UNITED
NATIONS

EP

United Nations
Environment
Programme

Distr.
LIMITED

UNEP/OzL.Pro/ExCom/41/65
9 December 2003

ORIGINAL: ENGLISH

EXECUTIVE COMMITTEE OF
THE MULTILATERAL FUND FOR THE
IMPLEMENTATION OF THE MONTREAL PROTOCOL
Forty-first Meeting
Montreal, 17 - 19 December 2003

LIQUID CARBON DIOXIDE (LCD) TECHNOLOGY AND GUIDELINES FOR LCD PROJECTS: FOLLOW-UP TO DECISIONS 39/52 (b) and 40/17 (g)

This document consists of:

I. Report on the follow-up study on LCD technology: On-site visits to selected enterprises that are making successful use of LCD technology in Article 5 countries (Decision 39/52 (b)).

II. Report on the follow-up study on LCD technology: On-site visits to foam manufacturing enterprises with approved LCD projects in Morocco (Decision 40/17 (g)). (To be issued separately as an addendum to this document)

REPORT ON THE FOLLOW-UP STUDY ON LCD TECHNOLOGY

I: ON-SITE VISITS TO SELECTED ENTERPRISES IN ARTICLE 5 COUNTRIES MAKING SUCCESSFUL USE OF LCD TECHNOLOGY FOLLOW-UP TO (DECISION 39/52 (b))

SUMMARY OF CONCLUSIONS

1. The study that the Secretariat conducted covered seven completed LCD foam projects which initial assessment from the report on LCD technology and from project completion reports had been identified as successful cases of the use of the technology. The Secretariat's representative visited four of the seven enterprises and collected information from the other three through a questionnaire. A report from the World Bank on LCD trials for projects in China added useful information to the exercise. The study of the Secretariat leads to the following conclusions:

(a) In four of the seven enterprises, the contribution of LCD technology to the foam production of the enterprises is below 20%. (In two of those cases there is no contribution). In the other three the contribution was about 30%, 80 and 100%.

(b) LCD technology was approved for application under the Multilateral Fund primarily for manufacturing low density foams. However it has been found that all the enterprises covered in the study have experienced difficulty in using LCD to produce foams of density below 14 kg/m^3. The applicability of LCD technology in the foam manufacturing industry in Article 5 countries is therefore limited, because most of the foam produced in Article 5 countries is of this specification.

(c) Compared with methylene chloride, the introduction of LCD tends to require a greater number of trials and test runs and consequently a higher cost for trials due to longer plant down-times and higher cost of materials. Its limited applicability leads to short production runs and increase in unit production cost.

(d) The ability to successfully retrofit existing foam production machines using the predominant LCD technology selected in approved projects varies markedly with the type of foam machine in use in the enterprise.

(e) The difficulties in implementing the technology evident in most projects indicate that the maturity of LCD technology for application in Article 5 countries' industrial and market environment has not yet been fully proven. Its application in Article 5 countries currently appears to require continued technical support by technology suppliers after commissioning of the equipment and completion of the project by the implementing agencies. The extent to which this extended support may be provided for in contractual arrangements for approved projects, for example, through warranty, is not clear.

(f) Without additional funding from the Multilateral Fund, support is to be provided by the equipment supplier and by UNDP for some of the projects in Morocco, which are subject to the same technical problems. It may be necessary for arrangements of the same nature to be concluded in relation to LCD projects in other countries which have not yet been brought to a successful conclusion.

(g) Any future projects for LCD technology would have to be developed taking fully into consideration:

(i) the ability of the LCD technology to produce the specific foam grades manufactured by the enterprise;

(ii) the compatibility between the equipment provided by the LCD technology supplier and the equipment in place in the enterprise;

(iii) the need for long term technical support beyond the currently defined completion date of the project; and

(iv) having regard to the above technical constraints, the ability of LCD technology to contribute to reductions in CFC-11 consumption soon enough to meet the schedules in relevant national CFC phase-out plans.

