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Executive Committee of
the Multilateral Fund for the
Implementation of the Montreal Protocol

Seventeenth Meeting
Montreal, 26-28 July 1995

PROJECT PROPOSAL: ZIMBABWE

This document includes the following project proposal:

- CFC refrigerant recovery and reclaim project — UNIDO

2 June 1995

PROJECT COVER SHEET

Country:	**Zimbabwe**
Project Title:	CFC Refrigerant Recovery and Reclaim
Sectors Covered:	Automotive Air Conditioning, Domestic &Commercial Refrigeration, Commercial Air Conditioning
ODS Use in Sector (1993):	196.5 metric tons. (180 tons in 1994) and 96.5 ODP weighted tons
Project Duration:	3 years
Project Impact:	ODS recovered = 28.3 mt/year, ODS release reduction = 23,2 mt/year, **Total ODS phase out = 46,5 mt/year.**
Capital Cost:	US$ 388,566
Implementing Agency's Overhead (13%)	US$ 47,225
Incremental Operating Cost:	Not claimed
Proposed MF Financing:	**US$ 435,791**
Cost Effectiveness:	US$ 8.36/kg ODP
Implementing Agency:	UNIDO
Coordinating Ministry:	Ministry of Environment & Tourism, Ozone Office

PROJECT SUMMARY

The objective of the project is to prevent the release of ODS, particularly CFC-12, into the atmosphere during the service and disposal of ODS dependent refrigeration equipment and to reclaim a substantial part of CFC-12. Two main ways of reducing the release of CFCs will be from:

1. *Establishment of a nationwide network for the recovery of refrigerant during service and disposal of equipment, and reclaim of recovered refrigerant for re-utilization;*
2. *Improving the maintenance procedures of cooling equipment through training and introducing up-to-date practices in CFC charging and handling.*

The reclaimed CFCs will provide an alternative source from imported virgin CFCs. It is expected that by securing this volume of refrigerant the country's demand for imports of CFC-12 will be reduced by 16%. The amount of refrigerant available for reclamation in the country, and the price difference between the recovered old refrigerant and the reclaimed one are sufficient to set up a sustainable, self-financing business operation if the basic investment and training cost is provided in kind through the Multilateral Fund.

I. BACKGROUND

Protection of the stratospheric ozone layer is of utmost priority for Zimbabwe, which became a party to the Montreal Protocol under the provisions of Article V, Paragraph 1 in November 1992. In March 1994, the Ministry of Environment and Tourism organized a national workshop on the implementation of the Montreal Protocol. Scope of the workshop, in which all concerned parties from the public and private sector took part, was to provide a basis for the formulation of the Country Programme which was approved in July 1994. The targets set by the Country Programme are the complete phase-out of halons by 2005 and the complete phase-out of CFCs by 2010. The Country programme has also identified the refrigeration sector as the priority area. The national implementing agency has been identified as the Ozone Office to be established under the Ministry of Environment and Tourism. For this purpose, the first of the six project proposals included in the Country Programme was approved. Among the other strategic projects the "CFC Recovery, Recycling and Reclamation" was considered to be of the highest priority to be formulated for submission by the implementing agency to the Executive Committee.

The government of Zimbabwe is hopeful to eliminate the use of ODS on a schedule far more aggressive than is required under the rules of Article 5. This also will be a result of the great interest, that the industries of Zimbabwe have in the recovery and reclaim of CFCs, which was confirmed by the large participation of entrepreneurs at the National Workshop and by their willingness to provide full support to the initiative.

Zimbabwe's annual consumption, based on imports, of ODS included in the refrigeration sector has risen over the years from 96 metric tons in 1991 to a high of 196 metric tons in 1993, which represented 87.7% of total consumption of CFCs and 61.2% of total ODP. Information on 1994 seem to indicate a slight decrease to a total consumption of about 180 tons. The number of new appliances manufactured and imported in Zimbabwe using HCF-134a is still negligible compared to the existing CFC units. It will take some time before the effects of the introduction of alternative refrigerants will change the consumption of CFC. It is therefore anticipated that the trend of the country's consumption of CFC will remain basically unchanged in the next 3 to 4 years and then sharply decline to zero in the following 6-7 years. It should be noted, that with the drastic world-wide reduction of these chemicals, there may not be enough refrigerant available to satisfy Zimbabwe's future demand. There is clearly an immediate need for recovering these refrigerants whilst there is still the opportunity to do so. Recovered CFCs are the best and perhaps the only longer term source of these refrigerants in the future. However, it should be noted that there has already been some marketing efforts from a few overseas companies to market ODS outside of the restrictions on international trade as covered under the Montreal Protocol. This scenario further illustrates the importance to establish a recovery and reclaimation network in Zimbabwe.

As far as price of CFCs is concerned, the scenario that can be anticipated is rather different. The spreading awareness of the problems caused by the use of ODS, the comparative economic disadvantages of converting the existing units, the marginal economic impact that the price of CFC-12 has on the end users, the higher prices of the next alternative HFC-134a and the higher prices of CFC-12 in the neighboring countries (namely South Africa) allows one to reasonably assume a relatively steady increase in the prices of CFC-12 from now to total phase-out.

The whole refrigeration sector in Zimbabwe includes four sub-sectors.

