UNEP

Training Resource Kit: Preparing Small Businesses for the Transition Away from CFCs in Refrigeration and Air Conditioning

A support guide for National Ozone Units (NOUs) and their Local Partners in Developing Countries

United Nations Environment Programme

Disclaimer

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the United Nations Environment Programme concerning the legal status of any country, territory, city or area or of its authorities, or concerning delimitation of its frontiers or boundaries. Moreover, the views expressed do not necessarily represent the decision or the stated policy of the United Nations Environment Programme, nor does citing of trade names or commercial processes constitute endorsement.

ISBN: 92-807-2602-1

TRAINING RESOURCE KIT:

PREPARING SMALL BUSINESSES FOR THE TRANSITION AWAY FROM CFCS IN REFRIGERATION AND AIR CONDITIONING

A support guide for National Ozone Units (NOUs) and their Local Partners in Developing Countries

United Nations Environment Programme

Division of Technology, Industry, and Economics

2005

Acknowledgments

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

The project was managed by:

Mrs. Monique Barbut, *Director*
Mr. Rajendra M. Shende, *Head, OzonAction Branch*
Mr. James S. Curlin, *Information Manager, OzonAction Programme*

The document was researched and written by:

Mrs. Elizabeth Martin Perera, ICF Consulting, USA
Mr. David Hathaway, ICF Consulting, USA
Mr. R. Gopichandran, Centre for Environment Education, India
Mr. Mark Wagner, ICF Consulting, USA

Quality review was provided by:

Mr. Yerzhan Aisabayev, *Programme Officer - Institutional Strengthening/ Refrigerant Management Plans, OzonAction Programme*
Mr. Atul Bagai, *Regional Coordinator (Networking), South Asia Network Compliance Assistance Programme OzonAction Programme UNEP*
Mr. Yamar Guisse, *Programme Officer - Refrigerant Management Plan Implementation, UNEP Regional Office for Africa*
Mr. Shaofeng Hu, *Programme Officer - Refrigerant Management Plan Implementation, UNEP Regional Office for Asia and Pacific*
Mr. Gary McNeil, *USEPA, Director of EPA Regional Mobile Air Conditioning Project*
Mr. Marco A. Pinzon, *Programme Officer - Refrigerant Management Plan Implementation, UNEP Regional Office for Latin America and the Caribbean*
Mr. Suresh Raj, *Capacity Building Manager, OzonAction Programme*
Mr. Ayman El-Talouny, *Programme Officer - Refrigerant Management Plan Implementation, UNEP Regional Office for West Asia*

Major contributions were made by:

IT Power India Pvt Ltd, National CFC Consumption Phase-Out Plan (NCCoPP) Regional Training Management Organisation and UNEP National Partner

The preparation of this document has involved contributions from a wide range of organizations and individuals. It could not have been prepared without their input. UNEP and ICF Incorporated wish to thank all contributors and their employers for helping to make this document possible.

About this Document

The Need to Assist Small Companies

The majority of the completed ozone depleting substances (ODS) phase-out projects have focused on enterprises which were large and easy to regulate. Most of the remaining ODS is consumed primarily by small and medium enterprises (SMEs) and/or residual users in the refrigeration and air conditioning industry. The definition of SMEs varies greatly between institutions and countries and has become a term to generally refer to small businesses. For purposes of this kit SME means a small or micro enterprise, traditionally from one to twenty employees. While each SME may use small amounts of ODS compared to larger enterprises, these small enterprises are large in number. Therefore, the total ODS consumed is substantial. Not addressing these enterprises and residual users could result in increased consumption and risks which would undermine the progress made in larger enterprises. SMEs continue to be a major challenge under the Montreal Protocol, and compliance with the treaty can be assured only if SMEs are addressed. In addition, SMEs play a crucial role in the economies of the developing world. These enterprises need support in order to successfully transition from ODS to Non-ODS alternatives.

Objective of this Kit

These materials are intended to be used to reach SMEs that are not reached by ordinary training methods/courses. They are designed to help the national ozone unit (NOU) attract SMEs that would otherwise not be involved in the phase-out and give them key messages and guidance to help avoid phase-out difficulties. The target SMEs include those that operate informally and would not necessarily be eligible, interested, or able to participate in formal training. This kit is a hybrid between outreach and education materials and provides SMEs with a basic introduction to: 1) what the Montreal Protocol and the phase-out of ODS means in their country, 2) what phase-out means for their business, and 3) what they can do to take action (e.g., improving service practices or replacing equipment). This kit does ***not*** provide formal training or take the place of formal training in refrigeration and air-conditioning good practices under the Multilateral Fund.

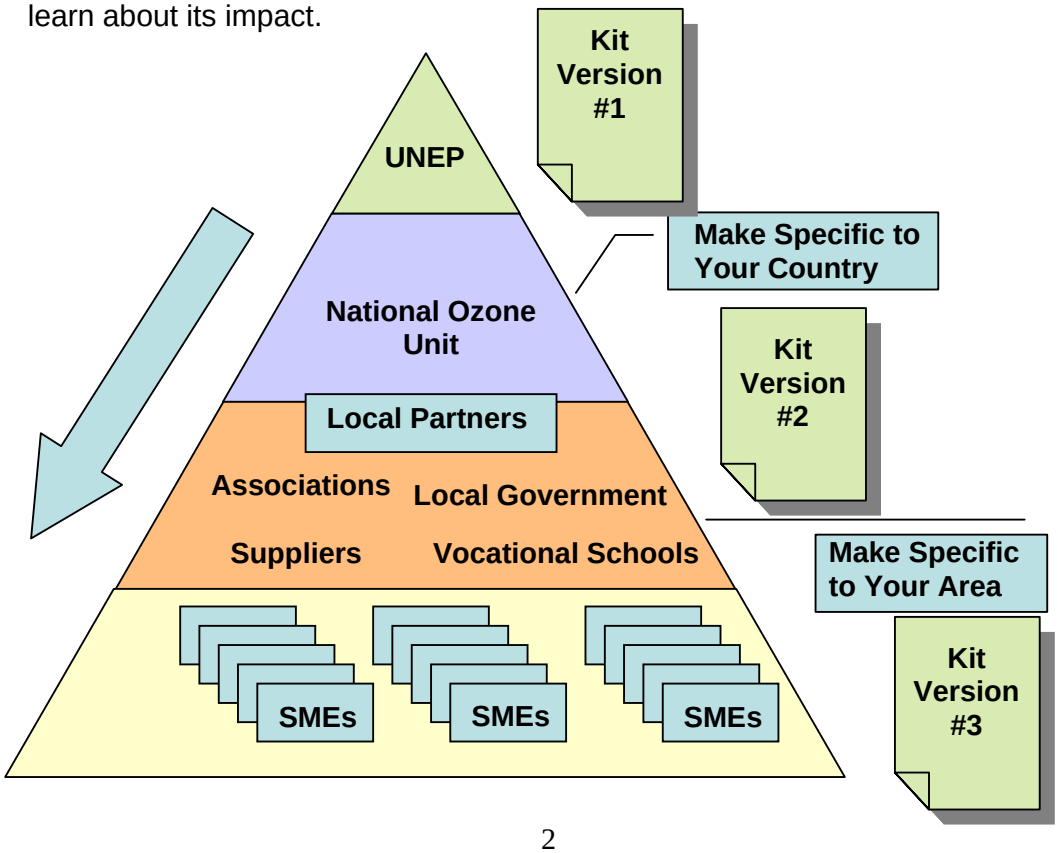
The good practice materials included here are based on existing expert sources (UNEP manuals, implementation experience of the authors, inputs from Quality Review Team members, etc). HIDECOR, a refrigeration and air-conditioning training program that works with primarily SMEs in India also provided significant input to the Kit, including training materials and advice on content and presentation. Good practice in refrigeration and air conditioning aims to reduce the emissions of ozone depleting refrigerants during servicing, maintenance, installation, commissioning or decommissioning of refrigeration and air-conditioning systems.

Guidance for the NOU:

How to Use this Kit

This kit is designed to complement traditional trainings currently taking place in your country. The materials constitute an early warning system to create understanding among SMEs concerning the implications of ODS phase-out to their business/livelihood, and point them to sources of further assistance. The focus of the materials is refrigeration and air conditioning, as it represents the largest share of ODS consumption in developing countries and has the greatest opportunity for supporting the objectives of the Montreal Protocol. This kit is designed to be tailored by the NOU and then be distributed to local partners or intermediaries that may include the following: suppliers, vocational schools, industry associations, and local government business development agencies. Please read the guidance provided for the NOU carefully (pages 1 to 11) and familiarize yourself with the rest of the publication. Please also consider how to best integrate these materials into existing ODS phase-out activities or projects involving SMEs.

You will be asked to modify a small number of pages to add key information relevant to your country's ODS phase-out. You will also be asked to identify SME intermediaries and contact them to determine if they are interested in meeting with SMEs in their local areas. You will then send the modified printed or electronic materials to the interested SME intermediaries using a modified version of the cover letter provided on page 12. Finally, please contact the local partner after they have held a training session for SMEs to learn about its impact.



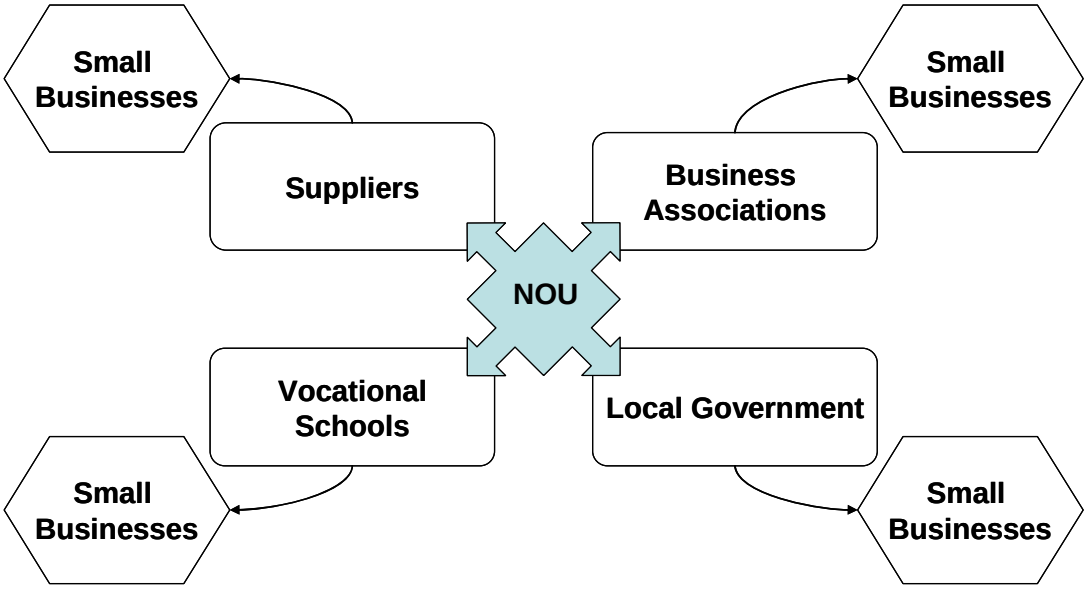
Guidance for the NOU:

Use Local Partners to Disseminate Kit

This kit is designed for dissemination to intermediaries that will then train small business technicians that work with CFCs in the refrigeration and air-conditioning sector. Local intermediaries are best equipped to connect and communicate with small businesses because they live and work with them in their community. Because intermediaries interact with small businesses on a day to day basis, they know how to locate them and what is important to them. Therefore, local intermediaries can act as an expert advisor for the small business community. These intermediaries may include the following:

- suppliers (chemical or equipment),
- vocational schools,
- business or industry associations,
- local government business development agencies
- rotary clubs
- etc.

Through these local partners, you will be able to reach more small businesses than if acting alone.



Guidance for the NOU:
Find a Local Champion

One of the best ways to help local partners attract SMEs is to help them find a local champion in Refrigeration and Air Conditioning Good Practice.

An enthusiastic refrigeration or air conditioning technician, e.g. one who has been trained under a Multilateral Fund training project, can be an important contact for a local intermediary working with SMEs. NOUs should be able to access a list of all such trained Refrigeration and Air Conditioning technicians and provide suggested names to the local partners for potential "leaders." This local champion would be asked to speak on technical issues at a meeting and serve as a local expert contact for SMEs needing technical advice. In addition, a local expert could also be asked to review the technical materials presented to SMEs in order to check their appropriateness.

#1 in Ref & AC

Guidance for the NOU:

Explaining Benefits to Local Partners

Strengthening their linkages to small businesses can benefit intermediaries in several ways:

- Local intermediaries can strengthen their networks and local markets.
- Suppliers can improve customer and government relations and get free publicity.
- Suppliers can also gain new customers by explaining benefits of new chemicals and equipment.
- Vocational schools can attract new students and encourage technicians to receive further training.
- Local government business development agencies can generate contacts and expand their business networks.
- Industry associations can gain the opportunity to broaden membership and generate greater support and interest in the industry.
- Support for your country's compliance with international obligations under the Montreal Protocol
- Positive public image by helping SMEs and protecting the environment

Guidance for the NOU:
Working with Small Businesses

Things to Remember:

A number of barriers have been identified and several lessons have been learned from projects working with small businesses in the past. Technicians in small businesses, especially those in the informal sector, are very difficult to reach. These small businesses are often outside of the mainstream industry and thus are difficult to identify and motivate to participate in trainings or other types of workshops.

Barriers to reaching small businesses and providing ODS management training include:

- Undereducated and inadequately skilled workforce
- Fear of government regulation
- Large and diverse informal sector
- Lack of information and training on ozone issues
- Geographically dispersed small businesses

Lessons Learned:

The following is a list of lessons learned from various projects involving small businesses and the phase-out of ODS:

- The importance of communications and publicity, both to get out the word and to enhance the intermediary's credibility
- Incentives for project participation should be made clear
- Local support for the project is critical
- Having the small businesses cost-share training at a moderate level promotes commitment among business, but does not prohibit participation
- Training should be extremely short as small businesses cannot afford to close their shops or lose one (or more) of their technicians for very long
- Data collection at SMEs should be as minimal as possible, if it occurs
- Local networks should be relied upon to reach many small businesses

Motivations for small business participation include:

- Savings, through the reduction of ODS use through improved servicing practices, and the recycling and reuse of ODS
- Ability to cope with rising ODS costs
- Getting low-cost and high quality technician training
- Positive feedback from customers aware of the ozone layer issue

Guidance for the NOU:
How to Customize the Kit for your Country

The materials included in this kit have been developed in such a way that they can be easily adapted by the NOU to include country-specific information and contacts. This customization process is designed to be very easy to implement: the following check list indicates each of the sheets that you need to modify by adding information. Everything in brackets ([x]) should be customized. Please check off each sheet as you customize it:

☐ 1) The Individual Country Worksheet (Page 11)

This sheet should be tailored with information on CFC phase-out in your country. This page is useful because it presents relevant information in a clear and comprehensive format for those businesses that will be affected by CFC phase-out in your country.

☐ 2) In-country Assistance for SMEs Phasing-Out CFCs (Page 12)

This will be an important resource for small businesses in your country and should include information on general small business assistance as well as phase-out assistance.

☐ 3) Cover letter to for the intermediaries (Page 13)

Please tailor the draft cover letter provided for you.

Once this information is included with the following section for intermediaries, your kit will be customized, and will be ready to use by local intermediaries to reach SMEs. However, the materials in this package are designed to be templates to help NOUs conduct outreach and awareness for SMEs in the most effective way possible based on local conditions, and NOUs should feel free to modify or add any additional information as required.

Note: *Customize the following pages with the requested information for inclusion with the materials given to the local partner.*

Guidance for NOU:
Individual Country Worksheet

[Note to NOU: Please customize this form and include it with the materials for the local partner.]

