisfactory (HU): Implementation of **none** of the components is in substantial compliance with the original/formally revised plan.

Global Environment Objective/Development Objective Ratings

Highly Satisfactory (HS): Project is expected to achieve or exceed **all** its major global environmental objectives, and yield substantial global environmental benefits, without major shortcomings. The project can be presented as "good practice".

Satisfactory (S): Project is expected to achieve **most** of its major global environmental objectives, and yield satisfactory global environmental benefits, with only minor shortcomings.

Moderately Satisfactory (MS): Project is expected to achieve **most** of its major relevant objectives but with either significant shortcomings or modest overall relevance. Project is expected not to achieve **some** of its major global environmental objectives or yield some of the expected global environment benefits.

Moderately Unsatisfactory (MU): Project is expected to achieve of its major global environmental objectives with major shortcomings or is expected to achieve only **some** of its major global environmental objectives.

Unsatisfactory (U): Project is expected **not** to achieve **most** of its major global environment objectives or to yield any satisfactory global environmental benefits.

Highly Unsatisfactory (HU): The project has failed to achieve, and is not expected to achieve, **any** of its major global environment objectives with no worthwhile benefits.

Risk ratings

Risk ratings will assess the overall risk of factors internal or external to the project which may affect implementation or prospects for achieving project objectives. Risks of projects should be rated on the following scale:

High Risk (H): There is a probability of greater than 75% that assumptions may fail to hold or materialize, and/or the project may face high risks.

Substantial Risk (S): There is a probability of between 51% and 75% that assumptions may fail to hold and/or the project may face substantial risks.

Modest Risk (M): There is a probability of between 26% and 50% that assumptions may fail to hold or materialize, and/ or the project may face only modest risks.

Low Risk (L): There is a probability of up to 25% that assumptions may fail to hold or materialize, and/ or the project may face only modest risks.

2. Summary of Reporting Requirements

Full Sized Projects (FSP):

- Submit baseline information at CEO endorsement;
- Start implementation six to eight months after CEO endorsement;
- Submit Project Implementation Reports (PIR) annually until project closure for projects that have been under implementation for one year or longer;
- Submit a midterm review (MTR);
- Submit tracking tools **three** times during the life of the project: at CEO endorsement, midterm, and project closure; and
- Submit Terminal Evaluation (TE) to the GEF Evaluation Office after project implementation end. The report should be submitted to the GEF EO no later than 12 months after project completion.

Medium Sized Projects (MSP):

- Submit baseline information at CEO approval;
- Start implementation six to eight months after CEO approval;
- Submit PIR annually until project closure for projects under implementation for one year or longer;
- Encouraged to but not required to submit a midterm review or evaluation report (MTR);
- Submit tracking tools **twice** during the life of the project; at CEO approval and at project closure;
- Submit Terminal Evaluation (TE) to the GEF Evaluation Office after project implementation end. The report should be submitted to the GEF EO no later than 12 months after project completion.

Enabling Activities (EA):

- Submit a status report every year.
- Submit a terminal evaluation for EAs that are $500,000 or greater to the GEF EO after EA is completed and no later than 12 months after project completion.

Co-financing

Projects which, during the reporting fiscal year, have gone through mid-term reviews/evaluations or that have been closed are required to report on co-financing. Co-financing are resources committed by the GEF Implementing and/or Executing Agencies or by other non-GEF source, that will be managed with the GEF allocation as part of the initial financing package for the GEF project and without which the GEF objectives cannot be met.

Tracking Tools (TT) Requirements

Tracking tools are intended to roll up indicators from the individual project level to the portfolio level and track overall portfolio performance in focal areas. Each focal area has developed its own tracking tool to meet its unique needs. The overall approach for capturing data and reporting to the GEF Secretariat will be uniform across all focal areas, this includes:

i. **FSPs,** in any focal area, that are CEO Endorsed after December 31, 2010, are expected to submit tracking tools **three** times during the life of the project: at CEO endorsement, midterm, and closing.
ii. **MSPs,** in any focal area, that are CEO Approved after December 31, 2010, are expected to submit tracking tools **two** times: at CEO approval and at closing.
iii. Tools must be filled out in the Excel sheets, which are provided by the GEF Focal Area teams[4].
iv. When a project is implemented by more than one Agency, only the Agency with largest portion of the GEF grant should submit a TT on behalf of the entire project. Other cooperating Agencies are expected to provide the reporting Agency with relevant input.

