Final Parking Lot Shading
(April 9, 2001)

Pollution Source: Parked Automobiles and Light Duty Trucks

Illinois 1996 Emissions Inventory
Approximate Contribution to Ozone: 268 tons VOC per day

Activity: Plant shade trees around parking lots

Potential Reduction: 0.645 to 1.132 lbs VOC per 1000 vehicles parked per day

Cost Estimates: Uncertain cost differential

Description/Calculations:

For new or existing parking lots in the Chicago ozone nonattainment area, a 50% canopy of shade is to be provided by the presence of trees.

Background:
Pilot studies at Davis and Los Angeles, California[1], have been performed on parking lot microclimates to measure the impact of shade tree cover. According to the studies, a 50% canopy of tree cover lowers the ambient temperatures for parked vehicles by approximately 4^{o} - 8^{o} F. The studies present estimations for the volatile organic materials (VOM) reductions that result due to less evaporation from the fuel and fuel systems of the parked vehicles. No such studies were found for locations in the Midwest.

The evaporative emissions reductions occur due to lowered ambient temperatures (Diurnal Losses); less evaporation at constant lower temperatures of the shaded vehicles (Resting Losses); lower losses immediately following engine shutdown (Hot Soak Losses); and lower evaporations in the first few minutes of start-up and idling of parked vehicles (Starting Losses).

Based on the California studies, which were performed at ozone day episodic temperatures, the estimated available VOC emissions reductions due to a 50% canopy of shade was in the range of 1.5% to 2.0% of the light duty auto and truck countywide on-road emissions.

Estimated Emissions Reductions
Using data from the 1996 periodic ozone emissions inventory, parking lot shading emissions reductions estimates for the Chicago ozone nonattainment area were made based on the California studies cited. Estimated reductions in evaporative emissions from light duty trucks and cars were calculated using MOBILE5b for the diurnal, hot soak, and resting type evaporative emissions. No reductions were included for Starting Losses based on discussions with U. S. EPA mobile source staff in Ann Arbor, Michigan. These emissions are considered exhaust emissions and not evaporative[2].

An average ozone season temperature of 82° F was used as the reference in the model rather than the Sacramento episodic ozone day temperatures, which exceeded 104° F in the mid afternoon. In addition, because Chicago receives less direct beam sunlight than Sacramento the shading effect is considered less effective in Chicago. Therefore, after further discussions with U.S.EPA, 2° F and 4° F temperature decreases in fuel and fuel tank temperatures were considered more reasonable for the 25% and 50% canopies of shading, respectively. This compares to the 4° F to 8° F decrease found in the Sacramento study. Until a similar study is performed in Chicago to provide more accurate estimates of the impact of shading, these assumptions are being used to determine the emission estimates. Based on these assumptions, the following table presents the estimated VOC reductions determined by the Mobile5b computer model:

VOC REDUCTIONS PER 1000 VEHICLES (lbs/day)

TYPE OF EMISSIONS	25% CANOPY	50% CANOPY
DIURNAL	0.215	0.407
HOT SOAK	0.253	0.548
RESTING	0.177	0.177
TOTALS	**0.645**	**1.132**

Notes:

1. No start-up emissions included per discussions with OMS Ann Arbor. (See footnote 2)
2. 1996 Chicago ozone season MOBILE5b emissions output data used
3. Maximum average 1996 ozone season temperature used was 82° F.
4. Only Light duty vehicles (LDGV) and light duty gas trucks (LDGT1 and LDGT2) emissions were used.

Summary of Emission Reductions

For the Chicago NAA, the VOC contribution from parked cars is estimated to be 5.2 tons VOC per day per million vehicles parked. The estimated VOC reductions resulting from parking vehicles in parking lots with a 25% canopy of shade are 0.645 lbs. per 1000 vehicles parked per day. For a 50% canopy, the estimated VOC reductions are 1.132 lbs. per 1000 vehicles parked per day. For a municipality to obtain one ton per day of VOC emissions reductions, this equates to parking approximately:

A. 1.8 million vehicles daily in shaded parking lots that have 50% shade canopies, or
B. 3.1 million vehicles daily in shaded parking lots that have 25% shade canopies.

Eligibility Criteria for Emissions Reductions:

1. At a minimum one tree is required for every four parking spaces and City of Davis Municipal Code 29-160 or other local landscaping ordinance followed..
2. Within ten years, the shade canopy must cover 50% of the parking lot as determined by City of Davis Municipal Code 29-160 or other local landscaping ordinance.

Examples of ordinances for parking lot shading guidelines are available from the following cities:

City of Chicago: "Guide to the Chicago Landscaping Ordinance" relating to Municipal Code Title 10, Chapter 32 and Title 17 Chapter 194A, and

City of Davis, California: Municipal Code Section 29-160, Davis, California.

[1] "Effects of Tree Cover on Parking Lot Microclimate and Vehicle Emissions", Klaus Scott et al, Journal of Arboriculture 25(3), May 1999 p. 129 -142.

[2] November 9, 1999, Discussion with Dave Brezezinski, OMS, Ann Arbor, MI identified that start-up emissions are exhaust emissions and should not be considered evaporative. .