BACKGROUND INFORMATION

1. At the 39th Meeting a report on the study on liquid carbon dioxide (LCD) technology and guidelines on LCD projects was submitted to the Executive Committee. The main conclusion of the report was that the LCD technology had achieved limited success in Article 5 countries and most of the 21 out of 60 enterprises that had been commissioned with LCD and reported by implementing agencies as completed had not succeeded in converting their foam production to the LCD technology and were using methylene chloride rather than LCD as blowing agent. It was apparent that enterprises were unable to sustain the conversion to the new LCD technology, leading to the conclusion concluding that the large investment in the technology by the Multilateral Fund has not been cost-effective.

2. As an outcome of the discussion on the report, the Executive Committee decided:

> "To request the Secretariat to make a small number of on-site visits to companies that were making successful use of LCD technology in Article 5 countries and submit relevant additional information to the 41st Meeting of the Executive Committee;
>
> Not to approve any future projects utilizing LCD technology pending consideration of the information referred to under sub-paragraph (b) above."

METHODOLOGY

3. Before undertaking the on-site visits to enterprises in Article 5 countries the relevant sections of the study of LCD technology and guidelines for projects converting to LCD technology, the relevant sections of the foam sector evaluation report as well as project completion reports (PCRs) submitted by the implementing agencies were reviewed again. Project documents of the selected enterprises were reviewed to study the baseline conditions prior to project implementation. In addition samples of purchase orders and Bid Analysis Reports were studied with a view to getting an understanding of the basis of the choice of equipment and the level of financial participation of the companies in their project's implementation. Implementing agencies were also requested, where available, to provide the latest information on completed LCD projects subsequent to the submission of the consultant's report on LCD technology. UNDP and UNIDO responded, but did not provide new information, however UNDP, in its comments on the consultant's report had earlier provided extensive information on successes achieved in its projects in Argentina and Brazil. UNIDO stated that all three LCD technology suppliers have been making necessary effort to adapt the quality of the LCD-blown technology to the specific requirements of the markets in the developing countries and therefore, the recently completed projects could be considered as more successful than the first LCD projects. UNIDO also indicated that normally upon financial completion of the projects and submission of the project completion reports attaching destruction certificates, the implementing agencies do not continue monitoring of the plant operation. There were no responses from the World Bank and GTZ.

4. Based on the reviews and updated information received from UNDP, eight out of the twenty one enterprises reported as completed were identified as enterprises which were likely to

be making successful use of the LCD technology. The assessment was made according to the following criteria:

- The project has been reported by the relevant implementing agency as completed.
- The project completion report has been submitted by the implementing agency.
- Commercial production (on a continuous basis) of at least one grade of foam with LCD at the enterprise appears likely or has been reported through the foam evaluation and other reports.

5. Further examination of the identified enterprises based on communication with NOUs and some of the enterprises, where possible, narrowed down the number of enterprises to be visited to six, four in Argentina, one in Brazil and one in Macedonia. Due to scheduling difficulties the enterprise in Macedonia could not be visited, while the enterprise in Brazil which was using similar technology and equipment and implemented by the same implementing agency (UNDP) as those in Argentina was removed as a cost and time saving measure.

6. A revised version of the questionnaire used for the earlier study was provided to the four enterprises to be visited in Argentina. Three of the four enterprises completed and returned the questionnaire. There was no response from the fourth enterprise (Suavestar). The questionnaire formed the basis for discussions with management during the visits. The questionnaires were also provided to the other enterprises in Macedonia and Turkey which were not visited, for additional information (see Table 6). All three companies, two of whom received a Beamech LCD unit while one received a Hennecke unit, provided responses or information on the status of use of their LCD equipment.

7. The enterprises which were visited in Argentina are listed below. The on-site visits to the individual enterprises were undertaken from 17 to 19 September 2003 by the Senior Project Management Officer of the Fund Secretariat responsible for foam sector projects. He was accompanied on the visits by an official of the national ozone unit (OPROZ) and the local consultant of UNDP. Each visit involved the following activities:

- Inspection of the plant facility with particular attention to the LCD installations.
- Inspection of chemical and raw material storage facility.
- Observation of foam production run, where possible.
- Inspection of inventory of foam produced.
- Discussion with management.