In [YEAR], [COUNTRY] signed the Montreal Protocol which sets forth guidelines for the phase-out of production and consumption of CFCs. Based on this agreement, [COUNTRY] must stop production and consumption of CFCs in all sectors by [YEAR].

A. Current National Policy and Regulations

1. In [YEAR], [COUNTRY] consumed approximately [NUMBER] tonnes of CFCs in the refrigeration and air-conditioning sector out of a total consumption of [NUMBER] tonnes of CFCs.

2. The final CFC phase-out date is _____.

3. A summary of relevant current regulations is as follows.

4. Existing local and national resources include [Note to NOU: this list of resources could include trade associations, technical schools, or implementing agencies with programs in your country]:

B. Future of CFCs in Your Country

1. Amount of CFC available annually until phase-out:

2. In the future, new regulations may include:

C. Potential Effect on Your Business:

1. Possible cost increases

2. Loss of customers

Guidance for NOU:

In-Country Assistance for SMEs Phasing Out CFCs

[In-Country Assistance Worksheet to be customized by the NOU]

This worksheet should include a list of local and national sources of assistance for SMEs. It should also include a list of organizations who have trained technicians in your area, and existing programmes.

Guidance for NOU:
Introduction

[Note to NOU: Please customize this letter and include it with the materials for the local partner.]

[INSERT NOU OR RELEVANT GOVERNMENT LOGO HERE]

Dear [BUSINESS CONTACT NAME]:

Our Government is a Party to the Montreal Protocol on Substances that Deplete the Ozone Layer, a global treaty that controls and eliminates the production and consumption of ozone depleting substances, like CFCs, according to a strict timetable. On [PHASE-OUT DATE], these ozone depleting substances, which include many types of refrigerants, will be [INSERT RELEVANT LANGUAGE] in your country. Most of the large enterprises in your country have already made the transition to non-ozone depleting substances. However, many small and medium sized businesses (SMEs) have been left behind and therefore need assistance to make this transition away from ozone depleting substances.

You organization has been chosen to help small and medium-sized refrigeration and air-conditioning businesses in your area to reduce and ideally eliminate their use of ozone depleting substances. The materials in this kit constitute an early warning system to help small businesses understand the implications of the ozone depleting substance phase-out to their business and livelihood and point them to sources of further assistance. This kit is designed to compliment formal trainings on good practices in refrigeration and air-conditioning currently available in your country. Information on these formal trainings is available upon further request.

The materials in this kit were produced by the United Nations Environment Programme (UNEP) as part of its work programme under the Multilateral Fund for the Implementation of the Montreal Protocol. Through a partnership between [MINIISTRY NAME] and the UNEP DTIE OzonAction Programme these materials have been adapted for use in [YOUR COUNTRY NAME]. Information presented to technicians from this kit can be tailored to fit the SMEs knowledge so that the information is not repetitive or too advanced to be easily understood. This should be done at the discretion of the training local partner involved.

Your participation is greatly appreciated!

Sincerely,

[NOU REPRESENTATIVE]

Please Customize the Preceding Sheets Before Distribution to Selected Local Partners
and
Reinsert customized materials into the next section.

Guidance for Local Partners:
Introduction

[PLACE HOLDER FOR CUSTOMIZE LETTER TO LOCAL PARTER]

[INSERT NOU OR RELEVANT GOVERNMENT LOGO HERE]

Dear [BUSINESS CONTACT NAME]:

Our Government is a Party to the Montreal Protocol on Substances that Deplete the Ozone Layer, a global treaty that controls and eliminates the production and consumption of ozone depleting substances, like CFCs, according to a strict timetable. On [PHASE-OUT DATE], these ozone depleting substances, which include many types of refrigerants, will be [INSERT RELEVANT LANGUAGE] in your country. Most of the large enterprises in your country have already made the transition to non-ozone depleting substances. However, many small and medium sized businesses (SMEs) have been left behind and therefore need assistance to make this transition away from ozone depleting substances.

You organization has been chosen to help small and medium-sized refrigeration and air-conditioning businesses in your area to reduce and ideally eliminate their use of ozone depleting substances. The materials in this kit constitute an early warning system to help small businesses understand the implications of the ozone depleting substance phase-out to their business and livelihood and point them to sources of further assistance. This kit is designed to compliment formal trainings on good practices in refrigeration and air-conditioning currently available in your country. Information on these formal trainings is available upon further request.

The materials in this kit were produced by the United Nations Environment Programme (UNEP) as part of its work programme under the Multilateral Fund for the Implementation of the Montreal Protocol. Through a partnership between [MINIISTRY NAME] and the UNEP DTIE OzonAction Programme these materials have been adapted for use in [YOUR COUNTRY NAME]. Information presented to technicians from this kit can be tailored to fit the SMEs knowledge so that the information is not repetitive or too advanced to be easily understood. This should be done at the discretion of the training local partner involved.

Your participation is greatly appreciated!

Sincerely,

[NOU REPRESENTATIVE]

Guidance for Local Partners:

Common Abbreviations

CFC Chlorofluorocarbon

GWP Global Warming Potential

HC Hydrocarbon

HCFC Hydrochlorofluorocarbon

HFC Hydrofluorocarbon

MAC Mobile Air-Conditioning

NOU National Ozone Unit

ODP Ozone-Depleting Potential

ODS Ozone-Depleting Substance

R-12 Refrigerant-12 (CFC-12)

R-143a Refrigerant (HFC-134a)

Ref/AC Refrigeration and Air-Conditioning

R&R Recovery and Recycling

UNEP United Nations Environment Programme

UNEP DTIE UNEP Division of Technology, Industry and Economics

Guidance for Local Partners:

How to Identify Refrigerants

Ozone Depleting Refrigerants

The names used for refrigerants can often be confusing. In the tables below the prefix CFC or HCFC has been used. This is helpful as it clarifies what type of refrigerant is being referred to. Unfortunately, the prefixes are often not used – they are replaced with a trade name or the prefix "R". Hence CFC 12 may also be R12 or Arcton© 12 or Forane© 12. The list below shows the most common trade names. Some of these are used for different refrigerant types (e.g. Forane© is used for CFCs, HCFCs and HFCs (hydrofluorocarbons)) whereas others are more descriptive (e.g. Klea© is only used for HFC refrigerants).

Common Trade Names

Arcton© Care© Freon© Forane© Genetron©
Greencool© Isceon© Klea© Solkane© Suva©

Klea = HFCs, Forane = CFCs, HCFCs and HFCs

Ozone Depleting Substances

Name	Refrigerant Name
CFC-11	R-11
CFC-12	R-12
CFC-113	R-113
CFC-114	R-114
CFC-115	R-115
CFC-13	R-13
CFC-111	R-111
CFC-112	R-112

Transitional Ozone Depleting Substances

Name	Refrigerant Name
HCFC-123	R-134a
HCFC-124	R-124
HCFC-141b	R-141b
HCFC-142b	R-142b
HCFC-22	R-22
HCFC-225	R-225

Guidance for Local Partners:

How to Identify Refrigerants

Alternative to Ozone Depleting Refrigerants

Alternatives

Name	Refrigerant Name
HFC-245fa	R-245fa
HFC-125	R-125
HFC-134a	R-134a
HFC-143a	R-143a
HFC-152a	R-152a
HFC-23	R-23
HFC-32	R-32

When in doubt,common refrigerants can be identified through:

- **The stamp provided on the unit data plate.**
- **Thermostatic Expansion Valve for specific refrigerant.**
- **Standing pressure using P-T chart of refrigerant being verified (see table below for the saturation pressure of a few common refrigerants).**

Ambient temperature	Refrigerant	Saturation pressure
30°C	R-12	847.72 kpa Or 108 psig
	R-134a	886.63 kpa Or 114 psig
	HC	107 psig

Guidance for the Local Partners:
Why get involved?

Why were you chosen to Help:

This program is designed to disseminate important and up-to-date information to small businesses working as refrigeration and air-conditioning technicians. Your company/organization was chosen to participate in this project because of your close association with refrigeration and air-conditioning technicians in your area. You also have expertise and contacts necessary to work effectively with small companies, and have the ability to reach and communicate with small companies in your area.

Why You Should Participate:

By participating in outreach to small business in your area, each local partner stands to gain benefits. The follow is a list of likely intermediaries and the benefits they can gain through participation.

Suppliers can:

- Improve loyalty of existing customers
- Benefit from free publicity
- Attract new customers
- Improve their business
- Establish and or improve relationship with government

Vocational schools can:

- Attract new students
- Encourage technicians to seek further training at their school
- Benefit from free publicity to students and the public

Local government business development agencies can:

- Help small companies avoid potentially catastrophic economic dislocation as a result of eventual CFC restriction
- Help introduce new technologies to local businesses.
- Strengthen the capacity of local businesses in their area

Industry associations can:

- Broaden membership
- Generate more support and interest in the industry

For all local partners, involvement can give you a chance to build or strengthen a relationship with the NOU and make a positive contribution to global environmental issues.

Guidance for the Local Partners:
What is Required

The major resources that you will be required to offer are the following:

- **You will need access to a computer and a printer.**
- **You will also need to be able to make copies.**
- **In addition, you will need to have access to a meeting facility.**

The general time requirements for conducting a project like this are:

- **Starting meeting planning two weeks before meeting date at least.**
- **You should need to spend no more than one hour a day to be able to plan this meeting and conduct outreach and publicity.**

Guidance for the Local Partners:
Distribution

Distribute the Materials Contained in this Kit:

This kit contains materials that will help small business managers and technicians improve their business and technical skills, save money, and reduce waste.

In order to inform those businesses and individuals that will benefit most from of this important information about your country's mandatory phase-out of CFCs, your National Ozone Unit (NOU) would like you to help reach out to small businesses in your community. CFCs are widely used by refrigeration and air-conditioning technicians and these technicians need support to make a smooth transition to CFC-alternatives.

The best way to reach out to these small businesses in your area is by organizing one or more information or training meetings with individual businesses or groups of businesses in order to raise their awareness about CFC phase-out. In order to increase attendance to theses meetings we suggest that the local partner walk into some local shops and talk to individuals. Going door-to-door is the best way to reach out to refrigeration and air conditioning technicians in shops. These shops could be mobile air conditioning shops or refrigeration repair shops. It is important to attract technicians as well as owners of these service shops. Therefore it might be necessary to hold one workshop in the day (when technicians are available) and one workshop at night (when store owners are more available).

The following materials in this kit provide basic information on how technicians can improve their technical knowledge, reduce emissions of CFCs, and speed the transition to CFC-alternatives.

Guidance for the Local Partners:
Find a Local Champion

One of the best ways to help local partners attract SMEs is to help them find a local champion in Refrigeration and Air Conditioning Good Practice.

An enthusiastic refrigeration or air conditioning technician, e.g. one who has been trained under a Multilateral Fund training project, can be an important contact for a local intermediary working with SMEs. NOUs should be able to access a list of all such trained Refrigeration and Air Conditioning technicians and provide suggested names to the local partners for potential "leaders." This local champion would be asked to speak on technical issues at a meeting and serve as a local expert contact for SMEs needing technical advice. In addition, a local expert could also be asked to review the technical materials presented to SMEs in order to check their appropriateness.

#1 in Ref & AC

Guidance for the Local Partners:
Plan a Meeting

Plan a Meeting:

If you choose to plan an informational or training meeting, you should follow these basic guidelines for success. In order to allow everyone with interest to attend, the meeting should be held in a central, comfortable location, such as a store, school, workshop, office, or local community center. The meeting should last for about two hours and be held at a time that will not interfere with business or family time. When you are planning this meeting, remember that many small businesses cannot afford to close their shop or lose technicians for more than a few hours. Food should be served in order to attract attendees.

Meeting Basics:

- Approximately 1-2 hours
- At store, school, or community center
- Offer refreshments

Sample Agenda:

TOPIC	SPEAKER	TIME
Registration of Participants	Meeting Host	5:00pm
Opening Remarks	Meeting Host	5:00-5:10pm
Introduction to Project	Technical Expert	5:10-5:15pm
Basics on the Ozone Layer	Meeting Host	5:15-5:45pm
Basics on ODS Phase-Out in Your Country	Technical Expert	5:45-6:00pm
Improving Technical Skills	Technical Expert	6:00-7:00pm

Guidance for the Local Partners:
Advertising

Advertise the Meeting

Now that you've made the preparations, you need to advertise this free information or training meeting to all of the small businesses in your area. For examples of promotional materials please refer to the end of this section.

Effective ways to advertise an information or training meeting include the following:

- Distribute fliers in local community centers or on community/college/ vocational school bulletin boards
- Advertise in local newspapers or trade publication
- Travel door-to-door to tell local businesses of the meeting
- Inform all interested parties of the meeting and ask them to spread the word
- Contact interested parties through refrigeration associations, manufacturers of refrigeration equipment, refrigerant distributors, contractors, and/or importers and wholesalers of refrigeration components and refrigerants.
- Prepare a press release and call members of the appropriate local press to ask their support in publicizing the event
- You could advertise through community meetings, marketplaces, business circles, trade fairs, radio, posters.

Guidance for the Local Partners:
Working with Small Businesses

Things to Remember:

A number of barriers have been identified and several lessons have been learned from projects working with small businesses in the past. Technicians in small businesses, especially those in the informal sector, are very difficult to reach. These small businesses are often outside of the mainstream industry and thus are difficult to identify and motivate to participate in trainings or other types of workshops.

Barriers to reaching small businesses and providing ODS management training include:

- Undereducated and inadequately skilled workforce
- Fear of government regulation
- Large and diverse informal sector
- Lack of information and training on ozone issues
- Geographically dispersed small businesses

Lessons Learned:

The following is a list of lessons learned from various projects involving small businesses and the phase-out of ODS:

- The importance of communications and publicity, both to get out the word and to enhance the intermediary's credibility
- Incentives for project participation should be made clear
- Local support for the project is critical
- Having the small businesses cost-share training at a moderate level promotes commitment among business, but does not prohibit participation
- Training should be extremely short as small businesses cannot afford to close their shops or lose one (or more) of their technicians for very long
- Data collection at SMEs should be as minimal as possible, if it occurs
- Local networks should be relied upon to reach many small businesses

Motivations for small business participation include:

- Savings, through the reduction of ODS use through improved servicing practices, and the recycling and reuse of ODS
- Ability to cope with rising ODS costs
- Getting low-cost and high quality technician training
- Positive feedback from customers aware of the ozone layer issue

Guidance for the Local Partners:
Guide to Kit Materials

There are a variety of materials in this kit that can be used to help refrigeration and air-conditioning technicians reduce their dependence on ozone depleting refrigerants and prepare for their unavailability in the future. The table below presents a description of the various materials available for distribution. Depending on the targeted businesses and technicians, a selection of materials can be chosen for distribution, using the 'How To Use It' column as a guide.

