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

Eighth Meeting
Montreal, 19-21 October 1992

Addendum

PROJECT PROPOSAL: VENEZUELA

This document consists of the Initial Executive Project Summary prepared by the World Bank.

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEplete THE OZONE LAYER

PROJECT COVER SHEET

COUNTRY: Republic of Venezuela

PROJECT TITLE: Substitution of HFC-134a for CFC-12 in Central Air Conditioning Systems

SECTORS COVERED: Central Air Conditioning w/CFC-12 Chillers

**ODS CONSUMPTION IN
AFFECTED SECTORS:** Estimated total CFC-12 in 1992: 3040 tons;
Stock of substitutable CFC-12 in compatible
central air conditioning systems estimated at 80
tons. (Estimated 155 units.) Est. 1992 ODS
consumption for all central systems (estimated
1,000 chillers) 250 tons.

PROJECT IMPACT: ODSs PHASED-OUT: 12 tons of initial charge and
50 tons total of CFC-12 including projected
replacement for 20 years (based on assumed 15%
average annual replacement rate).

PROJECT DURATION: 18 months for implementation

TOTAL PROJECT COST: US\$ 2.115 million

PROPOSED ODS GRANT: US\$ 1.100 million incremental costs

COST EFFECTIVENESS: Unit abatement costs: Retrofits US\$ 3.84/kg ozone
depleting potential (ODP); New \$7.48/kg; total
cost basis, \$ 2.90/kg (incremental cost basis -
\$3.39, \$0.75, respectively).

IMPLEMENTING AGENCY: World Bank

COORDINATING NAT. AGENCIES: Interministerial Working Group; financial
intermediary to be designated; compressor
manufacturers local representative.

BENEFICIARIES: 2 private/7 Social Security System hospitals; 1
public sector/1 private foundation office
buildings.

PROJECT SUMMARY

Please refer to attached Executive Project Summary

THE MONTREAL PROTOCOL ON SUBSTANCES THAT DEplete THE OZONE LAYER

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PROJECT IMPACT: ODSs PHASED-OUT: 12 tons of initial charge and 50 tons total of CFC-12 including projected replacement for 20 years (based on assumed 15% average annual replacement rate).

PROJECT DURATION: 18 months for implementation

TOTAL PROJECT COST: US\$ 2.115 million

PROPOSED ODS GRANT: US\$ 1.100 million incremental costs

COST EFFECTIVENESS: Unit abatement costs: Retrofits US\$ 3.84/kg ozone depleting potential (ODP); New \$7.48/kg; total cost basis, \$ 2.90/kg (incremental cost basis - \$3.39, \$0.75, respectively).

IMPLEMENTING AGENCY: World Bank

COORDINATING NAT. AGENCIES: Interministerial Working Group; financial intermediary to be designated; compressor manufacturers local representative.

BENEFICIARIES: 2 private/7 Social Security System hospitals; 1 public sector/1 private foundation office buildings.

PROJECT SUMMARY

Please refer to attached Executive Project Summary

MONTREAL PROTOCOL (MP) PROJECT FOR VENEZUELA

INITIAL EXECUTIVE PROJECT SUMMARY

Country: Republic of Venezuela

Project Name: Substitution of HFC-134a for CFC-12 in Central Air Conditioning Systems

Associated Bank Project: None. Free Standing Project.

Borrower: None. Montreal Protocol Ozone Trust Fund Grant to Government.

Grant Amount: US\$ 1.100 million requested. Total estimated project cost is US\$ 2.115 million. Beneficiaries will provide US\$ 1,015,000.

Beneficiaries: 2 private/7 Social Security System hospitals; 1 public sector/1 private foundation office buildings.

Tentative Appraisal Date: 3rd Quarter FY'93

RVP Approval Date: 4th Quarter FY'93

Board Presentation Date: Not required per modified procedures for GEF and MP projects.

Environmental Category: B.

1. Summary: The proposed project includes: i) retrofitting of 27 existing Westinghouse/SnyderGeneral McQuay (SGMQ) chiller units (100-315 tons of refrigeration (TR) size range) currently operating with CFC-12 to permit use of zero ODS HFC-134a refrigerant; (ii) installation of seven new SGMQ HFC-134a chillers (size range 252-540 TR), 4 to replace old Westinghouse units which were not suitable for retrofits, and 3 to use instead of less expensive CFC-11 chillers in a new hospital wing. This is the first ODS phase-out for central air conditioners for which OPTF funding is requested. Eligible incremental costs have been estimated on the following basis: (i) retrofits - all new parts and installation costs unique to the required retrofit modifications; (ii) new units - the cost difference (installed price basis) between SnyderGeneral McQuay HFC-134a chillers and the lowest priced alternative CFC-11 or CFC-12 chillers commercially available in Venezuela for the same service. The project was submitted directly to the MP Secretariat on 2 September 1992 by the GOV (Annex 2). The MP Secretariat in turn requested the Bank to carry out a technical evaluation and determination of eligible incremental costs in order that the MP Executive committee (MPEC) may vote on the grant request during the MPEC meeting of 19-21 October 1992. Given the tight time frame, this IEPS encompasses only the incremental cost and technical analyses requested of the Bank by the MP Secretariat in order to determine the eligibility of the project for OPTF funding. If approved by the MPEC, significant preparatory work will still be

required to develop arrangements for technical and financial oversight, procurement and disbursement satisfactory to the Bank in its role as Fund Trustee.

2. Based upon Bank and OORG technical evaluations (Annexes 4 and 5), the Bank concurs that the proposed SGMQ equipment is proven, commercially available, technically viable, equipment specific retrofit technology for the 27 Westinghouse chillers. The Bank also concurs that the 7 new SGMQ chillers proposed for replacement or new installations were, at the time of equipment selection the only zero ODS (i.e. HFC-134a as opposed to transitional substances such as HCFC-22 and HCFC-123) chillers in this size range commercially available in Venezuela. Procurement of these chillers on a sole supplier basis, subject to reasonableness of price quotations, is acceptable since the retrofits involve redesign of proprietary equipment and installation will be carried out by the manufacturer's authorized service representative in Venezuela, who will also be able to provide service warranties. Comparator prices for new chillers were found not to be sufficiently equivalent for incremental cost determination. Pending further verification on a comparable basis, incremental costs were estimated to be 10% of the HFC-134a chiller costs, a representative price differential under competitive conditions in the U.S.A. The Bank therefore recommends funding of the project's eligible incremental costs with an OPTF grant of US\$ one million for the retrofits. Approval is recommended for funding of US\$ 100,000 of incremental costs for the new chillers, subject to adjustment pending further verification of comparator prices. It is probable that some additional funding (US\$ 50-100,000) may be required for independent project management during implementation. The estimated unit abatement cost for the retrofitted chillers is US\$ 3.84/kg ODS consumption eliminated for an assumed 20 year useful life, and for the new chillers, US\$ 7.48/kg both on a total cost basis: the corresponding figures are US\$ 3.39 and US\$ 0.75/kg on an incremental cost basis. The overall composite figure is US\$ 4.97/kg ODS eliminated on a total cost basis, and US\$ 2.58 on an incremental cost basis.