1. Automotive Air Conditioning

The estimated number of vehicles equipped with air-conditioning is 200,000 units. The refrigerant for this sector is almost exclusively CFC-12 although some of the new imported cars have installations using HFC-134a. The installed volume of CFC-12 for this sector is estimated at 130 metric tonnes. The average amount of charge is 650 grams. Considering an average time of 2 years between recharges and an average recoverable part of the charge of 15% as from evidence found in the country, the recoverable amount of CFC is 9.7 metric tonnes.

2. Domestic Refrigeration

Recovery in this sector may be the least cost effective as the potential for recovery is estimated to be only 15% of the charge which is by nature a small one, only 250 grams on average. Similar to the automotive air-conditioning also for the domestic sector the most common reason for recharging is the presence of leakages in the circuit and that explains the low recovery yield. The total number of domestic refrigerators is estimated to be around 500,000 units. These refrigerators have, until recent introduction of HFC-134a based units, been exclusively using on CFC-12. The installed volume of CFC-12 in this sector is estimated to be around 125 tonnes, whilst the annual demand for CFC-12 is estimated to be 12.5 tonnes. Experience shows that in the country the average time between recharges is 10 years, therefore, the projected recovery yield per annum is 1.9 tonnes.

3. Commercial & Industrial Refrigeration

There is a distinct advantage in targeting this sector aggressively because the machinery tends to contain a large volume of refrigerant (1 to 50 kg) and it should prove to have a relatively high yield per service job. The estimate number of units in this sector is 40,000 with an average charge of 4 kg for a total installed base of 160 metric tonnes. The total annual consumption of the sector is 53 tonnes. The average time between recharges is estimated to be 3 years and the recoverable CFC represents 20% of the total charge. The yearly potential for recovery is 10.7 tonnes.

4. Commercial Air-Conditioning

This sector is in many ways similar to the commercial refrigeration described above and as such the same features apply here as well. There is one feature that makes this sector unique. These systems tend to have charges in the range of 250 to 700 kg. One recovery from these systems could yield a volume equivalent to 2,000 domestic refrigerators. It is for this reason that all service persons in this sector be given comprehensive training and support with equipment that will meet their particular requirements. The estimated recoverable amount is 6 tonnes per year.

Table 1 summarizes the situation for the different sectors.

Table 1 Amount of Recoverable and Reduction of Release of CFC Refrigerant

Sector	Unit	Domestic Refrigeration	Commercial & Industrial Refrigeration	Automotive Air Conditioning	Commercial Air Conditioning
No. of refrigeration & a/c units	units	500,000	40,000	200,000	data not available
Average time between recharges	years	10	3	2	data not available
Units recharged per year	units	50,000	13,333	100,000	data not available
Average CFC content	kg	0.25	4.00	0.65	data not available
Installed volume of CFC	kg	125,000	160,000	130,000	data not available
CFC Consumption	kg	12,500	53,333	65,000	50,000
Average recoverable CFC per unit	%	15%	20%	15%	12%
Recoverable CFC refrigerant per year	kg	1,875	10,667	9,750	6,000
Reduction of release through better maintenance	%	10%	15%	10%	15%
Non-recoverable reduction of release	kg	1,250	8,000	6,500	7,500
Total Recoverable CFC	28,292 kg				
Total Non-recoverable reduction of release	23,250 kg				
Grand-Total: 46,542 kg					

The need for this project can best be described in terms of impact on Zimbabwe's economy. Zimbabwe has requirements for ODS in applications ranging from domestic refrigeration to commercial refrigeration. The amount of equipment represented nation-wide is estimated at over US$ 1 billion or Z$ 8 billion. Without a programme for managing and reclaiming ODS, which is critical for the continued use of valuable equipment, the premature capital loss risk is extreme. Even the conversion of this equipment, so that it may be operated with alternatives, represents a cost, which the consumers and the industries can ill afford to pay for. The cost of recovery equipment is expensive enough to deter most companies from purchasing these tools. The cost of CFCs is still low enough that, unless this recovery equipment is provided in line with the terms of the Montreal Protocol for Article 5 countries, it is most unlikely, that companies will ever acquire the equipment. This is further supported by considerations on the price of the alternative refrigerant. At the time of writing, the cost of CFC-12 in Zimbabwe varies from Z$ 35 to Z$ 45 per kg, whilst the price for HCF-134a is around Z$ 120/kg. Business managers recognize, that the cost of the next technically feasible alternative is difficult to justify with today's price for CFCs.

II. PROJECT OBJECTIVE

The objective of the project is to prevent the release of ODS, particularly CFC-12, into the atmosphere during the service and disposal of ODS dependent equipment in the above described sectors and to reclaim a substantial part of CFC12.

Two main ways of reducing the release of CFCs will be from:

1. recovery of refrigerant during service and disposal of equipment, and reclaim of recovered refrigerant for re-utilization;

2. Improving the maintenance procedures of cooling equipment through training and introducing up-to-date practices in CFC charging and handling.

The reclaimed CFCs will provide an alternative source from imported virgin CFCs. It is expected, that by securing this volume of refrigerant, the country's demand for imports of CFC-12 will be reduced by 16%.

III. PROJECT DESCRIPTION

The project entails the establishment of a network for the recovery and reclamation of CFC refrigerant such as CFC-12 and, when the need will occur, other refrigerant gases such as R-134a. Different alternatives concerning the operation of the network have been examined and it was found, that the most appropriate solution is a system, where a number of decentralized recovery units provide the refrigerant to a central reclaim unit, which in turn redistribute the refrigerant to the final users. A comparative analysis of the alternatives is summarized in Annex I.