List of foam enterprises visited in Argentina

Enterprise	Location	Date Visited
Limansky	Rafaela, Santa Fe	17 September 2003
Simmons de Argentina S.A.I.C. (Belmo) (Buenos Aires)	Buenos Aires	18 September 2003
Piero	Buenos Aires	19 September 2003
Suavestar	Buenos Aires	19 September 2003

8. Following the visits to the enterprises a meeting was organized at the national ozone office (OPROZ) at which relevant issues relating to project implementation were discussed.

FINDINGS

9. Tables 1 to 5 provide a summary of the findings of the follow-up study. In addition to the companies in Argentina, the findings also cover the use of the liquid carbon dioxide technology by three other companies in Macedonia and Turkey which were also included in the study.

Enterprise Background

10. All the companies operate single foam lines. Piero used to operate a second line for round blocks but as part of the project it has been decommissioned and replaced with a block peeling machine which is used to peel square blocks to provide the sheets which used to be obtained from the round blocks. Companies Limansky and Simmons in Argentina operate Cannon Viking low pressure Maxfoam machines, while companies Piero and Suavestar operate Hennecke UBT high pressure machines (Piero and Suavestar now belong to the same group of companies). Foam production at the four enterprises in 2002 ranged from 1,200 tonnes to over 1,700 tonnes. At the time of the preparation of the LCD projects for these companies in 1996 they all produced foam ranging in density from 15 – 65 kg/m^3, with the “standard” low density grades ranging in density from 15 kg/m^3 to 22 kg/m^3. Currently as a result of economic difficulties the market demand was reported to have shifted to lower density foams below 15 kg/m^3. Hence for all the enterprises that are currently in production foams of density 10 - 14 kg/m^3, common in most developing countries, have become a significant portion of their production.

11. All the enterprises have facilities for manufacturing mattresses. Thus, part of the foam produced by each enterprise is fabricated in-house while part is sold as blocks or sheets to other users. One company sells as much as 50% of its production as blocks. Another company exports foam to neighbouring countries (Brazil, Chile and Uruguay). The extent of the export or the sale to other fabricators and users of the foam produced appeared to have an impact on the level of use of liquid CO_2 as blowing agent. Foams used in-house for making products such as spring interior mattress where defects, such as pinholes, top skin and other defects would not have a significant impact on the quality of the final product are blown with LCD. Also foams used for products where the intrinsic characteristics of LCD foam, such as softness could be an advantage, as in the case of pillows, could be blown with LCD. However, foams that have to be cut or peeled into sheets or used to produce products where uniform cell structure or product aesthetics play significant role are almost exclusively blown with methylene chloride.

Choice of Technology

12. Bid analysis reports made by UNDP’s foam experts showed that at the time there were only four potential equipment manufacturers, namely Beamech, Cannon, Hennecke and Laader Berg who could supply LCD equipment and technology. Only Cannon and Beamech of these four companies submitted bids for the projects. Of the two suppliers, Cannon’s bid was

considered the more qualified for several reasons, among which were that Cannon had more experience with its Cardio technology which was already being used by several foam manufacturing companies in Europe and USA to manufacture foams; the Cardio technology could produce foam to the minimum density of 10 kg/m^3 while Beamech's CO_2 technology could reach a minimum density of 14 kg/m^3; the Cardio technology was capable of processing polymer polyols while the CO_2 technology could not and that the Cardio technology could process formulations which include calcium carbonate fillers but the CO_2 technology could not. These specific characteristics and the competitiveness of the Cardio technology appeared to be the deciding factor for the choice of the Cardio technology by UNDP. Beside the information from the bid analysis report some of the companies themselves visited the technology suppliers' facilities and toured foam manufacturing plants using the LCD technology in Europe.

