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Mission Report for UNIDO Contract no. 98/038P

**Provision of Refrigerant Recovery and Recycling Handling Training
Services**

Comprising the following Projects MP/BEN/97/093
MP/BKF/97/094
MP/GAM/97/095
MP/GUI/97/096
MP/SEN/97/098

Activity Code: 420D31

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Introduction

The contract involved delivering training courses for Montreal Protocol funded training projects in each of five West African countries. Original course material in English and French was created under the contract.

The courses were delivered as prescribed in the contract. Dates were changed with agreement with the UNIDO task manager and the work was completed by March 13th, 1999. The performance of participants was generally good with over 80% of participants obtaining a good mark in the final assessment.

Some problems were encountered regarding refrigerant recovery and recycling equipment supplied under the contract. These are believed to have now been resolved.

1. General

1.1 Course Material

The courses were held as described below. A training manual was written in English by Cool Concerns (UK), a specialist training consultancy. This covered all topics mentioned in the original proposal to UNIDO by Dewpoint Consultants Ltd. The courses were translated into French by David Gibson with the assistance of Joelle Buisson, a native French speaker. All courses were delivered by David Gibson.

The course material was provided in the form of printed trainer manuals (10 at each venue) and a CD. Unfortunately on the eve of departure for Guinea, the first venue, the CD's were found to have been infected by a new virus. All countries now have a virus-free copy of the CD.

The course was generally well received. It is clear that some items such as retrofit with hydrocarbons and more emphasis on retrofit with other refrigerants should have been included (though not mentioned in the original TOR). A final version of the course will be produced shortly which includes these topics and takes into account comments and suggestions from local experts and trainers.

The course material was deliberately designed to appeal to untrained refrigerator repair technicians who are assumed to constitute the bulk of potential attendees on the technician training courses (i.e. the courses which the participants on these courses were being trained to give). A great deal of colourful original overhead projector material had been created for the courses (around 100 slides). Supplied in CD form, future trainers will be able to modify these and the training manual provided to accommodate local conditions and personal preferences.

1.2 Course Dates

Three courses were given before Christmas. These were:

Guinea	6th.-11th. December
Senegal	14th.-19th. December
Gambia	21st.-24th. December ¹ .

The remaining courses were delivered in March 1999:

¹ The course was delivered in 4 days instead of 5, owing to the proximity of Christmas. The full course was covered including practical tasks by extending the number of teaching hours per day

Benin	1st.-5th. March
Burkina Faso	6th.-9th. March ²

1.3 Delivery of Courses

The course started with a pre-course assessment, followed by about 1.5 days of lecturing and 2 days of largely practical work, finishing with a post-course assessment. Since this was a "Train the Trainers" course, all participants gave a presentation in pairs of one of five topics that had been covered in the course. These were Safety, the Environment, Accessing Systems and Charging, Fault Finding, and Recovery and Recycling (students' performance on these presentations did not count towards the formal assessment). Participants were generally either academically trained specialists with limited practical experience, or experienced refrigeration mechanics with little academic training. The course benefited both. The deliberately simplified theory helped practical people understand the need for important procedures such as evacuation (about which they were initially sceptical³). Academic people benefited greatly from the substantial practical content, which included the assembly and commissioning of a complete refrigeration system (see below). A good atmosphere prevailed at all the venues.

1.4 Specific Problems

1.4.1 Using the Training Module

In the original projects it was proposed that each venue would be supplied with a refrigeration training module on which activities such as fault finding could be carried out. Funding was also requested for a set of refrigeration tools for each venue to ensure that these were available for the course. In the event, funding shortfalls meant that a simple kit of parts for a small refrigeration system was provided at each venue⁴. One toolkit was purchased and carried by the trainer from one venue to the next. The problem of what to do with the kit of parts provided was solved by constructing a

² As with Gambia, the course was delivered in 4 days because of an awkward public holiday. Given the fact that Benin and Burkina had to be done consecutively this was the only week available given the need for local Ozone officers to attend MP meetings. Burkina had initially not accepted the course because of misunderstandings over funding with UNIDO. This delayed the earliest start. The situation was further complicated by the week of the Burkina film festival FESPACO when all hotel rooms are booked well in advance.

³ The need to use a vacuum pump to evacuate circuits rather than an old compressor was clearly demonstrated with the aid of a vacuum gauge and sealed bottle of water. It was shown that the water would not boil unless a very low pressure was reached, which could be obtained by a compressor.

⁴ This cost about \$US 500, whereas a proper training module would have cost \$US 5,000.

collapsible frame in the UK which was also taken from country to country. This was devised by Cool Concerns and proved a very good idea indeed, since the limited facilities at each venue meant that assembly of the parts in any more conventional way would have been impractical.