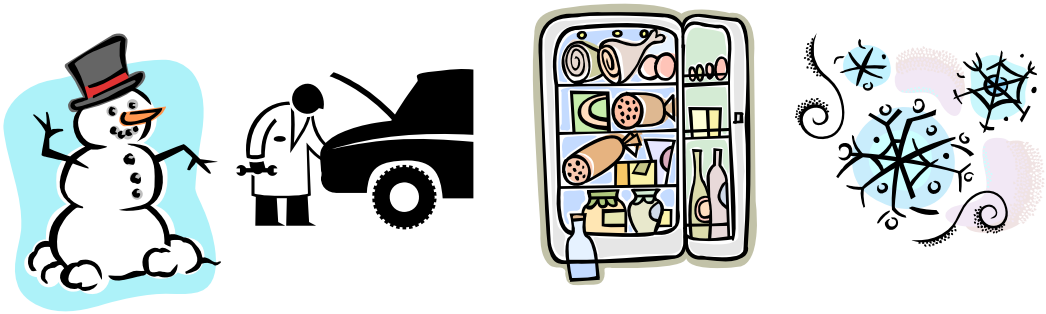
Material Name	How To Use It
Promotional Strategy for SME Meeting	These materials can be used to advertise your meeting and will help establish your credibility as a reliable source of information.
• Advertising Fliers	Flyers should be posted in locations where they will be easily visible to technicians and SME owners, especially at shops which supply CFCs and equipment related to refrigeration and air conditioning.
• Meeting Agenda	A sample meeting agenda is provided, in order to help you organize the meeting and to ensure that all the key information is covered. This agenda can be reproduced and distributed to all meeting attendees.
• Press Releases	This sample press release can be customized and distributed to local media in order to advertise your meeting. If possible, a connection should be made between the program and a high-profile person within the local community.
Outreach and Awareness	These materials can be distributed to small businesses as general awareness materials for them and their customers. In addition they can be made available in public places to raise community awareness. Materials on the quality of recycled CFCs and other ozone depleting substances should be located at facilities where recycling is offered.
• General Ozone and Environment Issue • Ref/AC Servicing and the Environment • Recycled ODS Quality	
Technical Assistance	
• Phase-Out of ODS in Your Country	This information sheet has been tailored with information about the future availability of CFCs in your country. All interested parties should receive a copy of this sheet.
• Stationary Ref/AC Servicing Guide	This guide can be used to train stationary refrigeration and air-conditioning servicing technicians in the basics of stationary refrigeration and air-conditioning servicing and emissions reductions.
• Mobile Air Conditioning (MAC) Servicing Guide	This guide can be used to train MAC servicing technicians in the basics of MAC servicing and emissions reductions.

Promotional Materials: Sample Flyer

LEARN HOW TO BE A

COOLER

AIR CONDITIONING AND REFRIGERATION TECHNICIAN!!



MEETING LOCATION?

MEETING TIME?

LOCAL OFFICIAL OR EXPERT TO ATTEND?

Promotional Materials: Sample Meeting

TOPIC	SPEAKER	TIME
Registration of Participants	Meeting Host	5:00pm
Opening Remarks	Meeting Host	5:00-5:10pm
Introduction to Project	Technical Expert	5:10-5:15pm
Basics on the Ozone Layer	Meeting Host	5:15-5:45pm
Basics on ODS Phase-Out in Your Country	Technical Expert	5:45-6:00pm
Improving Technical Skills	Technical Expert	6:00-7:00pm

Promotional Materials: Sample Press Release

[Insert your government logo here]

[Insert your business logo here]

PRESS RELEASE: [Add local business name] TRAINS REFRIGERATION TECHNICIANS TO SAVE OUR OZONE LAYER
For Immediate Media Release

Contact Information:
[add your information here]

On [insert date] [insert local business name] is planning a meeting to assist local refrigeration and air conditioning technicians and businesses in their phase-out their use of dangerous ozone depleting substances like CFCs. [Local business name] will be working with small and medium-sized refrigeration and air conditioning businesses to raise their awareness of the date that CFCs and other ozone depleting substances will become illegal, [Insert date here].

The stratospheric ozone layer protects life on Earth from short-wavelength ultraviolet radiation produced by the sun. Excessive ultraviolet- B radiation is well known to cause human health problems such as skin cancers, eye cataracts, and weakening of the immune system; it also results in smaller crop yields and damage to plant genetic material, damage to marine ecosystems, reduced fishery yields, and animal health problems. The ozone layer absorbs almost all most ultraviolet-B radiation, and completely screens out ultraviolet-C radiation, thus shielding the earth's surface.

In many developing countries, CFC-12 and CFC-11 refrigerants will have to be phased out by 1st January 2010. However, HCFC-22 used as a refrigerant in air-conditioners, can be phased out by 1st January 2040; indicating availability of more time for its phase-out. Production and consumption of CFCs in developing countries must stop by the year 2010, although many developing countries have pledged to reduce and cease production / consumption before that date.

This Concludes the Guidance Section of the Document. The next section of the document contains materials for SMEs.

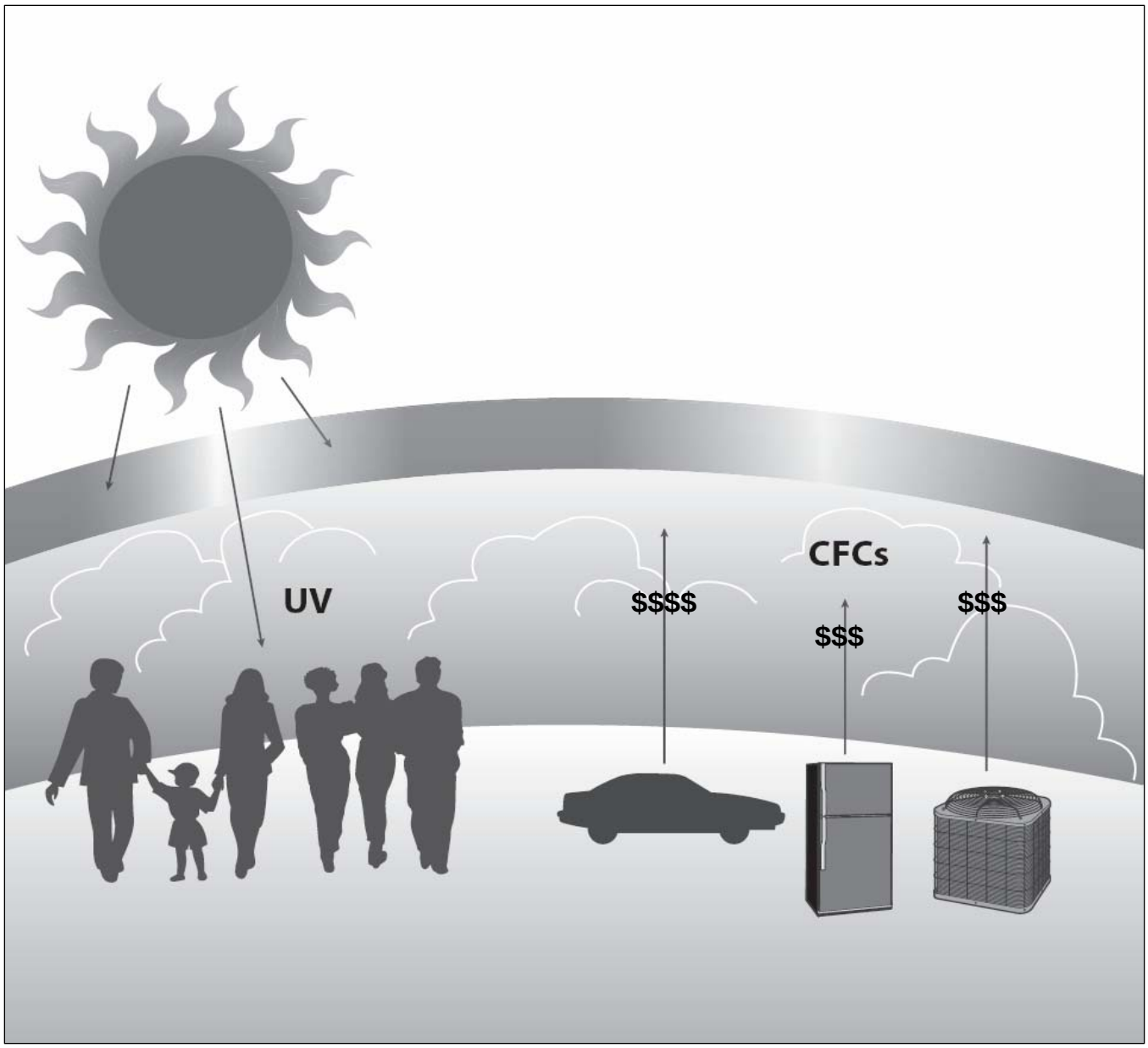
This Includes:

1. **The Small Business Ozone an ODS Awareness Workbook**
2. **The Stationary Ref/AC Servicing Guide**
3. **The Mobile AC Servicing Guide**

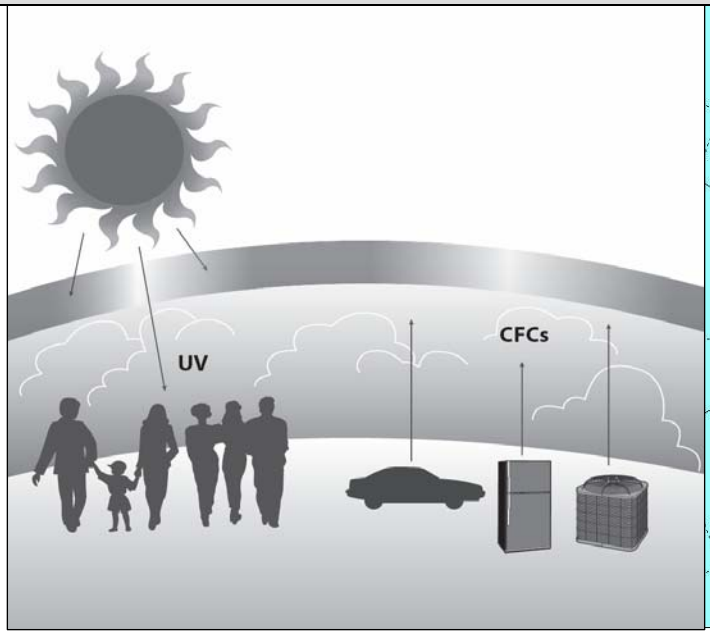
STOP WASTING CFCs!

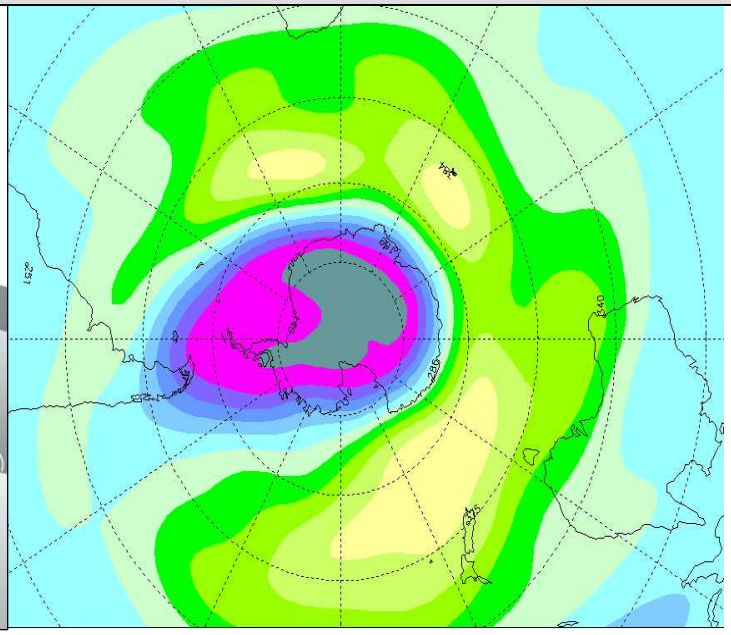
HOW YOUR BUSINESS CAN SAVE THE OZONE LAYER AND MONEY $$

A SUPPORT GUIDE FOR SMALL BUSINESSES



What's wrong with the Ozone Layer?





Hole in Ozone Layer

Our Damaged Ozone Layer

- **Scientist worldwide have concluded that CFCs and other gases released into the atmosphere deplete the ozone layer.**

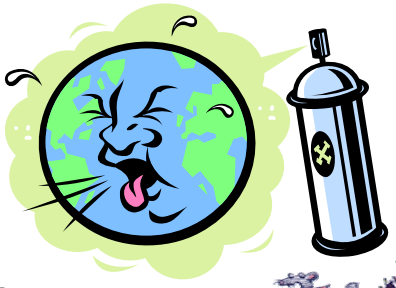
- **Depletion of the ozone layer allows more UV radiation to reach the earth. Scientists around the world agree that increased UV radiation can cause:**
  - **Health Impacts, such as a rise in cases of skin cancer and cataracts, and**
  - **Damage to important food crops and ecosystems.**

Why is this happening?

- It is happening because of many reasons, for example some are released due to:
  - poor servicing or maintenance practices by technicians
  - leaks from operating equipment (e.g. air conditioners in automobiles)
  - damaged, discarded or scrapped equipment
  - inadvertent release during chemical production

- CFCs can be found in your air conditioner, refrigerator and your car air conditioner to name just a few locations.

- CFCs hurt the ozone layer when they are released into the atmosphere as waste!



- Waste CFCs are also a waste of money!

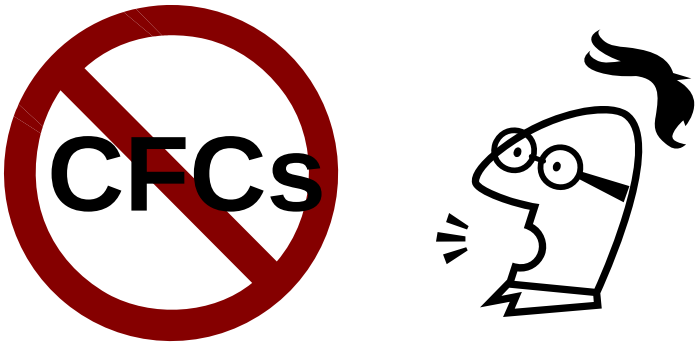
$$$$$$$

-NEWS FLASH-
Almost every country has agreed to stop using and making CFCs by 2010!!

Individual Country Worksheet

[Place holder for Individual Country worksheet to be customized by the NOU]

What does this mean for me and my business?



"I will no longer be able to buy and use CFCs!!"

- CFCs are being phased out and will not be available forever.
- If you do not switch to other refrigerants and/or equipment, the profitability of your business will be at risk.
- Better to switch sooner rather than later. Many companies and countries have already made the transition away from CFCs.
- Don't wait until it's too late!

Will this cost me money?

Use this table to calculate the cost to your business from the rising cost of CFCs in the next 6 years. On the right of the table calculate the potential savings through CFC Usage Reduction.

Existing CFC Usage (kg)		Existing Costs ($)		CFC Use Reduction (kg)		CFC Cost Savings ($)	
Monthly Usage	Annual Usage	Monthly Cost	Annual Cost	Monthly Reduction	Annual Reduction	Monthly Savings	Annual Savings
25	300	75	900	7.5	90	22.5	270
50	600	150	1800	15	180	45	540
100	1200	300	3600	30	360	90	1080
200	2400	600	7200	60	720	180	2160
300	3600	900	10800	90	1080	270	3240
400	4800	1200	14400	120	1440	360	4320
500	6000	1500	18000	150	1800	450	5400

Note: For purposes of illustrating this point we assume the unit cost of CFC to be $3/kg. This is meant to be illustrative only and not the true cost of CFCs.

Based on experience in other countries, it is possible that prices of CFCs may double by 2010. The table below describes how your business operating costs related to purchasing CFCs may increase over time as a result of this rise in the market price.

IF CFC PRICES DOUBLE BY 2010						
Your Monthly CFC Useage (kg)	Your Current Annual CFC Cost ($)	Your Future Annual CFC Costs ($)				
		2006	2007	2008	2009	2010
25	$900	$1,035	$1,190	$1,369	$1,574	$1,810
50	$1,800	$2,070	$2,381	$2,738	$3,148	$3,620
100	$3,600	$4,140	$4,761	$5,475	$6,296	$7,241
200	$7,200	$8,280	$9,522	$10,950	$12,593	$14,482
300	$10,800	$12,420	$14,283	$16,425	$18,889	$21,723
400	$14,400	$16,560	$19,044	$21,901	$25,186	$28,964
500	$18,000	$20,700	$23,805	$27,376	$31,482	$36,204

Note: The authors cannot accurately predict if prices will rise, but this table provides an illustrative example of possible price increase if prices rise at the level indicated.

