1. SUMMARY

Summarized below are the key findings and conclusions of our staff paper:

Human Health Effects

0 Ozone has been shown to cause immediate, short-term changes in lung function and Increased respiratory symptoms. There is ample evidence that some healthy adults who exercise heavily for one to two hours during periods of elevated ozone concentrations (greater than 0.18 ppm) experience pronounced symptoms (such as cough and pain on deep breathing) and significant decreases in lung function. **A** number of new studies show some temporary reduction of lung function among moderately to heavily exercising children and adults exposed for one to two hours to ozone concentrations comparable to peak levels found in many nonattainment cities (O. 12-0.16 ppm). Short-term decreases in lung function and increased respiratory symptoms have also been shown to occur in healthy, exercising individuals exposed for prolonged periods to ozone as low as the current standard level of 0.12 ppm. Some researchers have expressed concern about effects occurring at ozone concentrations between 0.08 and 0.12 ppm among people exposed for up to six hours. The long-term implications of these short-term changes are uncertain.

0 Ozone has been suspected of playing a role in the long-term development of chronic lung diseases. While not dismissing the short-term effects of ozone, many health professionals appear to be more concerned that repeated exposure to ozone over a lifetime may result in permanent impairment of the lung. New epidemiologic research suggests that accelerated rates of decline of lung function with aging occur among residents of communities with high ozone concentrations. Clinical studies of humans have recently shown that prolonged exposure to low ozone concentrations results in progressively larger changes in respiratory function and symptoms with time. Animal studies have shown that prolonged ozone exposure can cause biochemical and structural injury to the lung. Some of these changes are suspected of playing a role in the development of chronic lung disease, although inherent uncertainties in extrapolating from animal data make it difficult to assess human risk from these studies. Together, these studies suggest that there may be some persistent effects associated with long-term exposure to ozone. However, at this time our understanding of the contribution of ozone to the development of chronic lung disease is limited.

0 Two groups have been identified by EPA as being potentially at increased risk of developing adverse health effects when exposed to elevated ozone concentrations: 1) a subgroup of the general population with preexisting respiratory disease (e.g. asthma, chronic obstructive pulmonary disease), and 2) those individuals who exercise or work outdoors. The first group is of concern because their respiratory systems are already compromised. The strongest evidence of increased risk exists for people who exercise heavily outdoors. They are at risk because the doses they receive are high due to their increased breathing rate. EPA also estimates that about 5 to 20 percent of the healthy population may represent a subgroup of "responders" who may be significantly more responsive than the general population to the same dose of ozone.

Exposure to Ozone

0 Based on 1983-1985 ozone data, 76 areas (encompassing 94 individual metropolitan statistical areas (MSAs) and 10 non-MSA areas) are in violation of the health-based National Ambient Air Quality Standard for ozone, which allows no more than one exceedance per year (on average over three years) of a daily maximum one-hour average ozone concentration of 0.12 ppm. Approximately 130 million people reside in the 76 areas.

0 Based on hourly ozone data for the period 1983-1985, and taking into account people's daily activity patterns (e.g. when and where they are indoors and when and where they are outdoors) and exercise levels, we estimate that about 35 million people -- 25 percent of the people who reside in nonattainment areas -- are exposed to ozone concentrations above the standard for at least one hour each year. Nationwide, more than 10 million people are estimated to be exposed to concentrations above the standard while exercising at moderate to heavy levels of exertion.

0 Outside of the Los Angeles area, people who are exposed to ozone concentrations above 0.12 ppm during normal activities (i.e., not exercising) are exposed for an average of about 4 hours per year. People who live in the Los Angeles area and are exposed to ozone concentrations above 0.12 ppm during normal activities are exposed for an average of more than 20 hours per year.