3. Venezuela Ozone Depleting Substance (ODS) Sector Background. Venezuela signed the Montreal Protocol on September 16, 1987, and ratified it on February 6, 1989. As an Article 5 signatory (annual per capita ODS consumption of less than 300 grams), Venezuela is eligible for OPTF support. ODS's are produced in six developing nations, Argentina, Brazil, China, India, Mexico, and Venezuela. Total production of CFC's and MCF in these nations in 1989 was approximately 70,000 tons, of which Venezuela's share was 4150 tons, or 6%. MCF consumption in 1991 was 130 tons, down from 570 tons in 1990. All CC14 (1350 tons in 1991) is used as a chemical intermediate feed stock. CFC/Halon consumption in Venezuela in 1990 was 3420 tons, but rose to 3820 tons in 1991, still a decrease of 12% since 1986. Distribution by end use in 1991 was AC/refrigeration 77%; foaming agent 16%; aerosols 4%; Halon fire extinguisher 1%; and solvents 2%. Of the AC/refrigeration share, an estimated 80% was for aftermarket use for servicing and leak replacement. Per capita annual consumption of CFC's decreased from 270 grams in 1986 to 170 grams in 1990. A breakdown of estimated CFC-12 consumption for 1992 in the AC/refrigeration subsectors and more detailed national data are found in Annex 1, National Production and Consumption Patterns.

4. ODS Phase-Out Strategy. With more than 75% of Venezuela's CFC consumption currently used in A/C refrigerator applications, these subsectors are

therefore the principal focus of the national ODS phase-out strategy. The action plan for the A/C refrigeration sector includes both ODS conservation and replacement measures. Conservation initiatives will include workshops and technology dissemination to promote: i) establishment of programs to recover and recycle refrigerating agents; ii) improvement of draining (venting) system, iii) installation and maintenance techniques to reduce leakage. Replacement strategy will focus on retrofitting and/or replacement of ODS using equipment with equipment that operates with final non-ODS substitutes as such new technology becomes commercially available. Increased use of transitional substances such as HCFC-22 and HCFC-123 will only be promoted when they can be used as drop in replacements for ODS in existing equipment. Promotion of replacement technologies involving transitional substances which also require capital investments will explicitly not be encouraged. This ordering of priorities leads to the following air conditioning subsector strategies: i) auto air conditioners - introduction of HFC-134a units in 1993 and better emissions control practices for the existing stock; ii) central air conditioning (1000 chillers estimated national stock) - for the one half of existing chiller stock which uses HCFC-22, better leakage control; for the 25% using CFC-11, improved leakage and purge system control and operation; replacement/retrofitting to use HCFC-123 not to be promoted; for the 25% currently using CFC-12, retrofitting/replacement as appropriate to substitute CFC-12 with HFC-134a; iii) individual window units - use HCFC-22, strategy depends on future HCFC-22 classification and world market developments. The proposed project has been developed to eliminate CFC-12 consumption in 34 of the existing 115 Westinghouse/SnyderGeneral McQuay central chillers in Venezuela. The SnyderGeneral McQuay retrofit/replacement technology has been commercially available in the United States since early 1991, and already been proven in 8 installed retrofits, and over 125 new installations. Corresponding figures for all manufacturers are 20 retrofits and 250-300 new chillers.

5. Project Objectives. The project's direct objective is to eliminate the use of CFC-12 refrigerant in the central air conditioning chillers through its substitution by HFC-134a. Its secondary objective is to demonstrate through the successful introduction of replacement technology for medical sector beneficiaries (31 of 34 chillers) who could not undertake the ODS phase out in the absence of the Fund subsidy, the ability of the OPTF to create a demand which will motivate other equipment suppliers to introduce replacement technology in Venezuela, and thereby create a competitive local market for ODS phase out technology.

6. Project Description. The total project as proposed comprises retrofitting of 27 existing chiller units currently operating with CFC-12 for use with HFC-134a and the installation of seven new chillers for use with HFC-134a. The refitting is basically mechanical, involving changing of gears, seals, and gaskets. Energy and thermal efficiency after the retrofits is essentially equal to that of the original units. All the chillers to be retrofitted are Westinghouse centrifugals. The retrofits are equipment specific, and have been engineered, and specified by the SnyderGeneral McQuay Co. (SGMQ), the successor of the former Westinghouse chiller production operation. All new units proposed will also use SGMQ compressors on a sole supplier basis. This latter procedure is considered acceptable as the SGMQ chillers are proven technology, and were the only HFC-134a chillers for which quotations could be obtained in Venezuela at the time of equipment selection.

7. The actions proposed for the individual beneficiaries are summarized as follows: i) Instituto de Prevencion Social del Medico (IMPRES). Two units with a total capacity of 540 tons of refrigeration (TR). One (304 TR) can be retrofitted. The second chiller (252 TR) is too seriously damaged to permit retrofitting. A new HFC-134a chiller has been proposed, rather than a less expensive CFC-11 unit, the other commercially available alternative. ii) Centro Medico Docente La Trinidad. Two existing units with capacities of 120 TR and 312 TR each will be retrofitted. Three new centrifugal units of 500 TR each operating with HFC-134a, are proposed for installation in a new hospital wing under construction. The available alternatives would be less expensive CFC-11 chillers. iii) Clinica Atlas Hospitalization and Services, C.A. Three 100 TR chillers will be retrofitted for use with HFC-134a. iv) Instituto Venezolano de los Seguros Sociales (IVSS). Twenty one (21) identical existing chillers of 200 TR each, located in seven different hospitals are proposed to be retrofitted for use with HFC-134a. v) Congreso de la Republica. Three Westinghouse CFC-12 chillers of 540 TR each had reached the limit of useful life and required replacement. Available alternatives were less expensive new CFC-11 units, or new Mc Quay HFC-134a chillers. Two of the latter have already been operating successfully for several months, and the third is now being installed. Financing of the eligible incremental costs is being requested under the MPEC decision on eligibility for financing of previously incurred eligible incremental costs.