Project Implementation and Application of the LCD Technology in Argentina

13. Cannon Viking supplied the LCD equipment for the projects of all the continuous flexible slabstock foam manufacturers (eight companies, four of which are currently in production) which was consistent with bid analysis reports. Thus, all the companies in Argentina which were supported to convert to LCD technology had their baseline foam machines retrofitted with the Cardio system of Cannon. The companies operating low pressure Maxfoam machines had indirect retrofit, while those operating high pressure machines had direct retrofit of their machines.

14. Based on the information provided by the companies, the delivery of all the necessary equipment and parts of the Cardio (LCD) unit were received at the plants as one package, and for those companies using Maxfoam machines in the baseline, retrofit of the foam machines with the Cardio units and trials and commissioning of the Cardio-equipped foam machines were successful and encountered minimum delay. Although the project completion report indicated delays of the project partly due to supplier backlog delaying equipment supply, it appeared that from the companies' standpoint the speed of delivery of equipment was generally acceptable.

15. Trials were run for foams of density 15 kg/m^3 - 22 kg/m^3. This compares with trials and commissioning conducted by Cannon between April 1995 and July 1996 in 9 plants in Europe and North America (USA). The trials were done for three of their standard grades of foam, which were within the same density range as in Argentina (15 kg/m^3 - 22 kg/m^3). At six plants the trials and commissioning took 12-20 days (average of 15 days) to complete, while in the three other plants it took 30-69 days to complete. Cannon reported that subsequent technical visits to the plant showed that some of the companies had converted other grades to the Cardio technology. It also reported that six months after commissioning the nine companies were producing 20-80 per cent (average 43 per cent) of their total production with the Cardio technology.

16. As shown in Table 2, at Limansky and Simmons, the two companies using Maxfoam machines, it took about 15-16 months after the projects were approved for the retrofit of the liquid carbon dioxide equipment to be completed and trials took about 1-2 months to be completed after equipment installation. It took 16-18 months after the project's approval for the companies to produce foam with LCD on a commercial scale. However, the company Piero which is operating a Hennecke UBT foam machine encountered major mechanical and electrical

problems with the attempt to covert the machine using the Cannon system. These resulted in two unsuccessful commissioning trials in 1998 and 1999. The trials resulted in production of foam of non-homogenous structure and inconsistent quality. Following the second unsuccessful commissioning trial some changes to the equipment were made reducing some of the mechanical problems. A third commissioning trial continued to produce foams of unacceptable quality, necessitating further mechanical changes. The final commissioning was conducted in September 2001. Since then, the company has been working on its formulations in order to achieve consistency in the quality of foam produced with LCD, i.e. foams of density 15 - 18 kg/m^3. It has not succeeded in producing foams of density lower than 15 kg/m^3.

17. Thus, it took Piero 3 years and 3 months to achieve satisfactory trials and nearly 4 years to develop functional LCD production unit and to begin commercial scale LCD-blown foam production. For this reason a corporate strategic decision was taken to delay the implementation of the LCD conversion at Suavestar, a company which is now owned by the same group as Piero, in order to learn from Piero’s experience and avoid costly trials.

Product Quality

18. None of the enterprises visited expressed complete satisfaction with the quality of the LCD foam. Some of the quality problems were stated to be pin holes and splits in the foam, larger cell structure and higher compression set. These problems result in a higher scrap rate and by implication increase in production costs. The shorter the run-time, the higher the scrap rate. However, some companies reported that with time defects, such as splits become infrequent, though still significant for some applications.

Limitations of the LCD Technology

19. The major limitation is that currently the efficacy of the production with LCD is limited to foams of density 14-22 kg/m^3. As can be seen in Table 3 all the companies that have succeeded to different degrees in the use of LCD can only produce foams of densities equal to or greater than 14 kg/m^3. One of the enterprises indicated that the best performance of the technology is within 15-18 kg/m^3 density range, at higher densities than 22 kg/m^3 the result is poor while at lower densities below 13 kg/m^3 there is a serious risk of fire. Some enterprises have attempted limited trials with production of foam of 10 kg/m^3 density but found it impossible.