The financial calculations prepared for the project proved, that the amount of refrigerant available for reclamation in the country, and the price difference between the recovered old refrigerant and the reclaimed one is sufficient to set up a sustainable, self-financing business operation, if the basic investment and training cost is provided in kind through the Multilateral Fund. The local company, which has been indicated by the Ministry of Environment and Tourism to operate the network, is Zimbabwe Ozone Solutions.

The salient features of the network are the following:

1) Central Unit.

A central reclamation unit will provide a service for the thorough reclamation and laboratory analysis of the recovered refrigerants to all industry sectors manufacturing or servicing ODS based refrigeration equipment. This analysis will ensure, that systems down-stream will not be contaminated from the introduction of refrigerant with inadequate quality standards. Service technicians and consumers will therefore rest assured that no degradation of their equipment will occur.

2) Recovery

120 recovery machines will be distributed among the various service stations. Placements of recovery systems will be determined by calculating the most effective locations with regards to their access to large and consistent volumes of CFCs. With time, these locations will change their requirements and the machines may be relocated to a facility, which has a greater need. Although there are over 400 locations where CFCs are being handled, it is not economically feasible for each location to have recovery systems on-site all the time. Therefore the number of recovery machines considered in this project is less than the number of sites. It is proposed, that for the smallest users of CFCs, recovery systems will be made available for short "rentals" with no charge for use, but only a security deposit to help protect the equipment.

3) Collection.

A transport system will assure the transportation of the recovered refrigerants to the central plant, followed by transportation of the reclaimed refrigerants back to industry for re-use. This would be accomplished by a pick-up truck, which would travel to each of

the workshops and return with recovered refrigerant to the reclamation centre for reprocessing. The CFCs would, for the most part, be stored in 20 kg refillable storage tanks. Log books will need to be maintained to record each tank transportation event. Each tank will be tagged with information as to the amount of CFCs and the customer source, as well as type of CFC. The central office will gather phoned-in tank requests and programme the most efficient schedule for pick up. At the time of pick up, an empty tank will be left to replace the one taken away. The customer will be paid for the recovered old refrigerant and/or given an option to purchase back reclaimed CFCs kilo for kilo, less 5% for processing losses.

4) **Operations.**

Storage tanks will be distributed with the recovery machines. The Network will be called by customers as they fill up their tank. The Network vehicle will be sent to collect the full tanks and leave empty, clean tanks. Back at the central unit the recovered refrigerant will be weighted and checked for levels of contaminants and then processed in the reclamation equipment. After processing the reclaimed gas will be chemically tested and certified, and then, delivered back to the customers.

Each customer will be allocated a volume of reclaimed refrigerant to match the volume of recovered refrigerant, which he has contributed, less a nominal allowance of 5% for wastes and handling and processing losses. This percentage will be adjusted to be in line with the averages. A tolling charge for handling and reclaiming the CFCs, which will include costs of operations plus a reasonable margin for profit, will be paid by the client industry/workshop to the Company. Should the customer not have a requirement for the refrigerant, they will be paid a nominal reward as an incentive for capturing more CFCs.

The Network Operator should keep accurate records of the amounts, types, sources and destinations of the refrigerants collected and processed. Quarterly reports with the above information should be sent to the Ozone Office by the Network Operator for the whole duration of the project. This will allow the Ozone Office both to exercise its supervisory role for the effective operation of the network and to monitor and control the impact of the project on the reduction of CFCs used and released into the atmosphere.

5) **Organizational set-up.**

The network will be operated by the selected private company. The Network Operator will be responsible for establishing the network throughout the industries and workshops operating in the sectors covered in this project. The equipment for recovery and reclaim of CFCs (recovery units, reclamation equipment, laboratory equipment, transport equipment) will be entrusted to the Company for distribution and proper operation. The Company will provide all remaining components of the project as described in the financial plan. These include: land and building, services and facilities, administrative office, telecommunication equipment, labour force, working capital.

6) **Monitoring and Supervision.**

In its capacity of coordinator of the activities related to the Montreal Protocol in the country, the Ozone Office will monitor and supervise the operations of the network to assure, that the most effective use of the above equipment is attained. In particular the Ozone Office will make sure that:

- the recovery machines are distributed according to criteria of maximum recoverability of CFCs;
- the re-distribution of the processed refrigerants is done according to the "re-buying option" of the suppliers of recovered refrigerants;
- all the equipment of the network is properly kept and maintained;
- proper records of the amounts of CFCs recovered, reclaimed and re-distributed are kept by the Network Operator.

The title of ownership of the machines and equipment provided under the Multilateral Fund will be kept by the Ozone Office throughout the duration of the project (3 years) and then transferred to the Network Operator. The transfer will be subject to final evaluation of the activities carried out by the Network Operator and final judgment on its capacity to run the network effectively.

Disputes and complaints will be handled by the Ozone Office.

7) **Training.**

This is an important capacity building component for users. The on-the-job training will improve the operational discipline and encourage recycling. It has been recognized that some workshops are manned by unqualified artisans with very little to no formal training. Normal routine operations will identify the extent of the training needs. Training will form an input component of the Ozone Office.