Effects of Ozone on Crops and Forests

0 At many locations throughout the southern and eastern halves of the United States, rural ozone concentrations are high enough to reduce yields of economically important crops by 1 to 20 percent compared to yields that would be expected if ozone concentrations were

at natural background levels. The most heavily affected crops include soybeans, wheat, cotton, and some types of produce. Agricultural benefits of about $2 billion would be anticipated if rural ozone concentrations could be reduced by 25 percent.

o Ozone causes foliar injury and reduced growth rates in sensitive trees of several species. Exposure to ozone can lead to increased susceptibility to diseases and other stresses, increased mortality of individual trees, and eventually to overall decline of affected species. All of these effects of exposure to ozone have been observed in forests in the mountains bordering the Los Angeles basin. Ozone damage has also been observed in ponderosa and Jeffrey pine at other locations in California. In the eastern United States, ozone is held to be responsible for widespread foliar injury, reduced growth, and increased mortality in eastern white pine. Ozone has also been suggested as a causal or contributing agent in reported declines or growth rate reductions of red spruce, yellow pine and sugar maple.

Sources of Volatile Organic Compounds (VOCs]

o Ozone is not emitted, but rather is produced in the atmosphere from reactions involving two pollutants: volatile organic compounds (VOCs) and nitrogen oxides (NO_x). EPA has historically encouraged exclusive reliance on VOC emissions controls to meet the ambient air quality standard for ozone.

o Nationwide VOC emissions totaled about 19 million tons during 1985. About 7.7 million tons were emitted in nonattainment areas. Without additional regulations, emissions will decline by about 3 to 5 percent through the mid 1990s, and then slowly rise back to current levels by 2003. Projected VOC emissions reductions from highway vehicles are expected to be offset by emissions growth from small stationary sources,

o Highway vehicles contributed about 30 percent of the total VOC emissions in 1985. Another 30 percent originated from evaporation of organic solvents used in surface coatings, printing, dry cleaning, and for decreasing metal parts and products. About half of the total 1985 VOC emissions originated from small stationary sources that, individually, emit less than 50 tons per year.

VOC Emissions Reductions and Costs

o OTA was able to identify potential emissions controls to lower VOC emissions in nonattainment cities by about 20 percent below current levels by 1993. We believe that the large majority of VOC emissions reductions possible with currently available control methods are accounted for in our analysis.

0 The VOC emissions reductions in nonattainment cities in 1993 from each of the nine control strategies analyzed by OTA are as follows:

1. "Reasonably availabIe control technology" (RACT) controls on existing stationary sources: 6 percent;
2. Limits on gasoline volatility: 6 percent;
3. Inspection and maintenance programs for cars and trucks: 3 percent;
4. Federal controls on selected small VOC sources: e.g., consumer and commercial solvents, architectural surface coatings): 3 percent;
5. Stage II gasoline vapor recovery: 3 percent;
6. "Onboard" technology on motor vehicles to capture gasoline refueling vapors: 1 percent by 1993, 3 percent by 2003;
7. Substitution of methanol for gasoline as fuel for centrally-owned highway vehicle fleets: 1 percent;
8. Adoption of new "Control Technique Guidelines" for existing stationary sources: 1 percent; and
9. More stringent tailpipe emissions standards for gasoline highway vehicles: less than 1 percent by 1993, 1 percent by 2003.

0 By 1993, after implementation of all the VOC control strategies analyzed by OTA, many nonattainment cities with peak ozone concentrations less than about 0.14 ppm should be able to attain the standard. Areas with more severe ozone problems will be able to significantly lower peak ozone concentrations, but will fall short of attainment. For example, in areas with current peak ozone concentrations around 0.16 ppm, peak concentrations can be lowered by about one-third to two-thirds of the way to the standard by 1993. Areas could come closer to attainment if they are able to implement controls on source categories we were unable to analyze (e.g. transportation control measures). In some areas, controlling NO_x emissions in addition to VOCs would be effective.

