

# EPA'S VINTAGING MODEL OF ODS SUBSTITUTES

## A Summary of the 2017 Peer Review

### OVERVIEW

An independent peer review was conducted on EPA's Vintaging Model (VM) in 2017. The VM simulates the transition from ozone depleting substances (ODS) to alternative processes and chemicals in several industrial sectors in the United States. The VM is used to evaluate and report banks<sup>1</sup> and emission trends for ODS and ODS substitutes to support policy and regulatory analysis. As a result of the peer review, some updates were completed in 2018 and others, requiring further research and information, will be considered in future updates of the VM.

### THE VINTAGING MODEL

EPA's Vintaging Model was developed in the 1990s as a tool for estimating the annual chemical emissions from industrial sectors that have used ODS in their products. The VM estimates the emissions of various ODS substitutes reported in the [U.S. Greenhouse Gas \(GHG\) Inventory](#) and submitted annually to the [United Nations Framework Convention on Climate Change \(UNFCCC\)](#).

Under the *Montreal Protocol on Substances that Deplete the Ozone Layer* ([Montreal Protocol](#)) and the [Clean Air Act Amendments of 1990](#), the United States is phasing out production and consumption of ODS including chlorofluorocarbons (CFCs), halons, carbon tetrachloride, methyl chloroform, and hydrochlorofluorocarbons (HCFCs). As a result of the ODS phaseouts the affected industrial sectors transition to other chemicals. As these industries have moved toward ODS alternatives, the VM is a tool for estimating the rise in consumption and

The VM estimates emissions from **six industrial sectors**:

- Refrigeration and Air Conditioning
- Cleaning Solvents
- Foam Blowing Agents
- Aerosols
- Fire Suppression
- Sterilants

Within these sectors, there are 66 independently modeled end-uses.

emissions of these alternatives and the decline of ODS consumption and emissions.

The model requires information on the market growth for each of the end-uses, a history of the market transition from ODS to alternatives, and the characteristics of each end-use such as market size or charge sizes and loss rates. As ODS are phased out, a percentage of the market share originally filled by the ODS is allocated to each of its substitutes.

<sup>1</sup>The "bank" of an ODS or ODS substitute is the cumulative difference between the chemical that has been consumed in an application or sub-application and that which has already been emitted.

Refrigeration and Air Conditioning



Foam Blowing Agents



Fire Suppression



Aerosols



Sterilants



Cleaning Solvents



## HOW DOES THE VINTAGING MODEL CALCULATE EMISSIONS?

The VM is a “bottom-up” model named for its method of tracking an inventory of the in-use stocks and emissions from annual “vintages” of new equipment containing ODS and ODS substitutes that enter into service. It models the consumption of chemicals based on estimates of the quantity of equipment or products sold, serviced, and retired each year, and the amount of the chemical required to manufacture and/or maintain the equipment. Emissions are estimated by applying annual leak rates, service emission rates, and disposal emission rates to each population of equipment. By aggregating the emission and consumption output from the different end-uses within each sector, the model produces estimates of total annual use and emissions of each ODS and major ODS substitutes from 1985 through 2050.<sup>2</sup> As a bottom-up model, the VM produces results in mass, ozone depletion, and carbon dioxide equivalent terms.

The VM synthesizes data from a variety of sources, including data from EPA’s [ODS Tracking System](#), the [Greenhouse Gas Reporting Program](#), information from submissions to EPA under the [Significant New Alternatives Policy](#) (SNAP) program, and published sources such as documents prepared by the Montreal Protocol’s [Technology and Economic Assessment Panel](#) and the [U.S. Department of Energy](#). EPA also coordinates extensively with numerous trade associations and individual companies. The VM is regularly updated to incorporate up-to-date market information, including equipment stock estimates, leak rates, and sector transitions.

## OVERVIEW OF PEER REVIEW PROCESS

An independent peer review of EPA’s VM was conducted by a contractor in 2017 for six specific VM end-use groups: fire suppression, motor vehicle air conditioning (MVAC), unitary air conditioning (AC), refrigerated transport, large retail food, and construction foam. A list of 15 candidate peer reviewers were identified through known industry contacts, grey literature, and EPA stakeholder meetings.

Reviewers were selected independently, consistent with the guidelines of the EPA Peer Review Handbook, and based on the following criteria:

- Well-known, respected subject matter experts with expertise in one of the end-uses/sectors selected for peer review,
- No association with the VM, and
- Interest and availability.

The peer reviewers were provided with two technical summaries (i.e., an overview of the methodology for calculating emissions and consumption within the selected sector, and an overview of the assumptions for calculating emissions and consumption for the selected end-use) and an individualized letter indicating the charge questions. The peer reviewers provided written responses to the peer review coordinator. The comments received were used to identify potential updates to the VM. Seven peer reviewers responded to the peer review across four end-use groups: fire suppression, MVACs, unitary AC, and refrigerated transport.

