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EXECUTIVE COMMITTEE OF
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COST FOR CONVERSION OF COMPONENT MANUFACTURING VS. INCREMENTAL OPERATING COST (DECISIONS 59/14 AND 60/45)

1. The Secretariat identified during the preparation for the 59th Meeting of the Executive Committee an issue related to the cost for conversion of component manufacturing vs. incremental operating cost. In decision 59/14 the Executive Committee decided to defer the discussion to the 60th Meeting, and in decision 60/45 to defer it to the 61st Meeting.

2. The related issue was originally two-fold namely, whether cost for the manufacturing of components is eligible versus a possible increase in incremental operating cost, and in which cases in particular the retooling of heat exchanger production would constitute incremental cost.

3. This document has been updated from the version submitted to the 60th Meeting in order to reflect decisions taken at the 60th Meeting as well as additional information obtained by the Secretariat since that meeting.

Manufacturing of components vs. increased incremental operating costs

4. In this paper, manufacturers producing products containing ODS, i.e. air conditioning or refrigeration equipment, are called "original equipment manufacturers" (OEM). The OEM use components to produce their equipment, these components being either produced by the OEM (in-house manufacturing), or the OEM purchases them from component manufacturers. The terms OEM, in-house manufacturing and component manufacturers, as well as the term "component source" which subsumes component manufacturer and in-house manufacturing, are used throughout this document based on these definitions. These terms relate purely to manufacturing in Article 5 countries, unless specifically noted. The most prominent component typically provided by a component manufacturer is the compressor.

5. HCFC phase-out projects submitted by the implementing agencies propose that the Multilateral Fund should fund the conversion of both in-house manufacturing and component manufacturers. In the past, the Executive Committee used to either fund the conversion of the component sources, or include in the incremental operating costs (IOCs) for the OEM's possible cost increases of the components for the new technology. Funding both IOC and component sources was seen as double funding, and significant efforts were undertaken to avoid this.

6. IOCs are meant to offset for a transition period the higher costs of manufacturing products presently containing ODS with an alternative technology. The cost increases are, typically, predominantly related to the purchase price of alternative substances and components. In the past, the Executive Committee had assumed that funding the conversion of component sources would reduce the IOC for the related component to zero, and has modified the IOC accordingly on a case-by-case basis. However, this requires both a clear relation between the component source and the OEM, and the ability to recalculate IOCs.

7. In the past, an IOC was determined on a case-by-case basis for each single conversion, trying to take into account the actual costs. At its 60th Meeting, the Executive Committee, through decision 60/45, defined the levels of IOC for different sectors solely depending on the quantity of HCFC phased out. With the decision 60/45, the determination of an IOC is indifferent to the actual costs the enterprise experiences when converting from one technology to another.

8. The phase-out of CFCs during the 1990's, and in the first years of this century, was characterised by a multitude of stand-alone projects. Funding guidelines had to establish rules with general applicability on how to differentiate between cases where the IOC was being paid in full, and when component manufacturers were converted and only a reduced IOC was provided. Phase-out plans were typically prepared only after a large part of the industry had already been converted. However, the approach to HCFC phase-out differs since it is using an integrated approach from the outset, combining a

large number of projects under one phase-out plan. This enables the Executive Committee to make decisions on a country basis instead of the need for generic rules, which had to be established for CFC phase-out.

9. It might therefore be prudent to request agencies to present, as part of a phase-out plan, any conversion activities foreseen for component manufacturers at the same time as conversion activities for the sector using these components. The Secretariat could inform the Committee about the incremental capital costs for conversion of the OEM and the component manufacturer, and about the incremental operating costs arising for the OEM based on either current prices or decision 60/45, depending which of the two would be lower; the Secretariat could also strive to provide an indication for the IOC for one component, i.e. typically a compressor, under these circumstances. According to information collected by the Secretariat, countries which might include compressor conversion activities in the air conditioning sector would probably be China and Thailand, in the refrigeration sector compressor conversion activities might be included in plans for China, India and Brazil and, possibly, depending on eligibility (share of Article 5 country ownership and technology presently used), Egypt, Indonesia, Malaysia and Mexico. Information for component manufacturers producing heat exchangers could not be obtained.

Incremental cost of heat exchangers

10. As part of the review of project submissions, the Secretariat identified as one issue the question whether the conversion of heat exchanger production would be considered as an incremental cost. The following paragraphs attempt to explain the very technical aspects of the issue to enable the Executive Committee to take an informed decision on the matter.

