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VIA ELECTRONIC SUBMISSION
Mr. Joe Calavita
Manager, Consumer Products Implementation Division
California Air Resources Board
Sacramento, CA 95812-0806
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csmrprod@arb.ca.gov

RE: **Comments on California Air Resource Board Proposed Amendments to the Consumer Products Regulation for VOC Limits presented at the November 7, 2019 Public Workshop**

Dear Mr. Calavita:

Unilever United States Inc. is pleased to offer comments on the California Air Resources Board (ARB) proposed amendments for Article 2 of its Consumer Products Regulation as presented at the November 7, 2019 public workshop.

Unilever is one of the world's largest consumer product companies – our personal care, foods and home care brands have been trusted the world over since 1890. Our personal care products include many leading brands in the United States, such as Axe®, Caress®, Degree®, Dove®, Dove® Men+Care, Love Beauty and Planet®, Nexxus®, Noxzema®, Pond's®, TRESemmé®, and Vaseline®.

We thank California ARB for seeking input from a diverse group of stakeholders and we hope that Unilever's comments will help inform on the science to advance an actionable and effective regulation. We are concerned that the challenging VOC reduction targets proposed by California ARB to improve air quality may not be achievable in the short term without increases in the use of the greenhouse gas such as HFC-152A. We strongly suggest that California ARB consider the adoption of Maximum Incremental Reactivity (MIR) targets as an approach to reduce the amount of ground level ozone created while reducing use of greenhouse gases (HFC-152A), specifically in the three personal care product categories under consideration: hair finishing sprays, no rinse shampoo, and deodorant body sprays, which is part of the personal fragrance products with less than 20% fragrance category.

Unilever is committed to reducing the greenhouse gas impact of our products across their lifecycle as part of the Unilever Sustainable Living Plan and we look forward to working with California ARB to achieve our mutual air quality goals.

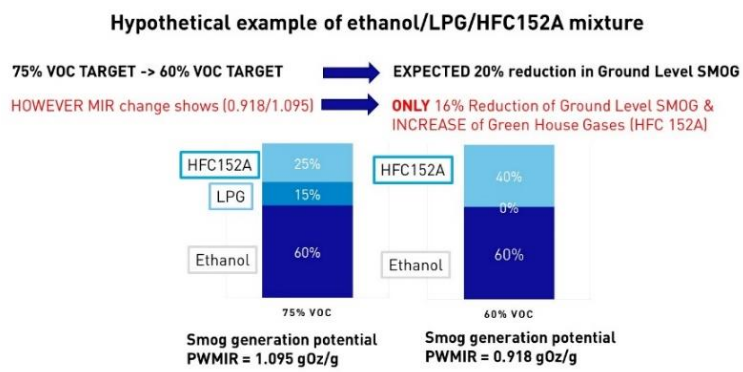
1. **<u>Maximum Incremental Reactivity (MIR)</u>**

MIR targets are currently used by California ARB in Article 3 of the Regulation for Aerosol Coating products. We urge California ARB to consider a Maximum Incremental Reactivity (MIR) based approach as an alternative to the proposed VOC reduction targets. This would provide increased flexibility to product formulators to develop new formulations to attain known reduction of smog generation potential in consumer products, while minimizing increases in the use of greenhouse gases, such as HFC-152A.

During the November 7, 2019 workshop, California ARB indicated that "future reactivity limits dependent on industry development of test methods procedures." We look forward to collaborating with California ARB to develop acceptable analytical test methods for assessing product compliance with a MIR-based approach.

Figure 1 below shows a simplified hypothetical aerosol deodorant body spray product formulation using a propellant system of ethanol, liquified petroleum gas (LPG) and HFC-152A and has 75% VOC content by weight. When reducing the VOC content to 60%, the easiest way to achieve this is to eliminate the LPG and increase HFC-152A.

Figure 1. Smog reduction with MIR targets compared to VOC targets for aerosol products



A 20% reduction in smog generation would be expected based on the 20% reduction in VOC content. However, when calculating the change in MIR **only a 16% reduction** in smog generation is achieved; at the expense of a 60% increase in greenhouse gas emissions.

Table 1 shows three hypothetical examples, comparing to a baseline body spray formulation which meets the current VOC maximum of 75%. They are provided to show how a MIR-based approach might be used to reduce the amount of ground level ozone created, with the additional benefit of reducing greenhouse gases (HFC-152A), even though the "real VOC" increases. The MIR approach works best when there are high levels of ingredients with "high reactivity" in the product, such as ethanol and the flexibility to replace with lower reactivity VOC ingredients.