8. Project Cost and Financing. Project costs are summarized in Tables 1 and 2 of Annex 3, Summarized Project Capital and Incremental Costs. Total CIF La Guaira price quotations for the seven new chillers is US\$ 986,821. Up to US\$ 100,000 is eligible incremental costs. The latter estimates were developed through cost comparisons for the least cost CFC-11 or CFC-12 chiller for equivalent service, the obvious ODS choice for the beneficiaries in the absence of the OPTF subsidy. These quotations were judged not to be representative by the OORG reviewer to establish comparability. The 27 retrofitted chillers have a total installed cost of US\$ 1,128,360, of which \$1,000,000 is considered to be incremental costs. Total capital cost is therefore US\$2,115,000 of which total incremental costs are US\$1,100,000. The difference, US\$1,015,000 will be financed by the beneficiary institutions. It is anticipated that an additional US\$ 50-100,000 to be financed by the OPTF may eventually be required for third party project management expertise during project implementation. It is also possible that additional repairs to the retrofitted chillers will be required once disassembled for retrofitting. These will not be project costs, and will have to be borne by the respective institutions.

9. Determination of Incremental Costs. The incremental costs eligible for MPIMF grant funding have been estimated based upon the following criteria: i) for retrofits: the total equipment and installation cost of all modifications unique to retrofitting for HFC-134a, such as gears, seals, etc. are eligible. Costs of replacement such as condensers, piping etc must be evaluated on a case by case basis to determine whether they are unique to HFC-134a use or would have been necessary anyway, if in the event of continued CFC-12 use. To allow for allocation of installation costs and generic parts to other programmed maintenance, the basis for adjustment of quoted prices to estimate incremental costs was: incremental costs equal 75% of generic parts and installation plus 100% of all other costs, excepting heat exchangers (see Note 2, Annex 3). ii) for new units: incremental costs will be the difference between the quoted installed costs of the HFC-134a system, and the least cost alternate quotation for a CFC-11

or CFC-12 system for the same service. Pending verification of comparable quotations for CFC-11 laterates, incremental costs for the new HFC 134a chillers were assumed to be 10% of the chiller cost, a representative price differential currently prevailing in the American market. Central air conditioning system chillers provide a service, air conditioning, for a multiplicity of users, building occupants, who pay for the service provided, not for the apparatus itself. This pattern of use, that of an intermediate good, is fundamentally different from that of household refrigerators or window unit air conditioners, which are clearly durable consumer goods for end use by the purchaser. The Bank consequently considers that central system chillers are most properly classified as intermediate goods, not consumer goods, and their phase-out therefore is eligible for OPTF funding. The adjusted incremental cost estimation is summarized in Annex 3, Project Capital and Incremental Costs.

10. Project Implementation. Project implementation will involve provision of equipment and services by the supplier to five different institutions and in 11 different sites, 7 of which are outside of Caracas (the 7 IVSS hospitals). Arrangements will be developed during project preparation. Given the multiple beneficiaries, a solution which might be more workable than others if the proper controls can be established would be a lump sum contract for the SnyderGeneral McQuay authorized representative in Venezuela to carry out the installations subject to a performance guarantee, with third party project management and verification on behalf of the beneficiaries. The GOV's Montreal Protocol Interministerial Working Group (IWG), or FONDOZONO, its likely successor, will be responsible for administrative liaison with the Bank and with beneficiaries. Technical oversight will be provided by the Bank's Ozone Operations Resource Group (OORG). Procurement and disbursement arrangements will be in accordance with Bank guidelines.

11. Project Sustainability. The purpose of the OPTF is provide a financial incentive to facilitate ODS phase-out. In operational and environmental terms, the operation is sustainable due to the fact that the subsidy will permit the permanent elimination within the next 18 months of CFC consumption in 34 air conditioning systems. In the absence of the subsidy, each chiller would have continued to use and to leak CFC-12 or CFC-11 into the atmosphere until the end of its useful life.

12. Rationale for Montreal Protocol Financing. A demonstration of successful use of OPTF funding for phase-out in the central A7C sector should result in increased demand for OPTF resources for this purpose, and thereby hasten the creation of a competitive market for imported replacement technology in Venezuela. Existence of competitive market conditions will eventually enable the Government to enact regulations against the use of controlled substances in central air conditioning systems for new construction, and to regulate replacement of equipment in existing systems. CFC-12 recovered from replaced and retrofitted units will be recycled to supply the needs of other CFC-12 equipment users, thereby reducing demand for new CFC production.

13. Issues and Actions. The principal potential issues concern i) eligibility of new central system chillers for OPTF support; ii) procurement of new HFC-134a chillers from a sole source supplier; and iii) allocation of a percentage of retrofit installation costs to normal maintenance expenses. The Bank's position on the first issue has been discussed in para. 9. Concerning a

sole source supplier, while HFC-134a chillers of several makes are now commercially available in these TR ranges, and manufacturers claim the same is true in Venezuela, at the time that equipment selection decisions were made, SnyderGeneral McQuay was the only vendor offering non-ODS equipment in Venezuela. Three fourths of retrofit installation costs have been considered to be incremental, assuming that retrofits will take place during normally scheduled overhaul maintenance among some of the beneficiary institutions.

14. Environmental Aspects The elimination of CFC-12 consumption, is the basic objective of the conversions. There are no major environmental issues associated with the installation or operation of the converted chillers themselves, other than routine workplace safety measures.

15. Project Benefits. Total immediate elimination of CFC-12 will reach 12,000 kg for all 34 units, less than one percent of current consumption, but at the same time, permanently eliminating ODS use in over 20% of the nations stock of Westinghouse and SnyderGeneral McQuay chillers. An additional 38,000 kg of potential ODS consumption will be prevented, equivalent to the refrigerant required throughout 20 years of assumed useful life, at an assumed annual leakage rate of 15%, if retrofitting and or replacement were not carried out. Credible actual consumption rates could not be estimated with data made available by beneficiaries. The estimated unit abatement cost for the retrofitted chillers is US\$ 3.84/kg ODS consumption eliminated for an assumed 20 year useful life. For the new chillers, the corresponding figure is US\$ 7.48/kg ODS on a total cost basis, and US\$ 0.75/kg on an incremental cost basis. The overall composite figure is US\$ 4.97/kg ODS eliminated on a total cost basis, and US\$ 2.58 on an incremental cost basis. As will be the case with virtually all AC/refrigeration replacement/retrofit technology, these abatement costs per unit of ODS consumption eliminated, which are dictated by the nature of the technology involved, will be higher than those associated with aerosol, solvent, and foaming agent applications. Nevertheless, with over 75% of Venezuela's CFC consumption concentrated in A/C and refrigeration, to materially diminish CFC consumption, it is necessary to begin investment in these relatively capital intensive types of phase-outs.

16. Projects Risks. Given the multiplicity of beneficiary institutions and sites, effective supervision of works and disbursements could be a problem in the absence of some form of central but independent project management. A potential technical risk concerns the chilling capacity, energy efficiency, and mechanical performance of both retrofitted and new systems. The manufacturer, SnyderGeneral McQuay, does however, guarantee the efficiency and capacity stated in the technical proposal when compared with CFC-12 units for the same service. The local SGMQ representative guarantees operation of new units for 1 year, and up to 4 years with operation and maintenance contracts, and for 4 months and two years for retrofits.