A training programme will be organized and run to complement the operation of the network and improve its effectiveness. Training is a crucial aspect of this project, as the field of refrigeration has changed dramatically with the requirements of the Montreal Protocol. Many of the service persons in Zimbabwe have never received detailed training. It is assumed that with training, many situations of careless venting will be eliminated and this may indeed yield the highest reduction of demand for CFCs. Currently, when servicing equipment, it is common practice to clean the system with CFC-12 prior to final charging. Sometimes a leak is only discovered after charging the system and this charge then needs to be vented. In such a situation up to three times of the proper charge is used.

It is still a common practice to use CFCs for flushing the systems to clean them of non-condensables and moisture. This practice is extremely wasteful and needs to be discontinued. A far better practice is running a vacuum pump until a deep vacuum is reached. This vacuum will dramatically reduce both non-condensables as well as moisture.

With training in alternative techniques, these improper practices can be minimized and excess waste could be greatly reduced.

The training programmes will take advantage of what has been learned and developed during previous training workshops sponsored by the Montreal Protocol and others as well. There is extensive information available. It is imperative that training is provided to all individuals in these sectors. Otherwise it is unlikely, that they will learn all the issues around "Ozone Layer Protection" and the many improved service practices when working with CFCs.

A series of training events must be accomplished over time, so that all technicians will have the opportunity to attend. All training must include a portion of hands-on training with a special focus on leak detection. A final certificate will be awarded to the technicians, who have completed the training successfully. This certificate should become, as soon as possible, one of the requirements to be licensed by the national authority to operate with ODS. A first course will be held by the technicians working for the central unit for those who will receive the recovery machines. Further training needs will be assessed during the operations of the network. It is expected that, after the appropriate regulatory framework is put in force (license to operate with ODS), the demand for training will raise from the ones willing to regularize their position.

Training will be the responsibility of the Ozone Office in close cooperation with the Network Operator. Two experts on refrigeration system maintenance and CFCs recovery and reclaim will be fielded for one month as soon as the Network Operator is ready for operations and the Ozone Office has organized the training logistic. The main tasks of the expert will be to:

- carry out the training activities for refrigeration system maintenance, recovery and reclamation of CFCs ;
- assist in the start-up of the Network.

The training program will include a number of important issues, for example:

- The correlation of CFCs and the Ozone Layer;
- The consequences of Ozone Depletion;

- The production and supply trends of CFC refrigerants CFC-12;
- Proper and safe handling of CFCs;
- Recovery, Recycling and Reclaim;
- General mistakes in maintenance leading to waste and release of CFCs;
- Proper maintenance and housekeeping procedures, e.g., importance and methods of evacuation of systems before recharging, prevention and early detection of leaks, etc.

The final outcome of this project may reveal, that one of the largest reductions in venting was accomplished by merely providing training and that with conservation measures the industries will realize substantial savings.

8. Special Arrangements (Awareness).

Providing information and stimulating motivation are probably the least expensive and most effective ways to reduce the amount of CFCs released into the atmosphere. Therefore, it is important that special stickers and tags are supplied to industries and workshops to be placed in the areas where CFCs are handled. Special stickers will be also fixed to the storage tanks belonging to the Network and to each tank used to transport and deliver CFCs in the country. The tags and stickers should reference the Ozone Layer and state in large letters, that CFCs must not be vented. The stickers to be fixed to the tanks should also reference the Network, its purpose, address and telephone.

IV. INPUTS

1. *Capital goods*

The following equipment will be provided to the Network Operator:

Item	*qty*
On site recovery	
Recovery system 1/8 HP compressor with 5-15 kg tanks	50
Recovery system 1/3 HP compressor with 20-30 kg tanks	70
Storage tanks 15 kg	30
Storage tanks 25 kg	100
Storage tanks 100 kg	16

Leak detection sets	120
<u>Plant equipment</u>	
Reclaim plant	1
Gas chromatograph	1
Laboratory equipment	1
Storage tanks 15 kg	10
Storage tanks 25 kg	40
Storage tanks 100 kg	20
Recovery system large	1
Leak detectors	15
Spare parts	1
Floor jack	1
Set of tools	1
Gas welding set	1
Merchant scale	1
Work benches	2
Metallic shelves	4
Hand trucks	2
Set of pressure gauges	3
Vacuum cleaner	1
Fire extinguishers	3
Pick up truck	1

2. *Training*

The training component will include the following inputs:

Expert	2 m/m
Training materials	

V. PROJECT IMPLEMENTATION

The project will be implemented according to the rules and procedures of the United Nations Industrial Development Organization, under the management of the backstopping officer of UNIDO, in close cooperation with the Network Operator and the Ozone Office. The latter will also perform the necessary local coordination and control as mentioned above.

The detailed terms of reference for the supplies and services to be provided under the project will be formulated after the project approval and communicated to the Ozone Office and the Network Operator. After competitive bidding, performed according to UNIDO's financial rules and procedures, a supplier will be contracted by UNIDO. The supplier will be responsible for providing the necessary equipment, its installation and commissioning and on the-job-training of the Network Operator's staff.

Having accepted to operate the network for recovery, and reclaim of CFC refrigerants under this project, the Network Operator will be committed to provide the following inputs:

- All activities and costs related to the construction, or renting of the adequate facilities to accommodate the reclaim plant and to properly operate the network, as described by the project document. The relevant construction work or lease agreement will have to be arranged by the Network Operator in line with the established milestones of the project;

- Technical staff as described in the project document;

- Provision of materials, furniture, facilities, service, manpower, etc. related to commissioning, start-up, trial runs and operation of the equipment and the network;

- Local transport, communication and secretarial facilities for the supplier's staff and the expert, as well as for the UNIDO's staff involved in the project implementation;

- All other expenses not included in this project document and not covered by the budget approved by the Multilateral Fund for the Implementation of the Montreal Protocol.