GEF CC Mitigation Tracking Tool: Please ensure targets and results reported in the tracking tools are consistent with targets and results in the mid-term reviews or terminal evaluations. The GEF CCM tracking tool can be found here: http://www.thegef.org/gef/tracking_tool_CCM

GEF IW Tracking Tool: The new GEF IW TT consolidates the GEF-3, GEF-4 and GEF-5 replenishment targets and strategic outcomes and outputs as per the different IW strategies into one TT. GEF IW tracking tool with accompanied guideline can be found here: http://www.thegef.org/gef/node/4402

GEF Persistent Organic Pollutants (POPs) Tracking Tool: The GEF POPs tracking tool can be found here: http://www.thegef.org/gef/POPs_tracking_tool

GEF LD Tracking Tool: The GEF LD tracking tool with accompanied guideline can be found here: http://www.thegef.org/gef/node/4403

Multifocal Area Projects (MFA): for MFA and MTF projects, the
Secretariat does not require the full set of tracking tools be applied. The tools should only be completed for the essential focal area indicators that need to be monitored throughout MFA projects.

[4] Please do not use alternative formats when submitting the tool since data validation settings were designed within the tool to ensure data quality and consistency. If additional data fields are needed for the benefit of internal reporting, please inform the Secretariat so that Agency needs can be incorporated into the official format

3. List of Acronyms

FSP – Full Sized Project
MSP – Medium Sized Project
EA – Enabling Activities

Focal Areas
BD – Biodiversity
CC – Climate Change
IW – International Waters
LD – Land Degradation
ODS – Ozone Depleting Substances
POPs – Persistent Organic Pollutants
MFA – Multi-Focal Area

Regions
AFR – Africa
ECA – Europe and Central Asia
EAP – East Asia and Pacific
LAC – Latin America and Caribbean
MNA – Middle East and North Africa
SA – Southeast Asia
Regional – covers multiple countries in 1 region
Global – covers multiple countries in different regions

4. Overview of GEF M&E Design and Budget Requirements

As outlined in the GEFs M&E Policy (2010), all projects and programs must include a concrete and fully budgeted M&E plan by CEO endorsement for full-size projects (FSPs) and CEO approval for medium-size projects (MSPs). GEF project and program objectives as well as intended results should be specific and measurable so as to make it possible to monitor and evaluate the project and program effectively.[5]

Design of M&E Plan
A project or program's logical/results framework should align to the GEF's focal area results frameworks (http://www.thegef.org/gef/node/3624). Minimum requirement 1, established in the M&E policy is as follows:

- "SMART indicators for results and implementation linked appropriately to the focal area results frameworks; additional indicators that can deliver reliable and valid information to management may also be identified in the M&E plan.
- Baseline for the project or program, with a description of the problem to be addressed, with indicator data or, if major baseline indicators are not identified, an alternative plan for addressing this, by CEO endorsement.

[5] Refer to the Minimum Requirement 1 of the M&E Plan, in *The GEF Monitoring and Evaluation Policy 2010*, Evaluation Document November 2010, No. 4 (p.29).

- Identification of reviews and evaluations that will be undertaken, including midterm reviews and terminal evaluations.
- Organizational set-up and budgets for M&E."

The GEF Secretariat program managers review all projects and programs prior to their approval to ensure that they meet the above minimum requirement, including the use of indicators and targets that align with focal area objectives and indicators.

Monitoring and Evaluation Budget Requirement

A budgeted M&E plan is distinct from the project management cost (PMC) budget. When project documentation is submitted at the PIF stage an estimate of the M&E costs should be embedded in the project budget. A fully outlined and budgeted M&E plan must be included by CEO Endorsement. The budget for the M&E plan can be spread across the various components of a project, as applicable. In the CEO Endorsement document a separate budget for what will be spent on M&E should be provided.

For the application of M&E plans, minimum requirement 2 in the GEF M&E Policy (p.30) states that:

"Project and program monitoring and supervision will include implementation of the M&E plan, comprising the following:

a. SMART indicators for implementation actively used
b. SMART indicators for results actively measure, or if not, a reasonable explanation provided
c. The baseline for the project fully established and data complied to review progress, and evaluations undertaken as planned
d. The organizational set-up for M&E is operational and its budget is spent as planned."

A budgeted M&E Plan therefore includes activities to monitor project indicators, to complete tracking tools, to undertake monitoring reports and related mid-term and evaluation reports.