Guidance for Local Partners:

How to Identify Refrigerants

Ozone Depleting Refrigerants

The names used for refrigerants can often be confusing. In the tables below the prefix CFC or HCFC has been used. This is helpful as it clarifies what type of refrigerant is being referred to. Unfortunately, the prefixes are often not used – they are replaced with a trade name or the prefix "R". Hence CFC 12 may also be R12 or Arcton© 12 or Forane© 12. The list below shows the most common trade names. Some of these are used for different refrigerant types (e.g. Forane© is used for CFCs, HCFCs and HFCs (hydrofluorocarbons)) whereas others are more descriptive (e.g. Klea© is only used for HFC refrigerants).

Common Trade Names

Arcton© Care© Freon© Forane© Genetron©
Greencool© Isceon© Klea© Solkane© Suva©

Klea = HFCs, Forane = CFCs, HCFCs and HFCs

Ozone Depleting Substances

Name	Refrigerant Name
CFC-11	R-11
CFC-12	R-12
CFC-113	R-113
CFC-114	R-114
CFC-115	R-115
CFC-13	R-13
CFC-111	R-111
CFC-112	R-112

Transitional Ozone Depleting Substances

Name	Refrigerant Name
HCFC-123	R-134a
HCFC-124	R-124
HCFC-141b	R-141b
HCFC-142b	R-142b
HCFC-22	R-22
HCFC-225	R-225

Guidance for Local Partners:

How to Identify Refrigerants

Alternative to Ozone Depleting Refrigerants

Alternatives

Name	Refrigerant Name
HFC-245fa	R-245fa
HFC-125	R-125
HFC-134a	R-134a
HFC-143a	R-143a
HFC-152a	R-152a
HFC-23	R-23
HFC-32	R-32

When in doubt, common refrigerants can be identified through:

- **The stamp provided on the unit data plate.**
- **Thermostatic Expansion Valve for specific refrigerant.**
- **Standing pressure using P-T chart of refrigerant being verified (see table below for the saturation pressure of a few common refrigerants).**

Ambient temperature	Refrigerant	Saturation pressure
30°C	R-12	847.72 kpa Or 108 psig
	R-134a	886.63 kpa Or 114 psig
	HC	107 psig

What are my options?

The following is a list of four options for you to explore. This workbook is laid out with a section for each option.

1. Follow Good Practices

- **Training to prevent waste CFCs**
- **Please refer to Stationary and Mobile Servicing Guides on basic good practice (attached).**

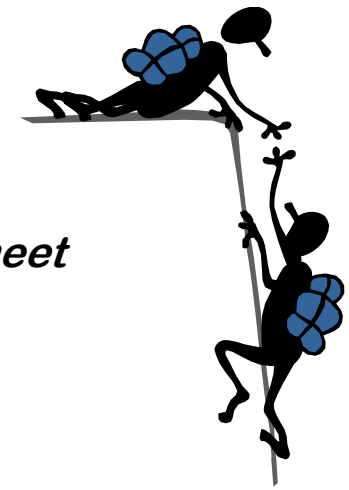
2. CHANGE TO ALTERNATIVE REFRIGERANT

- **Change CFCs to an Alternative, like**
  - **HFC 134a (R-134a),**
  - **Hydrocarbons, or**
  - **Drop-Ins (blends of refrigerants).**

3. GET NEW EQUIPMENT

- **New Servicing Equipment**
- **Recycling Equipment**

4. HELP IS AVAILABLE



Please refer to
In-Country Assistance Worksheet

1. Follow Good Practices:

Stationary Refrigeration and Air Conditioning Good Practices

BASIC STEPS TO

Refrigeration and Air Conditioning Good Practices

STEP 1: Recover of Refrigerant

STEP 2: Removal and replacement of the compressor, filter drier, evaporator, capillary, condenser etc.

STEP 3: Service and Repair: Flush and Clean the System

STEP 4: Replacing Components and rebrazing them into the system.

STEP 5 : Leak Testing and Evacuating the System

STEP 6: Accurate Refrigerant Charging

Important Reminders!

- Do not top off before repairing leakage
- Do not flush system letting CFCs escape
- Do not overcharge
- Retrofit or drop-in
- Safety

FOR MORE DETAIL SEE STATIONARY AND MOBILE SERVICING GUIDES
(Provided by your meeting organizer)

1. Follow Good Practices:

Stationary Refrigeration and Air Conditioning Good Practices

(Explanation of these steps was written by NCCoPP)

STEP 1: Recovery of Refrigerant

Recovery is to remove refrigerant in any condition from a system and store in an external container without necessarily testing or processing. Before you start major work on a unit all refrigerant must be recovered. One can use either an active or a passive way to recover refrigerant. For more details please see the stationary and mobile servicing guides.

STEP 2: Preparation for Repairs

Prepare for repairs with brazing kits, double-mouthed filter driers, extra lengths of process tubes, hand shut-off valves/ball valves or process tube adaptors and couplers, and cut off/debraze the components that need replacement. Filter driers should always be replaced.

STEP 3: Flush & Clean

Flush and clean the system with nitrogen of purity of at least 99.995% and -40C Dew Point at 5 bar pressure. Use trichloroethylene to clean the components if the compressor has suffered a motor burnout. After using trichloroethylene, remember to heat the components with high watt bulbs or a heat gun to vaporize and remove all traces of liquid trichloroethylene.

STEP 4: Re-assembling

You can re-assemble the system with new or repaired components. Use electrodes with at least 45% silver when brazing the steel tubes of the condenser to the compressor discharge tubing or the filter drier, both being made of copper to avoid brittle joints. Once the brazing is done, check for brazing chokes, particularly at the capillary ends using nitrogen.

1. Follow Good Practices:

Stationary Refrigeration and Air Conditioning Good Practices

(Explanation of these steps was written by NCCoPP)

STEP 5: Leak Testing and Evacuating

Leak test the re-assembled system with pure dry nitrogen at 10 bar pressure. Then evacuate the system using: A two-stage, rotary oil, sealed vacuum pump with a two or four-way manifold or with a composite E&C unit comprising the vacuum pump, manifolds, gauges, interconnections and charging hoses. An electronic vacuum gauge that can read vacuum in microns of Hg. Ensure that vacuum is pulled down to 500 microns or lower and then have the system tested for its ability to hold vacuum. The upper level of acceptance for the holding test is 1500 microns. The lower the level, i.e. the closer to 500 microns, the better is its vacuum holding or leak-prevention capacity.

STEP 6: Accurate Charging

After the evacuation of the system, it has to be charged with the refrigerant, preferably of the same weight mentioned by the OEM of the appliance on the nameplate. After charging the refrigerant, test whether the appliance is functioning properly. During the performance test, make sure that:

1. **The appliance is pulling down from the ambient temperature to the expected temperature within a reasonable time. The temperature should be measured with a thermometer, whose sensor is placed in the air inside the cabinet or freezer.**
2. **The current drawn by the appliance at the voltage prevailing at the site is monitored. Any abnormally high or low current needs investigation after correcting the voltage.**
3. **The suction and discharge pressures during and after pull down have stabilized. Any abnormally low or high suction or discharge pressure is a cause for concern.**

2. CHANGE OLD EQUIPMENT:

Change CFC Equipment to an Alternative

New equipment installations should not use CFC refrigerants. Where possible, refrigerant with small or zero ozone- depleting potential (HFCs or HCs) should be used, bearing in mind the overall environmental impact with regard to safety issues. If CFC refrigeration systems need to be installed, the following aspects should be considered in addition to goodservicing principles for operation and maintenance:

1. Check the machinery room for appropriate size and ventilation; maintain a minimum distance from the walls to avoid overheating of compressors and condensers.
2. Ensure cleanliness of piping systems and fittings prior to fitting into position and during installation.
3. Prevent oxidation during brazing or soldering by flushing through with dry nitrogen.
4. Blow through the pipework with dry nitrogen to remove welding, brazing or cutting debris; under no circumstances should oxygen be used.
5. Check the accessibility of piping with regard to inspection, maintenance and repair and avoid refrigerant-carrying lines in the ground, lakes or watercourses.
6. Check all refrigerant lines and mechanical joints for tightness before introducing tracer gas.
7. Perform leak testing to ensure system tightness.
8. Label each system with clear details of the equipment, technical data, and the type and volume of the refrigerant and lubricant.
9. Check the pressure vessel documents and pressure-testing certificates and ensure that containers have appropriate name plates.

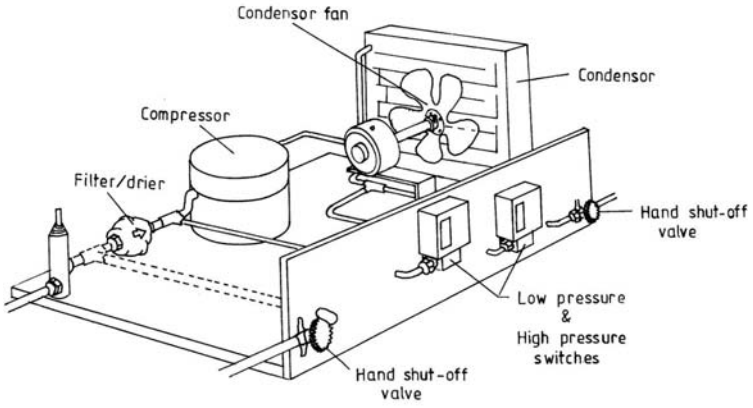
3. GET NEW EQUIPMENT:

Buy New Equipment

- **New Servicing Equipment**
- **Recycling Equipment**
- **Some recovery machines also are recovery/recycle machines**

Simple Recovery Machine

- Recovers the refrigerant as a vapor and condenses it before it enters the cylinder

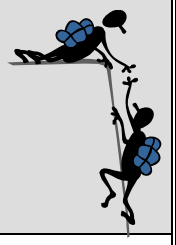


Recovery Machine Diagram: Courtesy of HIDECOR

Mobile Air Conditioning Recovery Recycling Machine Courtesy of ICF

4. Help is on the Way:

In-Country Assistance Worksheet



[Place holder for In-Country Assistance Worksheet to be customized by the NOU]

The following are servicing guides for stationary and mobile refrigeration and air conditioning. Local partners will be able to distribute these guides to SMEs who are interested in additional information on good practices.

Ref/AC Servicing Guide

Topic Guide

1. RAC Basics
2. Refrigerants
3. Leak Testing
4. Flushing/Purging/Cleaning
5. Charging Refrigerants
6. Recovery, Recycling, Reclamation Definitions
7. Recovery
8. Recycling
9. Retrofitting

Ref/AC Servicing Guide

RAC Basics: Steps Involved in Servicing

Servicing of RAC-Based Appliances Include:

- Recovery of Refrigerant
- Cleaning and Flushing
- Repair
- Flushing and Choke Testing
- Evacuation & Vacuum Holding
- Charging Refrigerant
- Sealing of Process Tube
- Checking for Proper Operation

Additional steps in HC-Based Appliances Include:

- Safe venting of HCs.
- Removal of left-over refrigerant using vacuum pump.

Ref/AC Servicing Guide

RAC Basics: Problems due to air and moisture

Problems resulting from air in a system:

- Increased high-side and low-side pressure.
- Increased energy consumption.
- Unable to achieve low temperature.
- Trips high-pressure safety cut-out.

Problems resulting from moisture in a system:

- Blocked expansion valve/cap tube.
- Acid formation in refrigerant oil.
- Premature compressor bearing failure.
- Winding burnout in hermetic compressors.

Ref/AC Servicing Guide

RAC Basics: Servicing Precautions

During recovery of gases:

- **Do not overfill the cylinder.**
- **Do not mix grades of refrigerant.**
- **Use only clean cylinders.**
- **Check pressure of cylinder.**
- **Recovery cylinder has a specific indication depending on the country in order to not be confused with virgin refrigerant container.**

Key Ideas:

- **Taking correct servicing precautions will help ensure safety and improve servicing results.**

Brazing is required for correct joint preparation. It requires:

- **Right surface preparation**
- **Joint clearances**
- **Correct temperature**
- **Correct flux**

For cleaning and flushing, do not use:

- **CTC/Petrol (gasoline)**
- **Air**
- **Oxygen**

Leak Testing:

- **Do not use compressed air as it contains moisture, lubricants, other gases and refrigerants.**

Ref/AC Servicing Guide

RAC Basics: Refrigerants and Safety

Safe handling, transport and storage of cylinders:

- Clearly label cylinders to indicate type of refrigerant.
- Fit the valve cap when cylinder is not in use.
- Do not expose cylinder to temperatures greater than 50°C.
- Do not tamper or repair valves or cylinders.
- Do not refill cylinders except when they are specifically designated for recovered refrigerant.
- Decanting of refrigerant:
    - Decant in a well-ventilated area.
    - Evacuate and weigh cylinder before filling.
    - Use a short transfer hose to reduce refrigerant loss.
    - Evacuate or purge air from the hose carefully to minimize refrigerant loss.
    - Fill cylinder to 80% full by weight with liquid refrigerant to allow expansion if cylinder temperature increases.

Key Ideas:

- Avoid contact with refrigerants.
- Insufficient ventilation may cause suffocation.

Safe Handling of Refrigerants:

- Contact with liquid refrigerant causes freeze burns. Treat by washing affected area with cold water.
- Gloves, goggles, and protective clothing should be worn when handling refrigerant.
- Because refrigerants are heavier than air, they will collect at low levels. These areas should be well-ventilated.
- Refrigerants displace air and may cause suffocation. Person suffering should be moved to an uncontaminated area and kept warm. Medical attention and artificial respiration may be necessary.
- Most commonly used refrigerants are non-toxic but exposure should be minimized.

Ref/AC Servicing Guide

RAC Basics: Refrigerants and Safety

Safety during servicing:

- Never smoke while handling refrigerants as they are flammable.
- Work in a well-ventilated area.
- Do not vent refrigerant to the air.
- Keep charging equipment in a safe place.
- Have fire extinguishers in the servicing area.

Safety during transportation and storage:

- Store refrigerant cylinders and appliances vertically.
- Transport in open vehicles.
- Store gases in a secure location protected from weather and direct sun.
- Do not store cylinders next to windows.
- Close and cap cylinder valves.
- Use cylinders only to carry refrigerants.

Ref/AC Servicing Guide

Refrigerants: Different Types
Refrigerants: HC Refrigerants

Different Types of Refrigerants Include:

- **Chlorofluorocarbons (CFCs)**
- **Hydrochlorofluorocarbons (HCFCs)**
- **Hydrofluorocarbons (HFCs)**
- **Halogen-free refrigerants – Ammonia, Hydrocarbons**

Common Refrigerants Can Be Identified Through:

- **Refrigerants stamped on unit data plate.**
- **Thermostatic Expansion Valve for specific refrigerant.**
- **Standing pressure using P-T chart of refrigerant being verified.**

Ambient temperature	Refrigerant	Saturation pressure
30°C	R-12	847.72 kpa Or 108 psig
	R-134a	886.63 kpa Or 114 psig
	HC	107 psig

Ref/AC Servicing Guide

Refrigerants: R-12 and R-134a Appliances

Technical Tips:

- **R-134a requires a different motor and lubricant.**
- **Compressor's displacement may be slightly larger with R-134a.**
- **Filter driers with R-134a must have greater moisture absorption capacity.**
- **Capillary tube for HFC-134a is 10%-20% longer.**
- **R-134a charge is about 90 – 95% of the R-12 charge.**
- **Condenser may be about 15% larger for R-134a equipment.**

Ref/AC Servicing Guide

Leak Testing: Causes of Leakage

What causes of leaks?