UNIDO as Implementing Agency has the necessary experience and capabilities for the successful implementation of the project. Upon approval of the project by the MFMP the entire budget will be transferred to UNIDO. The respective project allotment document will be then issued by UNIDO's Finance Section. Any technical, operational or financial deviation from the approved project document is subject to approval by the MFMP and UNIDO.

VI. PROJECT COST

1. *Total Cost*

Investment cost will cover new machinery for decentralized recovery and for the central unit, testing equipment, spares, transport equipment, some of the office supplies, training and technical assistance for the commissioning of the machinery and the start-up of the operations.

The provision of other equipment, such as office supplies, furniture, stationery as well as services, facilities and manpower and all related costs will be responsibility of the Network Operator.

The cost breakdown of all inputs is in Annex II.

Implementing Agency's overhead costs are 13%.

2. *Contingency Fund*

Ten percent of the project is to be allocated for contingencies. This amounts to $32,500 US$, which will be used to cover unforeseen expenses which may occur during the project implementation and the increase of prices.

The project budget is shown in Table 2.

Table 2 Project Budget

Budget Line		Duration	Cost
		work months	US$
11-50	International Consultants	2	26,000
21-01	Subcontract		312,242
31-01	Training of service technicians		15,000
51-00	Miscellaneous (contingency)		35,324
99-99	Subtotal		388,566
Implementing Agency Overheads, 13%			47,225
PROJECT TOTAL			435,791

Request funding by the MFMP: US$ 435,791

Cost Effectiveness has been calculated as US$ 8.36/kg of ODP (Annex 3)

VII. IMPLEMENTATION SCHEDULE

The project will begin in September 1995 and will continue until September 1998. It is anticipated that the business, which supports this project, will continue to provide the scope of this project for ten years, or until the volume of ODS is close to nil.

VIII. PREREQUISITES

Certain prerequisites are necessary to assure the correct implementation of the project and to achieve its ultimate objective. These preliminary conditions are of various nature and of different order of priority, but all are meant to build up the proper environment for this and other projects to succeed.

1. The Ozone Office, the institution of which is the object of an already approved project under the Multilateral Fund, should be established and become operational as soon as possible. All sectors in which the ODS are used, and in particular the refrigeration sector, need close supervision and control and above all, to be regulated. The Ozone Office should involve in the decision making process representatives of both the public institutions concerned and of the private sector. The Ozone Office must play an important role of supervision of the operations of the network to ensure, that all parties in each sector are being treated fairly and promptly and that the project machinery is being used effectively and is properly supported with maintenance.

2. There is a general consensus amongst industry representatives, that an association of the industries in the refrigeration sector should be established, to play an active role in the operations of the Ozone Office. Industry, through the association, will be able to direct or influence the activities of the Network Operator. With 400 or more locations nationwide, that have some aspects of dealing with CFCs, it is extremely difficult to communicate across such a diverse and fragmented group. Awareness promotion is certainly one of the most effective means to reduce the release of ODS into the atmosphere and, at the same time, convert all sectors to the new technologies. An association could play a very important role in gathering and disseminating critical information quickly and efficiently amongst its members.

3. Activities in the refrigeration sector need to be regulated. It is important that all operators dealing with ODS undergo proper training and prove their qualifications. Non-qualified manufacturers or repair personnel should not be allowed to operate and all activities related to ODS should require licenses. The possession of the license would enable the operator to import, buy and sell refrigerants.

4. Adequate tariff barriers should be put in place to discourage the import of CFCs. At the time of writing the market price of CFC-12 in Zimbabwe is about one fourth of the

price of its next alternative HCF-134a. Moreover, the price of CFC-12 in South Africa is much higher than in Zimbabwe. This situation can, in the immediate future, create distortion and impair both the effectiveness of the project and the monitoring of its impact.

IX. RISKS

The following are the risks, which may impair the project activities or affect the impact of the project. Whenever the case occurs, immediate actions should be taken by the Ozone Office in cooperation with the Network Operator to correct the situation in order to eliminate or diminish the related risk.

- Lack of concern about the environmental impact of releasing ODS. For the service sector it should be clearly illustrated, that without recovery there will be even greater shortage of refrigerants and thus the operators will potentially lose revenues by not being able to recharge their equipment.

- Industries/workshops may decide not to bring recovered refrigerants to the central reclaim unit, because they may feel the quality is good enough for immediate re-use. All operators in the sector should be informed, that the quality of their work and the lifetime of repaired equipment depends greatly on the quality of the refrigerants they use.

- There are numerous locations, which offer service for refrigerators, but do not perform this service regularly enough to justify the placement of recovery equipment. Though in theory this could be solved by loaning the machines, it may prove to be impractical because of the logistics of delivering and returning the equipment. It may be, that casual service locations will have to be ignored for the time being. These companies may be encouraged to pass the job onto other locations, that have recovery equipment.