Examples of Activities covered include:

- Tracking tool measurement, monitoring of Global Environmental Benefits (GEBs),
- and any associated monitoring expenses;
- Monitoring of all project indicators, including assessment and inventory stocktaking for chemicals, pollution reduction, and/or documenting, evaluation of project changes;
- Periodic monitoring reports;
- Independent terminal evaluation of the project; and
- Midterm review/evaluation: either by independent reviewer/consultant or government entity.

Activities not covered under M&E Budget[6]:

- Oversight activities on the implementation of a project, which should be covered under the project management cost (PMC);
- Periodic progress reporting of the project to the GEF Agencies;
- Consultation with project stakeholders, which should be covered under the PMC;

[6] Most of the confusion in charges to M&E is with respect to project management activities handled by the project executing agency. Most of the activities listed here should be charged to PMC.

- Financial audit for the project, should be included in the PMC; and
- Technical reports for specific technical components, which should be part of the project component cost, not an M&E item, nor should it be charged to PMC.

Other Activities not covered in M&E Budget but are functions of the GEF Agencies[7] include the following:

- All activities related to the performance of project cycle management services by a GEF Agency which include identification, preparation, appraisal and supervision of projects;
- Midterm review performed by a GEF Agency;
- A review of the terminal evaluation reports that are prepared by an independent consultant hired by the government;
- Quality control and review of tracking tools; and
- Preparation of annual Project Implementation Reviews (PIRs) and other related GEF portfolio reports to GEF Secretariat or to GEF Trustee.

[7] All functions performed by a GEF Agency which involved the project cycle management services should be charged to the GEF Agency fee.

Appendix 1

Ammonia as a replacement for medium sized modular R-22 systems

Ammonia as a replacement for medium sized modular R-22 systems

Andy PEARSON

Star Refrigeration Ltd,
Glasgow, UK
apearson@star-ref.co.uk

ABSTRACT

This paper indicates how ammonia systems might be adapted to make them more suitable for use on installations which traditionally adopted CFC and HCFC refrigerants in the range 100kW – 600kW cooling capacity for warehouses, blast freezers and food factory applications. The examples draw on over twenty years of experience with low charge systems in Europe, but are specifically focussed on the American market, where a ten year phase-out program for R-22 has just started. Key parameters are explained, and barriers to implementation are identified. The way in which these barriers can be overcome is illustrated through case studies and performance data logged from operational installations.

1. INTRODUCTION

The final stages of the actions mandated by the Montreal Protocol on Substances that Deplete the Ozone Layer are now in place. Article 5 of the protocol lists countries which are granted some leeway on the phase out dates due to their economic standing. They are sometimes called "Article 5 countries", or more colloquially "developing countries". In all other nations, not listed in Article 5 and sometimes called "non-article 5 countries" the use of CFCs and HCFCs in new equipment has been prohibited. According to the Montreal Protocol timetable the prohibition on HCFCs dates from 1 January 2010, so this is a new situation for many nations, including the United States of America. In other regions however, for example Europe, local regulations were used to accelerate the phase out of CFCs and HCFCs, so that R-22 has not been permitted in new installations in Europe since 2002. This difference in phaseout timetables means that many lessons have been learned in Europe, and other regions can benefit from the experience gained.

End users have a choice: they can opt to move away from HCFCs as soon as possible so that their business has the maximum amount of time to adjust to new technology, or they can conserve cash by delaying the change until the last possible moment, but then run the risk that the overstretched engineering resource is not able to meet their urgent demands when action is ultimately required. In Europe both courses of action were followed. Those who opted for change either changed the refrigerant in their equipment to an HFC, or replaced the equipment with ammonia plant. Those who delayed until the last minute were not able to design, install and commission ammonia systems quickly enough when the supply of R-22 all but dried up and were forced to make rapid conversions to HFC blends. The European regulations would have permitted the use of recycled R-22 in existing equipment until 2015, but the flow of R-22 back from the market was virtually non-existant – estimated by one commentator to be about 3% of the demand for R-22, so the availability of refrigerant is far less than expected. In the UK the current selling price (April 2010) for recycled R-22 is approximately £20 per kg, whereas a year ago, before the ban on "virgin R-22" came into effect the price was about £4 per kg. In addition the price is changing regularly, and is only going in one direction. Demand for HFC blends suitable for retrofit in existing systems is said to have increased by a factor of 4 between December 2009 and January 2010, and, like the price of R-22, is also still rising. Some end users attempted to beat the ban by building a stock of recycled R-22 before the end of 2009, buying new refrigerant and charging it into their plant, then removing the excess and storing it. This is a very high risk strategy, because one large leak could use their entire stockpile, and one stroke of a legislator's pen could change the rules and leave them needing to dispose of a large stockpile of chemical waste.