- **Vibration – causes "work hardening" of copper, misalignment of seals, loosening of securing bolts to flanges, etc.**

Key Ideas:

- **Environmental changes can cause leaks.**
- **Poor materials can cause leaks.**

- **Pressure changes – can result in material stress and differential expansion and contraction.**
- **Temperature changes – can result in material stress and differential expansion and contraction.**
- **Frictional wear – can result in material failure.**
- **Incorrect material selection - certain types of hoses have a known leakage rate; some materials known to fail under conditions of vibration, changing pressure and temperature.**
- **Poor quality control on original equipment – changes in vibration, pressure and temperature will cause failure.**
- **Accidental damage.**

Ref/AC Servicing Guide

Leak Testing: General Tips for Leak Testing

Technical Tips:

- **If refrigerant is low, system must be tested for leaks before recharging.**
- **There are a number of problems that may occur in an air-conditioning system which may appear like a refrigerant leak**
    - **E.g. Fan, compressor and various controls are in operation, but system is not cooling**
- **Presence of oil around a tubing joint usually indicates leaks, but this should not be a determining factor.**

Key Ideas:

- **Test for leaks before recharging.**
- **Test whole system even if one leak has already been found.**

Types of Leak Testing:

- **<u>Electronic and ultrasonic testers:</u> are effective for locating the general area of small leaks. Many electronic leak detectors sniff or take small air samples around equipment to detect leaks.**
- **<u>Bright (red or blue) oil-soluble dyes</u>: improve the odds of identifying leaks by adding bright red or blue dyes to the system that mix with the oil residue at the source of small leaks.**
- **<u>Ultraviolet lamps</u>: illuminate the fluorescent dye and detect leaks as small as a quarter of an ounce per year. An ultraviolet lamp leak detection system requires that an additive be introduced into the refrigerant system. The additive will show as a bright yellow-green or blue glow under the ultraviolet lamp at the source of the leak.**
- **<u>Ultrasonic leak detectors:</u> listen for leaking gas. This method requires some advance knowledge of the location of the leak and a fairly low background noise level. It is used with a nitrogen test gas and can also be used with a noise source of a specific frequency placed inside the equipment and the detector tuned to the frequency.**

Ref/AC Servicing Guide

Leak Testing: Soap Solution & Ultra-violet Lamp Method

Soap Solution Method:

- Use pure dry nitrogen at a pressure of about 10 bar.
- Let nitrogen into the system with the valve on the filter drier closed.
- Apply soap solution with brush to identify leaks.
- Release the nitrogen and repair faulty joint.
- Retest for leaks.

Key Ideas:

- Bubbles reveal the presences of a leak.

Key Ideas:

- A yellow-green glow under the ultraviolet lamp indicates a leak.

Ultra-violet Lamp Method:

- This method is often used in large systems that prevent the use of soap solution or electronic detectors.
- A dye is added to the system servicing valves.
- A yellow-green glow occurs when the ultraviolet lamp is applied to the dye indicating a leak.

Ref/AC Servicing Guide

Leak Testing: Electronic Leak Detector

Technical Tips:

- One person should be designated by the shop to use and take care of the leak detector.
- Tip of the electronic leak detector is fragile and should be handled carefully.
- When using an electronic leak detector, run the probe UNDER the seals, hoses, etc., because refrigerant is heavier than air and will settle toward the floor. Also, you can cup your hand under the suspect leaks to catch the refrigerant that escapes and therefore detect leaks more easily.

Key Ideas:

- Never place the probe in areas where severe leaks are know to exist as the sensitivity components could be damaged.
- DO NOT use high powered fans near the unit when using an electronic leak detector because refrigerant that has already leaked tends to settle to a corner and may be stirred up by the fan, thereby causing an incorrect leak detection.
- Electronic leak detectors should be used in well-ventilated areas; otherwise the leak detector may detect CFC in the ambient air.

Ref/AC Servicing Guide

Leak Testing: Halide Torch & High-pressure Method

Halide Torch Method:

- Blue flame draws air and refrigerant up to sniffer hose.
- Refrigerant burns causing the blue flame to change to green.

Key Ideas:

- Flame changes from blue to green when there is a leak.

High-pressure Method:

- Use nitrogen gas to increase system pressure to value of 300 psig at maximum.
- Monitor pressure drop on gauges or listen to leak whistle.

Key Ideas:

- Dropping pressure indicates a leak.

Ref/AC Servicing Guide

Flushing/Purging/Cleaning

Why is flushing required?

- Flushing is important before replacing components after servicing. Motor burn outs or failures of compressors lead to contamination of systems.
- The compressor, filter drier and capillary will have to be replaced when the compressor burn out is complete.
- The rest of the system has to be cleaned with either Trichloro-ethylene or Hexane. The cleaned components should then be warmed to evaporate all the residual Trichloroethylene. The presence of any chlorinated compounds in liquid form can lead to formation of gel and sludge which can choke the capillary. This happens more in case of HFC – 134a.

Key Ideas:

- Flushing is recommended to remove debris and contamination left behind after compressor failure, desiccant breakdown, or repeated clogging of the orifice tube or expansion valve.
- Flushing is also recommended if the system may have been contaminated by anything other than the original refrigerant or if it contains excessive refrigerant oil.
- R-12 and R-11 deplete the ozone so it is very important to prevent their escape during flushing.

Precautions to be taken:

- Isolate and segregate sections of the system to the maximum extent possible.
- Transfer contaminated refrigerant to approved recovery containers.
- Clean each section separately using a non- ODS
- After cleaning the evaporator and condenser with the chemical agent the system will then have to be flushed with pure dry Nitrogen. Please check for purity of nitrogen (99.995% and dew-point of -40C).

Ref/AC Servicing Guide

Flushing/Purging/Cleaning

Technical Tips:

- If the compressor motor has burnt-out, acid and sludge will have spread throughout the system. Therefore a chemical must be used to clean the system. Trichloroethylene or Hexane solvent can be used. Do not use CTC or Petrol.
- When using tricholoroethylene, work in a ventilated area and wear gloves. After using Tricholoroethylene, the components should be heated with high wattage bulbs or a heat gun in order to evaporate all the chemical.
- After the use of a chemical cleaning agent, the system must be flushed with nitrogen.
- If the compressor motor has not burnt-out, it is only necessary to flush with nitrogen.
- Remember to flush in both directions to dislodge any material caught in condenser and other system components.
- Using very high pressures above 150 psi may damage system components
- Solvents used in flushing must be fully extracted from the system. If any solvent is left behind, the solvent may destabilize the refrigerant and damage the system.
- High pressure flushing may cause leaks. Check thoroughly for leaks after flushing.
- Flushing removes oil from the system, which must be replenished before recharging.
- Flushing with nitrogen does not remove oils.
- New flushing substances include a hydrocarbon turpine solution and an ester solution.
- Never use compressed air to flush an R-134a system or R-134a servicing equipment. Pressurized air and R-134a can cause a fire or explosion. Compressed air contains humidity which may damage the system.
- Never flush with CFC products, since this will result in unnecessary and costly emissions of an ozone depleting substance. Flushing an R-134a system with a CFC product may also result in the breakdown of the lubricant or in system corrosion.
- Open vent flushing does not always remove failed compressor material from condenser units. Use of in-line filters is considered a more effective method of controlling debris resulting from component failures.

Ref/AC Servicing Guide

Charging Refrigerants

Technical Tips:

- To charge precisely and avoid future problems:
  - Use a thermometer, a manifold gauge set and a pressure/ temperature chart (see next page) indicating the proper relationship between system pressure and temperature of the air
  - Use a scale that weighs the refrigerant
  - Use a graduated cylinder that measures the refrigerant
  - Use an automatic recharging station
- Charging based only on pressure can be imprecise, potentially causing overcharging and eventual damage to the system.

Key Ideas:

- If a system needs recharging, it must have a leak somewhere.
- Overcharging can damage the compressor.
- Charging should be done slowly and gradually.
- Only evacuated systems should be charged.

- When charging with pressure, the technician should consider the humidity and air temperature inside the shop.
- Air-conditioning systems should be fully evacuated and all moisture should be removed before a system is charged.
- If refrigerant is recovered from an A/C system using a recovery/recycling machine, oil must be added during the recharging.
- Never mix R-13 and R-134a gases or oils.
- Technicians should recommend to customers that a system's refrigerant be recovered if the system needs charging, so that leaks can be found and repaired. "Top-up" charging without evacuation and leak repair lead to unnecessary leakage of refrigerant.
- The following conditions are good signs that a system has been under or over changed.

Undercharged	Overcharged
Low Suction Pressure	High Discharge Pressure
High Superheat	High Discharge Temperature
Compressor Motor Overheats	Liquid flood back into compressor
Low Cooling Capacity	Low Cooling Capacity
Poor Energy Efficiency	Poor Energy Efficiency
Sludge/ Carbonization in Compressor	Sludge/ Carbonization in Compressor

Ref/AC Servicing Guide

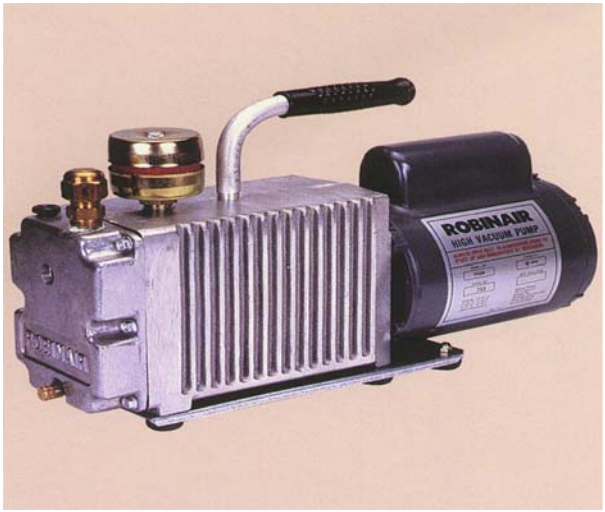
Evacuation

Key Ideas:

- A refrigerating system must contain only the refrigerant and dry oil in order to function properly. Everything else, like air and moisture, must be removed through evacuation.
- Failure to evacuate the system properly will result in repeated component failure and unnecessary repairs.

Technical Tips:

- Always evacuate a system when:
  - Replacing a compressor, condenser, drier, evaporator, etc.
  - The system has no refrigerant.
  - The refrigerant is contaminated.
  - The refrigerant lubricant is changed.
- Evacuation removes moisture and air from the system by boiling the moisture and removing it with the air using a vacuum pump.
- If heating is necessary, use warm air, heat lamps, or water. Never use a torch!



Courtesy of HIDECOR

- Not all gauges are set to read zero at atmospheric pressure so make sure to check.
- When evacuating R-134a systems, use an R-134a vacuum pump or an R-134a recovery/recycling/recharging station equipped with a vacuum pump.

Ref/AC Servicing Guide

Recovery, Recycling, and Reclamation

Definitions:

- **Recovery**: The process of removing a refrigerant in any condition from a system and storing it in an external container without necessarily testing or processing it in any way.

- **Recycling**: The process of reducing the contaminants in used refrigerant by oil separation, non-condensable removal, and core filter-dryers, which reduce moisture, acidity, and particulate matter. Many recovery units also perform recycling so that it can be done on-site and refrigerant can be re-used.

- **Reclamation**: The process of reconditioning used refrigerant to the level of purity of virgin refrigerant. Chemical analysis is required to assure that the appropriate purity levels are met. Refrigerant is typically sent to a company that specializes in reclamation.

Ref/AC Servicing Guide

Recovery: Overview

Key Ideas:

- Recovery should always be practiced. Do NOT vent the refrigerant into the atmosphere.
- The following methods can be used to recovery refrigerant from a system:

  Passive Recovery

  - Charge migration method
  - Accelerated passive recovery using a system compressor

  Active Recovery

  - Simple recovery machine
  - Recovery machine with oil separation
- Decanting refrigerants into service cylinders is a hazardous practice. It should always be carried out using the method prescribed by the refrigerant manufacturer.

Technical Tips:

- When to recover refrigerant:
  - Recover all of the R-12 that is being vented.
  - Recover R-12 used for leak detection.
  - Recover R-12 from “empty” cylinders.
  - Recycle all the recovered R-12 to be able to reuse it.
  - Improve the quality of new R-12 that arrives contaminated or with humidity.

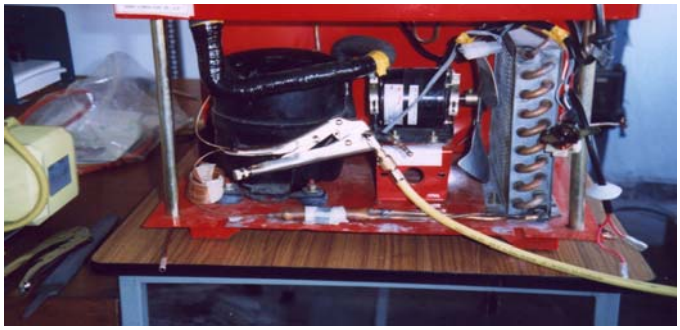
Ref/AC Servicing Guide

Recovery: Overview

Technical Tips continued:

- Depending on the condition of the refrigerant, i.e., the level and types of contaminants it contains, recovered refrigerant may be reused in the same system for which it was removed or sent to a reclamation facility.
- Refrigerant from a unit with a burnt-out compressor should not be re-used, unless it is recovered with a unit incorporating oil separator and filters.
- Test kits are available, which permit the refrigerant to be tested for water contamination and acidity, such as a refrigeration-oil-text-kit.
- If the oil is discolored (dark brown, black), it should be subjected to an acid-test.
- If the oil tests positive for acidity, the refrigerant and oil should not be re-used. Keep this refrigerant separate and deliver it to a facility which can reclaim or destroy it.
- Guidelines for determine the type of recovery method to use:
    - Passive method: best for charges up to 400 grams
    - Active method: best for charges greater than 400 grams

Pictures below: Refrigerant Cylinder and Recovery Unit

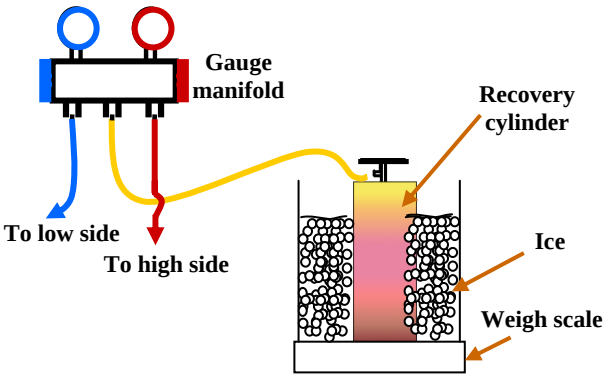


Ref/AC Servicing Guide

Recovery: Passive Methods

Charge Migration

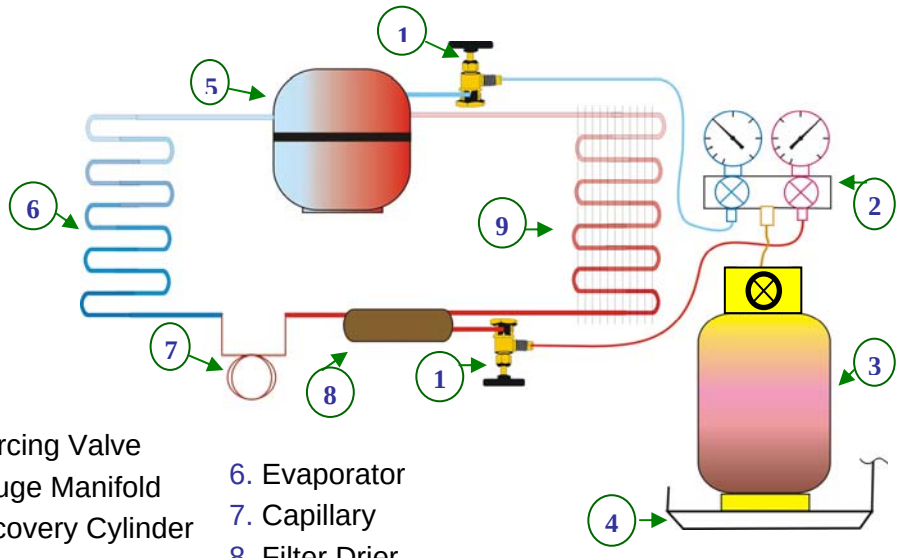
- The refrigerant moves into the recovery cylinder due to the difference in pressure between the system and the recovery system.
- In order to increase the rate of movement of refrigerant, the recovery cylinder can be evacuated before recovery or placed in an ice bath.
- Charge migration can only recovery a small percentage of the total charge.



