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To: NIOSH Docket Office (CDC); mortparty@gmail.com
Subject: 245 - Criteria for a Recommended Standard: Occ Exp to Diacetyl and 2,3-pentanedione

The release of volatile chemicals: when this occurs in trace quantities it is recognized as flavor or fragrance, yet the release of concentrated vapors has the potential to be harmful. In reality, all flavors and perfumes are simply blended chemicals (mixtures of natural and/or artificial ingredients). Only when an aromatic compound volatilizes can it be enjoy as a flavor or fragrance – it can not be detected if confined or bound physically or molecularly. Across the gamut of flavors and fragrances, one could infer that any blend of chemicals can be safe, yet can also be harmful at highly concentrated levels. Currently OSHA/NIOSH is faced with the challenge to determine a level above which a volatilized diacetyl and related compounds can be injurious. In lieu of the many opinions expressed during this assignment, this task has proven daunting.

In the late 1920's, diacetyl was identified as the key flavorant in high-quality butter. Dairymen knew that fresh-cream butter was bland and often used salt for flavor, yet if the cream was allowed to "sour" before churning, it was rich with flavor. Many cold-processing food manufacturers (specifically dairies) have long used diacetyl-containing flavors without incident. Typically their HACCP plans and operations feature cold processing, they use flavors with less than 1.5% diacetyl, they handle the flavor for only a short period of time, and the final product contains trace quantities of diacetyl.

Today, those skilled in the art of flavor/fragrance creation are aware of the many virtues of diacetyl and its derivatives, and their importance in buttery notes, cream notes, caramel notes, ripe berry profiles, maillard-reaction flavors, and their uses as crucial flavor modifiers. Within the flavor/fragrance industries, the terminology "15X" represents 15,000 ppm, or 1.5%. Many other flavor compounds may be present in said flavor, yet the flavor/fragrant "strength" has been standardized using diacetyl as an effective benchmark. Brewers and vintners also familiar with diacetyl as a natural metabolite, encountered when fermenting eukaryotes (yeast) and prokaryote (bacteria) It can be found in beer, wine, and many other fermented foods. Wthin these cells, diacetyl is a natural metabolite, part of butylene glycol biochemical pathway, mixed-acid fermentation pathway. In addition, it develops naturally as certain fruits ripen. And as a ubiquitous bacterial metabolite, standard microbiological classification systems test for the production of diacetyl in its reduced form – better known as acetoin (Voges-Proskauer method). Again, these food and beverage industries have long dealt with diacetyl and diacetyl-containing flavors without incident.

A food-related occupational hazard was first reported with diacetyl in the relatively young industry of microwave popcorn. Manufacturing this convenience-food item used highly concentrated flavor (up to 30% diacetyl) in a heated mixing process. This is in stark contrast to the 1.5% diacetyl found in more traditionally-used butter or other dairy flavors. For microwave popcorn production, the flavor was blended into hot fat, that, once dispensed into a final container (bag), would then solidify. Heating has the effect of increases vapors by decreasing liquid viscosity and increasing flavor evaporation. Subsequently, microwave popcorn plant QC methods repeatedly pop bags in a microwave oven throughout the day: this exposed the flavored oil again to liquefaction, heat, as well as the steam and pressure generated by popping corn kernels. Such conditions can exacerbate the release of any volatile component of a flavor or fragrance.

In general, heating a flavor in oil, influences flavor solubility and affects the partition coefficients of the flavor molecules. In contrast to dairies and other food processing plants that use the cold flavors with 1.5% diacetyl, popcorn plants used heated flavors with up to 30% diacetyl. While food manufacturing plants feature cold

processing (*e.g.*, dough handling), production lines in microwave popcorn plants added highly concentrated diacetyl-containing flavors to high-temperature melted fats, then maintained high temperatures to prevent the fats from solidifying before being dispensed.

Once the possibility of an occupational hazard was identified, diacetyl quickly became a scapegoat within the flavor/fragrance industry, diverting attention away from other more common or lucrative volatile compounds. And since diacetyl is the quintessential, and characteristic note of butter, many butter, cream, and caramel flavors rapidly fell under the same ire and scrutiny. NIOSH has made concerted efforts to assess the safety of diacetyl-containing flavors. With the help of scientist, scholars and testing, NIOSH has offered exposure limit values, yet the misunderstanding and misinterpretation of the relevance of this published information is causing unnecessary fear and confusion. Worker safety equates to exposure to vapors, yet the food industry is more familiar with values relating to concentrations in solution. Regarding diacetyl, these concentrations are quoted as parts-per-million (ppm). In reports focusing on worker safety, NIOSH is recommending extremely low parts-per-billion (ppb) for both short-term exposure limits (STEL) and time-weighted averages (TWA). With orders-of-magnitude difference between ppm and ppb, many in the food industry confused.

To best serve the food industry, NIOSH should generate tables that allow food manufactures to better access their potential risks to workers. These tables could be structured as follows:

Solution description: 1.5% diacetyl (15,000 ppm), aqueous base

Temperature of solution or process	ppb (vapors) released by solution in 15 minutes.
30°F	AA ppb
40°F	BB ppb
50°F	CC ppb
60°F	DD ppb
70°F	EE ppb
80°F	FF ppb
100°F	GG ppb
120°F	HH ppb

Similar tables as shown above should be generated to provide information on vapor release at different temperatures for different concentrations, bases, and forms, since liquid flavors are available in many concentrations (e.g., 0.1% – 30% diacetyl), in various bases (*i.e.*, water *vs.* oil *vs.* alcohol), and forms (*e.g.*, emulsions *vs.* homogeneous blends). Provided with these data, any manufacture can identify their flavor strength, recognize their process temperatures, and better assess their manufacturing operations. Again, any chemical or blend of chemicals can be used safely, yet has the potential to be harmful at high concentrations if handled inappropriately. By providing information similar that that shown in the tables and data above, manufactures, occupational safety professionals, and should prove to be an invaluable tool to all pertinent industries.