20. From a commercial perspective, the need for low density hard foam makes the use of LCD more complex and costly and therefore less attractive in a situation where a much simpler alternative such as methylene chloride is available for use with existing equipment notwithstanding the occupational health disadvantages. For the companies using equipment like the Hennecke UBT there was the additional limitation of inability to change formulation density during production. Any change in density while the foam was running on this equipment required a change in the equipment configuration which necessitated production stoppage resulting in delays in product delivery and an increase in scrap rate. In the opinion of the companies, it appeared that the Cardio technology was not designed and tested on a UBT machine before being supplied to companies operating such machines.

Development of the LCD Technology

21. The companies considered the technology as still in the process of development and expected the vendors to continue its development and pass information on new improvements to their clients. The companies are working to improve production with the new technology and reduce waste. However, there do not appear to be adequate incentives or the resources for the companies to develop the process to overcome the major limitations of producing the low density, hard foam commonly used in Article 5 countries, and on which the commercial viability of some foam producing enterprises depends.

22. In view of the need for additional chemicals and usually shorter runs of the LCD foam due to its limited uses, the production costs in most cases were reported to be higher than that of methylene chloride, which in turn was reported to have lower production costs than with CFC. Thus, the incentive to develop and expand the use of LCD is diminished.

Application of the LCD Technology in the Former Yugoslav Republic of Macedonia and Turkey

23. As mentioned earlier, in addition to the on-site visits three companies, one in the Former Yugoslav Republic of Macedonia (Sileks) and two in Turkey (Safas and Urosan Kimiya) which the report on evaluation of foam projects identified as enterprises that were making use of LCD technology were requested to provide an update of the application of the technology at their plants through questionnaires. Responses which included data were received from Sileks and Urosan Kimiya while a descriptive report was received from Safas.

24. The information received from the three companies can be summarized as follows:

<u>Sileks</u>

- Although its production has gone down drastically for economic reasons, it uses LCD exclusively for producing its low density foams which are within the density range of 14-20 kg/m^3.

- Unlike other companies which produce low density foams that require addition of prepolymer polyol to the conventional polyol, Sileks uses only conventional polyol.

- Its average LCD foam production costs were reported to be slightly lower than that of CFC foam.

<u>Safas</u>

- The company is no longer using the LCD technology as it found it unsuitable for producing its low density and high density soft foam.

- The company could not succeed in sustaining an LCD foam production for longer than 20 minutes, which it did not consider as commercial scale production.

- Production with LCD equipment was inefficient and maintenance after each run was costly and time consuming.

- The quality of the foam was not acceptable.

- The company incurred losses and its low density foam became less competitive on the market.

- As a result of the technical and commercial problems, the company made a strategic decision to produce only high density foam requiring no auxiliary blowing agent, and to produce high density soft foam with the use of softening additives.

<u>Urosan Kimiya</u>

- The company has experienced technical difficulties which the technology provider (Beamech) has not rectified.
- Production of low density foam with methylene chloride is cheap and the technology is simple which gives a competitive advantage over the use of LCD.
- As long as methylene chloride remains available and no solutions are found by the technology provider to the technological problems associated with the LCD equipment and process, there will not be any incentive for the company not to use methylene chloride.
- The company has stopped the use of LCD as a blowing agent and is using and will continue to use methylene chloride exclusively as the blowing agent for its low density foams.

Success of the LCD Technology

25. Table 3 shows that 2%-60% of the foam produced by the companies is produced with LCD while tables 4 and 5 indicate the extent of use of LCD as a blowing agent for producing low density and high density soft foams at the enterprises in the sample. As indicated in Table 3, of all the companies so far surveyed, Sileks is the only company which has succeeded in using LCD exclusively as the blowing agent for producing all its low density foams.