Note: The examples shown in Table 1 have not been fully assessed for safety or consumer acceptability and are used for illustrative purposes. Extensive testing of prototypes will be required to avoid any safety concerns. In Example A3, the predicted mixture pressure would be too high for a high pressure (DOT 2Q) can.

Table 1: Ozone-forming potential compared to Product Weighted MIR for hypothetical examples of deodorant body sprays.

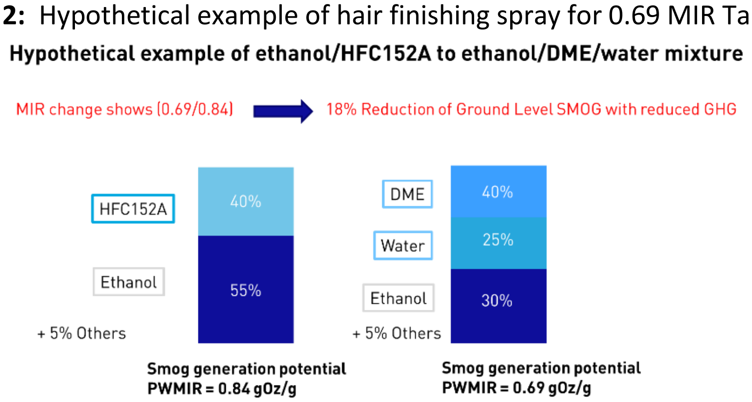
Example	Ingredient	% w/w	MIR (Ingredient)	Weight Adjusted MIR Contribution	"Real" VOC (%)	Total VOC (tons/day)	Product-weighted MIR	Ozone Forming Potential (tons/day)	Greenhouse Gas (HFC) Emissions (tons/day)	Predicted Mixture Pressure (Psig)
Baseline	Fragrance	2	2.8	0.014						
	Ethanol	73	1.53	1.117						
	HFC 152A	25	0	0						
					73.5	**5.12**	**1.13**	**7.87**	**1.74**	**101**
A1 Lower Ethanol to 50%, Lower HFC 152A to 10%	Fragrance	2	2.8	0.014						
	Ethanol	50	1.53	0.765						
	HFC 152A	10	0	0						
	Propane	19	0.49	0.093						
	Butane	19	1.15	0.219						
					88.5	**6.16**	**1.09**	**7.50**	**0.7**	**150**
A2 Lower Ethanol to 35%, Lower HFC 152A to 10%	Fragrance	2	2.8	0.014						
	Ethanol	35	1.53	0.536						
	HFC 152A	10	0	0						
	Propane	26.5	0.49	0.130						
	Butane	26.5	1.15	0.305						
					88.5	**6.176**	**0.98**	**6.85**	**0.7**	**158**
A3 Lower Ethanol to 35%, Lower HFC 152A to 20%	Fragrance	2	2.8	0.014						
	Ethanol	35	1.53	0.536						
	HFC 152A	20	0	0						
	Propane	21.5	0.49	0.105						
	Butane	21.5	1.15	0.247						
					78.5	**5.46**	**0.90**	**6.28**	**1.39**	**174**

Using California ARB data, **used 6.96 tons/day** as the estimate of sales of deodorant body sprays to calculate tonnage emissions for VOC and ozone-forming potential.

- Weighted adjusted MIR = (% ingredient/100) x MIR of ingredient
- PWMIR = sum of all weight-adjusted MIR for each ingredient in the sample
- Total VOC (tons/day) = tonnage of product sold in California multiplied by (% VOC/100)
- Ozone Potential = tonnage of product sold in California multiplied by the PWMIR for the sample product
- HFC Emissions = tonnage of product sold in California multiplied by (% HFC-152A/100)

Figure 2 below shows a hypothetical hair finishing spray aerosol product going from Ethanol/ HFC-152A mixture to Ethanol / Dimethyl Ether (DME) / water mixture. Although this equates to 70% VOC, MIR would provide a significant reduction in ground level smog by 18%.

Figure 2: Hypothetical example of hair finishing spray for 0.69 MIR Target.