- Low cost "parallel market" for refrigerants may be very attractive to distributors and to service industries. There have already been a few attempts to sell low cost refrigerant from overseas companies. Accurate control of the imports, inflows and outflows to and from the reclaim unit, as well as proper incentives and disincentives for CFCs trading can be the most appropriate solutions.

ANNEX 2 Equipment list

Item	*Price,* US$	*Q-ty*	*Total,* US$
ON SITE RECOVERY:			**145,000**
Recovery system 1/8 HP compressor 5-15 kg Storage tank	800	50	40,000
Recovery system 1/3 HP compressor 20-30 Kg Storage tank	1,500	70	105,000
CENTRAL RECLAIM:			**128,970**
Reclaim plant	50,000	1	50,000
Gas chromatograph	15,000	1	15,000
Laboratory equipment	5,000	1	5,000
Storage tanks 15 Kg.	70	50	3,500
Storage tanks 25 Kg	100	120	12,000
Storage tanks 100 Kg	250	30	7,500
Recovery system large	4,500	1	4,500
Leak detectors	250	15	3,750
Spare parts	7,000	1	7,000
Floor jack	300	1	300
Set of tools	300	1	300
Gas welding set	350	1	350
Merchant scale	500	1	500
Work benches	150	2	300
Metallic shelves	150	4	600
Hand trucks	60	2	120
Set of pressure gauges	100	3	300
Vacuum cleaner	200	1	200
Fire extinguishers	50	3	150
Pick up truck	15,000	1	15,000
Computer	2,000	1	2,000
Printer	600	1	600
FREIGHT + INSURANCE			27,397

Item	*Price,* US$	*Q-ty*	*Total,* US$
START UP AND COMMISSIONING			15,000
TRAINING			31,000
Expert (m/m)	13,000	2	26,000
Teaching materials			5,000
SUBTOTAL			347,367
CONTINGENCY	10%		34,737
*OFFICE EQUIPMENT AND SUPPLIES**			5,000
GRAND-TOTAL			382,104
* *To be provided by the Network Operator*			

ANNEX 3 Calculation of Cost Effectiveness

A	***ODS Phase out***	Unit	Total Project
A1	Average use of CFC 12 per year	mt	46.5
A2	ODP of CFC 12		1
A3	ODP-weighted CFC 12 phase out (A1*A2)	mt	46.5
B	***Incremental capital cost***	***Unit***	***Total Project***
B1	Total investment cost (incl. 10% contingency)	US$	388,566
C	***Annual incremental operating cost (reduced)***	US$	Not claimed
D	***Cost Effectiveness***	Unit	***Total Project***
D1	Cost Effectiveness (B1/A3/1000)	US$/kg	8.36

T. Grof/er
9 June 1995

Comments on the Technical Review of project entitled 'CFC Refrigerant Recovery and Reclaim Conditioning, Domestic & Commercial Refrigerator, Commercial Air Conditioning Zimbabwe and Seychelles, prepared by WS Atkins Consultants Limited

1. Rationale

a) The basic objection of the reviewer against the projects is, that no refrigerant recycling recovery reclaiming projects are successfully operated in developed countries and thus there is no reason to believe, that such project will be effective in a developing country. Based on the recommendations of the Executive Committee, it was decided to formulate such projects. These projects are a result of this attempt and we suggest to use it as pilot projects before implementing similar ones in other developing countries.

The reviewer states, that Indian manufacturers are selling CFCs around the world. This argument can not be used to stop the introduction of reclaiming and recycling projects. On the contrary, action should be taken on governmental and intergovernmental level to stop these practices in line with the signed agreements.

The project for Zimbabwe is formulated in a country where the consumption of CFC is high enough to justify a self-sustainable network. Financial calculations were prepared to justify this assumption. The calculations were made using fixed prices, the only price which was changed is the price for the refrigerant. The reason behind this assumption is, that in case the Government restricts import of the refrigerant, this commodity becomes scare and the price level of the reclaimed or new CFC will grow faster than the overall inflation rate in the country. The price of the recovered refrigerant will grow parallel with the inflation rate. The calculation proved, that the operation will yield in profit and thus the operation can be sustained.

2. Other comments for Zimbabwe

a) The equipment selected as a reclaim station is A'gramkow Type RE1215 which is operating automatically and can provide a refrigerant in accordance with ARI Standard 700-88 'Specification for Fluorocarbon Refrigerants'. The gas chromatograph will be used for quality control purposes. The project indeed will require inputs from a chemical engineer. This was raised during the formulation of the project. The company selected by the Government of Zimbabwe assured to provide such a person on their own cost.

b) The selected operation of the network is described in details in the project document. The idea of collecting the refrigerant by simple recovery units cannot be accepted because this might lead to mixing of various refrigerants, contaminating of more pure refrigerant with very contaminated ones, etc. In such a case, the confidence of the industry will be lost in the whole recovery scheme and the project indeed will become a 'white elephant'. The central station will not only reclaim the refrigerant but assure proper chemical analysis.

c) The amounts of recoverable refrigerants are estimates. These estimates are not optimistic at all in view of the very low standard of maintenance procedures in the country. Some experts claim, that these estimates (12-20% recovery and 10-15% reduction of release) are even too conservative. Even the reviewer claim, that 'most of the developing countries report one system charge per year'. In this project we have calculated only 25-35% of the charge with a recharging cycle of 2-10 years (page 4, table 1).

d) Even though CFC-11 was not mentioned separately, it is clear, that CFC-11 and CFC-12 have to be handled separate. The same applies for the collection.

e) The project document including the actions to be taken was approved by the Government. The approval is attached to the project document.