IMPLEMENTATION OF LCD FOAM PROJECTS IN CHINA

26. During the preparation of this report, the Secretariat received a report from the World Bank on the Huangzhou Huangfa Co., a project approved at the 28th Meeting in July 1999, as well as a report on the World Bank's plant visits to Huangzhan and four other Chinese companies during trials on LCD equipment. In view of the relevance of the information provided by the World Bank to the report, effort was made to reflect the information in this report. The following is a summary of the report provided by the World Bank on the projects:

Changzhou Huangfa

27. The project was approved at the 28th Meeting in March 1999. Installation of the LCD equipment was completed in November 2002 and two trial runs were made in November 2002 and March 2003 respectively. The enterprise stated that trial runs were not successful, especially for foam density lower than 12 kg/m^3. The quantity of chemicals used during the trial run was three times more than what had been agreed on in the technical specifications of the LCD equipment. During the trials in March, 15 runs were made at 17 kg/m^3 consuming 16.20 tonnes of raw material. Hennecke engineers set 17 kg/m^3 as the technical limit for LCD. A company has also not been able to achieve change of density on the fly. This has led to a dispute between the enterprise and the supplier. The World Bank has urged both parties to review the contract with the procurement agency, determine the technical deficiencies, if any, and to resolve the issue as soon as possible to permit the project's completion.

Huojia Xinyuan

28. The project was approved in March 1999 and at the time when the inspection of the World Bank took place, the project had the LCD equipment installed and had completed the trial production of the foam products. Both the supplier and the enterprises were satisfied with the technology and the products it produced.

Nanjing Jinling

29. This is a project implemented by UNDP although it was also included in the inspection report of the World Bank. The project was approved at the 25th Meeting in July 1998. Installation of LCD equipment started in February 2001 and was completed in December 2001. Between April 18 and May 20 2002, a total of 17 test runs were carried out and nearly US $50,000 of raw materials were used. However, the results were not satisfactory and the enterprise had run out of capital to continue with the trials. The enterprise concluded that the LCD technology could not operate normally on their foam producing equipment.

ISSUES ASSOCIATED WITH THE IMPLEMENTATION OF THE PROJECTS

Continued technical support from suppliers after equipment commissioning

30. The earlier study on the LCD technology as well as the visits of the Secretariat to the enterprises with completed projects have confirmed the importance of developing the right

chemical formulation for the foam during implementation of the LCD projects. In developed countries the three selected foam grades on which trials and commissioning are usually concluded are the most significant commercial grades. In the Article 5 countries however, as is evidenced from this study, the commissioning trials do not cover a significant portion of the commercial foam grades produced by the companies. The grades which are not covered are those that are more difficult to produce with the LCD technology. Thus the time period for the more challenging conversion to lower density grades extends well beyond the certified completion date of the project, at which time the involvement of the implementing agency has ceased.

31. From this point onwards, without any further monitoring and/or assistance, the companies are likely to abandon the technology if formulation development becomes technically difficult or financially prohibitive. Additionally, the studies and information from China have shown that in view of the favourable price of methylene chloride compared with CFC-11, the technological simplicity of producing with this blowing agent and comparable properties with CFC foam there are no incentives for the companies to invest their production time and financial resources in the development of the LCD formulations.

32. If LCD technology is not to be abandoned, it appears necessary that enterprises which have adopted the LCD technology require continued technical support from the suppliers. It is also in the interest of the suppliers to see that the LCD technology is successfully applied in developing countries. It is not clear to what extent that this continued support beyond the commissioning of the equipment is included in the contractual arrangement between the supplier and the enterprise (or the implementing agency) in the completed projects. For instance, it is not clear whether the suppliers' one year warranty beyond commissioning covers the equipment malfunctioning or its inability to meet the technical performance required by the enterprise. For those enterprises which are contemplating introducing the LCD technology, it is prudent to include in the contract, specific provisions for continued technical support by the supplier for a reasonable period of time beyond commissioning of the equipment.