Note 1: The examples shown in Table 2 have not been fully assessed for safety or consumer acceptability and are used for illustrative purposes. Note 2: Dimethyl Ether (DME) may be used as a blend of propellant and with water, water/ethanol or ethanol. The limitation of using DME alone is that it contributes to VOC so is competing with VOC contribution from ethanol. Using water alone or as a water/ethanol blend will impact the product performance as spray becomes too wet.

Table 2. Ozone-forming potential compared to Product Weighted MIR for hypothetical examples of hair finishing sprays.

Example	Ingredient	% w/w	MIR (Ingredient)	Weight Adjusted MIR Contribution	"Real" VOC (%)	Total VOC (tons/day)	Product-weighted MIR	Ozone Forming Potential (tons/day)	Greenhouse Gas (HFC) Emissions (tons/day)	Comment
Today, 55% VOC	HFC-152A	40	0	0						
	Ethanol	55	1.53	0.84						
	Other	5	0	0						
					55	**10.72**	**0.84**	**16.38**	**7.8**	
2023 Target 50% VOC	HFC-152A	45	0	0						Even though VOC and Ozone forming potential is reduced, greenhouse gas emission is increased
	Ethanol	50	1.53	0.76						
	Other	5	0	0						
					50	**9.75**	**0.76**	**14.82**	**8.78**	
2027 Target MIR Equivalent to 45% VOC	DME	40	0.81	0.24						Even though VOC level increases, there is significant reduction in ground level SMOG, without greenhouse gas. Spray could be too wet
	Water	25	0	0						
	Alcohol	30	1.53	0.45						
	Other	5	0	0						
					70	**13.65**	**0.69**	**13.46**	**0**	

Using California ARB data, **used 19.5 tons/day** as the estimate of sales of hair finishing sprays to calculate tonnage emissions for VOC and ozone-forming potential.

- Weighted adjusted MIR = (% ingredient/100) x MIR of ingredient
- PWMIR = sum of all weight-adjusted MIR for each ingredient in the sample
- Total VOC (tons/day) = tonnage of product sold in California multiplied by (% VOC/100)
- Ozone Potential = tonnage of product sold in California multiplied by the PWMIR for the sample product
- HFC Emissions = tonnage of product sold in California multiplied by (% HFC-152A/100)

2. Formulation Considerations for No Rinse Shampoo

The proposed targets of 50% VOC by weight by 1-January-2023 and 45% VOC by weight by 1-January-2027 are challenging as this product type requires anhydrous ("dry") formulations to deliver the consumer benefit while avoiding making the hair too wet during use. Alternative propellant systems for No Rinse Shampoo products present several challenges. For example, replacing:

- Liquified Petroleum Gas propellants with more HFC-152A delivers a reduction in VOC; however, this would increase greenhouse gas emissions.
- HFC-152A with HFO 1234ZE may lead to product compatibility and performance issues with some product formulations. (Refer to section 4 below)

- HFC-152A with compressed gases changes the product performance, such as decreasing pressure with every use and product cannot be sprayed upside down as noted in section 5 below.
- Propellant or ethanol with water will make the product wetter and could potentially lead to can corrosion.

Note: The example shown in Table 3 has not been fully assessed for safety or consumer acceptability and is used for illustrative purposes.

Table 3. Ozone-forming potential compared to Product Weighted MIR for hypothetical examples of No Rinse Shampoos.

Example	Ingredient	% w/w	MIR (Ingredient)	Weight Adjusted MIR Contribution	"Real" VOC (%)	Total VOC (tons/day)	Product-weighted MIR	Ozone Forming Potential (tons/day)	Greenhouse Gas (HFC) Emissions (tons/day)	Comment
Today, 95% VOC	AP-46	85	Tri Blend	1-1.1 Range						Higher VOC, no greenhouse gas
	Ethanol	10	1.53	0.15						
	Other	5	0	0						
					95	**1.13**	**1.15-1.25**	**1.37-1.49**	**0**	
2023 Target 50% VOC	HFC-152A	45	0	0						Even though VOC and Ozone forming potential is significantly reduced, greenhouse gas significantly increased
	AP-46	40		0.44						
	Ethanol	10	1.53	0.15						
	Other	5	0	0						
					50	**0.60**	**0.59**	**0.70**	**0.54**	

Using California ARB data, **used 1.19 tons/day** as the estimate of sales of no rinse shampoos to calculate tonnage emissions for VOC and ozone-forming potential.