17. Technical Evaluation. The Bank's technical assessment consisted of a detailed review of the technical and financial proposals with both the manufacturer's sales engineering department and its Venezuelan representative, field inspection of existing units and proposed replacement installations, and verification of local consultants technical reports and financial proposals. A summary of the detailed technical report is included in Annex 4, "Technical Evaluation, et. al. The complete report is available in project files.

18. On the basis of the assessment, the Bank considers the proposals to be of sound technical design, and qualified for OPTF grant financing of eligible incremental costs. The SnyderGeneral McQuay authorized representative in Venezuela is judged to be technically and organizationally capable of implementing the project. Annex 5 indicates concurrence with the project by the Bank's Ozone Operations Resource Group (OORG) technical expert for air conditioning and refrigeration projects, subject to the incremental cost adjustments already discussed.

19. Staff Review Implementation Arrangements: The following staff are responsible for the Project and for the review:

Task Manager:	Donald J. Rhatigan, LA1EI
Division Chief:	Stephen J. Ettinger, LA1EI
CD Director:	Armeane M. Choksi, LA1DR
RED Chief:	Dennis J. Mahar
Bank Technical Advisor:	Donald Brown
Outside Specialist: (Technical Evaluation)	Francisco A. Munoz
OORG Reviewer:	James M. Calm

October 15, 1992

VENEZUELA: NATIONAL PRODUCTION AND CONSUMPTION PATTERNS OF ODS

Production: PRODUVEN C.A., a 50/50 joint venture between PEQUIVEN S.A., a parastatal petrochemical producers, and ATOCHEM (France), is the only Venezuelan ODS producer. The plant is of swing type design with a design capacity of 10,000 ton/yr of CFC-11/12 or 5,000 tons/yr HCFC-22. Recent annual output has been about 4,000 tons CFC-11 and CFC-12 combined, and 1,500 tons HCFC-22, of which 1,000 tons, mostly CFC-11 and CFC-12 has been exported to neighboring countries. PRODUVEN C.A. is expected to announce that a HFC-134a production unit, also with a 10,000 ton/yr design capacity, will go on stream in 1997. Most production in initial years of operation is expected to be exported to both developed and developing countries, to satisfy what ATOCHEM predicts will be an initial worldwide excess of demand over production. This projection is likely to be even more valid as a result of the recent decision to accelerate the phase out deadline in non-Article 5 countries to 1996. Current thinking calls for continuing CFC and HCFC-22 production in the current fully amortized facility as long as residual demand for these products results in viable capacity utilization rates.

Consumption: National consumption in 1989 was 3,731 tons of CFC's and Halons, of which 335 tons (Halon, and CFC-113, -114, -115) was imported. Estimated use by major application was 12% aerosols; 8% foaming agent; 75% refrigeration and air conditioning; and 5% other (fire extinguishers, solvents, etc.). Substitution of CFC's in aerosol applications is almost complete, consumption of CFC 12 for this purpose having decreased from 5,000 tons in 1980 to 230 tons in 1990. CFC consumption as a blowing agent for flexible foams in 1990 was only 173 tons, indicating that substantial substitution of CFC 11 by methylene chloride in flexible polyurethane production has already taken place. Total consumption of controlled CFC's has decreased from a maximum 7,400 tons in 1980 to 3,400 tons in 1990. The attached table, "Cuadro 1, Summary of Sales, National Market - Controlled CFC" summarizes CFC sales in Venezuela for 1990 and 1991. It indicates, unfortunately, a 13.6% increase of CFC consumption from 1990 to 1991. Cuadro 2 indicates the increase took place in all principal applications except aerosols, where CFC use decreased by 30%. Cuadro 2 also indicates a 19% increase in HCFC-22 use, and a 25% decrease in exports from 1990 to 1991. The last table, "Consumption of Controlled Substances by End Use in Venezuela" gives a complete breakdown of ODS consumption in Venezuela by end use for 1990 in a more legible presentation. It demonstrates quite clearly the 77% market share of AC/refrigeration applications in total national CFC consumption.

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MERCEDES NACIONAL

ANALISIS POR TIPO DE MERCADO (Kcs)

MERCADO	ACUM. 91	ACUM. 90	PROMEDIO ULT. 3/M	PROMEDIO AÑO ACT	PROMEDIO AÑO 1990	PROMEDIO AÑO 1989
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AEROSOL

F11	25.880	23.900	1.667	2.240	1.992	3.672
F12	52.860	146.406	5.297	4.905	12.201	20.918
FMEZC	38.530	43.660	3.000	3.211	3.638	6.154
F113	36.000	14.700	3.200	3.000	1.225	1.920
F114	50	1.000	17	4	83	100

TOTAL

TOTAL	160.320	229.666	13.380	13.360	19.139	32.763
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LIMPIEZA INDUSTRIAL

F11	132.560	105.149	7.869	11.046	8.762	10.998
F113	12.600	8.820	1.600	1.050	740	1.050

TOTAL

TOTAL	145.160	114.029	9.467	12.096	9.502	12.048
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COLLAPSE

F11	373.880	227.124	34.782	31.157	18.927	17.030
F11-S	155.680	118.160	14.187	12.973	9.847	5.740
F12	77.300	57.150	6.900	6.442	4.763	3.860
F22	0	0	0	0	0	0
FMEIC	10.000	9.088	0	833	757	600

TOTAL

TOTAL	616,860	411,522	55,869	51,405	34,294	27,230
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FRIO INDUSTRIAL

F11	75.900	52.824	5.902	6.325	4.402	4.931
F12	2.759.938	2.506.450	242.276	229.995	208.871	236.622
F22	1.671.097	1.385.112	146.612	139.258	115.425	136.370
F113	0	0	0	0	0	0
F114	7.200	3.400	1.533	600	283	400
F502	101.939	73.270	12.900	8.495	6.106	5.940
F11-S	0	0	0	0	0	0

TOTAL

TOTAL	4.618.074	4.021.056	409.223	384.673	335.088	384.253
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TOTAL NAC.