2. KEY CONSIDERATIONS IN REPLACING R-22 SYSTEMS

This paper specifically addresses the needs of users who have medium sized facilities which are currently served by packaged, air-cooled compressor/condenser packages using R-22. A typical installation might have four or five of these units mounted on the roof of a cold store, or dispersed along the length of the loading dock canopy. Each unit is about the size of a medium-sized pick-up truck and could have a refrigeration capacity up to 200kW (60TR). The units are connected to evaporators mounted in penthouses or suspended from the cold store ceiling, and installed with copper piping. They have a simple thermostat control and are expected to operate automatically without any manual intervention. Regular maintenance may not be done, and they will only receive the attention of a service technician when they stop working and the store temperature is affected.

It is possible to replace the R-22 in these systems with a blend of HFCs and there are many case histories of successful conversions. However it is likely that system capacity may be reduced, and efficiency may be worse than the R-22 system. Operating pressures may also be a bit higher, and system leakage tends to increase on the HFC blends. With care in the conversion, for example by changing the lubricant to a polyol ester and replacing all of the synthetic rubber seals the effects of capacity, efficiency and leakage can be minimized. However it is highly likely that if the refrigerant change is rushed through without sufficient planning then performance and reliability will be adversely affected.

To achieve a successful conversion, the user should consider the following points:

- What is the current performance of the system?
- How much does it leak at the moment?
- What performance is acceptable in future?
- What rate of leakage is acceptable in future?
- What steps can be taken to minimize leaks?

The current performance should be assessed on the basis of store temperature profile, downtime as a percentage of total operating time, electrical consumption per week, refrigerant top-up per week. These parameters should have been tracked for several months before the conversion is started, so that the success or otherwise of the change can be assessed, and the true impact on the business can be estimated. Therefore even if the user intends to delay the conversion for as long as possible, the monitoring should start immediately so that when action is required it can be properly appraised.

3. ASSESSMENT OF THE POTENTIAL OF AMMONIA IN THIS APPLICATION

The measurement exercise might also provide the basis for making a business case to take action earlier, in order to deal with issues in efficiency and reliability that had previously been unchecked. There are a number of good reasons for considering a switch to ammonia as the refrigerant if the equipment is to be replaced due to poor efficiency or excessive leakage.

- It should be possible to achieve significantly higher efficiency than can be reached with R-404A or other industrial HFC blends
- The leakage of ammonia from industrial systems can be reduced to zero in normal operation due to the more rugged industrial construction required due to material compatability
- The future availability of “high global warming potential” HFCs is currently under discussion. Proposals have been tabled by the United States of America and “the Island States” (Micronesia) to introduce a “phase-down” of HFCs
- If the current range of HFCs are to be replaced with other fluorocarbons in the “low global warming potential” group then these will probably be unsaturated HFCs (“uHFCs”), also known as hydrofluoroolefins (HFOs).

Each of these considerations requires further explanation.

3.1 System efficiency

The physical properties of ammonia make it very suitable as a refrigerant. It has an exceptionally high latent heat and also a high critical temperature compared with R-22. These two properties result in a very low mass flow for a

given capacity. Low mass flow results in relatively small pipe sizes and reduced pressure drop, although the vapour swept volume is high due to the low vapour density. Further details can be found in numerous publications for example the ASHRAE Refrigeration Handbook (2010) and the International Institute of Refrigeration's "Guide to Ammonia as a Refrigerant (Pearson, 2008a). These show that in comparison with R-404A ammonia is likely to consume 30% less power for a given system application, assuming similar system design considerations (evaporator and condenser sizing, compressor efficiency, pressure drop). In air-cooled systems the difference is more pronounced due to the large difference in critical pressure: for ammonia this is 133°C whereas for R-22 it is 96°C and for R-404A it is 72°C. A more complete explanation of the reasons for the disadvantage that this brings to R-404A can be found in Pearson (2010). Clearly moving from R-22 to R-404A is a step in the wrong direction in this respect. Low critical pressure also results in a high percentage of flash gas after expansion. This can be countered by the use of an economizer in screw compressors, however for R-404A the heat exchanger would need to be five times larger than that required for ammonia, and would only bring the economized R-404A efficiency up to the same level as un-economised ammonia. (Pearson, 1999).