CONCLUSIONS

33. The conclusions are presented up-front.

LIST OF TABLES

Table 1: Summary of Experiences with LCD Technology of Enterprises in Three Countries

Enterprise	LCD use in production of foam with auxiliary blowing blowing agents %	Success of the LCD technology	Remarks
Argentina			
Limansky	2	Equipment conversion successful but is of very low utility	Company had problems manufacturing LCD foam with polymer polyol to obtain the low density hard foam required by its market. Hence produces small quantity of LCD-blown foam in the density range of 14 - 18 kg/m^3 that is produced with conventional polyol only. LCD technology used to produce very limited grade of foam which constitutes about 1% of its production output. The LCD technology is not indispensable for the grade of foam produced. Company in an ISO 14000 company that aspires to the use of clean production technologies and would apply the technology completely if it were commercially and technologically viable with regard to its production needs.
Piero	80	Moderate to the extent possible	Production within limited range of density. LCD technology cannot fully meet current production needs.
Simmons	27	Moderate to the extent possible	Production within limited range of density. LCD technology cannot fully meet current production needs
Suavestar	--	Moderate to the extent possible	Production within limited range of density. LCD technology cannot fully meet current production needs
Sileks	100	Good	Uses only LCD technology to produce all low density foams which are in the density range of 14-20 kg/m^3. The relatively high cost-efficiency value compared to the low baseline cost-effectiveness value (US $1.86/kg) is due to economic downturn in the country following break-up of the Yugoslav federation resulting in drastic reduction in foam production.
Turkey			
Safas	0	Failed to meet company's production needs	The LCD technology is no longer used since foam production is difficult, inefficient and expensive and product quality is unacceptable on the market. As a result company has switched to high density foam production requiring no auxiliary blowing agent, while production of soft high density foams has been switched to the use of softening additives instead of auxiliary blowing agent as company used to do with CFC.
Urosan	0	Failed to meet company's production needs	The LCD technology is no longer used due to higher cost of production and technical difficulties, such as inability to use the Beamech technology with solid particles and the fact that "production with methylene chloride is very easy".

Table 2: Project Implementation

Enterprise	Date of project approval	Date of project completion	Implementing Agency	Technology Provider	Type of Foam Machine	Delivery of Equipment following Project Approval (months)	Completion of Equipment Installation following Project Approval (months)	Type of Retrofit	Time taken for trials and Commissioning (months)	First Commercial Production following Project Approval (months)	Average Production Run with LCD (minutes)	Longest Production Run with LCD (minutes)	No. of production runs since commissioning	Range of Density of LCD Foam Produced (kg/m^3)
Simmons SAICFI (Belmo) Buenos Aires	Oct-96	Dec-98	UNDP	Cannon Viking	Cannon Viking Maxfoam	5	15	Indirect	2	16	30	68	332	15-22
Limansky S.A.	Oct-96	Dec-98	UNDP	Cannon Viking	Cannon Viking Maxfoam	5	16	Indirect	1	18	28	38	76	15-18
Piero SAIC	Oct-96	Sep-01	UNDP	Cannon Viking	Hennecke UBT	17	47	Direct	39	47	75	120	N/A	15-25
Suavestar	Oct-96	Nov-02	UNDP	Cannon Viking	Hennecke UBT	N/R	N/R	Direct	N/R	N/R	N/R	N/R	N/R	N/R
Sileks (Macedonia)	May-97	Dec-98	UNIDO	Beamech	Viking/Beamech	25	31	N/A	8	31			180	14-20

N/R: No response provided by the company to the questionnaire.
N/A: Company did not have information available.

Table 3: Production Statistics in 2002.