11. The heat exchanger production referred to in this document relates to the production of refrigerant-to-air heat exchangers. These consist typically of a number of copper tubes with plate-like aluminium fins perpendicular to them, and there are usually several copper tubes through each fin. The manufacturing of the fins is done with complex dyes which punch and form the fin using multiple hits. The external diameter of the tubes is minimally smaller than the diameter of the holes in the fins, so the fins can be aligned easily on a set of tubes. Typically, the tubes have been straightened previously and bent into a U-shape ("hairpins"), so that each tube goes twice through the heat exchanger; one heat exchanger can have numerous tubes. The tubes are laced into a stack of fins (up to several hundred) on a horizontal table. Once all of the hairpins have been placed into to the stack of fins, a rod with a precision ball tip slightly larger than the tubes inner diameter is pushed through the tube, enlarging the tubes interior and, therefore, outer diameter slightly, and so creating a fit between the tube and the fin. In high speed production all of the tubes are expanded at the same time. In very low volume production, the tubes are sometimes expanded one tube at a time. These heat exchangers are called tube-and-fin heat exchangers.

12. Refrigerant-to-air heat exchangers are very common in refrigeration and air conditioning systems, in particular in large scale production of systems. In cases of mass production the heat exchangers are either optimised for each model and purchased from an external supplier or optimised for the manufacturer's model range and manufactured on site. Typically the same external tube diameter would be used for units with a wide range of capacities. In case of small scale production of refrigeration and air conditioning equipment, the heat exchangers are typically bought from a range of available models offered by a supplier. These heat exchangers do not substantially differ in their design or material between HCFC-22 technology and the various current HCFC-22 alternatives (except for ammonia and CO_2).

13. According to technical experts consulted by the Secretariat, it is not necessary to reduce the diameter of the tube from the perspective of system performance when changing from HCFC-22 to R-410A or R-32; this is also the case for changes to HFC-407C and the hydrocarbons HC-290 and HC-1270. However, a small adjustment of the tube wall thickness is needed to increase the strength for

the higher operating pressures of R-410A or R-32. This approach requires significantly less capital investment in equipment, and is therefore preferred by manufacturers. Another alternative is the use of specific, more expensive types of copper for the tubes that makes them more pressure resistant while having the same dimensions, or a combination of both. Reducing the external tube diameter, as requested in some project proposals, can result in system miniaturization and cost reduction. However, as demonstrated in project submissions, the costs for the re tooling of a smaller external diameter tube are very significant. Coils for CO_2 based systems would potentially need to use smaller diameter tubes because of the very high operating pressures of CO_2 systems and the different capacity per volume. Systems using flammable refrigerants (hydrocarbons and, to a smaller extent, HFC-152a and HFC-32) can reduce the refrigerant charge substantially by using smaller diameter tubing and thus enable the use of the refrigeration products using flammable refrigerant with little additional safety requirements as compared to present HCFC-systems.

14. The machines for the production of heat exchangers are to some extent customized, in particular for the external tube size. A change in external tube size will lead to a replacement need for the equipment, in particular the dies for manufacturing of fins, the machines to bend the copper tubes, auto brazing equipment and the machines used to expand the tubes. All these are usually fully automated precision production machines with relatively high modification or replacement costs.

15. In case of purchase of heat exchangers from external suppliers, the supplier will ask for some mark-up, and sometimes a supplier will not be able to meet high production volumes without making additional capital investments. Therefore large manufacturers will typically build their own heat exchangers while small manufacturers would find it more cost effective to purchase their heat exchangers from a specialty supplier. Should the supplier be flexible in its production set-up and able to supply heat exchangers with tubes of various external diameters a reduction in tube diameter, if desired, often might lead to the use of less copper in the production, which tends to reduce heat exchanger production costs and, therefore, market prices. In such cases, the refrigerant filling for the unit will also decrease, which leads to additional cost savings. However, as explained above, the Secretariat does not see these elements as related to the conversion from HCFC-22 to an alternative.

16. Companies are presently used to manufacturing their own heat exchangers in house, which provides them with a higher flexibility in designing and manufacturing larger air conditioning systems according to customers' specification and might also yield some savings in operational costs. Consequently, due to the present lack of demand external manufacturers with sufficient capacity might currently not be available in acceptable proximity to all manufacturing facilities. In terms of transition times, independent of whether the manufacturing of heat exchangers is done within an air conditioner manufacturer or at a specialised supplier, the Secretariat would like to point out that equipment used to produce air conditioner heat exchangers is complex and available only from a small base of suppliers. The regular lead time to purchase this equipment can range from 12-24 months depending on the number of manufacturers that are purchasing equipment at a given time. Should the number of projects initiated by the Multilateral Fund accelerate the rate of orders, further delays are likely.

17. The Executive Committee might wish to consider:

(a) Funding the conversion of component manufacturers only when submitted as part of a HCFC phase-out management plan (HPMP) or a sector plan under a HPMP, except for projects originally submitted to the 61st or earlier Meetings;

(b) Requesting the bilateral and implementing agencies in cases where countries wish to include component manufacturers in their phase-out plans to provide, as part of their submission, information about the incremental operating costs of all refrigeration or air conditioning equipment manufacturers included in the plan, as well as production and export data for compressors for the previous three years; and

(c) Not treating as an incremental cost, in case of conversion of refrigeration or air conditioning systems from HCFCs to a non-flammable HFCs, the capital costs related to retooling for a change in diameter of the tubing within tube-and-fin heat exchangers, since these are considered to constitute an avoidable technical upgrade.

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