TOTAL NAC.	5,538,414	4,776,273	487,941	461,535	398,023	456,305
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CUADRO No 2 ANALISIS POR TIPO DE MERCADO (Kgs) - DICIEMBRE 91

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MERCADO PRODUCTO	ACUM. 91	ACUM. 90	PROMEDIO ULT. 3/M	PROMEDIO ANO. ACT	PROMEDIO ANO 1990	PROMEDIO ANO 1989
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EXPORTACIONES						
F11	303.600	345.170	32.533	25.300	28.764	16.824
F12	443.636	702.686	36.817	36.970	58.557	50.479
F22	138.422	133.950	8.032	11.535	11.163	9.304
F502	9.581	10.730	900	798	894	675
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TOTAL (EX)	895.239	1.192.536	78.282	74.603	99.378	77.282
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TOTAL x PRODUCTOS

F113	48.600	23.580	4.800	4.050	1.965	2.970
F114	7.250	4.400	1.550	604	367	500
F11	1.068.500	872.327	97.140	89.042	72.694	59.195
F12	3.339.734	3.412.692	291.289	278.311	284.391	311.879
FMEZC.	48.530	52.748	3.000	4.044	4.396	6.754
F22	1.809.519	1.519.062	154.644	150.793	126.589	145.674
F502	111.520	84.000	13.800	9.293	7.000	6.615
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TOT. GENERAL 6.433.653 5.968.809 566.223 536.138 497.401 533.587

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TABLA Nº 2
CONSUMPTION OF CONTROLLED SUBSTANCES BY END USE IN VENEZUELA*
(1990 METRIC TONS)

Controlled Substance	Aerosols	Foams		Solvents	Sterilization	Refrigeration				Fire Extig. and Other*	Total (% of All CFC USE)
		Flex.	Rigid			Domestic	Industrial/Commercial	MACs	Total		
CFC-11	47 (9%)	153 (29%)	276 (51%)				69		69		545 508 (17%)
CFC-12	170 (7%)	20 (1%)	37 (1%)		16 (1%)	640 695	1419 1433	346 376	2306 2506 (70%)		2749 2549 (80%)
CFC-113	13 (28%)			21 (46%)					12 (26%)		46 (1%)
CFC-114							10		10 (100%)		10 (1%)
CFC-115							36		36 (100%)		36 (1%)
TOTAL	230 (7%)	173 (5%)	313 (10%)	21 (1%)	16 (1%)	640 695	1538	376	2633		3386 (100%)
Halon-1211										22 (100%)	22 (69%)
Halon-1301										10 (100%)	10 (31%)
TOTAL										32 (100%)	32 (100%)
MCF	100			100						370	570

* Data on carbon tetrachloride is not included because it is not available.

* For methyl chloroform, this includes: athletic shoe soles (250), primary metals industry (30), adhesives (30), correction fluid (30), and miscellaneous metal cleaning (30).

CONSUMO DE FORANE-12 EN VENEZUELA
EN 92
EN LOS SECTORES SIGUIENTES

en toneladas

		AIRE ACONDICIONADO			
CARROS	NEVERAS	PARTICULAR	EDIFICIOS	FRIO IND.	TOTAL
Nuev Mant.	Nuev Mant.	Nuev Mant.	Nuev Mant.	Nuev Mant.	Nuev Mant.
80 900	60 250	150 600	? 200	200 600	490 2.550

REPUBLICA DE VENEZUELA
MINISTERIO DE RELACIONES EXTERIORES

Grupo Interministerial Ad-hoc para la Aplicación del Protocolo de Montreal

Caracas, 2 de setiembre de 1992

Apreciado Dr. El-Arini:

Tengo el agrado de dirigirme a usted en la oportunidad de remitirle el proyecto denominado "Sustitución de CFC por HFC-134a como refrigerante en equipos de aire acondicionado central", a los fines de su revisión por la Secretaría a su cargo y por el Banco Mundial y su consideración por el Comité Ejecutivo del Fondo Multilateral para la Aplicación del Protocolo de Montreal en su reunión de octubre próximo.

Le informo igualmente que he solicitado con antelación al Banco Mundial que proceda a la evaluación técnica y financiera del proyecto y a la formulación de las recomendaciones respectivas.

El Grupo Interministerial Ad-hoc para la Aplicación del Protocolo de Montreal en Venezuela ha revisado el proyecto desde el punto de vista de su elegibilidad y de los costos adicionales, encontrando que el mismo calificaría para financiamiento del Fondo Multilateral, a partir de lo cual ha preparado la presentación. Sin embargo, llamo su atención sobre el hecho de que, para la determinación de los costos adicionales correspondientes a los equipos nuevos, sólo se pudo contar con los precios de equipos de referencia cotizados a los solicitantes, no siéndole posible al Grupo obtener una lista general de precios de equipos basados en CFC y HCFC existentes en el mercado, entre los cuales seleccionar para la comparación los de características más similares a los equipos nuevos basados en HFC-134a.

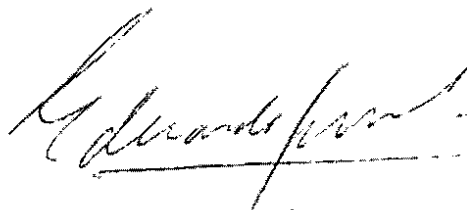
En vista de lo anterior, es probable que la evaluación del Banco Mundial implique algunas modificaciones en las cifras incluidas en la presentación que le remito.

Mucho le agradecería disponga lo conducente a fin de que el proyecto en referencia, con los anexos respectivos y las recomendaciones a ser consignadas por el Banco Mundial y por la Secretaría a su cargo, sean presentados al Comité Ejecutivo del

Fondo Multilateral en la oportunidad señalada.

Reiterándole las seguridades de mi mayor consideración, quedo de usted,

atentamente,

A handwritten signature in dark ink, appearing to read 'Eduardo López', written over a horizontal line.

Eduardo López

Representante de Venezuela en el
Comité Ejecutivo del Fondo Multilateral
para la Aplicación del Protocolo de Montreal

Al Señor Doctor
Omar El-Arini
Jefe de la Secretaría del
Fondo Multilateral para la
Aplicación del Protocolo de Montreal
Montreal, Canadá

Annex 3: Summarized Project Capital and Incremental Costs

Table 1: New Installations -- Incremental Cost Determination

(Costs in US\$)

Institution	Make and Model	Quantity (1)	HFC-134a Chillers			CFC-11 Chillers			Unit Incremental Cost (10% of McQuay) (6)	Total Incremental Cost (7) = (6) x (1)
			Tons of Refrigeration	Unit Cost (2)	Total Cost (3) = (1) x (2)	Make and Model	Unit Cost (4)	Total Cost (5) = (4) x (1)		
IMPRES CONGRESO CMDLT	McQuay PEH083K	1	252	77528	77528	Trane RTHA-300	62240	62240	7750	7750
	McQuay PEH087	3 (1 location)	540	152425	457275	Carrier 19DK78	90334	271002	15250	45750
	McQuay PEH087K	3 (1 location)	500	150671	452018	Carrier 19DK78	90334	271002	15070	45210
	TOTAL	7			986821			604244		98710
		(1)		(2)	(3)		(4)	(5)	(6)	(7)

Note 1: Carrier, Trane quotations not considered to be equivalent. Based on current market conditions in USA, incremental costs for equivalent conditions assumed to be 10% of Snyder General McQuay chiller prices.