3.2 Refrigerant leakage

Leakage rates from commercial refrigeration systems using HFCs are approximately 18% of the refrigerant charge per annum (UNEP, 2006). The majority of this leakage, 70%, is due to major releases, estimated by Clodic in 1997 and reaffirmed in a later report by Clodic et al in 2006. Most of these major releases are due to catastrophic failure of pipe and fittings (REALZero, 2009). Traditional industrial refrigeration systems using ammonia tend not to leak as much, and significant reductions have been achieved by focusing on eliminating the smell of ammonia in order to reduce the risk of injury (Pearson, 2008b). The use of steel pipe, with welded fittings also greatly reduces the probability of a refrigerant leak.

3.3 Availability of HFCs

The European "MAC Directive" (Mobile Air-Conditioning Directive, 2006) sets a threshold of 150 for the global warming potential of refrigerants to be used in the air-conditioning of new models of car after 2011, with a complete phase out of "high GWP" fluids by 2017. A recent report from the UNEP RTOC on "low GWP alternatives" sets the definition of high GWP as greater than 1000, and low GWP as less than 300. The directive has prompted a world-wide research effort into the development of alternative fluorocarbons. Since the current market in MAC for R-134a accounts for about 50% of production it is likely that supply to other markets will also be affected by the directive, albeit indirectly. However it is not at all clear what that effect might be. There may be a glut and prices will remain low for the foreseeable future, or lack of demand might cause some production plants to be closed, leaving severe shortages and high prices. There have already been a couple of occasions where short term shortages caused by production problems at the chemical plant caused a shortage and resultant spike in prices. The phase-down of HFC production was proposed at the 20th meeting of Parties to the Montreal Protocol in Doha, 2008, and presented to the Copenhagen Summit in December 2009, but no agreement was reached. The suggestion is that production of HFCs should be regulated using the Montreal mechanisms, proven to be successful over a 20 year period, with a cap on supply at 30% of 2006. This seems laudable, but it raises the prospect of accelerated reductions and ultimately phase out, as was the case with the Montreal Protocol for CFCs. "condemned to repeat"

3.4 Suitability of uHFCs

The proposed fluorocarbon alternative for MACs is R-1234yf, a hydrofluorocarbon based on propylene (propene). The double bond in the molecule results in a very short atmospheric life, and hence the global warming potential of the fluid is "ultra-low"; less than 30, according to the UNEP RTOC classification. Extensive testing has shown good performance and stability in sealed automotive systems, and testing is now being conducted on the suitability of these compounds for chillers and commercial refrigeration. However Low (2010) has shown that acid tends to form in the presence of moisture, which suggests that they will not provide sufficient stability in larger commercial or light industrial systems of the type discussed in this paper. It is extremely unlikely that an unsaturated hydrofluorocarbon (uHFC) will have been commercialized in these markets in the next five years, but this is the timescale under discussion for the initial HFC phasedown.

The family of CFCs and HCFCs contains a broad range of fluids with atmospheric boiling points ranging from R-22 at -40°C through R-12 at -30°C and R-134a at -26°C to r-123 at 23°C and R-123 at 27°C. In general the boiling point is related to molecular weight – the heavier molecules boil at higher temperatures. The same is true for the unsaturated HFCs, but with the added twist that those based on ethylene (ethene) and butylene (butene) are highly toxic. The heavier propene based uHFCs, R-1216 and R-1225ye(Z) have also been found to be toxic, leaving the R-

1234 (tetrafluoropropene) and R-1243 (trifluoropropene) families of isomers as the only contenders. In the same way as R-12 was suitable for car air-conditioners but not for industrial refrigeration, it seems unlikely that these fluids hold much promise for the industrial sector. uHFCs could be blended with more stable (higher GWP) chemicals to produce a compromise solution, but for this to be non-flammable it is likely to have a GWP higher than 300, and so will be, at best, in the "moderate" category.

In contrast consider where ammonia fits in these four considerations. It offers better efficiency than has been seen from any of the HFCs to date. It is a proven, low leakage refrigerant. It is widely available at a relatively low price. However suitability for the heavy commercial market is a more difficult question.