0 In nonattainment cities, the costs of control strategies analyzed by OTA range between $6 billion and $7 billion per year *in* 1993, and between $8 billion and $9 billion by 2003. Because some controls would apply nationwide, total costs are about $7 billion to $8 billion per year in 1993, and about $10 billion to $11 billion per year by 2003. The rising costs between 1993 and 2003 are due primarily to the increasing impact of more stringent highway vehicle emission standards.

0 The control strategies analyzed by OTA achieve about one-half the VOC reductions needed to attain the standard in nonattainment areas. Because we were not able to identify controls to achieve the other half, we could not estimate total costs to attain the standard.

o The cost effectiveness of most strategies falls between about $1,000 and $3,500 per ton of VOC reduced. "Reasonably available control technology" (RACT) requirements for all stationary sources and substitution of methanol for gasoline as a highway vehicle fuel are the most expensive measures, with cost-effectiveness estimates of about $2,900 to $7,300 per ton of VOC reduced and about $40,000 per ton, respectively. Limiting gasoline volatility is the least expensive measure, at about $320 to $700 per ton of VOC reduced.

Ozone and the Clean Air Act

o The **goal** of the Clean Air Act is to "protect and enhance the quality of the Nation's air resources." The Clean Air Act Amendments of 1970 established a partnership between the States and the Federal Government. EPA sets nationally uniform air quality standards and the States, with the Agency's assistance, are responsible for meeting them. Of the six "criteria" pollutants for which standards have been established, we have been least successful in our efforts to attain the standard for ozone.

o More than ten years have gone by since the passage of the last major set of amendments to the Clean Air Act. While some progress has been made in reducing VOC emissions and lowering ozone concentrations, more than 60 areas do not meet the ozone standard. As partial explanations for this failure, State and local air pollution control officials suggest that we did not accurately predict the level of emissions control required to meet the standard, and that State-level promulgation of regulations has been hindered by lack of federal support for proposed control measures. EPA officials suggest that emissions inventories and especially projections of emissions growth have been inaccurate, and that the deadlines for attainment established in the 1977 Clean Air Act Amendments were unreasonable. The bottom line, however, is that for a variety of reasons, we have not yet reduced emissions enough to meet the goal of attainment.

Proposals for Change: S.1894. H.R.3054. and EPA's Ozone Control Proposal

o H.R.3054 requires nonattainment areas to meet the standard within 3, 5 and 10 years, depending on the severity of their problem. S. 1894 sets a similar schedule for most areas, but allows the worst areas 15 years or longer. EPA's post- 1987 ozone policy establishes the longest schedules, Rather than establishing absolute attainment deadlines, EPA sets a schedule for emissions reductions under which some of the worst areas might take over 20 years to attain the standard.

o While none of the proposals alters the Act's ultimate requirement that the standard be attained, each adds interim requirements that may in practice be more important driving forces behind emissions reductions, The most important of these is the requirement for some or all areas to achieve regular increments of emissions reductions, following an explicit schedule in the proposal, or one assigned by EPA. All the proposals require VOC reductions in nonattainment areas of about 25 to 40 percent below current levels by 1993, and impose sanctions if the reductions are not achieved.

0 The new proposals also include source-specific technology or performance standards, with S. 1894 requiring the most source-specific controls and the EPA proposal the fewest. Some of the specified measures are to be implemented by the States in nonattainment areas only, whereas others are federally implemented controls that apply nationwide.

0 All three proposals include provisions for NO_x controls (which, to date, have only been required in California) but with varying degrees of flexibility. Flexibility is an issue because while NO_x controls may be necessary to attain the standard at some locations, controlling NO_x in addition to VOCs at other sites will result in ozone levels that are *higher* than they would have been after VOC reductions alone. The Senate Environment Committee proposal is the least flexible, requiring NO_x reductions from both existing and new sources in all nonattainment areas. The EPA proposal is the most flexible, allowing individual areas discretion to require NO_x controls if they judge them to be helpful.