Enterprise	Agency	Technoloy Supplier	Date Approved*	Date Completed	Project Grant (US$)	Baseline CFC Consumption (ODP tonnes)	Total Foam Output (Tonnes)	Non-ABA Foam** (Tonnes)	% of Total Foam	MC Foam (Tonnes)	% of Total Foam with ABA	LCD Foam (Tonnes)	% of Total Foam
Argentina													
Simmons SAICFI (Belmo) Buenos Aires	UNDP	Cannon	Oct-96	Dec-98	363,935	91	1,202	227.2	19	716	60	258.7	22
Limansky S.A.	UNDP	Cannon	Oct-96	Dec-98	472,637	95	1,520	316.8	21	1,203	79	22.4	1.5
Piero SAIC	UNDP	Cannon	Oct-96	Sep-01	341,000	64	1,727	431.75	25	259	15	1036.2	60.0
Suavestar	UNDP	Cannon	Oct-96		561,000	92.5	NA	NA	NA	NA	NA	NA	NA
Macedonia													
Sileks A.D.	UNIDO	Beamech	May-97	Dec-98	520,125	280	1,200	700	58	0	0	500	42
Turkey													
Urosan Kimiya	UNIDO	Beamech	Oct-96	Oct-97	643,500	135	4,300	3,063	71	1237	29	0	0
Safas	WB	Urosan	Nov-97	Mar-99	530,000	93.8	No longer produces foam with auxiliary blowing agent						

* All the projects except Suavestar were originally approved in November 1995 for conversion to various technologies. They were approved for change to LCD in Oct. 1996.

** High density foam produced without auxiliary blowing agent.

Table 4: Consumption of Auxiliary Blowing Agents in 2002

Enterprise	Project Grant US $	Baseline CFC Consumption (Tonnes)	Methylene Chloride Consumption (Tonnes)	LCD Consumption (Tonnes)	Required LCD for complete baseline CFC replacement (Tonnes)	CFC-Equivalent of current LCD usage* (Tonnes)	% of Baseline CFC Consumption	Project Cost-effectiveness US$/kg	CFC-Equivalent Cost-effectiveness (US$/Kg)
Simmons SAICFI (Belmo) Buenos Aires	363,935	91.0	37.7	10.7	20.2	41.3	45	4.00	8.82
Limansky SA	472,637	95.0	79.3	1.3	21.1	4.9	5	4.98	96.66
Piero SAIC	341,000	64.0	15.0	1.5	14.2	5.8	9	5.33	59.05
Suavestar	561,000	92.5		N/R	N/R	N/R	N/R		N/A
Sileks A.D. (Macedonia)	520,125	280.0	0.0	20.0	62.2	77.0	28	1.86	6.75

* CFC equivalent of LCD consumed calculated as 1:3.85 (LCD:CFC) Factor: 0.260

N/R: No response provided by the company to the questionnaire.
N/A: Company did not have information available.

Table 5: Production Statistics in 2002 - Foam Production with Auxiliary Blowing Agents

Enterprise	Agency	Technoloy Supplier	Per Cent of Total ABA Foam Produced with Methylene Chloride	Per Cent of Total ABA Foam Produced with LCD
Simmons SAICFI (Belmo) Buenos Aires	UNDP	Cannon Viking	73	27
Limansky S.A.	UNDP	Cannon Viking	98	2
Piero SAIC	UNDP	Cannon Viking	20	80
Suavestar	UNDP	Cannon Viking	N/A	N/A
Sileks A.D. (Macedonia)	UNIDO	Beamech	0	100
Urosan Kimiya (Turkey)	UNIDO	Beamech	100	0
Safas (Turkey)	World Bank	Hennecke	No longer producing foam with ABA	

ABA Foam: Foam blown with auxiliary blowing agent

Table 6: Sources of Information for the Follow-up Study

Enterprise	Implementing Agency	Country	Technology Provider	Remarks
Simmons (Belmo)	UNDP	Argentina	Canon Viking	Information through on-site visit
Limansky	UNDP	Argentina	Canon Viking	Information through on-site visit
Piero SAIC	UNDP	Argentina	Canon Viking	Information through on-site visit
Suavestar	UNDP	Argentina	Canon Viking	Information through on-site visit
Sileks	UNIDO	Macedonia	Beamech	Information through questionnaire
Urosan Kimiya	UNIDO	Turkey	Beamech	Information through questionnaire
Safas	World Bank	Turkey	Hennecke	Information through questionnaire