Ammonia is toxic and combustible. If the new refrigerant class of A2L is introduced in ISO5149 and ASHRAE-15 as proposed (ISO, 2009) then ammonia would be class B2L. This new "2L" designation denotes products which are "mildly flammable", but difficult to ignite and which cause less damage when they burn due to the low speed of flame propagation. The A and B designation relates to toxicity, since ammonia's long term exposure limit (LTEL), the eight-hour time-weighted average, is less than 400ppm it is in category B. However the traditional toxicity classification does not take account of the products of combustion or degradation. All HFCs produce toxic products, including HF when they burn, and uHFCs as mentioned earlier are less stable than saturated HFCs. In contrast ammonia burns to N_2 and H_20: harmless and abundant in the atmosphere. It is reasonable to conclude that products of degradation should be considered more carefully if unsaturated compounds, which by definition are more likely to degrade in use, are to be used. On balance, and considering the well-known pungent odour of ammonia in contrast to the unfamiliar and reportedly not unpleasant smell of highly toxic hydrofluoric acid, it seems that the toxicity risk associated with ammonia use are significantly easier to manage than the alternatives.

Traditional ammonia systems used in industrial cold storage and freezing however are not readily adapted to the heavy commercial/light industrial sector more used to packaged R-22. A traditional ammonia plant would be two stage compression, pumped circulated with evaporative condensers and a charge of several tonnes and with all the compression and pumping equipment housed in a purpose built special machinery room. This would not be an easy retrofit in an existing medium-sized facility which did not have a special machinery room and had no previous experience of maintaining a large ammonia facility. In addition, if the system charge exceeded 10,000 pounds (4,546kg) then, in the USA, the plant would need to be registered under the rules laid down by the Occupational Safety and Health Administration (OSHA). These mandate a range of compulsory measures including registration with local authorities, periodic inspection, strict requirements on reporting of any emissions and preparation of an offsite consequence analysis and emergency response plan (including regular drills).

There is a clear imperative to keep the charge of each system below the 10,000 pound threshold. This can be done through a number of strategies:

- Split the plant into separate modules with no cross connection
- Avoid "low pressure float" control, which requires a reservoir of liquid on the high pressure side
- Avoid thermosyphon oil cooling for the same reason
- Avoid two stage compression which requires intercooling
- Use DX economizers to improve the performance of single stage plant without raising the charge
- Avoid hot gas defrost, which requires a large receiver to collect the condensate generated during defrost
- Avoid long liquid lines – locate the condensers close to the evaporators

These can all be achieved through the use of a system described by S Forbes Pearson in a paper to the Institute of Refrigeration in 1996. A flow diagram of this type of system is shown in Figure 1. The compressor, condenser and evaporator are much the same as would be found in any other ammonia system, but some of the other components require some further explanation. The liquid flowing from the condenser to the expansion valve is subcooled by exchanging heat with liquid in the receiver. This ensures that the suction gas drawn to the compressor is dry, even though the return from the evaporator is wet. The expansion valve is placed after the subcooler, but is controlled by a float switch at the condenser. The control is arranged to open the valve if there is liquid at the condenser outlet, so there is no prospect of holding a reservoir of liquid on the high pressure side of the system. The discharge gas from the compressor and the suction gas from the evaporator pass through a four port ball valve. To defrost the evaporator the ball is turned 90 degrees and the system runs as a heat pump for a short period. This gives a quick and efficient defrost with no risk of liquid hammer or hydraulic shock. It also eliminates the possibility of

inefficient hot gas leakage during normal operation. The check valve in parallel with the expansion valve is to provide a bypass during reverse cycle operation. It is sometimes necessary to fit a second expansion valve (with non-return valve) on the condenser side of the subcooler to provide expansion during defrost operation. There is a pot on the bottom of the subcooler for collecting oil. This can be drained manually or, as shown in the diagram, it can be filtered and returned automatically to the compressor suction.