Table 2: Retrofits

(All costs in US\$)

Institution	Make and Model	Quantity (1)	Tons of Refrigeration	Parts Unit Cost (2)	Installation Unit Cost (3)	Total installed Cost Per Unit (4) = (2) + (3)	Value of CFC-12 Re-sold (5)	Eligible Unit Cost (Note 2) (6)	Total Incremental Cost (7)
IMPRES	Westinghouse PE079PE4239	1	304	48075	14382	62457	1218	41367	40148
CMDLT	Westinghouse PE320PE3602	1	120	33339	8769	42108	1296	38318	37022
	Westinghouse PF050CS1218	1	312	19969	8769	28738	277	25733	25457
ATIAS	Westinghouse PE050PE4007	3 (1 location)	100	25122	14382	39504	244	30058	89435
IVSS	Westinghouse PE200PE3642	21 (7 locations)	200	32321	10373	42694	786	39073	804027
	TOTAL	27		855490	292899	1148389	20029		896089
		(1)		(2)	(3)	(4)	(5)	(6)	(7)

Note 2: Basis for Calculation of Retrofit Incremental Costs:

-- 100% of gear, HFC-134a, Oil, and Transport

-- 75% of Generic Parts and Labor

-- 0% of Condensers and Evaporators

Less Re-sold CFC-12

CENTRAL AIR CONDITIONING SYSTEMS
SUBSTITUTION OF HFC-134a FOR CFC-12

PROJECT DESCRIPTION

The proposed project consists of the substitution of HFC-134a for CFC-12 as the refrigerating agent in central air conditioning units at five Venezuelan institutions. The project involves the retrofit of twenty seven units currently operating with CFC-12 and the replacement of seven units. The institutions are:

Instituto de Prevencion Social del Medico (Impress)
Centro Medico Docente la Trinidad (CMOLT)
Clínica Atías, Hospitalización y Servicios, C.A.
Congreso de la República
Instituto Venezolano de los Seguros Sociales (IVSS)
- Hospital Dr. Pastor Oropeza, Barquisimeto
- Hospital Dr. Juan Montezuma Ginnari, Valera
- Hospital Dr. Domingo Guzmanlander, Barcelona
- Hospital Dr. Rafael Calles Sierra, Las Peidras
- Hospital Dr. Adolfo Pons, Maracaibo
- Hospital Dr. Manuel Noriega Trigo, Macacaibo
- Hospital Dr. Patrocinio Peñuela Ruiz, San Cristabal

TECHNICAL EVALUATION

A technical assessment of the project was performed to determine the soundness of the project. The evaluation included:

1. An extensive and in-depth review of the technical and financial proposals. The review included discussions with McQuay's Sales Engineering Department and Arista Centri Servicios C.A., the sole authorized McQuay representative and distributor for Venezuela;
2. A detailed comparison of the results and recommendations of the McQuay/SnyderGeneral Factory Rating Program with the proposals submitted by Arista Centri Servicios, C.A.;
3. A spot check comparison of the equipment parts price quotations submitted by Arista Centri Servicios, C.A. with the official McQuay parts price list;
4. A review of the calculations and data used by Arista Centri Servicios, C.A. to arrive at the installation labor costs included in their proposals;
5. Meetings and discussions with the Venezuelan technical consultants used by the various institutions to verify their technical reports and recommendations;

6. Field trips to all locations to meet with the chief maintenance engineers, perform a visual inspection of the existing equipment and installations, and verify that the information included in the proposal is factual; and
7. Price quotations used to establish the incremental costs for new units were reviewed to verify they were comparable and factual.

RECOMMENDATION

The project proposals appear to be of sound technical design and qualified for MPIMF grant financing of eligible incremental costs. In view of the fact that some of the proposed retrofit units have not been in operation for need of repairs, assurances are required from the beneficiaries that such repair work will be carried out along with the retrofit.

GENERAL INFORMATION

1. McQuay HFC-134a Technology

SnyderGeneral is the only manufacturer with HFC-134a chillers commercially available to date, following the years of lab and field tests comparing the performance of HFC-134a to that of CFC-12, R-500 and other refrigerants.

In 1991, SnyderGeneral shipped over 100 McQuay centrifugal chillers with HFC-134a. Two new 500 TR HFC-134a McQuay chillers were installed and in operation for over four months at the Congreso de la Republica, Caracas. A third 500 TR unit is scheduled to be installed within a month.

It should be noted that the McQuay HFC-134a chillers are the only zero OD units commercially available as opposed to transitional refrigerants such as HCFC-22 and HCFC-123. HFC-134a is also safe, non-toxic and has a global warming effect 10 times lower than CFC-12.

2. McQuay Centrifugal Chiller Retrofit to HFC-134a

The proposed chillers to be retrofitted are all CFC-12 units. HFC-134a is compatible with all CFC-12 centrifugal chillers manufactured. McQuay/SnyderGeneral have developed a computer rating program which based on the original unit performance data determines the performance utilizing HFC-134a and establishes the retrofit changes required which include a gear set change, replacement of general parts and in some cases condenser and/or evaporator tubes.

The retrofit from CFC-12 to HFC-134a involves the following steps:

- Remove the CFC-12 with standard evacuation methods and drain the oil
- Change the gear set, which optimizes impeller tip speed to operate with HFC-134a

- Evacuate and charge the chiller with HFC-134a and a synthetic lubricant (HFC-134a is not miscible with mineral oils with CFC-12)

The optimization of the impeller tip speed for the isentropic head rise of HFC-134a allows the capacity performance to closely match the original CFC-12 performance. An HFC-134a retrofit does not require a compromise of operating efficiency or capacity to achieve operation.

Two types of retrofit can be made by McQuay:

- Retrofit to change to HFC-134a to basically match the original CFC-12 performance
- Retrofit to change the HFC-134a plus other changes to improve the efficiency

The retrofit proposed in this project are to match the original CFC-12 performance.

McQuay has successfully carried out eight retrofits. The first retrofit was performed in February 1991 at the Westinghouse Electronic Systems Group Headquarters located next to the Baltimore/Washington, D.C. International Airport. The retrofit of the 16-year-old Westinghouse centrifugal chiller involved a gear change and achieved the original capacity and improved efficiency.

3. Cost Basis

The incremental costs were estimated as follows:

- Retrofits - all new parts and installation costs specific to the required retrofit modifications
- New Chillers - the cost difference between the McQuay HFC-134a chillers and the lowest prices alternative CFC-11 or CFC-12 chillers selected by the beneficiaries for the same service. McQuay proposed various new chillers alternatives; the lowest price alternate was selected. (Note: Verification required of comparability of CFC-11, -12 quotations.)