3. Other comments for the Seychelles

a) The number of technicians to be trained is very limited as the whole country has 78,000 inhabitants only. The person identified as the project facilitator was already trained and has the technical background. Another person was identified as a trainer who has also acceptable technical background (see attached fax from the Ministry of Foreign Affairs, Planning & Environment).

b) The project is financially not viable without support from the Fund. Nevertheless, it is fully backed by the Government which gives high priority to it. This project is another pilot project for countries where the refrigerant available for recovery does not justify financially the operation of a recovery reclaim network. The merits of the project should be judged in light of these facts and in view of the political priorities given to activities in the small ODS consuming countries.

c) Helium recovery in para 10. of the review 'Recommendations', should read halon recovery.

d) The reclaim centre is justified on the basis of the very difficult logistics. It is very much doubtful, that this project will work if the refrigerant will not be claimed locally and will have to be transported overseas with all the usual bureaucratic procedures causing delays.

e) Regarding the amount of recoverable refrigerants, the same comments apply a in the case of Zimbabwe (see para c) above).

WS Atkins Consultants Ltd.
Montreal Protocol

Project Review

1. Country of Origin	Zimbabwe
2. Title	CFC Refrigerant Recovery & Reclaim
3. Sector:	MACS, Domestic & Commercial Refrigeration, Ai Conditioning.
4. Relationship to Country Programme	This has not been seen by the reviewer

5. Technology

It is proposed to set up a refrigerant recovery network that will be served by a central reclaim facility. Refrigerant will be collected by end users in situations where this would normally be deliberately vented to atmosphere, using recovery machines provided as part of the project. This will be collected by the company operating the company who will reclaim the used refrigerant and test to ensure purity levels.

This is supported by a technician training programme that in addition to teaching recovery skills will improve standard service procedures and thereby further reduce emissions.

The proposed arrangement is one of two standard approaches that might be employed, i.e. central reclaim or individually owned and operated recycling machines. The project discusses the merits of each and concludes that the former is most appropriate for Zimbabwe

6. Environmental Impact

The project claims that 28.3 tonnes of CFC refrigerant will be recycled per year, and that emissions will be reduced by a further 23.2 tonnes as a result of improved service procedures resulting from the training programme. This represents 14% and 12% respectively of the current sector consumption of 196 tonnes per year.

These are both considered highly optimistic figures. The latter is very difficult and can be little more than an inspired guess unless some supporting evidence can be presented (the saving made if the practice of flushing systems with CFC

were eliminated for example). The former can be judged against the performance of existing reclaim schemes in western countries. The performance of these has been very disappointing. Figures are hard to obtain, but this reviewer doubts that an overall recovery rate of 14% of sector consumption has been achieved anywhere.

7. **Project Costs**

The project costs consist mostly of equipment for the central reclaim facility and 120 recovery machines to partially equip the 400 businesses that are thought to have a potential to recover refrigerant.

These are generally of a level consistent with this reviewer's experience of similar projects. The operating company will provide personnel, premises etc. A pick-up truck is requested. MPEC normally reject any request for vehicles. The purpose of some is not clear (e.g. floor jack, vacuum cleaner, gas welding set). A computer is added. The purpose of this, or the software required is not mentioned.

8. **Comment**

In order for such a project to be viable, it is suggested that two crucial elements must be present:

i) The scheme must be profitable for all concerned.

The central reclaim company must make a profit or it will stop reclaiming. The benefit provided to end-users must be an adequate recompense for the time taken in recovering refrigerant, or nobody will bother.

ii) Participants must be provided with equipment and knowledge

Training must be provided. Equipment must be available to end users.

iii) Technicians must be adequately motivated to take part.

Adequate motivation probably comes from a combination of moral obligation, financial benefit and legal constraint.

None of these elements are present to the required degree in the opinion of this reviewer. (i) is superficially demonstrated by the cash flow tables presented. Closer examination shows some odd features. Plant utilisation remains at 100% despite the fact that amount recovered' falls. The price of CFC-12 rises at an annual average of 22% throughout the project 10 yr. life, which keeps the income absolutely steady at 1.8m $Z every year apart from the first year. The amount paid out for recovered refrigerant is not given specifically but has to be deduced from the figures ($Z25 approx.). It can be deduced that the amount paid out rises by

a similar amount, but apparently there is no other form of inflation in Zimbabwe. Costs remain exactly the same. Thus the 22% price increase is net of inflation which is a very high assumption. Whether this is an adequate level of recompense to promote participation is not discussed (a refrigeration mechanic's hourly rate would be a good basis for discussing whether this would encourage him to participate). One very significant cost element is omitted and dealt with on a "wait and see" basis in the text - that of transportation. Quite how the collection and pick-up will work is not described and one suspects that the problem of handling this in a fragmented service sector of 400 end-users in a large country has not really been addressed. This may affect the cost of delivering 1 kg of contaminated refrigerant to the reclaim plant considerably. The most obvious method is not even mentioned as a possibility, i.e. using whatever refrigerant distribution system currently exists to collect recovered refrigerant and re-supply with reclaimed product.

