any means that hydrocarbons are our major headache for all types of emissions. Photochemical studies indicate that various classes of compounds, e.g., olefins and certain dimethyl and trimethyl substituted benzenes, are more reactive than other classes, and vary in reactivity within the class. Hence, there will always be a need to measure quantitatively the various chemical species by class or individually. This now requires and will continue to call upon the adaptation of the most sensitive advanced technics for chemical separation and identification, including sampling procedures that will insure determination of exhaust constituents rather than those resulting from the sampling method.

As more knowledge of the presence and reactivity of specific hydrocarbons is amassed, it is reflected in consideration of improved criteria for control devices, and sets in motion a whole new chain of events involving instrumentation development, inspection requirements, and the like. The concept of controlling only portions of the exhaust from vehicles, e.g., hydrocarbons and carbon monoxide, but not nitrogen oxides, poses questions as to the effects on the pollution picture after such controls are implemented.

The role of organics other than hydrocarbons has already been mentioned. This is precisely the problem in diesel exhaust pollution. In the diesel engine, combustion takes place in a large excess of air as compared to combustion in the spark-ignited engine, which operates at air-fuel ratios in such a way that all of the hydrocarbon cannot be completely combusted. The diesel engine is comparatively efficient, and diesel exhaust will meet the present California standards without need for control devices. However, the large excess of oxygen in diesel combustion results in the synthesis of oxygenated organic compounds, which are malodorous. They are very obnoxious and public complaints are numerous, even though diesel fuel usage in urban areas is small in comparison to gasoline consumption, e.g., in Los Angeles County it is only 1 to 2 per cent.

In the area of engine modifications, effort at the present time relates to effects of fuel composition, ignition, engine timing, combustion chamber design, and fuel carburetion and distribution. The Chrysler proposal for exhaust reduction, tested for certification by the state of California, utilizes the advantages of lean carburetion operation coupled with spark retardation at low speeds (idle), which increases the combustion time during low-load, low-speed conditions when hydrocarbon concentrations in the exhaust are normally high. The systems to be used by General Motors and Ford involve the injection of air into the exhaust manifold at the valve parts to combust unburned hydrocarbons and carbon monoxide in the exhaust.

In our own laboratories in Cincinnati we are working on the feasibility of an economical system of distributing fuel to each cylinder individually to overcome problems of unequal distribution inherent in the present system. Carburetor and manifold wetting, and unequal air-fuel mixture delivery, due to the tortuous channels in the present carburetor-intake manifold system, may be an important factor in emissions. It is obvious that tuning the engine to insure combustion in the "poorest" cylinder of present engines results in over-rich mixtures in all others.

These are only a few engine modifications that should be explored. The need for such an interim program is twofold: (1) from an over-all point of view this approach is considered to be superior to the use of tailpipe devices as a method for control, in that control is built into the engine and the cost will be offset in part or in full by fuel savings, and (2) such modifications can be applied to the present engine and can be improved as the demand war-