The practical element started with conventional pipe forming and brazing exercises, but quickly passed to the practical business of assembling the module. This involved all the procedures also covered in lectures (setting pressure switches, pipe bending, flaring swaging and brazing, evacuation, charging) which took about a day and conveniently broke down into 5 major tasks which could be handled by a class of 10 working in pairs⁵. All students initially thought that a refrigerant recovery machine was a complicated piece of equipment until the simple construction of those provided under the project was demonstrated.

All quickly drew the logical conclusion that they could make a similar device for far less than the \$US 900 price tag of the A'Gramkow machine supplied. The course capitalised on this by then showing how one could be made in a few hours from old spares. It was recommended that for the final technician courses a pre-assembled training module like that made by the class should be used for fault finding, but that the assembly of the module should be replaced by construction of a recovery machine. This would involve all practical operations except evacuating and charging which could be carried out on the module. The number of recovery machines supplied under the project is very much less than the numbers required for a successful 3R scheme to work. Given the very high price (in West African terms) of proprietary machines, in-house fabrication is the *only* way enough machines will ever be available.

1.4.2 Venues

With the exception of Benin, all countries provided a refrigeration training workshop in a technical college for the workshops and the services of experienced teachers to assist. This was much appreciated. These workshops are run on a shoestring and often lack sufficient handtools and ready supplies of consumable materials such as refrigerant, copper pipe and brazing rod which have to be sourced specially. In Guinea, the workshop possessed really sophisticated training and demonstration modules provided by foreign funding (UNIDO), but lacked adequate basic material to run practical classes. The portable toolkit taken by the trainer was thus vital in being able to run the courses as designed. In Benin there is no refrigeration school. The course was run in a simple room in the Ministry of Environment building with only the portable toolkit and training module frame brought by the trainer. That the course was successfully concluded is owed in no small part to the good humour and flexibility of

⁵ In some venues, rather more than the 10 trainers for which the course was designed turned up. The difficulty of organising the practical element increased exponentially for every student over the 10 prescribed and emphasised how numbers in the technician courses should be kept down to 10 to be effective if only one teacher is available.

the participants in coping with these conditions.

1.4.3 Recovery Machines

It was discovered when preparing the course material that the wording on the machines was wrong and could lead to a dangerous situation. The problem was that a cheaper version of a standard machine was being supplied by A'Gramkow. The original machine was stopped automatically by a float switch when the recovery bottle was filled to a safe level. The new machine dispensed with this device but kept the original wording above the lights on the machine in such a way that if the operator waited for the light labelled "bottle full" to go out, the bottle would in fact be 100% full and in imminent danger of exploding. The equipment suppliers, HRP Focus (UK), were advised of this and prepared adhesive labels reading simply "High Pressure" and "Low Pressure" to place over the originals. These were not supplied to all countries initially owing to some confusion, but all countries are now thought to be in possession of these labels.

A critical sentence in the operation manual was wrongly translated into French. This was pointed out to HRP and a second translation made the same mistake. This is now believed to have been corrected.

1.4.4 Recycling Machines

It was discovered during the mission that handles on the almost identical cylinders used on the recovery and recycling machines were coloured in opposite ways. The liquid connection on the recovery machine cylinders were red and vapour connection blue, whereas the liquid outlet was blue on the recycling machine bottle and the vapour connection red. Since these had obviously come from the same original supplier and differed only in that the recycling machine cylinders had a float switch, it is difficult to see how this situation arose. The danger of this is that i) operatives may well be illiterate and unable to read the (correct) text embossed on the handles and ii) that when recycling refrigerant an operative would be using both bottles simultaneously and thus be confused. The suppliers, HRP Focus, have admitted that this situation is unsatisfactory and are now investigating ways of supplying appropriate covers for the recycling machine cylinder handles.

2. Individual Country Reports

2.1 Guinea 6th.-11th. December 1998

The premises supplied was a refrigeration training workshop in a technical college. This was adequate, though as with all venues there was a shortage of handtools which contrasted markedly with the sophisticated training and demonstration modules supplied under a previous UNIDO program. Two workshop technicians were supplied who also participated as students and were very competent and helpful.

10 persons attended the course. Roughly half had an academic background related to refrigeration with little practical experience, and half were very practical people with little academic engineering training who mostly ran their own refrigeration repair businesses.

The list of attendees with mark achieved in the final assessment are given below:

Sall N'Diaye	44%
Foue Sooy Keita	66%
Armadou Diarra	66%
Mohamed Camara	71%
Ansoume Sangon Conde	58%
Bangoura Mohamed	16%
Kemonson Conde	58%
Bah Omar	67%
Unknown	59%

Average 56%

Around 60% represents a good performance. All but two achieved this.

2.2 Senegal 14th.-19th. December, 1998

Senegal had earlier had a comprehensive train the trainers course where all of the 30 proposed trainers had attended a UNEP course. The course thus followed a different format where instruction was given to these trainers in operation of the recovery and recycling machines.

