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Comment by RLG on "Government Policies toward Automotive
Emissions Control" by Edwin S. Mills and Lawrence J. White.
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**Approaches
to Controlling
Air Pollution**

Ann F. Friedlaender, editor

Comment

Richard L. Garwin

I come to this writing and to these views as a physicist with more than twenty years of experience in science policy and in the management of industrial science and technology. Control of motor-vehicle emissions occupied me during four years of service on the National Research Council Committee on Motor Vehicle Emissions (CMVE) where, among other concerns, I was primarily involved with the technology of control. I endorse the view of the history of this field related by Mills and White in their paper.

The U.S. motor-vehicle manufacturers have had mixed interests. On the one hand, they could be expected to try to meet the emissions standards at the least manufacturing cost irrespective of operating cost (until EPA-mandated testing of fuel economy and the increased price of fuel). On the other hand, the manufacturers could be expected (and fulfilled these expectations) to lobby vigorously against the imposition of emission limits in order to avoid increasing the manufacturing costs of vehicles and thus (in view of the price elasticity of demand) reducing the number sold. The main problem has arisen because one of the chief arguments against the imposition of limits (or for the easing of limits) has been to show technological infeasibility of the standards. Thus, U.S. manufacturers long avoided assembling in a single car ("best car") the control technologies that they have demonstrated individually and that could be projected with assurance ("best technology") to work.

Foreign manufacturers seeking a share of the U.S. market had little confidence in their ability to lobby against the imposition of emission standards and have, as a result, been the source of some of the earliest-certified, least-cost (both manufacturing and operating) control technologies, some of them with performance much better than required by the standards at the time the vehicles were certified. Those engines that particularly come to mind are the Honda CVCC (a dual-carburetor stratified-charge engine) and the Bosch oxygen-sensor feedback-controlled fuel-injection system with three-way catalyst. The latter was certified in 1976 by Volvo.

Before proceeding further to detail the inadequacies of the motor-vehicle emissions control program and to recommend detailed improvements, I wish

to emphasize that I believe the incentives are all wrong under the absolute limits prescribed for emissions from new cars or from cars that have been in service for some time (as mandated by the Clean Air Amendments of 1970). As I have indicated, such absolute limits simply invite manufacturers to delay until they can demonstrate that they have little chance of responsibly planning to meet the limits at the time required; therefore (the manufacturers argue) if jobs are not to be lost and the economy to suffer, the limits must be relaxed. This incentive to delay could be removed and manufacturers given a positive incentive to reduce emissions as low as economically feasible by the imposition on manufacturers of an effluent tax on motor-vehicle emissions. Thus, if the desired limits on hydrocarbons, carbon monoxide, and nitrogen oxides are, respectively, 0.4, 3.4, and 0.4 grams per mile, then a car (that is, each generic car of a tested vehicle-engine combination) that emitted an excess 10 percent of one of the regulated pollutants would have to pay \$100 per vehicle. One that was 15 percent over would have to pay \$150; one that was high by 20 percent in one pollutant and 30 percent in another would have to pay \$500. In order to convert the tax from a money-maker for the government, and perhaps unintentionally reduce sales of motor vehicles, car types that produce less emission than the standard would receive rebates in like amount. If the standard is far under the average emissions of vehicles manufactured in a given year, a substantial tax would have been imposed on the industry (the customer). But there is a continuous differential to provide the incentive for the manufacturer to reduce the emissions from his vehicles so that he can sell cars in competition with other manufacturers. In similar manner, the requirements of the 1970 Clean Air Act that cars in *use* meet the limits could be reflected in a tax of similar nature and magnitude imposed on the manufacturer following testing by the EPA of sufficient number of cars in use (for 50,000 miles).

Some manufacturers, of course, may choose not to meet the standards in a given year, perhaps in order to introduce in the following year greatly improved technology. This would be their right—they could still sell cars but at a competitive disadvantage compared to other manufacturers. Yet they would not be able to argue that Congress and the EPA were making it impossible (or illegal) for them to manufacture and sell cars.

Some Details

Cost of NO_x Control by PEGR

Long after technical data were available to the contrary, opponents of in-

creasing the stringency of NO_x standards maintained that a very large fuel-economy penalty was experienced through the use of EGR. This was a reflection of the very earliest crude EGR, which was simply an orifice between exhaust and intake manifolds. Such an orifice provided highest flow rate of exhaust gases when the intake of the engine was *least*, with serious impairment of fuel economy at high EGR levels.

In contrast, proportional EGR (PEGR) provides a constant fraction of recycled exhaust gas at a reasonable cost.¹ For example, it has been estimated that it is possible to achieve equivalent fuel economy without EGR at an air-fuel ratio of about 16.7 and with PEGR at an optimized air-fuel ratio of 14.7.² In fact, the penalty for PEGR is not fuel economy at all but some increase in hydrocarbon emissions.

EPA Delays

I am dismayed by the intensity with which the EPA promulgates control plans that are unacceptable, infeasible, and often unnecessary. Relying on a simplistic model of dispersal of sulfates produced by oxidation catalysts, the EPA seemed well on the road to barring or limiting the use of catalysts. Not academic seekers after truth and better modeling, but General Motors, which had a massive investment in catalyst technology, demonstrated (in this case by experiment) that vehicle motion reduced the high local concentration predicted by the EPA model.

Emissions Averaging

It is of course the total emissions from a fleet of cars (the number of cars times the average emissions, by definition) that is important in air quality. Insistence on holding *every* car to the emissions standard lends force to the manufacturers' argument that the standards are unachievable. If the effluent tax were introduced, there would be no standard, and the tax would be assessed, obviously, on the average for the fleet. If one retains firm standards, I believe it important even at this late date to require only that the *average* emissions meet the standard. At the same time, it is obviously important to specify a "short test" that will at least verify that the emissions control equipment has not been disconnected. Such short tests could be made mandatory for licensing and relicensing of vehicles. Such tests would be facilitated by having ports conveniently available in the engine exhaust pipe, ahead of the after-treatment facility. Both sampling at this position and injection at this point could be used to verify the operability of the emissions control components.

EPA Transportation Controls

It does no service to the cause of environmental quality to mandate a 90 percent reduction in gasoline usage in the Los Angeles area. What *would* really improve air quality would be a ban or heavy tax on old vehicles, pre-1970 vehicles that emit thirty times the limit of carbon monoxide, and even 1970 vehicles that emit ten times the proposed limits on the three controlled pollutants. The social cost of such local licensing or control over old vehicles would be far less than that of reducing vehicle-miles traveled without such discrimination.

Other Sources

It has been argued that it is ridiculous to squeeze passenger-vehicle emissions so hard without controlling truck emissions and, therefore, that passenger-vehicle standards should be eased. Alternatively, it has been argued that trucks should be more vigorously controlled. I tend toward the latter view, from considerations of both cost-effectiveness and equity.

General Comment

It seems to me that the most important change we can make in our motor-vehicle emissions control regulations is to change from the present firm standards to an effluent tax. This switch would have the major effect of shifting the manufacturers' efforts from fighting the standards to controlling emissions and to reducing the cost of doing so.

Notes

1. The Consultant Report of September 1974 to the CMVE, *Manufacture Ability and Costs*, p. 142, estimated a \$20 sticker-price increase for the most advanced EGR. This situation was emphasized in the *Report of the Conference on Air Quality and Automobile Emissions*, 5 May 1975, to the Committee on Environmental Decision Making (National Research Council).
2. Marks and Niepoth, *Car Design for Economy and Emission*, SAE Automotive and Engineering Manufacturing Meeting, 13-17 October 1975, 750954, Figure 14.