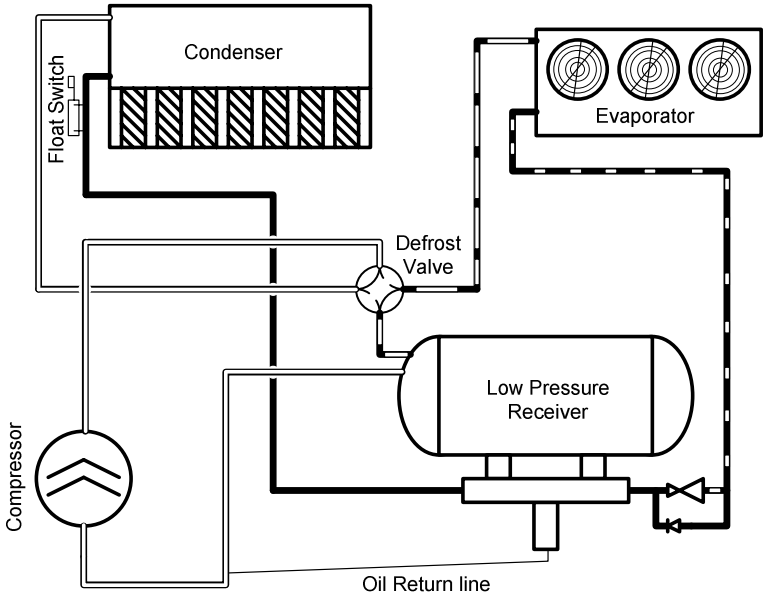

Figure 1 – Simplified flow diagram for an ammonia low pressure receiver system

The system is a form of direct expansion, since the liquid and gas from the expansion valve go "directly" to the evaporator (ie without being recirculated through a pump loop), but unlike conventional DX systems the suction from the evaporator is wet, so the full evaporator surface is used, and there is no superheat penalty on suction pressure. Like other DX systems the distribution of liquid and gas within the evaporator is critical: this means that some restrictions must be placed on the size, number and orientation of the air coolers. Up to four evaporators can be served by a simple system provided the liquid line is correctly balanced and distributors are used at each evaporator. The system is therefore best suited to smaller cold stores or installations where the plant can be arranged in modules serving groups of coolers. It is particularly well suited to penthouse applications where a packaged compressor set can be located on the roof next to the penthouse. The largest cold store evaporator that can be served by this type of system is about 250kW (75TR), and the optimum size is about half this. So a system with four coolers could provide 1000kW of cooling in a storage or freezing system.

4. CURRENT STATUS

Ammonia low pressure receiver systems have been installed in the United Kingdom since the late 1980s and have been used for cold storage, blast freezers, spiral freezers, chill stores, and in conjunction with plate heat exchangers for liquid chillers. Earlier installations used galvanized steel or stainless steel coolers, but in both cases it was difficult to achieve good distribution within the coolers under all load conditions. Recent developments in aluminum evaporators have significantly improved the boiling heat transfer within the cooler, and the better coefficient of heat transfer through the tube wall has ensured that the finned surface of the cooler is more effectively utilized. At a test site in Harlow, England a pair of stainless steel coolers installed with the original installation in 2002 were replaced with aluminum coolers in March 2009. Plant data logged between March and October suggest that the daily power consumption of the plant dropped from 1000kWh per day to 800kWh per day. This is attributed to the higher suction pressure and consequent improved CoP and reduced running hours achieved. A second installation is currently under construction, replacing R-22 plant in an installation completed in 1979. This system will be commissioned in June 2010, so more information will be available at the conference. The four evaporators are served by a single receiver and a pair of ammonia compressors. The plant has a capacity of 300kW.

5. FUTURE POTENTIAL

For systems in the medium sized R-22 sector it is possible to combine the benefits of the low pressure receiver with a packaged air-cooled compressor/condenser set. This arrangement is described in the context of water chillers by Pearson (2010). The arrangement of the condenser around the compressors, electrical panel and low pressure receiver is shown in Figure 2.

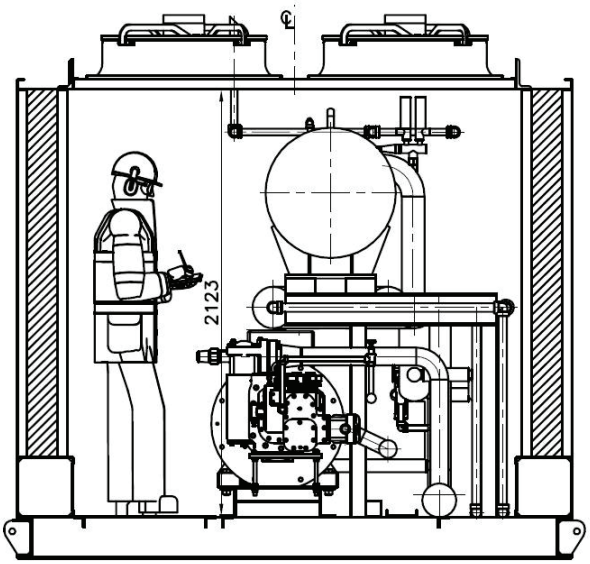

Figure 2 – arrangement of equipment in a packaged engineroom formed from an air-cooled condenser

