AIR QUALITY IMPACTS OF LOW VAPOR PRESSURE-VOLATILE ORGANIC COMPOUNDS

I. OBJECTIVE

The objective of this project is to investigate the emissions of low vapor pressure-volatile organic compounds (LVP-VOCs) from consumer products and their impacts on air quality. It is intended to complement ARB's efforts to improve the inventory and modeling of VOCs. This project will advance our understanding of LVP-VOCs used in various consumer products, key physical and chemical properties, evaporation profiles under ambient conditions, partitioning between gas and particle phases once released in the atmosphere, and their ozone and organic aerosol formation potential. The results will provide necessary technical information for the California Air Resources Board (CARB) to better assess impacts of LVP-VOCs on ozone and secondary organic aerosol (SOA) formation and provide data to assess whether the exemption for LVP-VOCs in the Consumer Products Regulations should continue as is or be modified. The results can also be used to improve SIP ozone and PM2.5 modeling.

II. BACKGROUND

LVP-VOC is a chemical "compound" or "mixture" that has relatively low vapor pressure/high boiling point, and is defined by CARB Consumer Products Regulations (Title 17, California Code of Regulations, section 94508(a)). LVP-VOCs are ingredients used in some consumer product formulations to meet VOC limits because the CARB Consumer Products Regulations provide an exemption for LVP-VOCs. The LVP-VOC exemption was initially developed to exclude compounds that do not readily participate in ozone formation (i.e. resins, surfactants and other non-volatile organic compounds) and typically represented a small fraction of the overall composition of a formulated product. However, some recent laboratory testing indicates that certain LVP-VOCs may be present in the gas phase under ambient conditions. These findings are important because some LVP-VOCs have high Maximum Incremental Reactivity (MIR) values relative to ethane which represents the traditional bright line between photochemically-reactive and non-reactive VOC compounds. Therefore, the emissions of LVP-VOCs could have a significant impact on the formation of ozone. The rate and amount of a

LVP-VOC emitted into the atmosphere depends not only on the vapor pressure of the individual compound, but may also be affected by:

1. the type of product in which the compound is used,
2. the particular characteristics of the product's formulation and product form (i.e. aerosol, liquid, etc.), and
3. the way in which the product is actually used by consumers.

The rates of volatilization of LVP-VOCs in different formulations of consumer products and the fate of those LVP-VOCs are not well characterized. Moreover, the ambient concentrations of LVP-VOCs are affected by both the rate and extent of release from emission sources and may be affected by the rate of removal through a variety of competing processes including disposal down the drain, atmospheric reactions, dry deposition and formation of SOA. The formation of SOA will contribute to ambient PM2.5 levels while reducing the contribution of LVP-VOCs to ozone formation. Further understanding of the partitioning of LVP-VOCs and their reaction products between gas and particle phases in the atmosphere will provide useful information for ozone and SOA model development. Research efforts, including emission tests, chamber studies, ambient measurements, and fugacity modeling are needed to further understand the role of LVP-VOCs on ozone and SOA formation and to improve modeling for SIPs. This project will be developed to address these knowledge gaps in LVP-VOC emissions and atmospheric processes that lead to ozone and SOA formation.

III. Scope of Work

This project will investigate the volatility of the most common LVP-VOCs used in consumer products and their partitioning between gas and particle phases once emitted into the atmosphere. The LVP-VOCs of interest will be determined in consultation with CARB, SCAQMD, and other interested stakeholders. Research results will be used to evaluate the impacts of LVP-VOCs on air quality and provide information to assess whether the existing LVP-VOC exemption should be modified. Proposals which address a single task will be considered. Potential tasks include:

- Investigate the ambient rates of volatilization of LVP-VOCs, such as glycols, glycol ethers and hydrocarbon solvents used in various product forms of consumer products sold in California (e.g., cleaners, detergents, personal care products, automotive

maintenance products) used in various applications. The investigation should include testing of pure analytes and fully formulated consumer products. Consumer product categories and product forms will be determined in consultation with CARB, SCAQMD, and other interested stakeholders.

- Conduct laboratory chamber studies on selected LVP-VOCs and products formulated with LVP-VOCs to investigate the atmospheric ozone and particulate matter impacts of LVP-VOCs. The goal would be to compare impacts of a particular compound used in a formulated product with that of the impacts of the LVP-VOC emitted in its pure form. If appropriate, develop emission factors to account for the amounts that do not affect air quality. Part of this task would be to determine if these materials exhibit vapor phase photochemistry due to thermal degradation from the high temperatures at which they are injected into the chamber.
- Investigate the environmental fate of LVP-VOCs in selected consumer products when they are disposed down the drain including the downstream emissions that may occur at water treatment or solid waste facilities and, if appropriate, determine emission correction factors to account for the amount that is not emitted into the air (e.g. down-the-drain factors).

IV. Deliverables

- Quarterly Progress Reports
- Final Report
- Additional deliverables to be determined in consultation with ARB

V. Timeline

It is anticipated this project will be completed in no more than 36 months from the start date depending upon the scope of work.