

**WORLD PRODUCTION AND RELEASE OF  
CHLOROFLUOROCARBONS 11 AND 12  
THROUGH 1981**

**CHEMICAL MANUFACTURERS ASSOCIATION  
FLUOROCARBON PROGRAM PANEL**

**September 15, 1982**

**Calculations by E.I. du Pont de Nemours & Company  
from data published by Alexander Grant & Company  
report, "1981 World Production and Sales of  
Fluorocarbons FC-11 and FC-12," of August 25, 1982.**

## CMA CFC-11 AND CFC-12 PRODUCTION AND RELEASE DATA

Since the analysis by McCarthy et al. (Atmos. Environ., 11,491-497, 1977) of production and release of CFC-11 and CFC-12, better information has become available on the use and emission of these CFCs. As the data record from the Atmospheric Lifetime Experiment (ALE) of the atmospheric content of CFC-11 and CFC-12 has lengthened, the importance of determining the release of these CFCs to the atmosphere as accurately as possible has become more apparent.

The CMA Fluorocarbon Program Panel (FPP) has critically examined the use categorization of collected production data and has attempted to refine the 1977 emission scenarios. In this study, the Panel consulted with the U.S.A. Environmental Protection Agency and the Rand Corporation, as well as with the associated Panel companies.

This work is incomplete, but sufficient information has been gathered to warrant some revisions to the presently-used assumptions at this time.

Earlier in 1982, a revised edition of production and release data through 1980, was made available by CMA. In the attached pages, the calculations are extended through 1981. The FPP believes that the attached tables are today's best estimates of releases. As various CMA initiatives to improve the data come to completion, CMA will publish further revisions in the data.

The following paragraphs describe the changes which were made in February, 1982.

### 1. Production Data

- 1.1 Production in the U.S.S.R. and other Eastern European nations has been estimated in DuPont calculations which were published by CMA in previous years. These estimates included no production prior to 1968, the first year for which data are available, and have assumed a 3% growth in the U.S.S.R. since 1975, the last year for which data are available. However, the published data from 1968 to 1975 show a growth rate of 18%/year, and it would seem more reasonable to assume a similar growth rate leading up to the 1968 levels from an initial production in 1950 and to continue this historic growth rate from 1975 to 1981 since per capita consumption in the U.S.S.R. remains very low. Production in other Eastern European nations continues to be estimated at 15% of U.S.S.R. production in the absence of firm data.
- 1.2 Though CFC-11 and CFC-12 are produced in the Peoples Republic of China (PRC), at this time no reasonable estimate of quantities is available and no PRC production is included in the calculation.

- 1.3 Production in India and Argentina for the year 1977 was based on rough estimates provided by other fluorocarbon producers, and was held constant in subsequent years. Revised estimates have been provided to Alexander Grant and Company for the years 1977 through 1980, and are included in the new calculations. The revisions include information that two companies in Argentina ceased fluorocarbon manufacture in 1979.
- 1.4 Production, as reported by reporting companies, excludes any CFC-11 or CFC-12 manufactured but released during production and in-plant filling operations. These losses are generally held to be around 2% of the carbon mass balance across the plant, and this material is clearly additional prompt release to the environment. It is estimated that about 1.5% of the input carbon is lost during the filling operation, i.e., in proportion to CFC-11 and CFC-12 production, and 0.5% of the input carbon is lost as CFC-12 from vents and leaks (CFC-12 is more difficult to condense and exerts a higher pressure).

Hence, the revised annual emission figures show an additional 1.5% prompt release of the CFC-11 production and 2.5% prompt release of CFC-12 production with no delay between production and release. These amounts have been included in release totals but not in production totals.

## 2. Prompt Release Categories

- 2.1 Aerosols - McCarthy et al. assumed a six-month delay between production and release. FPP knows of no data to suggest this figure is incorrect.
- 2.2 Flexible Foams - McCarthy et al. assumed a six-month delay between production and release. More recent analysis suggests that CFC-11 is released within a few days or weeks after it is used. In addition, foam manufacturers do not normally carry large inventories of CFC-11 but obtain the material from the manufacturer immediately prior to use. A two-month release delay is used as a better estimate.

Although the FPP has reservations about the division of the total foam use into the open cell and closed cell categories, there is reasonable agreement between these figures for CFC-11 in 1976 between the CMA U.S. production and use (where the numbers come from each U.S. company's understanding of sales) and the Rand Report [EPA-560/12-80-001 October 1980] (where the numbers come from end use analysis). Accordingly, the distribution of CFC-11 in the two categories has not been changed.

### 3. Refrigeration Uses

The 1977 categories for refrigeration recognized long lifetime refrigeration uses of approximately 12 years, and relatively short lifetime uses of approximately 4 years. These categories have been described as hermetically sealed and non-hermetically sealed, respectively. While the hermetically sealed concept appears valid for domestic refrigerators and freezers, the term is capable of broader interpretation in the mechanical sense. Consequently, the proportion of CFC-12 reported in the CMA annual production and use data as hermetically sealed is very much greater than that used in refrigerators and freezers. The Rand Report examines in depth the loss rates in various types of refrigeration use. Only the use in domestic refrigerators and freezers falls into this long lifetime category; all other uses are in the shorter lifetime category. In 1976, in the U.S.A., domestic refrigerators and domestic freezers accounted for 6 million pounds of CFC-12 and no CFC-11 (according to Rand, p. 35, Table 3.1). By contrast, the CMA U.S.A. hermetic category was reported as 72 million pounds CFC-12 and 8 million pounds CFC-11. A serious discrepancy exists between the CMA and Rand figures, and we have attempted to solve it. We assume the proportion of total refrigeration sales of CFC-12 used in domestic refrigerators and freezers in the U.S.A. in 1976 can be applied to the world refrigerant use, and that the proportion in all other years was the same as 1976. This estimate also must be considered only tentative, and further work is under way to improve it.

The current best estimate, therefore, is:

- o All CFC-11 use in refrigeration is in the short lifetime category.
- o 3.5% of CFC-12 use in refrigeration is in the long lifetime category.
- o 96.5% of CFC-12 use in refrigeration is in the short lifetime category.

### 4. Closed Cell Foam

CFC-12 in closed cell foam was estimated in 1977 to be principally used in thermoplastic foams, where the CFC is emitted during the first two years. CMA know of no data to suggest this assumption is incorrect.

CFC-11 in this category is principally used in rigid polyurethane foam production, and a 10% fabrication loss, followed by a 4-1/2 percent per year uniform loss rate over 20 years was assumed, being a combination of product lifetime and diffusional loss. The diffusional loss rate was indicated by the change in the K value ( a measure of foam insulating properties) assuming loss in K value was associated with loss of chlorofluorocarbon. It has

subsequently been shown that the change in K value is associated with air ingress rather than chlorofluorocarbon loss.

Estimates of the chlorofluorocarbon loss rate from polyurethane and similar closed cell foams vary quite markedly. Consequently, we do not propose any change to the 1977 assumption at this time. This should not be taken to indicate the 1977 estimate provides the correct loss rate, but that there is at this time no better basis for calculation.

Prepared by: Fluorocarbon Program Panel  
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