Courtesy of HIDECOR

Accelerated Passive Recovery using System Compressor

- The refrigerant is pumped out of the system using the compressor.
- This allows for more refrigerant to be recovered than charge migration, but still leaves refrigerant in the system.
- Ensure that the system compressor does not run below 0 PSIG.



1. Piercing Valve
2. Gauge Manifold
3. Recovery Cylinder
4. Weigh Scale
5. Compressor
6. Evaporator
7. Capillary
8. Filter Drier
9. Condenser

Courtesy of HIDECOR

Ref/AC Servicing Guide

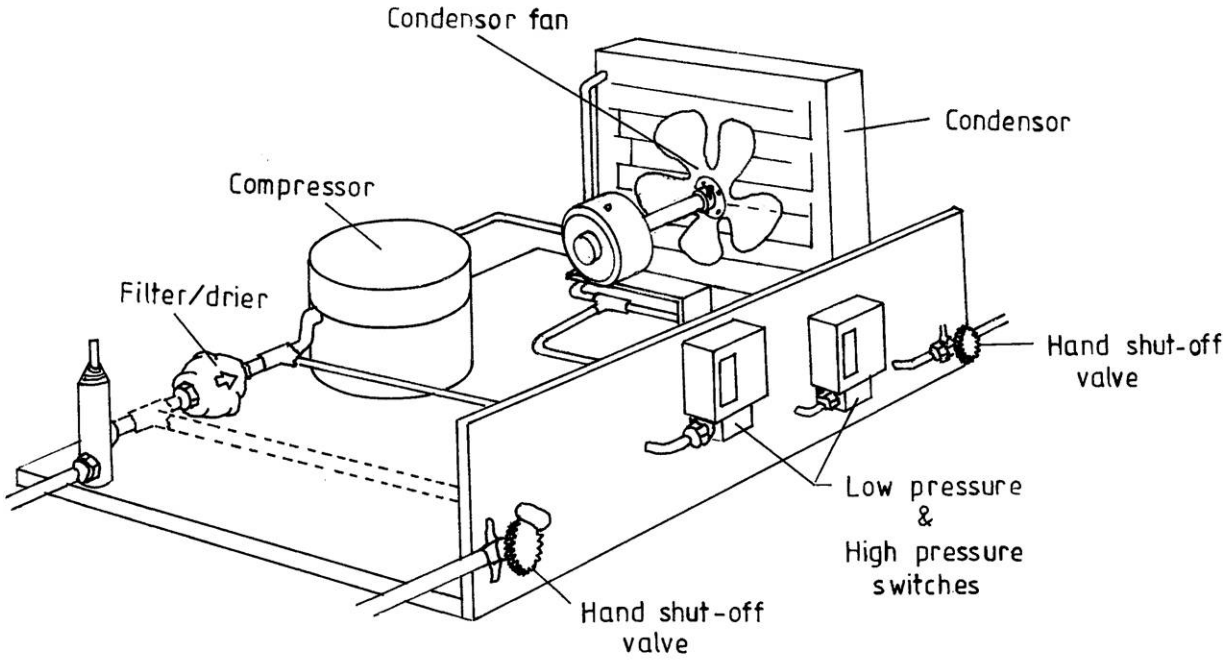
Recovery: Active Methods

Recovery Machine with Oil Separation

- Recovers the oil from the refrigerant and returns it to the system compressor.

Simple Recovery Machine

- Recovers the refrigerant as a vapor and condenses it before it enters the cylinder



Courtesy of HIDECOR

Ref/AC Servicing Guide

Recovery: Safety Tips

- Become very familiar with your recovery equipment.
- Liquid refrigerants can cause severe frostbite, so avoid the possibility of contact through use of adequate gloves and long sleeved shirts/cover.
- Extreme care must be taken to prevent oil spills of refrigerant vapors from making contact with skin and clothing surfaces when servicing contaminated equipment because they can contain corrosive acids.
- Wear protective great, such as safety glasses and shoes, gloves, safety hat or hardhat, long pants, and shirts with long sleeves.
- Refrigerant vapors can be harmful if inhaled. Avoid direct ingestion and always provide low-level ventilation.
- Ensure that all power is disconnected and disabled to any equipment requiring recovery. Disconnect and lock out any power supply with an approved locking device.
- Do NOT overfill the cylinder. Never exceed the cylinder's safe liquid weight level, based upon net weight. Maximum capacity of any cylinder is 80% by maximum gross.

Ref/AC Servicing Guide

Recovery: Safety Tips Continued

- When moving a cylinder, use an appropriate wheeled device. Ensure that the cylinder is firmly strapped in when the device is a handcart. NEVER roll a cylinder on its base or lay it down to roll it from one location to another.
- Use top quality hoses. Make sure they are property and firmly attached. Inspect all hose seals frequently.
- Hoses and electrical extension cords can be a trip hazard. Prevent an accident of this sort by placing proper barriers and signs. Place hoses sensibly where risk is minimized.
- Label the cylinder or container as specified in regulations.
- Do NOT mix grades of refrigerant or put one grade in a cylinder labeled for another
- Use only clean cylinders, free from contamination by oil, acid, moisture, etc.
- Visually check each cylinder before use and make sure all cylinders are regularly pressure tested.
- Ensure that cylinders have separate liquid and gas valves and be fitted with a pressure relief device.
- Ensure that all cylinders are in safe condition, capped as necessary, with proper identification.
- If reclaiming, contact the reclaim facility of your choice to arrange transportation.

Ref/AC Servicing Guide

Recycling

Technical Tips:

- About 10-20% of recovered refrigerants cannot be recycled. These include:
  - Refrigerant fractions recovered after compressor burn-out
  - Mixtures of different types of refrigerants
  - Residues from R&R processes.
- Venting of contaminated or mixed refrigerants is a bad practice and must be avoided.
- Refrigerants may be identified by the following methods:
  - Refrigerants stamped on unit data plate
  - Thermostatic Expansion Valve (TEV) for specific refrigerant
  - Standing pressure

Key Ideas:

- **Recycling** involves the following steps:
  - The machine circulates the R-12 through a heat exchanger, oil separator, and a filter-dryer.
  - The machine cleans the gas.
  - Clean refrigerant is stored in a tank.
  - Refrigerant in the tank can be used afterwards to recharge systems (just like new refrigerant).
- Refrigerant that is properly recycled functions exactly the same as new refrigerant.

Ref/AC Servicing Guide

Retrofitting

Retrofitting

Please consider the following while retrofitting:

- Know the operating parameters and performance data of the existing system and the proposed retrofit
- Energy efficiency improvement
- Direct retrofit costs and operating costs of the retrofitted system
- Appropriate equipment retrofitting procedure
- Clear labeling of retrofitted system and components
- Information on the refrigerant, lubricant change and service specifications

Additionally, gather information about the alternatives on

- Availability
- Access to appropriate servicing
- Ozone depletion potential
- Flammability
- Toxicity
- Energy efficiency
- Compatibility with compressors and existing part of RAC system
- Compatibility with lubricants
- Global warming potential

Please do not use alternatives without consulting the system manufacturer.

MAC Servicing Guide

Topic Guide

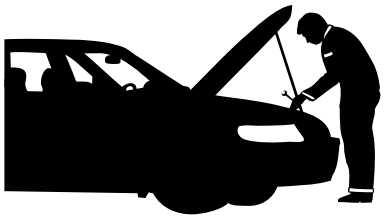
1. MAC Basics
2. Refrigerants
3. Leak Testing
4. Flushing/Purging/Cleaning
5. Charging Refrigerants
6. Evacuation
7. Recover, Recycling, and Reclaimation
8. Recovery
9. Recycling
10. Retrofitting

MAC Servicing Guide

MAC Basics:
Steps Involved in Servicing

Servicing of MACs Include:

- Recovery of Refrigerant
- Cleaning and Flushing
- Repair
- Flushing and Choke Testing
- Evacuation & Vacuum Holding
- Charging Refrigerant
- Sealing of Process Tube
- Checking for Proper Operation



MAC Servicing Guide

MAC Basics: Problems Due to Air and Moisture

Problems resulting from air in a system:

- Increased high-side and low-side pressure.
- Increased energy consumption.
- Unable to achieve low temperature.
- Trips high-pressure safety cut-out.

Problems resulting from moisture in a system:

- Blocked expansion valve/cap tube.
- Acid formation in refrigerant oil.
- Premature compressor bearing failure.
- Winding burnout in hermetic compressors.

MAC Servicing Guide

MAC Basics: Safety Precautions

Technical Tips:

- Liquid refrigerant evaporates so rapidly that it will freeze anything on contact.

Key Ideas:

- Prevent refrigerant from touching skin or eyes.
- Work in a well-ventilated area.

- Take extreme care to prevent refrigerant from coming into contact with the skin and the eyes.

- Should any refrigerant contact the eyes, apply a few drops of mineral oil to absorb refrigerant and wash eyes with weak solution of boric acid.

- Always wear safety goggles.

- Work in a well-ventilated area.
- When enough refrigerant replaces the oxygen needed for breathing, dizziness and suffocation can occur.

MAC Servicing Guide

MAC Basics:
Using a Manifold Gauge Set

Technical Tips:

- Manifold gauge set has a low-pressure side and a high-pressure side.
- Hand valve on the low-pressure side opens or closes the low-pressure side hose to the service hose for charging the system.
- Only pressure is measured by the high-pressure side of the manifold gauge set.
- Turn both manifold gauge set valves all the way to the right, closing the high- and low-pressure service hoses.
- Remove caps from high- and low- pressure service gauge port valves.
- Install the low- and high-pressure service hoses of the manifold gauge set onto the proper service gauge port valves:
    - Turn valve depressor knob on top of gauge set hose quick-connect fitting to left
    - Pull cage of service hose quick-connect fitting upward while installing fitting onto the service gauge port valve
    - Make sure cage snaps downward and locks quick-connect fitting into place
    - Turn knob on top of quick-connect fitting to right allowing refrigerant to flow into the manifold gauge set hoses
    - Caution: service ports must have screw-on protector caps or damage may result to the Schrader valves and allow refrigerant leakage

Key Ideas:

- Never attempt to use an R-134a manifold gauge set when servicing an R-12 A/C system, or vice versa, to avoid contamination and damage to the components of the system.

MAC Servicing Guide

Refrigerants: Differences between R-12 & R-134a systems

Technical Tips:

- To determine which type of air conditioning is in a vehicle, you will need to look at:
  - Refrigerant Charge Tag
  - Non-CFC Identifying Tags (if any)
  - Major Components
  - High Pressure Refrigerant Containment Devices
- R-12 and R-134a O-rings:
  - Brown O-rings used previously in R-12 systems are not compatible with R-134a refrigerant.
  - Green O-rings are compatible with both R-12 and R-134a refrigerant.
- R-134a Condensers
  - More fins per inch than most R-12 condensers.
  - Fins reduce condensing temperatures while maintaining equal or better performance levels as R-12 systems.
- Fixed Orifice Tube:
  - Some R-134a model vehicles may use orifice tubes different in size than those same models with R-12 system.
- Charge Port Valve Operation:
  - New R-134a valves have a different type of design from R-12 valves.
  - Charge port valves open and close the service outlets to the system providing access to both sides of the system for service hoses.
- Charge Ports:
  - R-134a systems uses high and low service charge ports.
  - Ports prevent connection of R-12 service hoses.
  - Reduce refrigerant leakage.
- Condenser Airflow:
  - Modifications to engine cooling fans increase volume of airflow through condenser and radiator to compensate for slightly higher pressures and temperatures of R-134a refrigerant.
  - Foam seals added between condenser and radiator on some R-134a applications.

Key Ideas:

- To determine type of refrigerant, look at refrigerant charge tags, non-CFC identifying tags, major components and high pressure refrigerant containment devices to determine type of refrigerant.
- O-rings, condensers, oils used and charge ports differ between R-12 and R-134a systems.

MAC Servicing Guide

Refrigerants: Alternatives
A Comparison of R-12 and R-134a

Technical Tips:

- Refrigerant oils used with R-12 systems will NOT work with R-134a systems for more than a short period of time because they do not provide adequate lubrication.
- R-134a lubricants absorb much more moisture than R-12 lubricants.
- Certain dessicants will only work with either R-12 or R-134a, while some dessicants can be used with both refrigerants.

Key Ideas:

- R-12 and R-134a are not interchangeable! Separate lubricants, hoses, gauges, and recovery/recycling machines must be used for each type of refrigerant.
- Proper handling and service of R-12 and R-134a equipment helps to maintain proper function of MAC systems, reduce unnecessary emissions, and prevent the waste of refrigerant and system resources.
- R-134a is used as an alternative to R-12 because it does not damage the ozone layer; however, it does induce greenhouse effects (global warming) and leakage into the atmosphere should be prevented whenever possible.

- High side operating pressure for R-134a is slightly higher than for R-12 and thus an R-134a system must have tighter hoses and valves.
- Proper air flow through the condenser is VERY IMPORTANT with R-134a systems.
- R-134a has a slightly lower boiling point than R-12.
- R-134a molecules are smaller than R-12 molecules, causing faster loss of the refrigerant through the hoses. Special hoses lined with nylon are available for use with R-134a.
- The boiling point of R-12 is -26°C.
- R-134a has zero ozone depleting potential but a relatively high global warming potential.
- R-134a is non-flammable.

MAC Servicing Guide

Refrigerants: Working with Systems using HFC-134a and PAG Oil

Technical Tips:

- PAG is volatile and does not leave traces.
- Keep oil containers sealed and never store PAG oils in plastic containers.
- Never mix R-134a service tools with R-12 service tools.
- Never flush the system with chlorinated materials (R-12 or Perchloro).
- Never clean the A/C system with compressed air when there is R-134a because of the high possibility of combustion.
- Charge the system precisely according to the instructions on the charge label.
- Always change the filter-dryer/accumulator to avoid the possible contamination.

Key Ideas:

- Never mix R-134a service tools with R-12 service tools.