4. Guarantees

SnyderGeneral/McQuay guarantees that the units will perform at the stated capacities and at similar efficiencies when compared with CFC-12 units for the same service.

Arista Centri Servicios' guarantees are as follows

- New Units - 1 year or up to 4 years if the beneficiary contract with Arista for the operation and maintenance of the units
- Retrofits - 4 months or up to 2 years if the beneficiary contracts with Arista for the operation and maintenance of the units.

5. CFC-12 Refrigerant Consumption

Given the lack of data and reliable information concerning annual refrigerant replacement, it is not possible to arrive at an accurate overall annual CFC-12 escape rate. Given the visual evidence of CFC-12 escape on a number of units, for purposes of calculating unit abatement costs, an escape rate of 15% has therefore been assumed.

6. Arista Centri Servicios, C.A.

This company, which is the sole authorized McQuay representative and distributor for Venezuela and the selected vendor appears to be very capable to successfully carry out the proposed project.

ANNEX 5

OORG REVIEW

Prepared by James M. Calm

MONTREAL PROTOCOL (MP) PROJECT FOR VENEZUELA OZONE OPERATIONS RESOURCE GROUP (OORG) TECHNICAL OPINION

1. Recommendation: Subject to reservations cited hereafter and reliance on the documentation provided, the proposed retrofits and new installations appear to be justified and consistent with the objectives of the Montreal Protocol Ozone Projects Trust Fund. Approval is recommended with adjustments to the incremental costs for the retrofits as discussed below and verification of the comparative bids for the replacements. The key issue for the comparative bids is assurance that the bids are firm and based on the same functional requirements.

2. Relevance and Adequacy of Information Provided: The chiller quotations and documentation provided are adequate for assessment of incremental equipment costs, but not for verification of the installation design or full retrofit procedures. The project comprises 27 retrofits from CFC-12 to HFC-134a, replacement of 4 chillers, and installation of 3 new chillers. Of the replacements, one is for a damaged chiller and three are based on age; two of the latter already have been replaced and the proposal provides for reimbursement of previously incurred, but eligible incremental costs. Insufficient information was provided to assess the justifications for replacement.

No information was provided to evaluate the efficiency levels selected. A limited range of performance selections is available for each of the capacities involved; such selections go beyond elimination of ozone-depleting substances (ODSs), but will impact operating costs, resource utilization, and the energy-related (indirect) component of global warming. The retrofits appear to have been selected to maintain capacity and efficiency. An alternative strategy is to retrofit for efficiency improvement at the expense of capacity, when a reserve exists, but the ranges for this approach are limited without an impeller replacement. Capacity-maintenance is the more common approach.

Whereas the proposed funding addresses incremental rather than full costs, the impacted facility owners have incentives to assess the cited issues. Annex 4 indicates that the Technical Evaluation Specialist may have examined them and contains a recommendation that necessary repairs for units to be retrofitted be assured. Funding also should be contingent upon identification and correction of the cause(s) of damage dictating one of the replacements.

3. Technical Soundness: The products involved are proven and the proposed equipment manufacturer is highly reputable. This reviewer has personally visited the factory where the new equipment is manufactured and tested, as well as the supporting development center, on other occasions. Moreover, the new chillers are rated under a voluntary industry performance certification program and separately subjected to product safety evaluations. The price quotations for new equipment include start-up by manufacturer representatives; on site operator training normally is included. It is important that operating instructions be translated if not so provided.

The Draft Executive Project Summary reviewed and Annex 4 to it incorrectly indicate that *the McQuay HFC-134a chillers are the only zero OD units commercially available as opposed to transitional refrigerants such as HCFC-22 and HCFC-123*. Carrier Corporation manufactures HFC-134a chillers in capacities of 250-10,000 tons, though the 19XL model (250-600 tons) probably was not yet available with HFC-134a when the subject bids were solicited. York sells HFC-134a chillers in capacities of 900-8500 tons. Moreover, chillers using R-717 (ammonia) have been available for more than 50 years in the capacities involved; safety considerations may have precluded their consideration. Finally, water/lithium bromide absorption chillers also are produced for the capacities involved, but would have more than doubled the costs.

4. Lessons from Experience: Three 550 ton SnyderGeneral/McQuay PEH-087 chillers using HFC-134a are in operation in Caracas, at the Judicial Courts Building of the Congreso de la Republica. An additional chiller is in use in Brazil and two more will be installed shortly. Superseding the information contained in Annex 4 and echoed in the Executive Project Summary, nearly 20 chillers have been successfully retrofit to use HFC-134a by SnyderGeneral and other manufacturers. 250-300 chillers are in operation with this refrigerant. The February 1991 retrofit cited in Annex 4 is the first commercial retrofit by SnyderGeneral, but not the first including test units by that manufacturer and others. The proposed retrofits and new equipment selections are reasonable based on the experience obtained to date, intensive evaluation of HFC-134a properties and compatibility by manufacturers and others, and growing use of this refrigerant in chillers and other equipment.

5. Environmental Issues: HFC-134a is one of the three most widely applied alternative refrigerants for chillers, the other two being HCFC-22 and HCFC-123. All three offer significant reductions in ozone depletion potential (ODP), compared to CFC-11, CFC-12, CFC-113, CFC-114, and R-500 (CFC-12/HFC-152a azeotrope) being phased out under the Montreal Protocol. HFC-134a is particularly attractive due to its ozone-depletion potential (ODP) of zero, as contrasted to HCFC-22 and HCFC-123 with ODPs of 0.055 and 0.02, respectively, and especially so when compared to CFC-11 or CFC-12 with ODP values of 1.0. HFC-

134a use also offers comparatively low global-warming potential (GWP), 1200 relative to carbon-dioxide for a 100-year integration time horizon (ITH). Contrasted to CFC-12, for which it is the primary alternative, the direct-effect warming contribution is reduced by a factor of nearly six. The GWP of HFC-134a is notably higher than that for HCFC-123 but less than that for HCFC-22, 90 and 1600 respectively for the same ITH. While global warming is not addressed by the Montreal Protocol, it is an environmental consideration.

HFC-134a is particularly suited for the proposed retrofits. The conversion costs from CFC-12 to HFC-134a are less than a quarter of the replacement costs, but essentially the same capacity and efficiency can be obtained due to the favorable heat transfer characteristics of this refrigerant. The primary requirements for retrofit (i.e., changing the impeller drive gear, components necessary for materials compatibility, the refrigerant, and the lubricant) are addressed in the proposal.

The environmental benefits calculated are based on annual leakage of 15%. Historical losses of 8% coupled with annualized retirement (disposal) losses of ½% were typical; current practice enables 4 and ¼%, respectively, and lower losses are likely in the future. The latest UNEP Technical Options Report suggests 8% annual losses falling to 6% by 1995 and 4% by 2000 for HCFC-22; those for HFC-134a should be comparable.¹ A significant share of the losses results from service practices rather than actual leakage.