## IMPLEMENTED UPDATES

Several updates in the refrigeration and AC and fire suppression sectors in response to peer review comments were implemented into the VM in March 2018 for inclusion in the publication of the 1990-2016 U.S. Greenhouse Gas Inventory. The remaining updates were implemented in August 2018.

### Unitary AC

The VM has three unitary AC end-uses: 1) residential unitary AC, 2) small commercial unitary AC, and 3) large commercial unitary AC.



<sup>2</sup> See Annex 3.9 of the U.S. GHG Inventory for the detailed methodology and assumptions of how the VM estimates the use and emissions of ODS and ODS alternatives.

Combined, the unitary AC end-uses are projected to contribute 26% of total ODS substitute emissions in 2020 on a global warming potential (GWP)-weighted basis.<sup>3</sup>

In response to peer review comments, updates to the unitary AC end-uses in 2018 included:

- Updated 1999-2016 **sales** estimates and 2017-2030 **growth rates** for residential and commercial unitary AC systems to reflect updated shipment data from the Air Conditioning, Heating, and Refrigeration Institute (AHRI) and align with projected household growth rates.
- Reduce **charge sizes** for residential unitary AC systems according to new values provided by peer reviewers.
- Reduced **annual loss rates** for residential and commercial unitary AC systems entering the market in 2006 or later and **disposal loss rates** for residential and commercial unitary AC systems in 2015 to represent improved systems and practices.

## MVAC

The VM has two light-duty MVAC end-uses—light duty cars (LDC) and light duty trucks (LDT). Combined, the MVAC end-uses are projected to contribute 14% of total ODS substitute emissions in 2020 on a GWP-weighted basis.

In response to peer review comments, updates to the MVAC end-uses in 2018 included:



- Updated **sales projections** of LDCs and LDTs in 2021-2025 to be consistent with the sales estimates from EPA's *Proposed Determination of the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Technical Support Document*.
- Reduced the **annual servicing loss rate** for LDCs and LDTs from 3.1%, reaching 2.7% by 2013, to accurately reflect the reported decrease in the amount of refrigerant required for servicing shown by the 2013 and 2016 Mobile Air Conditioning Society Field Surveys.

## Refrigerated Transport



The VM has six refrigerated transport end-uses: road transport; intermodal containers; merchant marine, naval, and fishing vessels; reefer ships; vintage (i.e., older-style) rail transport; and modern rail transport. Combined, the refrigerated transport end-uses contribute 5% of total ODS substitute emissions in 2020 on a GWP-weighted basis.

In response to peer review comments, updates to the road transport and intermodal container end-uses in 2018 included:

- Removed **refrigerant transition** to CO<sub>2</sub> in road transport and added a transition from R-404A to R-452A starting in 2017.
- Updated the **annual loss rate** to 15% for all HFC road transport vintages starting in 2000.

<sup>3</sup> Estimated emissions come from VM version VM IO file\_v4.4\_03.16.18, the version that was used for reporting to the UNFCCC in 2018.



## Fire Suppression

The VM has two fire suppression end-uses: 1) hand-held “streaming” applications (e.g., portable fire extinguishers) and 2) installed “flooding” systems (e.g., fixed systems protecting enclosed spaces). Combined, the fire suppression end-uses are projected to contribute 2% of total ODS substitute emissions in 2020 on a GWP-weighted basis.

In response to peer review comments, updates to the fire extinguishing end-uses in 2018 included:

- Updated **replacement ratios** for total flooding agents, assuming a weighted average between Class A and Class B values.
- Updated **growth rates** of the total flooding market from 1996 through 2030 to reflect real-world growth trends in the technology market.
- Implemented suggested changes to the **market transitions** for the total flooding and streaming end-uses.
- Increased the **lifetimes** of the total flooding (20 to 33 years) and streaming end-uses (12 to 24 years).
- Reduced **annual loss rates** for total flooding agents over time to represent improved systems and practices.



## IMPACTS OF UPDATES

Together, the implemented updates to the fire suppression, MVAC, unitary AC, and refrigerated transport end-uses in response to the peer review increased fluorinated greenhouse gas (F-GHG) emissions, excluding ODS, on average by 0.2 percent on a GWP-weighted basis between 1994 and 2003 and decreased emissions on average by 11 percent between 2004 and 2030. Prior to 1994, F-GHG emissions did not change. On a GWP-weighted basis, consumption of F-GHGs increased by an average of 1.5 percent in 1994 through 2005, but decreased on average by 7 percent between 2006 and 2030.

Figure 1: Comparison of United States F-GHG Consumption and Emissions from VM Peer Review Updates