The only differences between the air cooled chiller and the LPR system are that the plate and frame heat exchanger for the water cooling evaporator is not fitted, and a four port ball valve for defrost is added. The condenser is constructed from stainless steel tubes with coated aluminum fins. If the unit is to be installed in a noise sensitive area then housings can be provided for the screw compressors and slower running fans can be fitted to the condenser. It is also possible to fit adiabatic pads to the condenser faces to provide some pre-cooling of the air supply to the condenser. These pads are only used when the dry bulb temperature is high and there is a significant wet bulb depression.

The standard package configuration, with two screw compressors, gives up to 240kW (70TR) at cold storage conditions, and up to 780kW (220TR) at chill conditions. This sizing fits very well with the modular approach favoured in the medium sized cold stores where a pair of evaporators in a penthouse serve one bay of the store and are fed by a rooftop mounted condensing unit.

6. CONCLUSIONS

The excellent thermodynamic properties of ammonia set it apart from the recently developed HFC and uHFC refrigerants, which are likely to require 30% - 50% more electrical consumption for the same job. The dual safety concerns of toxicity and flammability can be fully addressed by designing the ammonia system for low charge and locating the equipment outdoors close to the evaporators. The low charge also means that the system is not subject to the complex management regulations which apply to larger ammonia systems.

The low pressure receiver system, which has been used with ammonia in Europe for twenty years offers an alternative to end users who are required to get rid of existing R-22 plant, but do not want to switch to traditional pumped ammonia systems and are concerned about the long term availability of HFCs or uHFCs. The capital cost of the ammonia pack is higher than a R-404A unit would be, mainly due to the rugged industrial construction and longer life expectancy. The efficiency is also higher than the R-404A system so it is possible to construct a payback on a case-by-case basis. When the cost of a special machinery room, required for a traditional ammonia installation, is factored out of the total project cost, the packaged LPR is a very attractive option. Operator costs are also lower

than required for pumped ammonia systems as the packs are fully automatic, only requiring periodic maintenance as specified by the compressor and condenser manufacturers.

This gives a credible “natural” alternative for R-22 replacement.

REFERENCES

Clodic, D. Zero Leaks, limiting emissions of refrigerants. ASHRAE, Atlanta, 1997.

Clodic, D., Palandre, L., Barrault, S., and Zoughaib, A., Short report of Inventories of the worldwide fleets of refrigerating and air conditioning equipment in order to determine refrigerant emissions. ADEME Paris, 2006.

Directive 2006/40/EC of the European Parliament and of the Council, Official Journal of the European Union, Brussels, 2006

International Standards Organisation, Draft International Standard 5149, Refrigerating systems and heat pumps — Safety environmental Requirements, ISO, Geneva, 2009

Low, R., Reducing The Environmental Impact Of Refrigeration: An Ineos Fluor Perspective, Proc IIR Conf, Sustainability and the Cold Chain, Cambridge, 2010

OSHA 29 CFR Part 1910,

Pearson, A., Air Cooled Chillers with Ammonia, Proc IIR Conf, Sydney, 2010

Pearson, A., (ed) Ammonia as a Refrigerant 3rd edition, IIR, Paris, 2008

Pearson, A., Ammonia’s Future, ASHRAE Journal, Feb 2008

Pearson, A., Ammonia, Proc Inst Ref Centenary Conf, London, 1999

Pearson, S.F., Ammonia Low Pressure Receivers, Proc Institute of Refrigeration, vol 92, London, 1996

REALZero, Minimising Refrigerant Emissions, Institute of Refrigeration, London, 2009

UNEP, 2006 Report Of The Refrigeration, Air Conditioning And Heat Pumps Technical Options Committee, UNEP, Nairobi, 2006

ACKNOWLEDGEMENT

Thanks are due to the directors of Star Refrigeration Ltd for permission to publish this paper, and to Mr Jeff Welch of Freeze-Pro, FL and Mr Bruce Nelson of Colmac Coil, WA for information and support.