Recovery equipment is provided for a portion of end-users. Others will have access to it but the way this will happen is very loosely defined. Lip service is paid to the need for training but no more. Apparently "a foreign consultant" will in the space of a month or so have enough time to provide the training required and assist in start-up of the facility. An estimate of the numbers of technicians in Zimbabwe who will need training is not given. It is felt that a more convincing approach would be to describe how a programme would reach the numbers who would need training, the human and physical resources required (*definitely* more than one month of a consultant's time), and the time it would take.

Bearing in mind that nearly half the project's saving in CFC consumption is said to come from improved service practices resulting from training, the scant attention paid to this is extraordinary.

A legal framework is briefly touched on. Making acquisition of a training certificate a legal requirement is mentioned, along with discriminatory tariffs. Does the Zimbabwe government know of these proposals? Do they agree in principal? Since the time required for training technicians has not been computed, you could not make a regulation making a training certificate mandatory until a scheme was in place where training could be provided before the regulation was due to take effect.

It is this reviewer's opinion that effective motivation will require exposure of technicians to a training course where the moral reasons for participating can be expounded in addition to recovery skills and improved service techniques.

Surprisingly, although the need to supply the refrigeration industry with refrigerant of a high purity level is emphasised several times, the *standard* which will be used is not mentioned. Crucial elements in achieving this have been ignored in description of the scheme's operation. How final testing is carried out (assuming the ARI 700 standard or equivalent is employed) is not described. The assumption is that reclaim centre operatives will do this with the gas chromatograph equipment requested. This simple gas chromatograph equipment is normally employed *to check for unrecoverable mixtures of refrigerants* when refrigerant is presented for reclaim. It is stated by companies engaged in this work that the required purity standards (10 ppm acid; 10 ppm moisture) cannot be checked by mechanics with a little

training but require the skills of an analytical chemist trained in fluorocarbon chemistry. Of two UK schemes known to the writer, one employs such chemists and the other has product batch tested at a local university.

9. Rationale

Apart from the flaws in project preparation enumerated above, it is thought that the very idea of a recovery scheme has to be justified in the first instance. The questions that have to be answered are:

i) Will CFC refrigerant really be in short supply in Article 5 countries? Indian manufacturers have 25,000 t excess capacity and can legitimately supply other Article 5 countries until 2006. They are known to be marketing aggressively in other Article 5 countries (e.g. Egypt) as developed countries cease to supply.

ii) If CFC prices rise in the fashion described, will not a point be reached where ownership of a recycling machine by individual companies is a more cost effective option for them than participating in the scheme. Western operators have found that these are perfectly adequate for handling recovered refrigerant with a normal level of contamination. A sophisticated central plant is only needed in cases of severe contamination following e.g. a motor burn-out on a (semi) hermetic system. These machines currently cost only $3,000 and can be used on site. The owner can make a much higher profit for a negligible increase in time taken.

iii) The widespread use and availability of HCFC-22 based CFC refrigerant drop-in replacements means that CFC refrigerant prices will never rise above these, which will in turn be affected by the availability of legitimate CFC refrigerant in Article 5 countries (from e.g. India).

10. Quality of Project

This reviewer respectfully suggests that this project was prepared by someone not overly familiar with the refrigeration business. The following are considered basic errors and omissions and their existence calls into question the project's validity.

i) Leaks are stated as being a principal source of consumption in domestic equipment. As factory assembled products made with brazed connections leaks are rare by comparison with commercial equipment.

ii) In estimating amounts recoverable from the commercial sector, an estimate of one system charge replacement every 4 years is used. If only that were achievable; it is far too low. Most developing countries report one system charge per year as being realistic. Of course much of this is lost in leaks. This can't be recovered. What are the circumstances in which refrigerant will be recovered? What type of repairs typically involve deliberate wasting of

refrigerant? Normally this would only be a motor burnout. How prevalent is this cause of breakdown?

iii) No attempt was made to differentiate between CFC-12 and CFC-11 in discussing the CFC recoverable from the air conditioning subsector. System charges were given as between 250 kg and 700 kg, and it is that this would be re-directed to other subsectors. This would be true for CFC-12 equipment, but not centrifugal plant using CFC-11. It is quite unusual to find air conditioning systems employing reciprocating compressors which use CFC-12. HCFC-22 is much more common.

iv) The problem of ensuring that different refrigerants are collected in separate cylinders and the need to screen incoming refrigerants for unrecoverable mixtures is not mentioned. It is assumed that this problem is not appreciated by the project's authors.

All communications should be addressed to The Secretary for Environment and Tourism

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ZIMBABWE

MINISTER OF ENVIRONMENT AND TOURISM
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Your Ref.:

Our Ref.:

June 1, 1995

FAX MESSAGE

TO: *Dr T Grof*
Chief
Refrigeration Unit
UNIDO
Vienna
Fax No. (43 - 1) 232156

FROM: *Mr M Moyo*
Ministry of Environment and Tourism
Zimbabwe
Fax No. (263 - 4) 755006

RE: CFC RECOVERY AND RECYCLING PROJECT: ZIMBABWE

I acknowledge with thanks your letter dated 25 May 1995 to which you attached your final draft proposal for the above project. I also refer to my telephone conversation with you of this morning.

This serves to confirm our approval of the project proposal and to request you to now submit it to the Multilateral Fund Secretariat in time for consideration at the next Executive Committee meeting in July.

We also look forward to your mission on preparation of investment projects within the refrigeration sector.

Finally, we thank you for your assistance in the implementation of our country programme.

With kind regards.