UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
SECTOR POLICIES AND PROGRAMS DIVISION
OFFICE OF AIR QUALITY PLANNING AND STANDARDS
OFFICE OF AIR AND RADIATION

September 28, 2017

MEMORANDUM

TO: Docket ID No. EPA-HQ-OAR-2015-0730

FROM: Allison Costa

SUBJECT: Analysis of "Average Option" Emission Limitations for the Manufacturing of Nutritional Yeast NESHAP

The National Emission Standards for Hazardous Air Pollutants (NESHAP) for the manufacturing of nutritional yeast source category promulgated in 2001 set emission limits for the category based on "maximum achievable control technology", commonly referred to as the MACT standard. The standard required facilities to monitor volatile organic compound (VOC) emissions (as a surrogate for the hazardous air pollutant of interest, acetaldehyde), record the readings at least twice an hour, and average these emissions over the course of a batch to develop a "batch-average VOC" concentration (BAVOC). The 2001 MACT standard set emission limitations of 300 ppmv, 200 ppmv, and 100 ppmv for BAVOC concentrations of each of the last three fermentation stages in the yeast manufacturing process and stated that 98 percent of the batches produced in rolling 12-month calculation periods had to meet these limits. The MACT standard applied the limits to 98 percent, as opposed to 100 percent, of batches because "EPA recognized that it is beyond the limits of process control technology for all fermentation batches to meet the concentration limits required by RACT or RACT-like rules" (see "Nutritional Yeast Manufacturing NESHAP project; Basis for MACT floor." Docket ID No. EPA-HQ-OAR-2004-0233-0048). The standard reflects input from the industry that, "although most batches display batch-average VOC concentrations below the RACT limits due to the natural variability of the biological process of yeast-growing, batch-average VOC concentrations display a bell-curve distribution. …[Additionally,] because of the bell-curve distribution of VOC concentrations, a source needs to target VOC concentrations well below the RACT limit in order for the distribution of actual concentrations to remain below the RACT limit" (see 66 FR 27880, May 21, 2001). However, since this standard was promulgated, the D.C. Circuit has determined that some CAA section 112 standard must provide emission reductions at all times. *Sierra Club v. EPA*, 551 F.3d 1019, 1027 (D.C. Cir. 2008). Therefore, the EPA has determined that the existing emission limits for this source category must be expressed in a form that applies continuously, to avoid allowing 2 percent of nutritional yeast batches to be produced without any applicable ceiling on emissions.

The proposed amendments to the NESHAP for the manufacturing of nutritional yeast source category included an "Average Option" that allowed facilities to average BAVOC emissions from each fermentation stage over 12-month rolling calculation periods to meet reduced emission limits. The proposed emission limits for the annual averaged BAVOC concentrations (285 ppmv, 190 ppmv, and 95 ppmv) were 5 percent lower than the emission limits established for individual batches in the 2001 MACT standard, which we referred to as a 5-percent "discount factor". The EPA has applied "discount factors" to other MACT standards (*e.g.*, Boiler MACT) that allow emissions averaging because averaging emissions from a number of batches to meet a specific emission limit can result in higher emissions than requiring every individual batch to meet the same emission limit. The proposed Average Option accounted for the variability of the yeast manufacturing process, while maintaining the sources' accountability for meeting health and environmental goals and maintaining the enforceability of the emission limits by regulatory authorities. We did not re-open the MACT calculation, but have finalized amendments, as contained in the Average Option, that revise the form of the MACT standard to establish continuous Section-112 compliant standards that continue to reflect the emission reductions achieved by the best performers as determined in the 2001 rule. The analysis of the MACT standard supporting the adoption of the Average Option is presented in this memorandum.

In order to revise the form of the MACT standard, we first examined which characteristics of the 2001 standard could be retained, so that facilities could adopt the revised form of the standard with as few changes to ongoing operations and reporting and recordkeeping procedures as possible. As mentioned above, facilities currently track BAVOC concentrations for each batch over rolling 12-month calculation periods. Then we considered different methods of revising the form of the standard that establish continuous standards. We determined that an annual averaging method was the most appropriate form to maintain the flexibility established in the 2001 MACT standard to account for the variability in emissions and retain elements of the reporting and recordkeeping provisions.

The 2001 MACT standard did not set the annual mean for the distribution of BAVOC concentrations at 300 ppm, 200 ppm, and 100 ppm for each of the last three fermentation stages, respectively. Rather, it established an upper threshold that no more than 2 percent of individual batches could exceed. We consider a normal distribution to adequately describe BAVOC concentrations observed from the yeast manufacturing process. The mean of a normal distribution represents the value that 50 percent of the values in a dataset exceed. As described in greater detail below, the emission limitations established under an annual averaging compliance method will necessarily be lower than the upper threshold established for the 98 percent of batches with individual batch emission limitations under the 2001 MACT standard because the limitations established under an annual averaging method represent the mean of a normal distribution instead of an upper threshold. To determine the average annual emission limitation that would reflect the level of emission reductions represented by the 2001 MACT standard, we considered the information from the promulgation of the standard. We also analyzed more recent emissions data from the facilities currently subject to this rule. In addition to general information about the process and overall emissions characteristics that we learned about each facility during the site visits conducted prior to the proposal of the amendments to this NESHAP, multiple years of individual BAVOC concentration data were available for two facilities and summary BAVOC data were available for an additional facility.