- Weighted adjusted MIR = (% ingredient/100) x MIR of ingredient
- PWMIR = sum of all weight-adjusted MIR for each ingredient in the sample
- Total VOC (tons/day) = tonnage of product sold in California multiplied by (% VOC/100)
- Ozone Potential = tonnage of product sold in California multiplied by the PWMIR for the sample product
- HFC Emissions = tonnage of product sold in California multiplied by (% HFC-152A/100)

3. <u>Safe Formulation Zone when formulating with propellant blends including HFC-152A</u>

Ethanol, water and liquified gas propellants (such as HFC-152A, HFO 1234ZE, DME and LPG) can form mixtures with multiple liquid phases – an example is shown in Figure 3 below. We would like to highlight that these blends have **small safe formulation zones** with HFC-152A in aerosol products, which is dependent on the level at which it is used, as well as the amount of water used. The addition of other materials, including fragrance, will also impact when two liquid phases form.

Figure 3. Use of HFC-152A in Aerosol Products

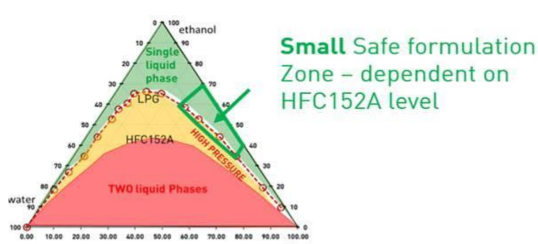


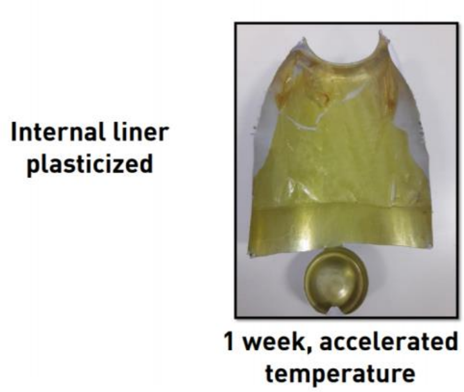
Figure 3 demonstrates the need to avoid the generation of two liquid phase systems, since this often leads to higher can pressures than desired and will not give the consumer a representative "dose," as one phase could be higher than desired in ingredients, such as fragrance. HFC-152A has a higher vapor pressure than butane and so the pressure in the can is higher than when LPG is used. The pressure with HFC-152A blends is predicted to exceed the current can design specification as water is added, even before two liquid phases are present. The current development work to understand can pressures has been focused on the current VOC targets and minimal use of HFC-152A. Additional work would need to be done at lower VOC targets and with higher levels of HFC-152A to understand can pressures to ensure safe products.

4. <u>Challenges with Formulating with HFO 1234ZE Propellant</u>

HFO 1234ZE is an alternative propellant that may be used in the longer term to reduce VOCs. Based on Unilever's experience with HFO 1234ZE, this new propellant presents several formulation challenges, specifically with product compatibility and performance. In certain aerosol products, HFO 1234ZE can react with polymers, neutralizers and fragrances leading to can liner degradation (see Figure 4 below), an increase in corrosion potential, a decrease in the pH of formulations and an increase the fluoride concentration. In sum, HFO 1234ZE is **<u>not</u>** the solution for all types of aerosol products. To use HFO 1234ZE, manufacturers would need to carry out extensive safety and compatibility testing on product formulations. There is also currently only one supplier of HFO 1234ZE, which can lead to supply chain challenges as the current supply is limited.

Figure 4. A photograph showing the degradation of the internal liner of an aerosol can of a prototype product with HFO 11234ZE after 1 week of accelerated temperature stability testing.

Container Incompatibility with HFO 1234ZE



5. <u>Challenges with Formulating with Compressed Gas Propellants</u>

We recognize the challenges California ARB mentioned in the November 7, 2019 workshop for compressed gas propellant systems and recommend that California ARB consider reporting VOC content based on percent volume instead of percent weight for the aerosol products using compressed gas propellants in order to properly identify the VOC content. Figure 5 illustrates that this challenge is presented because compressed gas, such as nitrogen, weighs so little when compared to other propellants (for example, HFC-152A). The two products in this figure both contain 50g of ethanol and the remaining fill is propellant. The product on the left contains 50% VOC, by weight. Because nitrogen weighs much less, the product on the right contains 98% VOC by weight. Reporting the VOC content by volume would be more representative of what happens when switching to a compressed gas propellant system, in a much clearer way.