No final test was given as this was felt to be inappropriate. The numbers concerned was very large, something that gave rise to problems in the premises provided. These were a refrigeration training workshop in the local technical college and were adequate, except for a shortage of working refrigeration systems on which the 30 attendees could practice operation of the equipment.

2.3 Gambia 21st.-24th. December

10 participants attended the course. These ranged from advanced college students from the technical college refrigeration department where the course was held, to proprietors of local refrigeration businesses and the Chief Engineer of the local brewery. Two refrigeration teachers also participated and were extremely helpful. The assistance of Mr. Bob Badjan who sat in on the classes was also appreciated. Mr. Badjan is a refrigeration teacher at the college and the Ozone Officer for Gambia.

Attendees and marks on final assessment:

Samura	57%
Chiam	68%
Hanson	71%
Jammeh	42%
Mindy	69%
M'Buye	59%
Joh	72%
Annoh	73%
Mboye	77%
Sanyang	24%

Average 61%. Good performance was achieved by eight of the ten participants.

2.4 Benin 1st.-5th. March, 1999

The course was held in a room in the new Bureau d'Ozone building, and in a meeting room of the Ministère de l'Environnement. This was because no refrigeration training facilities currently exist in Benin. This will change shortly however, and two of the teachers at the new department attended the course. They declared themselves particularly happy with the overhead course material, which they plan to incorporate into their own classes.

There were 16 participants in total which was rather too many, especially given the nature of the premises. The practical sessions were carried out in a plain room, with only the tools and equipment brought by the trainer. A good atmosphere prevailed and all made the most of a difficult situation which ended well. The need to restrict class sizes on the subsequent training courses to 10 pupils per teacher was obvious to all. Ironically given the high numbers and limited facilities, performance on the final course was the best of all countries. This was partly due to the high level of training already received by perhaps half the class who had studied on Russian scholarships at the Odessa Refrigeration Institute.

Benin had stated that they were particularly keen to have a demonstration of hydrocarbon retrofit. Unfortunately this could not be demonstrated owing to the incompatibility of UK and French bottle connectors. The subject was treated in detail, however, and extra training material produced that will be incorporated into the final course material.

Attendees and marks on final assessment:

Djima	78%
Ayaba	64%
Adjibade	54%
Monteho	46%
Bio Mama	64%

Mekpato	78%
Guidi	74%
Houihoumou	78%
Sacramento	60%
Motcho	73%
Sikirou	74%
Mededji	77%
Oazogbu	63%
Behanzin	67%
Biaou	84%
Athoussou	79%

Average 70%. An excellent result where all but two achieved 60%.

2.5 Burkina Faso 6th.-9th. March

The course was held in the well-equipped refrigeration department of a training college. The venue was probably the best equipped of all five encountered. 16 participated including the two teachers from the department, and 15 took the final assessment. Though too large a class for comfort, the results were nevertheless good. The course was given over a 4 day period owing to an awkward public holiday. Several circumstances conspired to make this the only possible week when the course could be held.

Attendees and marks on final assessment:

Racine	72%
Tougma	60%
Kabore	77%
Traore	62%
Ouedraogo	2%
Ouedraogo Z.A	60%
Bambara	67%
Ouedraogo J.	69%
Donhyre	41%
Ilboudo	61%
Kere	44%
Zoungrana	67%
Bo	57%
Ganba	45%
Salambanga	74%

Average 62%. A good result. Only three failed to get a good mark (about 60%).

Terminal Section

The courses were successfully delivered and a reasonable mark achieved by over 80% of participants. A body of trainers is now available to deliver training courses in good refrigeration practice, recovery and recycling (3R) scheme in each country. This is a vital element in reducing ODS use by each country which is overwhelmingly the consumption of CFC-12 refrigerant in the repair of refrigerators, commercial refrigeration systems and mobile air conditioning equipment.

Experience showed that delivering the courses became difficult when the class numbers exceeded 10 because of the highly practical nature of the course. It is recommended that the training courses themselves do not exceed a ratio of 10 participants to one teacher.

The numbers of recovery machines supplied under the Project are inadequate for a 3R Scheme. It is recommended that the practical activity on training course be centred on the construction of recovery machines. These can be made easily from spare parts. Unless these machines are made locally it is unlikely that enough will ever be available to make a 3R scheme work effectively.

Local Ozone officers will now be able to move to the next important step, namely organising the courses themselves and creating a refrigerant recovery and recycling network. The work carried out under this contract will thus have been a key element in enabling the countries concerned to meet their obligations under the Montreal Protocol.

The problems encountered with equipment could have been avoided if the suppliers had thought more carefully about the destination of the equipment being supplied and its function. In future consideration might be given to making the supplier's duty in this regard more specific under the supply contract.