6. Safety Issues: HFC-134a is not flammable under ordinary and standard testing conditions. Review of manufacturer Material Safety Data Sheets (MSDSs) reveals no alarming acute or chronic toxicity indications with proper safety precautions. The Program for Alternative Fluorocarbon Toxicity Testing (PAFT) has found HFC-134a to be at least as safe as CFC-12; no reason has been identified to preclude use of HFC-134a in general industrial applications, provided that recommended practices are observed.² A provisional (pending completion of the PAFT tests) safety classification of A1 – in the safest group – has been assigned.³ A recent notification to the U.S. Environmental Protection Agency (EPA) on tumors found in test animals following lifetime HFC-134a exposures, filed in accordance with the Toxic Substance Control Act §8(e), is based on extremely high concentrations, namely 50,000 ppm.⁴ Such tests are designed to maximize detection of effects, but are not regarded as indicative of normal exposures. Most of the major chemical manufacturers have determined that these findings do not support a change to recommended allowable (occupational) exposure levels.

Conformance to both the manufacturer installation recommendations and to safety standards is strongly recommended as a condition of funding.⁵⁻⁷ Key provisions of the latter address machinery room design and access, venting of relief valves to the outside, piping therefor, and installation of oxygen-deprivation sensors. The last item is necessary since HFC-134a (like most refrigerants) is heavier than air and could act as an asphyxiant in the event of a significant leak or spill. All new pressure vessels should be specified to meet applicable ASME codes.

7. Cost Effectiveness: Differences in capacities and efficiencies diminish the applicability of the competitive bids offered as substantiation. Using the chillers for the Instituto Medico de Prevision Social (IMPRES) as an example, the Trane RTHA-300 chiller offers 268 tons at 0.72 kW/ton; the SnyderGeneral/McQuay PEH063 offers 252 tons at 0.776 kW/ton (less efficient). The ratings for the latter are quoted for more severe operating conditions, however. The Trane quotation explicitly identifies necessary options that may be included, but are not cited in the SnyderGeneral/McQuay (Aristra Centri Servicios) quotation. While direct comparison is limited, the former appears to offer the more cost-effective option. Also, the SnyderGeneral quotation identifies a specific model by virtue of the performance data, but verification of that model would be facilitated by specifying the full rather than abbreviated model number, as it would appear on the name plate (i.e., including the impeller, evaporator, and condenser selections codes).

Whereas Carrier has suspended sales of HCFC-123 equipment, the model 19DK78 quotations would have to be for CFC-11 equipment, even though not so indicated. The performance of 0.672 kW/ton is somewhat low for current 500 ton, CFC-11 machines. The prices appear to be surprisingly low, so further investiga-

¹ *Report of the Refrigeration, Air-Conditioning, and Heat Pumps Technical Options Committee*, report RWR-570-LK-91423-al, United Nations Environment Programme, 1991

² G. M. Rusch and C. E. Finegan, *Status of Toxicological Alternatives, Program for Alternative Fluorocarbon Toxicity Testing*, September 1992

³ ANSI/ASHRAE Standard 34-1992, *Number Designation and Safety Classification of Refrigerants*, 1992

⁴ TSCA 8(e) filing by PAFT on ethane, 1,1,1,2-tetrafluoro- (CAS Registry Number 811-97-2), 10 September 1992

⁵ *Installation of Centrifugal Chillers*, bulletin IM 306-2, SnyderGeneral Corporation, September, 1988 (use current version at time of installation)

⁶ *Operation and Maintenance Data, Single-Compressor Centrifugal Chillers*, bulletin IM 307-4, SnyderGeneral Corporation, July, 1992 (use current version at time of installation)

⁷ *Safety Code for Mechanical Refrigeration*, ASHRAE Standard 15-1992, 1992

tion would be warranted. Also, there are minor differences between the costs for the 540 and 500 (505 ?) ton SnyderGeneral/McQuay chillers between Annex 3 and the underlying quotations.

The SnyderGeneral/McQuay cost estimates were compared to firm bids and cost data available from other work. The proposed prices are deemed to fall within a reasonable range of pricing considering the less-competitive market in Venezuela, added costs associated with product export, and cost variances related to local markets, timing, and similar factors. The total costs are plausible based on the limited nature of this review; the incremental costs are high if performed at the time of regularly scheduled compressor maintenance, but reasonable if performed separately.

The funding request opts for replacement of existing chillers and installation of new chillers with those using HFC-134a. Bids obtained for equipment using HCFC-22 and HCFC-123 were excluded even though offering substantially – nearly 40% – lower costs. The justification outlined in the Draft Executive Project Summary explains that other refrigerants would be ineligible for support by the Government of Venezuela (GOV) due to possible future reclassification of HCFC-123 (and presumably of HCFC-22). Binding restrictions of HCFC refrigerants are anticipated in the November 1992 revision of the Protocol, but such restrictions will allow use of HCFC-22 and HCFC-123 for an interim period. General exclusion of these refrigerants may lead to higher costs, particularly for high-efficiency selections. Whereas performance impacts resource use and indirect global warming, and whereas the GWP of HFC-134a exceeds that of HCFC-123, this reviewer does not concur with automatic exclusion of HCFC-22 and HCFC-123. The selection of HFC-134a is completely justified for the proposed retrofits, and makes sense for the third unit where two new chillers with HFC-134a already have been installed.

The retrofit costs were compared to estimates for other projects and found to be high for two reasons. First, condenser and evaporator tube replacements reflect repair requirements independent of the refrigerant change. Second, some of the seals and other generic materials would be needed for normally scheduled maintenance, if the retrofit were coordinated with service requirements. Gear, refrigerant (less recovery value for the existing charge), and lubricant costs should be viewed as incremental; tube costs should not. Approximately half of the generic-material costs would have been required for coordinated major maintenance; it therefore would be reasonable to allow between half and three-quarters of such amounts as incremental to adjust for those costs not necessary for normal maintenance.

Annex 6: Definition of Unit Abatement Cost, and Standard
Assumptions used for the Benchmarks

Capital costs are annualized and expressed as a ratio of the average annual amount of ODS reduction, weighted according to its ozone depleting potential.

The unit abatement cost is defined as follows:

$$c = \frac{CC.CRF + (OC - OS)}{M.ODP}$$

where:

c	=	unit abatement cost
CC	=	incremental capital costs (including all one-time costs such as training, installation, freight, etc.)
CRF	=	capital recovery factor
OC	=	incremental annual operating costs
OS	=	incremental annual operating savings, benefits
M	=	annual average mass of ODS not released as a result of the phaseout action
ODP	=	ozone depleting potential of the ODS

The figures upon which the calculations were based were developed from the project financial analysis which is available in the project file.