Figure 5. Weight of products with different propellant systems.

We recommend that California ARB adopt the following approach for declaring the % Volume:

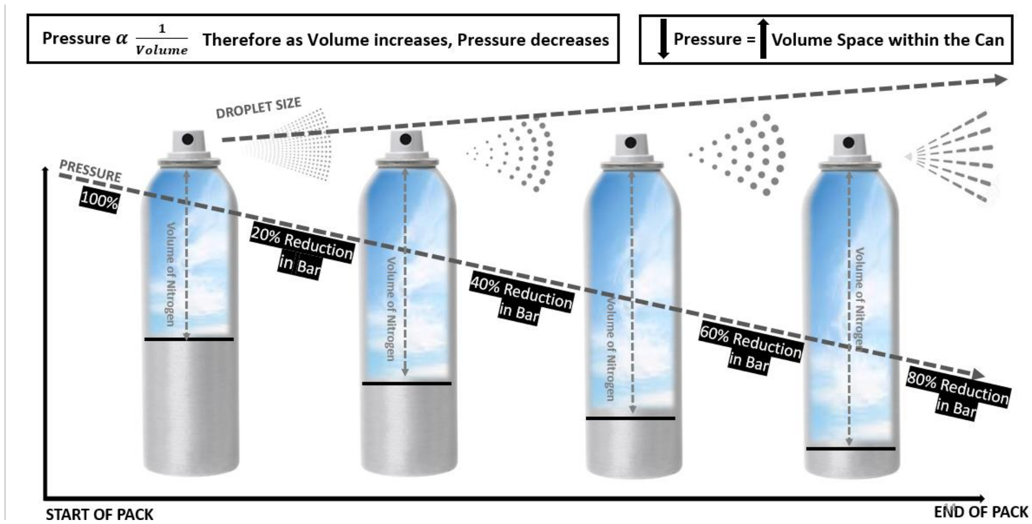
- % Vol = (Volume of VOC Liquid) / ('Overflow capacity')
- Volume of VOC Liquid = mass / density

We suggest that the "overflow capacity" be declared on the aerosol can as shown below:

UK Example USA Example

Compressed gas propellant systems do present specific technical challenges. As demonstrated in Figure 6, as a product is used up and the volume of the space within the can increases, pressure within the can decreases. This leads to an increase in the droplet size emitted from the can, which changes the product performance, spray quality and consumer experience over time and may lead to a lack of consumer acceptability. Another challenge is that the can with this type of propellant system cannot be used upside-down, which is common usage for various aerosol products. When used upside-down the gas propellant is lost very rapidly making the product unusable.

Figure 6. Technical Challenges with Compressed Gas Aerosols.



Extensive development work needs to be carried out by product manufacturers and valve suppliers in order to develop the appropriate valve design and ensure adequate valve supply, which can take time. Note: Development of new valve systems have been on-going for a long time with limited success.

6. <u>Sunset of the 2% Fragrance Exemption by 2027</u>

California ARB has proposed to sunset the 2% fragrance exemption from all regulated consumer products in Articles 1 and 2 by January 1, 2027, which would lead to a VOC reduction of 0.33 tons per day. We respectfully request that California ARB re-evaluate its proposal, especially for categories in Article 1 (antiperspirants and deodorants) where the current VOC limit is 0%. Without the fragrance exemption there is no way to formulate products in these categories with fragrances, which are an essential part of the consumer experience in these categories. We strongly urge CARB to reconsider this proposal and to keep the 2% fragrance exemption for Article 1 products.

We are appreciative of California ARB's willingness to work collaboratively with industry. We would like to stress that the proposed targets for personal care products (e.g., hair finishing sprays, no rinse shampoos, deodorant body sprays) are extremely challenging and are very unlikely to be achievable in the short term without increases in the use of HFC-152A. We strongly recommend that California ARB consider the adoption of MIR targets for these product types to give us the option to balance the required reductions in smog generating potential in California with our mutual desire for a reduced GHG footprint. We request that California ARB conduct a technology assessment to determine whether the proposed reduction targets comply with the statutory requirement that the regulation be commercially and technologically feasible.

Unilever appreciates the opportunity to provide these comments and we look forward to future dialogue on the proposed VOC limit regulations.

Respectfully Submitted,

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