MAC Servicing Guide

Refrigerants: Minimizing Contamination

Technical Tips:

- **Use of only certified recovery & recycling equipment.**
- **Follow the manufacturer's instructions on changing oil and filters.**
- **Employ only skilled personnel and providing appropriate training.**

Key Ideas:

- **Properly identify the refrigerant.**
- **Test oil for contamination.**
- **Do not mix refrigerants.**

- **Test for acidity.**
- **Perform preventative visual inspections of oil and lubricant.**
- **Avoid mixing refrigerants.**
- **Use refrigerant identifiers to identify the type of refrigerant or refrigerant mixtures.**
- **Test oil for contamination.**
- **Never use refrigerants after compressor burn-out (acidity).**
- **Use evaporation processes during recycling.**

MAC Servicing Guide

Leak Testing: General Tips for Leak Testing

Technical Tips:

- **Leaks often occur at the following places:**
    - **Threaded connections that have loosened**
    - **Hoses rubbing against a structural part in the system**
    - **Deteriorated hoses, seals, and structural parts, and**
    - **The compressor and in the column seal of the compressor**

Key Ideas:

- **Always check for leaks prior to recharging an A/C system.**
- **Repair all of the leaks in the system; otherwise the refrigerant will continue to escape, destroying the ozone layer.**
- **Always check the entire A/C system when checking for leaks, even after you find a leak. There may be multiple leaks.**

- **Leaks in the condenser can often be detected by oil stains in the shape of a Christmas tree.**
- **Evaporator leaks may be checked at the water drain hole or by using your leak detector at the air conditioning vents inside the car while the low-speed blower is on.**
- **A system with less than 3.52 kgf/cm2 (50 psi) of pressure will not emit enough refrigerant to be detected by a leak detector.**
- **Lubricants used with R-134a are water soluble. Do not count on seeing oil spots to identify leaks with R-134a vehicles.**
- **Dyes used for leak testing are specific to each refrigerant. Dyes for R-12 will not work for R-134a systems.**

MAC Servicing Guide

Leak Testing: Methods

-

Technical Tips:

- **The following types of leak detectors may be used:**

Method	Description
Halide (propane) torch	**A propane flame draws the leaking refrigerant over a hot copper alloy reactor plate. A color change in the flame occurs in the presence of refrigerant. This type is not recommended because of the danger associated with open flames and the formation of dangerous gases.**
Electronic Detector	**A test probe draws in any leaking refrigerant and sounds an alarm or creates a flashing light if refrigerant is found.**
Bubble Detector	**A solution is applied externally at suspected leak points. Leaking refrigerant causes the detector to form bubbles and foam.**
Dye Solution	**This is a colored solution that is introduced into the air conditioning system. The dye shows up and colors components at leak points**

MAC Servicing Guide

Leak Testing: Bubble Detector Leak-Test Procedure

Technical Tips:

- **Commercial bubble detectors are recommended, but household soap solution may be used.**
- **Use the dauber that comes with the soap solution to apply the solution to all joints, connections, fittings, or controls where a leak is suspected.**
- **Wherever bubbles form, leaks are present.**
- **Check entire system for other leaks.**

Key Ideas:

- **Household soap solution may be used.**
- **Check entire system for leaks.**

MAC Servicing Guide

Leak Testing: Electronic Leak Detector Leak-Test Procedure

Technical Tips:

- One person should be designated by the shop to use and take care of the leak detector.
- When using an electronic leak detector, run the probe UNDER the seals, hoses, etc., because refrigerant is heavier than air and will settle toward the floor. Also, you can cup your hand under the suspect leaks to catch the refrigerant that escapes and therefore detect leaks more easily.

Key Ideas:

- Never place the probe in areas where severe leaks are know to exist as the sensitivity components could be damaged.
- DO NOT use high powered fans near the car when using an electronic leak detector because refrigerant that has already leaked tends to settle to a corner and may be stirred up by the fan, thereby causing an incorrect leak detection.

MAC Servicing Guide

Flushing/Purging/Cleaning

Why is flushing required?

- Flushing is important before replacing components after servicing. Motor burn outs or failures of compressors lead to contamination of systems.
- The compressor, filter drier and capillary will have to be replaced when the compressor burn out is complete.
- The rest of the system has to be cleaned with either Trichloro-ethylene or Hexane. The cleaned components should then be warmed to evaporate all the residual Trichloroethylene. The presence of any chlorinated compounds in liquid form can lead to formation of gel and sludge which can choke the capillary. This happens more in case of HFC – 134a.

Key Ideas:

- Flushing is recommended to remove debris and contamination left behind after compressor failure, desiccant breakdown, or repeated clogging of the orifice tube or expansion valve.
- Flushing is also recommended if the system may have been contaminated by anything other than the original refrigerant or if it contains excessive refrigerant oil.
- R-12 and R-11 deplete the ozone so it is very important to prevent their escape during flushing.

Precautions to be taken:

- Isolate and segregate sections of the system to the maximum extent possible.
- Transfer contaminated refrigerant to approved recovery containers.
- Clean each section separately using a non- ODS
- After cleaning the evaporator and condenser with the chemical agent the system will then have to be flushed with pure dry Nitrogen. Please check for purity of nitrogen (99.995% and dew-point of -40C).

MAC Servicing Guide

Flushing/Purging/Cleaning

Technical Tips:

- If the compressor motor has burnt-out, acid and sludge will have spread throughout the system. Therefore a chemical must be used to clean the system. Trichloroethylene or Hexane solvent can be used. Do not use CTC or Petrol.
- When using tricholoroethylene, work in a ventilated area and wear gloves. After using Tricholoroethylene, the components should be heated with high wattage bulbs or a heat gun in order to evaporate all the chemical.
- After the use of a chemical cleaning agent, the system must be flushed with nitrogen.
- If the compressor motor has not burnt-out, it is only necessary to flush with nitrogen.
- Remember to flush in both directions to dislodge any material caught in condenser and other system components.
- Using very high pressures above 150 psi may damage system components
- Solvents used in flushing must be fully extracted from the system. If any solvent is left behind, the solvent may destabilize the refrigerant and damage the system.
- High pressure flushing may cause leaks. Check thoroughly for leaks after flushing.
- Flushing removes oil from the system, which must be replenished before recharging.
- Flushing with nitrogen does not remove oils.
- New flushing substances include a hydrocarbon turpine solution and an ester solution.
- Never use compressed air to flush an R-134a system or R-134a servicing equipment. Pressurized air and R-134a can cause a fire or explosion. Compressed air contains humidity which may damage the system.
- Never flush with CFC products, since this will result in unnecessary and costly emissions of an ozone depleting substance. Flushing an R-134a system with a CFC product may also result in the breakdown of the lubricant or in system corrosion.
- Open vent flushing does not always remove failed compressor material from condenser units. Use of in-line filters is considered a more effective method of controlling debris resulting from component failures.

MAC Servicing Guide

Charging Refrigerants: Technical Tips

Purpose and Process of Charging:

- Charging of the system is the addition of a proper quantity of the coolant depending on the status of evacuation.
- The quantity of the coolant is determined by specifications of design for efficient performance.
- The two methods of charging are:
    - o Vapor refrigerant charging (VRC)
    - o Liquid refrigerant charging (LRC).
- The level of refrigerant can be viewed through the glass tube. This helps in precise transfer. It also helps in quantification with respect to temperature, since liquid refrigerants have different volumes at different temperatures.
- When the systems are charged with more than one type of refrigerant, it is advisable to use separate charging stills for each type of refrigerant.

Key Ideas:

- Charging of the system is the addition of a proper quantity of the coolant depending on the status of evacuation.
- The two methods of charging are:
    - o Vapor refrigerant charging (VRC)
    - o Liquid refrigerant charging (LRC).

MAC Servicing Guide

Charging Refrigerants: Technical Tips

Technical Tips:

- To charge precisely and avoid future problems:
  - Use a thermometer, a manifold gauge set and a pressure/ temperature chart (see next page) indicating the proper relationship between system pressure and temperature of the air
  - Use a scale that weighs the refrigerant
  - Use a graduated cylinder that measures the refrigerant
  - Use an automatic recharging station
- Charging based only on pressure can be imprecise, potentially causing overcharging and eventual damage to the system.

Key Ideas:

- If a system needs recharging, it must have a leak somewhere.
- Overcharging can damage the compressor.
- Charging should be done slowly and gradually.
- Only evacuated systems should be charged.

- When charging with pressure, the technician should consider the humidity and air temperature inside the shop.
- Air-conditioning systems should be fully evacuated and all moisture should be removed before a system is charged.
- If refrigerant is recovered from an A/C system using a recovery/recycling machine, oil must be added during the recharging.
- Never mix R-13 and R-134a gases or oils.
- Technicians should recommend to customers that a system's refrigerant be recovered if the system needs charging, so that leaks can be found and repaired. "Top-up" charging without evacuation and leak repair lead to unnecessary leakage of refrigerant.
- The following conditions are good signs that a system has been under or over changed.

Undercharged	Overcharged
Low Suction Pressure	High Discharge Pressure
High Superheat	High Discharge Temperature
Compressor Motor Overheats	Liquid flood back into compressor
Low Cooling Capacity	Low Cooling Capacity
Poor Energy Efficiency	Poor Energy Efficiency
Sludge/ Carbonization in Compressor	Sludge/ Carbonization in Compressor

MAC Servicing Guide

Charging Refrigerants: Pressure Chart

R-12 Temperature-Pressure Chart

Temperature		Pressure		Temperature		Pressure	
°F	°C	PSIG	kPA	°F	°C	PSIG	kPA
65	18.3	74	510	90	32.2	110	758
66	18.9	75	517	91	32.8	111	765
67	19.4	76	524	92	33.3	113	779
68	20.0	78	538	93	33.9	115	793
69	20.6	79	545	94	34.4	116	800
70	21.1	80	552	95	35.0	118	814
71	21.7	82	565	96	35.6	120	827
72	22.2	83	572	97	36.1	122	841
73	22.8	84	579	98	36.7	124	855
74	23.3	86	593	99	37.2	125	862
75	23.9	87	600	100	37.8	127	876
76	24.4	88	607	101	38.3	129	889
77	25.0	90	621	102	38.9	130	896
78	25.6	92	634	103	39.4	132	910
79	26.1	94	648	104	40.0	134	924
80	26.7	96	662	105	40.6	136	938
81	27.2	98	676	106	41.1	138	951
82	27.8	99	683	107	41.7	140	965
83	28.3	100	689	108	42.2	142	979
84	28.9	101	696	109	42.8	144	993
85	29.4	102	703	110	43.3	146	1007
86	30.0	103	710	111	43.9	148	1020
87	30.6	105	724	112	44.4	150	1034
88	31.1	107	738	113	45.0	152	1048
89	31.7	108	745	114	45.6	154	1062

MAC Servicing Guide

Recovery, Recycling, and Reclamation

Definitions:

- **Recovery**: The process of removing a refrigerant in any condition from a system and storing it in an external container without necessarily testing or processing it in any way.

- **Recycling**: The process of reducing the contaminants in used refrigerant by oil separation, non-condensable removal, and core filter-dryers, which reduce moisture, acidity, and particulate matter. Many recovery units also perform recycling so that it can be done on-site and refrigerant can be re-used.

- **Reclamation**: The process of reconditioning used refrigerant to the level of purity of virgin refrigerant. Chemical analysis is required to assure that the appropriate purity levels are met. Refrigerant is typically sent to a company that specializes in reclamation.

MAC Servicing Guide

Recovery: Overview

Key Ideas:

- Recovery should always be practiced. Do NOT vent the refrigerant into the atmosphere.
- The following methods can be used to recovery refrigerant from a system:

  Passive Recovery

  - Charge migration method
  - Accelerated passive recovery using a system compressor

  Active Recovery

  - Simple recovery machine
  - Recovery machine with oil separation
- Decanting refrigerants into service cylinders is a hazardous practice. It should always be carried out using the method prescribed by the refrigerant manufacturer.

Technical Tips:

- When to recover refrigerant:
  - Recover all of the R-12 that is being vented.
  - Recover R-12 used for leak detection.
  - Recover R-12 from “empty” cylinders.
  - Recycle all the recovered R-12 to be able to reuse it.
  - Improve the quality of new R-12 that arrives contaminated or with humidity.
  - Recover R-12 from the vehicles that come in for an estimate.
  - Recover R-12 from the neighboring service shops that don’t own recycling equipment.
  - Recover R-12 in other services in which the air condition system must be dismounted.

MAC Servicing Guide

Recovery: Overview

Technical Tips continued:

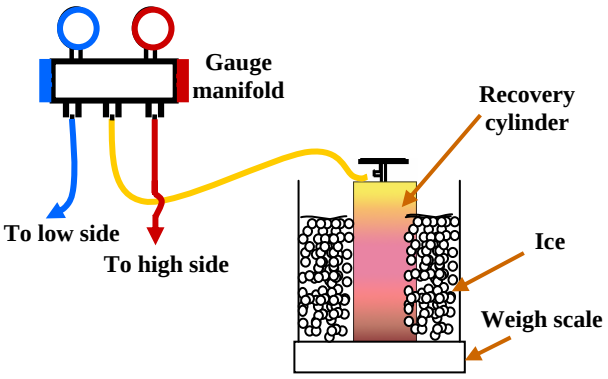
- Depending on the condition of the refrigerant, i.e., the level and types of contaminants it contains, recovered refrigerant may be reused in the same system for which it was removed or sent to a reclamation facility.
- Refrigerant from a unit with a burnt-out compressor should not be re-used, unless it is recovered with a unit incorporating oil separator and filters.
- Test kits are available, which permit the refrigerant to be tested for water contamination and acidity, such as a refrigeration-oil-text-kit.
- If the oil is discolored (dark brown, black), it should be subjected to an acid-test.
- If the oil tests positive for acidity, the refrigerant and oil should not be re-used. Keep this refrigerant separate and deliver it to a facility which can reclaim or destroy it.
- Guidelines for determine the type of recovery method to use:
    - Passive method: best for charges up to 400 grams
    - Active method: best for charges greater than 400 grams

MAC Servicing Guide

Recovery: Passive Methods

Charge Migration

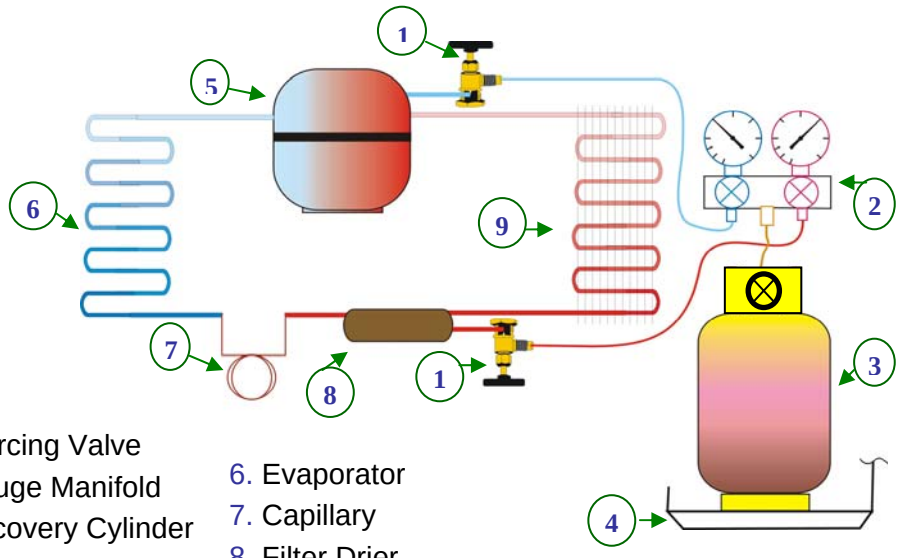
- The refrigerant moves into the recovery cylinder due to the difference in pressure between the system and the recovery system.
- In order to increase the rate of movement of refrigerant, the recovery cylinder can be evacuated before recovery or placed in an ice bath.
- Charge migration can only recovery a small percentage of the total charge.



Courtesy of HIDECOR

Accelerated Passive Recovery using System Compressor

- The refrigerant is pumped out of the system using the compressor.
- This allows for more refrigerant to be recovered than charge migration, but still leaves refrigerant in the system.
- Ensure that the system compressor does not run below 0 PSIG.