First, available BAVOC data from two facilities were graphed and found to support the statement above that batch-average VOC concentrations approximate a bell-curve distribution. The symmetrical nature of the data, combined with the managed nature of the manufacturing process, supported selection of the normal distribution as a reasonable statistical model to use in our analysis for the revision to the form of the emission limits for this NESHAP.

Second, we used the normal distribution to simulate the annual average and variability in BAVOC emissions. Importantly, because we were not recalculating the MACT floor, we did not base the annual average BAVOC concentration limitations on the average emissions of the available data. Rather, we used the available data to inform our analysis of simulated statistical distributions, as explained in the following paragraphs.

A normal distribution is defined by two parameters: mean and standard deviation. As applied to the amendments for this NESHAP, the mean represents the annual average emissions limitation and the standard distribution reflects the variability in emissions between different batches of yeast across the 12-month period. Because the mean and standard deviation are not constant, due to day-to-day operating conditions and the biological nature of yeast manufacturing, the observed distribution will differ both between facilities and over time within a facility. A facility with low variability is most accurately simulated by a normal distribution with a small standard deviation (reflecting a higher percentage of the data closer to the mean). Conversely, a facility with high variability and a greater spread of values away from the mean is most accurately simulated using a larger standard deviation. By simulating annual BAVOC data using the normal distribution, we can select combinations of simulated means and standard deviations so that a given percentage of the simulated data lies above (or below) any given VOC value. For example, Figures 1 and 2 both show simulated yeast manufacturing BAVOC data having a normal distribution of VOC concentrations and 2 percent of the data points above 300 ppm. A facility with lower simulated annual variability, as represented by the simulated distribution with a standard deviation of 7.3 ppm in Figure 1, could have an annual average BAVOC concentration of up to 285 ppm and have no more than 2 percent of batches with BAVOC concentrations above 300 ppm. In contrast, a facility with higher simulated annual variability between batches, as represented by the simulated distribution with a standard deviation of 14.6 ppm in Figure 2, would have to maintain an annual average BAVOC concentration of 270 ppm or less to have no more than 2 percent of batches with BAVOC concentrations above 300 ppm.

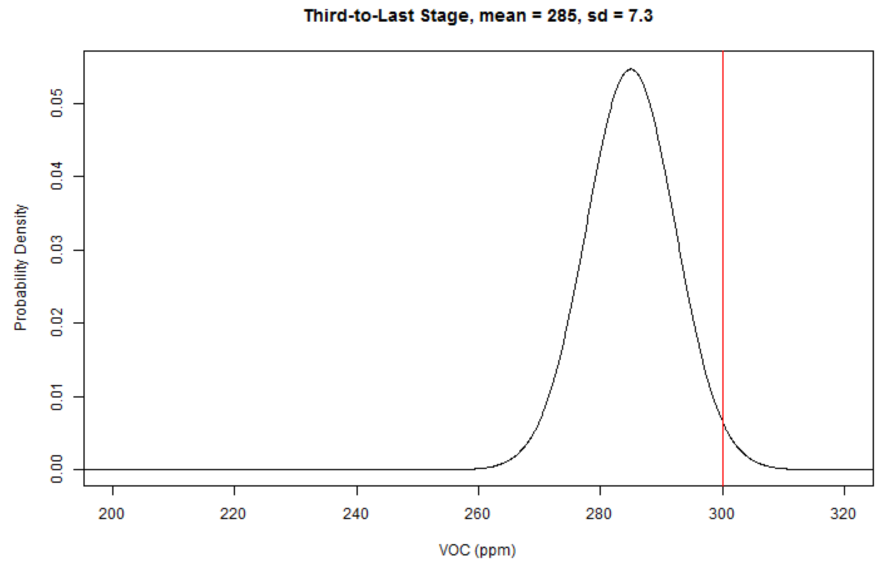

Figure 1. Simulated BAVOC data (black line) based on a normal distribution with a mean of 285 ppm and standard deviation of 7.3 ppm, in which 2% of data exceed 300 ppm (red vertical line).

