Appendix IV-e. Reactivity Research Work Group and NARSTO – Overview

NARSTO established the Reactivity Research Work Group (RRWG), an ad hoc, multi-stakeholder panel consisting of U.S. federal and state regulatory personnel, government and academic research scientists from North America and Europe, air quality consultants, and industry representatives. The mission statement of the RRWG reads was as follows:

Mission Statement

"Our mission is to provide an improved scientific basis for reactivity related regulatory policies. That will be accomplished by bringing together all parties actively interested in sponsoring, planning, performing or assessing policy-relevant scientific research on the reactivity's of organic compounds emitted to ambient air, as related to the formation of ozone, PM2.5, and regional haze. This is for the purposes of coordinating such research and defining potential applications, while continuously involving key policy makers."

Formation of RRWG

The RRWG began when Basil Dimitriades of the U.S. Environmental Protection Agency (USEPA) called for a workshop with the aim of providing the USEPA up-to-date scientific guidance on various options for implementing reactivity-based regulations, such as those intended by Section 183(e) of the 1990 U.S. Clean Air Act. That legislation called for the control of volatile organic compounds (VOCs) in consumer and commercial products based on their potential to form ozone. Although ozone formation has been the dominant concern among reactivity scientists, the attendees of the initial RRWG workshop in May, 1998 included the examination of collateral impacts of VOCs, such as particulate and air toxic formation, global warming, and stratospheric ozone depletion. The RRWG elected Dr. Donald Fox of the University of North Carolina at Chapel Hill as its chairperson.

The Concept of Reactivity

Prior to the formation of the RRWG, the most advanced regulations of VOCs based on ozone formation potential were implemented by the state of California for the purpose of controlling emissions from automotive exhaust. California, since then, has been gearing up to extend reactivity rules to consumer products, beginning with an optional reactivity program sometime in the year 2000. Their implementation of the reactivity concept, however, had been based on episodic ozone formation in urban air sheds, a strategy that best fit the old U.S. ozone standard of 120 ppb averaged over 1 hour, rather than the new federal standard of 75 ppb averaged over 8 hours. A key question that the RRWG was particularly concerned about from its inception is whether or not to extend the concept of reactivity to longer timescales and larger spatial scales, in keeping with the new focus on chronic rather than episodic exposure.

The USEPA's current approach to reactivity is through a VOC exemption process, in which compounds with an urban ozone formation potential less than that of ethane may be exempted from VOC controls. The process, however, has some unintended impacts, such as the loss of emissions information on exempt compounds and the potential for adverse collateral impacts, especially on larger scales of pollution. Moreover, some industry stakeholders have historically sought more flexible regulations based on incremental differences in reactivity among VOCs. Another key task of the RRWG was therefore to define the research necessary to evaluate the efficacy of exemption schemes versus regulatory schemes based on a bin system or a continuous reactivity scale.

Sub-Teams

In keeping with the policy-relevant focus of the group, the RRWG had two sub-teams: one that concentrated on science, led by Dr. William Carter of the University of California of Riverside, and the other on policy, led by Tom Helms of USEPA. Each of these teams produced an initial assessment of the state of reactivity science and policy, which then led to another document establishing various research options. Individual projects among the research options were intended to furnish concrete answers to questions posed by the two initial assessments, and were be funded voluntarily by the various stakeholders.

Research Projects

The RRWG organized a series of research projects that have addressed issues such as:

• The sensitivity of ozone to VOC mass reductions and changes in VOC composition;

• The derivation and evaluation of reactivity scales using photochemical air shed models;

• The development of emissions inventory processing tools for exploring reactivity-based strategies; and

• The fate of VOC emissions and their availability for atmospheric reactions.

This research has led to a number of findings that increase our confidence in the ability to develop approaches that discriminate between VOCs on the basis of reactivity. These findings include:

• State of the art chamber studies at low VOC-NOX ratios demonstrate that current atmospheric chemistry models generally perform as well under "real world" conditions as under the high concentration scenarios used in their development.

• Substituting emissions of low reactivity compounds for emissions of high reactivity compounds can be effective in reducing 1-hour and 8-hour ozone concentrations. Substitutions based on equal mass, equal carbon, or equal molar concentrations will achieve different levels of ozone reduction depending on the chemicals being substituted. Similar to decreases in mass of VOC emissions, reactivity-based VOC substitution seems to reduce higher concentrations of ozone more than lower concentrations of ozone.

• There are several scientifically valid methods that can be used to calculate reactivity scales, each with different strengths and weaknesses. Although there is a high correlation between the different methods (even the simplest ones), important differences exist in their geographical representativeness and in the amount of spread between low reactivity and high reactivity compounds.

• Using available reactivity scales, it is possible to construct a VOC substitution scenario that will achieve approximately the same ozone reductions as reducing the overall mass of VOC emissions. However, when applied, the substitution scenario may increase ozone in some areas and decrease ozone in others depending on the robustness of the reactivity scale used.

• Several reactivity metrics derived with air shed models (such as the Maximum Ozone Incremental Reactivity to Maximum Incremental Reactivity (MOIR-MIR) and Least Squares Relative Reactivity (LS-RR)) appear to be robust over different regions of the country, meteorological episodes, year of analysis, averaging times, and models.

Policy Impacts

A major policy target envisioned by the RRWG was a proposed EPA Rulemaking on U.S. Federal reactivity policy. Anticipated for publication in 2005, this Rulemaking was to be based in part on RRWG scientific input. On September 13, 2005, U.S. EPA published in the Federal Register a Notice of Interim Guidance on SIP Development, in lieu of a more formal Advance Notice of Public Policy (ANPR). The interim guidance “encourages States to consider recent scientific information on the photochemical reactivity of volatile organic compounds” and “summarizes recent scientific findings” but “does not change any existing rules.” The guidance is available on the EPA website at: http://www.epa.gov/ttn/oarpg/t1/memoranda/27601interimguidvoc.pdf and http://www.epa.gov/ttncaaa1/t1/meta/m27601.html. It encourages the states to incorporate reactivity features into their individual State Implementation Plans.

EPA has also approved a California SIP revision employing reactivity-based regulations of aerosol coating products (http://regulations.justia.com/view/23068) and has subsequently proposed National (reactivity-based) Volatile Organic Compound Emission Standards for Aerosol Coatings (http://www.epa.gov/EPA-AIR/2007/July/Day-16/a13108.htm), finalized on 11/7/08.