1. Piercing Valve
2. Gauge Manifold
3. Recovery Cylinder
4. Weigh Scale
5. Compressor
6. Evaporator
7. Capillary
8. Filter Drier
9. Condenser

Courtesy of HIDECOR

MAC Servicing Guide

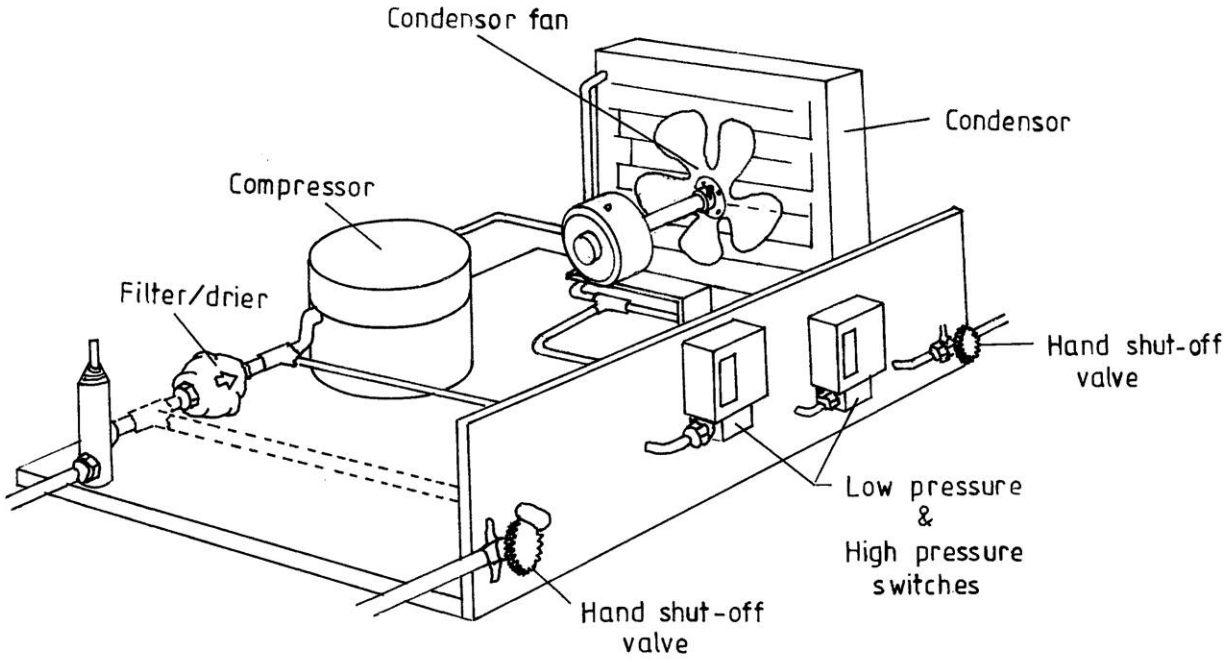
Recovery: Active Methods

Recovery Machine with Oil Separation

- Recovers the oil from the refrigerant and returns it to the system compressor.

Simple Recovery Machine

- Recovers the refrigerant as a vapor and condenses it before it enters the cylinder



Courtesy of HIDECOR

MAC Servicing Guide

Recovery: Safety Tips

- Become very familiar with your recovery equipment.
- Liquid refrigerants can cause severe frostbite, so avoid the possibility of contact through use of adequate gloves and long sleeved shirts/cover.
- Extreme care must be taken to prevent oil spills of refrigerant vapors from making contact with skin and clothing surfaces when servicing contaminated equipment because they can contain corrosive acids.
- Wear protective great, such as safety glasses and shoes, gloves, safety hat or hardhat, long pants, and shirts with long sleeves.
- Refrigerant vapors can be harmful if inhaled. Avoid direct ingestion and always provide low-level ventilation.
- Ensure that all power is disconnected and disabled to any equipment requiring recovery. Disconnect and lock out any power supply with an approved locking device.
- Do NOT overfill the cylinder. Never exceed the cylinder's safe liquid weight level, based upon net weight. Maximum capacity of any cylinder is 80% by maximum gross.

MAC Servicing Guide

Recovery: Safety Tips Continued

- When moving a cylinder, use an appropriate wheeled device. Ensure that the cylinder is firmly strapped in when the device is a handcart. NEVER roll a cylinder on its base or lay it down to roll it from one location to another.
- Use top quality hoses. Make sure they are property and firmly attached. Inspect all hose seals frequently.
- Hoses and electrical extension cords can be a trip hazard. Prevent an accident of this sort by placing proper barriers and signs. Place hoses sensibly where risk is minimized.
- Label the cylinder or container as specified in regulations.
- Do NOT mix grades of refrigerant or put one grade in a cylinder labeled for another
- Use only clean cylinders, free from contamination by oil, acid, moisture, etc.
- Visually check each cylinder before use and make sure all cylinders are regularly pressure tested.
- Ensure that cylinders have separate liquid and gas valves and be fitted with a pressure relief device.
- Ensure that all cylinders are in safe condition, capped as necessary, with proper identification.
- If reclaiming, contact the reclaim facility of your choice to arrange transportation.

MAC Servicing Guide

Recycling

Technical Tips:

- About 10-20% of recovered refrigerants cannot be recycled. These include:
  - Refrigerant fractions recovered after compressor burn-out
  - Mixtures of different types of refrigerants
  - Residues from R&R processes.
- Venting of contaminated or mixed refrigerants is a bad practice and must be avoided.
- Refrigerants may be identified by the following methods:
  - Refrigerants stamped on unit data plate
  - Thermostatic Expansion Valve (TEV) for specific refrigerant
  - Standing pressure

Key Ideas:

- **Recycling** involves the following steps:
  - The machine circulates the R-12 through a heat exchanger, oil separator, and a filter-dryer.
  - The machine cleans the gas.
  - Clean refrigerant is stored in a tank.
  - Refrigerant in the tank can be used afterwards to recharge systems (just like new refrigerant).
- Refrigerant that is properly recycled functions exactly the same as new refrigerant.

- In order to incorporate a recovery/recycling machine into the service shop routine, follow the steps below:
  - Recover refrigerant from vehicles until the tank is full
  - Recycle the refrigerant
  - Remove the tank that contains the clean refrigerant and place an empty tank in the machine
  - Recover refrigerant from additional vehicles
  - Recharge systems with the recovered/recycled refrigerant

MAC Servicing Guide

Retrofitting

Retrofitting

Please consider the following while retrofitting:

- Operating parameters and performance data of the existing system and the proposed retrofit
- Energy efficiency improvement
- Direct retrofit costs and operating costs of the retrofitted system
- Appropriate equipment retrofitting procedure
- Clear labeling of retrofitted system and components
- Information on the refrigerant, lubricant change and service specifications

Additionally, gather information about the alternatives on their

- Availability
- Access to appropriate servicing
  - Ozone depletion potential
  - Flammability
  - Toxicity
  - Energy efficiency
  - Compatibility with compressors and existing part of RAC system
  - Compatibility with lubricants
  - Global warming potential

Please do not use alternatives without consulting the system manufacturer.

Reference List and Sources of Additional Information

NOUs, Local Partners and SMEs can access a substantial amount of appropriate reference material from the list below:

1. Training Manual on Good Practices in Refrigeration (main support document), UNEP DTIE, 1994
2. Training Manual on Chillers and Refrigerant Management UNEP DTIE, 1994
3. Elements for Establishing Policies, Strategies and Institutional Framework for Ozone Layer Protection, UNEP DTIE, 1994
4. Practical Guidelines for Industry for Managing the Phase-out of Ozone Depleting Substances, UNEP DTIE, 1994
5. Guidebook for Implementation of Codes of Good Practice, Refrigeration Sector, UNEP DTIE, 1998
6. Guidelines for Recovery and Recycling Systems - Refrigeration Sector, UNEP DTIE, 1999
7. Code of Practice for the Minimisation of Refrigerant Emissions from Refrigerating Systems, The Institute of Refrigeration, UK, 1997.

Technical Guide References by Subject Area

Ozone and Environmental Issues

1. Educators' Kit, 1998, Centre for Environment Education, MoEF, Govt. of India
2. http://www.theozonehole.com
3. http://www.ciesin.org/TG/OZ/cfcozn.html
4. http://www.ciesin.org/TG/OZ/o3depl.html
5. http://www.ciesin.org/docs/011-462/011-462.html
6. http://www.epa.gov/ozone/science/index.html

Quality of recycled ODS

1. Recovery and recycling systems guidelines – Phasing out ODS in developing countries – Refrigeration Sector – 1999, UNEP DTIE, Multilateral Fund for the Implementation of the Montreal Protocol
2. http://www.uneptie.org/ozonaction/library/mmcfiles/3245-e.pdf
3. http://www.uneptie.org/ozonaction/library/mmcfiles/2174-e.pdf

Refrigeration and Air-conditioning – Servicing and the Environment

1. Recovery and recycling systems guidelines – Phasing out ODS in developing countries – Refrigeration Sector – 1999, UNEP DTIE, Multilateral Fund for the Implementation of the Montreal Protocol
2. http://www.uneptie.org/ozonaction/library/mmcfiles/3245-e.pdf

New Refrigerants and Technologies

1. http://www.bbc-consultancy.com/Hydrocarbon_Refrigerants_Guidelines.pdf
2. Eco-Cool, No. 6, March 2003. Pp8
3. Swiss Contact Skill Cards Steps 1-5

Refrigeration and Air Conditioning Service and Maintenance

1. HIDECOR training manual
2. http://www.rparts.com/Catalog/Tools_&_Equipment/vacuum_pumps.asp
3. National Training on Good Practices in Refrigeration: A Support Guide for NOUs Phasing out
4. ODS in Developing Countries (http://www.uneptie.org/ozonaction/library/mmcfiles/3467-e.pdf)

Refrigerants

1. HIDECOR training manual
2. http://www.york.com/products/esg/updates/eng-Updates/34.pdf

Leak Detection

1. Good practices in refrigeration – training manual, OzonAction, UNEP
2. HIDECOR training kit

Purging and Evacuation/Flushing

1. http://www.hyvac.com/tech_support/Gas%20Ballast%20Valve%20Explanation.htm
2. GUIDEBOOK FOR IMPLEMENTATION OF CODES OF GOOD PRACTICE: REFRIGERATION SECTOR, 1998 Phasing out ODS in Developing Countries
3. Multilateral Fund for the Implementation of the Montreal Protocol, United Nations Environment Programme, Industry and Environment. Pp 82
4. http://www.uneptie.org/ozonaction/library/mmcfiles/2174-e.pdf

Charging of refrigerants

1. GUIDEBOOK FOR IMPLEMENTATION OF CODES OF GOOD PRACTICE: REFRIGERATION SECTOR, 1998 Phasing out ODS in Developing Countries Multilateral Fund for the Implementation of the Montreal Protocol, United Nations Environment Programme, Industry and Environment. Pp 82
2. http://www.uneptie.org/ozonaction/library/mmcfiles/2174-e.pdf
3. HIDECOR Training kit

Recovery, Recycling and Reclaiming Refrigerants

1. HIDECOR training kit
2. ECOCOOL newsletter, No. 6, March 2003, Pp8

Retrofitting

1. GUIDEBOOK FOR IMPLEMENTATION OF CODES OF GOOD PRACTICE: REFRIGERATION SECTOR, 1998 Phasing out ODS in Developing Countries Multilateral Fund for the Implementation of the Montreal Protocol, United Nations Environment Programme, Industry and Environment. Pp 82
2. http://www.uneptie.org/ozonaction/library/mmcfiles/2174-e.pdf
3. ECOCOOL newsletter, No. 12, December 2004, Pp8

Removal and replacement of the compressor, filter drier, evaporator, capillary, condenser

1. http://www.emersonclimatecontractor.com/webapp/wcs/stores/servlet/ctp/cs/TSFAQCopeTech.jsp?RootNode=20_Tech_Support&OpenNode=15_Copeland_Technical&User=false#FAQ6
1. http://www.qwik.com/PMTech/PMTech_manual.pdf
2. http://www.hvacmechanic.com/trouble_shooting/sm01,02-5.pdf
3. http://occawlonline.pearsoned.com/bookbind/pubbooks/gurakconcise_lp/chapter13/medialib/refrige.htm
4. http://www.process-cooling.com/CDA/ArticleInformation/features/BNP__Features__Item/0,3674,14686,00.html

Service and Repair: Flush and Clean the System

1. http://www.ec.gc.ca/ozone/docs/sands/rac/en/cop/fluoro_cop.pdf
2. ECOCOOL newsletter, No. 8, October 2003. Pp 6.

Replacing Components and rebrazing them into the system. Reassembly

1. http://www.hvacmechanic.com/trouble_shooting/sm01,02-5.pdf
2. ECOCOOL newsletter, No. 9, December 2003. Pp 6.

Leak Testing and Evacuating the System

1. http://www.amgas.com/ldrefpage.htm
2. UNEP Training Manual, 1994
3. ECOCOOL newsletter, No. 6, March 2003 Pp8

Accurate Refrigerant Charging

1. http://www.hvacmechanic.com/trouble_shooting/sm01,02-5.pdf
2. UNEP training Manual - 1994
3. ECOCOOL newsletter, No.11, September 2004 Pp. 8

Other UNEP References

1. Innovative Approaches for the Phasing Out of Ozone Depleting Substances in Low ODS Consuming Countries, Nineteenth Meeting of the ExCom of the Multilateral Fund, UNEP, 1996
2. Report in UNEP's Continued Work on Addressing the Needs of Low Volume ODS Consuming Countries (LVCs), Twentieth Meeting of the ExCom of the Multilateral Fund, UNEP, 1996
3. 1994 Report of the Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee, UNEP, 1995 Assessment, 1995
4. Blends as Refrigerants to Replace CFCs and HCFCs, Information Paper, UNEP, 1995
5. Guidebook for Implementation of Codes of Good Practice - Refrigeration Sector UNEP IE OzonAction Programme 1998
6. Standards and Codes of Practice, Information Paper, UNEP, 1995
7. Practical Guidelines for Industry for Managing the Phaseout of Ozone Depleting Substances, UNEP, 1994
8. Recovery and Recycling, Case Studies, UNEP, 1994
9. Sourcebook of Technologies for Protecting the Ozone Layer, Refrigeration, Air- Conditioning and Heat Pumps, UNEP
10. Non- and Low-ODS Technologies, A Compendium of Case Studies Produced by Industry and Governments, UNEP, 1995

About the UNEP Division of Technology, Industry and Economics

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

The Division works to promote:

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

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

> **The International Environmental Technology Centre** - IETC (Osaka, Shiga), which implements integrated waste, water and disaster management programmes, focusing in particular on Asia.
> **Production and Consumption** (Paris), which promotes sustainable consumption and production patterns as a contribution to human development through global markets.
> **Chemicals** (Geneva), which catalyzes global actions to bring about the sound management of chemicals and the improvement of chemical safety worldwide.
> **Energy** (Paris), which fosters energy and transport policies for sustainable development and encourages investment in renewable energy and energy efficiency.
> **OzonAction** (Paris), which supports the phase-out of ozone depleting substances in developing countries and countries with economies in transition to ensure implementation of the Montreal Protocol.
> **Economics and Trade** (Geneva), which helps countries to integrate environmental considerations into economic and trade policies, and works with the finance sector to incorporate sustainable development policies.

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

For more information,
see **www.unep.fr**

This kit is designed to facilitate the National Ozone Unit's (NOU) efforts to reach Small and Medium-sized Enterprises (SMEs) often missed through formal training methods/courses and deliver key messages and guidance to help avoid phase-out difficulties. The guidance and materials in this kit are a hybrid between outreach and basic training materials. This kit instructs the NOU to utilize local partners, such as local chemical and equipment suppliers, to reach SMEs.

www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi, Kenya
Tel: (254 20) 621234
Fax: (254 20) 623927
E-mail: cpiinfo@unep.org
web: www.unep.org

UNEP

For more information, contact:

UNEP DTIE
OzonAction Programme
Tour Mirabeau
39-43 Quai André Citroën
75739 Paris Cedex 15, France

Multilateral Fund for the Implementation of the Montreal Protocol
1800 McGill College Avenue
27th Floor
Montreal, Quebec H3A 3JC
Canada

DIT/0659/PA