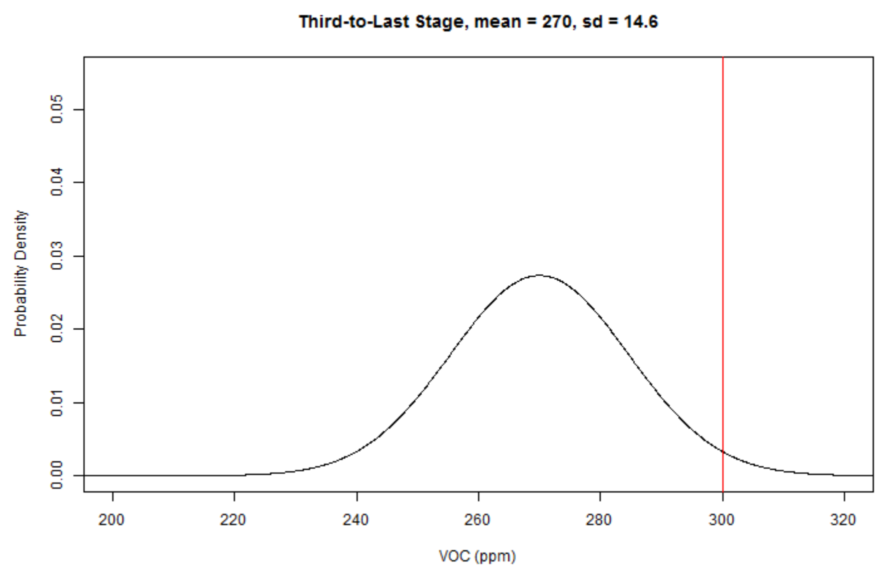

Figure 2. Simulated BAVOC data (black line) based on a normal distribution with a mean of 270 ppm and standard deviation of 14.6 ppm, in which 2% of data exceed 300 ppm (red vertical line).

Third, we developed a look-up table (Table 1) of simulated means and standard deviations for each of the three fermentation stages subject to emission limits under this NESHAP in order to select an appropriate discount factor. Table 1 lists the combinations of simulated means and standard deviations for normally distributed annual BAVOC data that “just meet” both (i) the existing MACT standard (no more than 2 percent of batches exceeding BAVOC values of 300 ppm, 200 ppm and 100 ppm on an annual basis) and (ii) the Average Option under discount factors from 1 to 10 percent. (Note that it is statistically impossible to "just meet" both (i) and (ii) with a 0 percent discount factor if data are normally distributed, since 50 percent of values will be above the mean.) Table 1 shows a similar pattern as Figures 1 and 2. To "just meet" criteria (i) and (ii) with a larger simulated annual standard deviation, a lower simulated mean was necessary, corresponding to a larger discount factor applied to the 2001 MACT standard emission limitations. For example, a 1-percent discount factor for normally distributed simulated BAVOC for the third-to-last stage corresponds to a simulated mean and standard deviation of 297 and 1.4 ppm (a higher mean but less batch-to-batch variability), while a 10-percent discount factor for the same stage corresponds to a simulated mean and standard deviation of 270 ppm and 14.6 ppm (a lower mean but greater batch-to-batch variability).

Table 1. Look-up table for normally distributed annual BAVOC data just meeting the existing MACT standard and the proposed Average Option.

Discount Factor (%)	Third-to-Last Stage		Second-to-Last Stage		Last Stage	
	Simulated Mean (ppm)	Simulated Standard Deviation (ppm)	Simulated Mean (ppm)	Simulated Standard Deviation (ppm)	Simulated Mean (ppm)	Simulated Standard Deviation (ppm)
1	297	1.4	198	0.9	99	0.4
2	294	2.9	196	1.9	98	0.9
3	291	4.3	194	2.9	97	1.4
4	288	5.8	192	3.8	96	1.9
5	285	7.3	190	4.8	95	2.4
6	282	8.7	188	5.8	94	2.9
7	279	10.2	186	6.8	93	3.4
8	276	11.6	184	7.7	92	3.8
9	273	13.1	182	8.7	91	4.3
10	270	14.6	180	9.7	90	4.8

Fourth, we used the look-up table (Table 1) to determine the appropriate discount factor for the Annual Average compliance option. As stated and illustrated above, the simulated distributions depend on two parameters – mean and standard deviation. Because the mean and discount factor are directly related, we utilized the standard deviation as the key parameter for determining the discount factor that would maintain both flexibility for process variability and the level of emission reduction established in the 2001 MACT standard. To do this we used the available BAVOC data from two facilities to calculate the standard deviation for 12-month rolling averages (65 total for each fermentation stage). The lowest observed standard deviations for each fermentation stage were 7 ppm for the third-to-last stage, 5 ppm for the second-to-last stage, and 3 ppm for the last stage of yeast manufacturing. Utilizing the least-variable 12-month period to determine the average emission limitation results in the lowest discount factor and gives facilities the ability to operate at the highest annual average emission limit. Applying these standard deviations to the look-up table results in discount factors of 5 percent for the third-to-last and second-to-last stage, and 6 percent for the last stage. Instead of selecting different discount factors for each stage, we determined that a 5-percent discount factor was appropriate to apply to the 2001 VOC concentration limitations to express the existing MACT standard in a new form.

In summary, the Average Option uses an annual averaging methodology to achieve the flexibility originally accomplished by allowing 2 percent of batches to exceed the established emission limits (300 ppm, 200 ppm, 100 ppm). The revised form of the standard sets annual average emission limits that are 5 percent lower than the 2001 upper threshold emission limitations for individual batches to maintain the level of emission reductions represented by the original form of the MACT standard. We concluded that the available data was representative of a range of operating conditions reasonably expected from the yeast manufacturing process based on the detailed data available from two facilities, as well as the summary statistics available for a third facility and information about the process characteristics and operating conditions of each of the four facilities currently subject to this rule that was gathered during the site visits and calls conducted prior to proposal of the amendments to this NESHAP.