



# Multilateral Fund

for the Implementation of the Montreal Protocol

## OBJECTIVE

To assess the technical and economic feasibility of HFC-32 technology for unitary and multi-connected commercial air-conditioning (AC) and heat pump applications



## DEMONSTRATION OF HFC-32 AS A REFRIGERANT IN COMMERCIAL AIR-SOURCE CHILLERS/HEAT PUMPS

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|------------------------------|---|
| Project title                | Demonstration project for conversion from HCFC-22 technology to HFC-32 technology in the manufacture of commercial air-source chillers/heat pumps at Tsinghua Tong Fang Artificial Environment Co. Ltd. |
| Country                      | China   |
| Agency                       | UNDP  |
| Sector                       | Industrial commercial refrigeration and air-conditioning (ICR)  |
| Subsector/application        | Unitary and multi-connected commercial air-conditioning (AC) and heat pumps   |
| Enterprise/systems house     | Tsinghua Tong Fang Artificial Environment Co. Ltd.  |
| Baseline technology          | HCFC-22   |
| Alternative technology       | HFC-32  |
| GWP (alternative technology) | 675   |
| Potential safety issues      | Flammable   |
| ODS phase-out (mt)           | 61.9  |
| ODS phase-out (ODP tonnes)   | 3.40  |

## DESCRIPTION

The project included product redesign and development, laboratory testing and performance evaluation, prototype testing, modifications to the equipment manufacturing line, and introduction of safety measures to handle the flammability of HFC-32.

Three equipment models with capacities of 13 kW, 30 kW and 60 kW and refrigerant charges between 5.1 and 24 kg of HCFC-22 were redesigned to operate with HFC-32. This included modifications to address the flammability and thermodynamic characteristics of the refrigerant. The production line conversion included: changes to the processing of the heat exchanger, reduction of the tube diameter from 9.5 to 7 mm to suit the lower charge; isolation of the charging area, including adequate ventilation and fire alarm systems for the safe use of flammable gases; introduction of helium-leak detectors into the production process; and upgrade of the quality inspection, in particular the safety inspection of electrical systems, due to the presence of flammable gases. A total of 230 workers received training.

## RESULTS

The redesign and manufacturing of the three models to operate with HFC-32 refrigerant was successful. The prototypes were produced by Tsinghua Tong Fang and tested by a third party.

- The actual efficiency of the HFC-32 heat pump/chiller prototype designed in this project was 3 to 5% higher than former HCFC-22 in cooling mode and 3% higher in heating mode
- The charge quantity of HFC-32 in the system is 20-40% less than the charge of HCFC-22
- The compressors used in the new models were provided by compressor manufacturers in China who redesigned and modified their R-410A-based compressors for HFC-32
- The cost of the HFC-32 heat pump/chiller was 20-30% higher than the HCFC-22-based product, mainly due to the increased cost of the compressor and electrical components. It is expected that large-scale production would reduce the incremental operating costs of HFC-32-based equipment

### HFC-32-based prototypes developed by the project and tested by a third party (Hefei General Machinery & Electrical Products Inspection Institute)



13 kW



30 kW



60 kW

## COST ANALYSIS

The total eligible incremental capital cost was US \$745,802. The incremental operating costs (IOCs) were as follows: US \$163/unit (or US \$32/kg) for the 13 kW model, US \$177/unit (or US \$14.8/kg) for the 30 kW model, and US \$286/unit (or US \$11.9 /kg) for the 60 kW model. On average, 65% of IOCs were related to compressor cost, and 35% to the sealing of electrical components. Incremental savings were achieved with the heat exchangers and the refrigerant.

## CONCLUSION

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The project successfully demonstrated that HFC-32 is a technically viable alternative to HCFC-22 in small-size (10 kW-60 kW) commercial air-source heat pumps/chiller products.

HFC-32 is flammable, but due to a lower overall flammability it is easier to design, market and operate than hydrocarbon-based systems. At the same time, HFC-32 has only 38 % of the GWP of HCFC-22 and only 35 % of the GWP of HFC-410A, the main alternative to HCFC-22 in AC applications.

It is expected that further improvements in compressor design and better adaptation of the compressor to HFC-32 properties, as well as further optimization of the overall system will provide further energy-efficiency gains.

New HFC-32 systems are produced in small quantities and are not being sold in the market because of restrictions within current standards. New products will be installed and maintained exclusively by factory-trained servicing staff, at least during the introduction of such products into the market.

The National Standard GB 9237 “Mechanical refrigerating systems used for cooling and heating – safety requirements”, one of the basic safety standards for refrigeration in China, restricts sales and operation of equipment using flammable refrigerants; this GB 9237 standard is a national version of the International Standardization Organization’s (ISO) 5149-1993, currently in the process of revision.

The project has directly led to the use of HFC-32 as a major alternative to HCFC-22 in the ICR sector plan of stage I of the HPMP for China, where currently six conversion activities with an aggregated consumption of approximately 3,000 mt of HCFC-22 are under implementation towards the use of HFC-32.

## FINAL REPORT AND SECRETARIAT’S COMMENTS

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<http://www.multilateralfund.org/72/English/1/7211a1.pdf>  
(paragraphs 12 to 25 and Annex I in page 18)