United States
Environmental Protection
Agency

Air and Radiation

EPA420-S-98-006
July 1998

Office of Mobile Sources

EPA

TRAQ Technical Overview

Transportation Air Quality Center

Transportation Control Measures: High Occupancy Vehicle Lanes

EPA's main strategy for addressing the contributions of motor vehicles to our air quality problems has been to cut the tailpipe emissions for every mile a vehicle travels. Air quality can also be improved by changing the way motor vehicles are used—reducing total vehicle miles traveled at the critical times and places, and reducing the use of highly polluting operating modes. These alternative approaches, usually termed Transportation Control Measures (TCMs), have an important role as both mandatory and optional elements of state plans for attaining the air quality goals specified in the Clean Air Act. TCMs encompass a wide variety of goals and methods, from incentives for increasing vehicle occupancy to shifts in the timing of commuting trips. This document is one of a series that provides overviews of individual TCM types, discussing their advantages, disadvantages, and the issues involved in their implementation.

Getting There with Clean Air

High Occupancy Vehicle (HOV) Lanes

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High Occupancy Vehicle (HOV) lanes are intended to maximize the person-carrying capacity of the roadway by altering the design and/or operation of the facility to provide priority treatment for HOVs. By providing two important incentives – reduced travel time and improved trip time reliability – HOV facilities encourage travelers to shift from low occupancy vehicles to HOV use. This shift should reduce vehicle trips, vehicle miles traveled (VMT), congestion, and associated emissions from these activities. In several regions, the scope of HOV facilities is being expanded to address regional problems of suburban mobility, congestion, and air quality.

HOV facilities have been implemented throughout the United States. HOV lanes are typically open to buses and other vehicles with a minimum of two or three occupants, although some are exclusive to buses. Many types of HOV facilities exist. Some examples include:

- **Separate roadways** for exclusive HOV use
- **Bypass lanes** at metered freeway entrance ramps
- **Lanes constructed within the freeway right-of way** but physically separated (e.g., by a concrete barrier) from the general-purpose freeway lanes and dedicated for HOV use only
- **Concurrent flow lane** (i.e., a lane moving in the same direction of travel that is not physically separated from the general-purpose traffic lanes)
- **Contraflow lane** (i.e., a lane in the off-peak direction of travel, typically the innermost lane, designated for exclusive use by HOVs traveling in the peak direction. This lane is separated from the off-peak direction general-purpose travel lanes by some type of changeable demarcation, such as plastic posts or pylons).

Other HOV facilities include queue bypass, bus streets, and bus tunnels. The most common form of HOV facilities are concurrent flow HOV lanes followed by exclusive HOV lanes in freeway rights-of-way. [1]

HOV facilities may involve adding entirely new capacity or reallocating existing capacity. Along with a range of physical options, HOV facilities have operative options such as full-time HOV-only use, peak time use, and reversing the direction of facilities during peak times.

1. Background

Although many HOV projects provide air quality benefits, these projects may have been implemented for reasons other than air quality improvement.

Over the past 20 years, as congestion has increased, HOV lanes have become one of the most frequently implemented TCMs. Although many projects do provide some air quality benefits, these projects may have been implemented for reasons other than air quality improvement. Increasingly, federal and state funding programs and regulations (such as the CAAA, Congestion Management System requirements, and local traffic mitigation ordinances) may place higher priority on including HOV facilities in state and regional transportation system plans. [2]

HOV lanes have been shown to increase transit use and car occupancy for work-related trips in congested urban travel corridors. The best HOV lanes now carry between 4,000 and 5,000 persons per hour, compared with around 2,000 for adjacent general purpose lanes. [3] The most effective HOV lane improvements generally involve regional networks of linked lanes, with a system of supporting facilities and services. Historically, the most successful HOV applications have been along "radial" corridors into major central cities. Factors contributing to success include the following:

- Population/employment densities
- Travel volumes
- Congestion levels
- Overall time savings
- Conditions at the destination area.

Little experience has been gained with HOV facilities in suburban and urban areas.

2. Costs and Benefits

HOV project costs vary greatly, depending on factors such as right-of-way acquisition or the cost of land, bridge and overpass modifications, and interchange and ramp modifications. A large portion of total costs often involves providing direct access to inside HOV lanes. Ramps that allow buses to exit and enter a freeway to serve a transfer point are expensive, and time spent getting on and off the freeway slows the trip. The Washington State Department of Transportation (DOT) recently completed a major study identifying projects needed to complete and integrate their HOV "Core" system. The total bill for completion in 1995 dollars was $1.25 billion, with an additional cost of $377 million for HOV Expressway access ramps. [3] A review of data obtained in the late 1980's from the Institute of Transportation Engineers for 19 existing and 11 proposed projects showed costs ranging from $4,000 to $24.5 million per lane mile. A concurrent flow priority lane located within the existing highway right-of-way may cost between $30,000 and $2 million per lane mile to implement while an exclusive right-of-way might easily exceed $8 million per lane mile. [4] A recent quote from the Virginia DOT cites the I-66 HOV lanes from Rt. 234 to Waples Mill Rd. (11.5 miles) at total cost of $115,154,000 (this figure includes the construction of new sound walls). The Right of Way cost alone was $5,117,000. [5]

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HOV impacts on travel are fairly well studied. Different types of HOV facilities achieve different amounts of time savings. The San Francisco Bay Area HOV Lanes Master Plan study estimated a range of time savings from 1 minute to nearly 20 minutes. HOV impacts on air quality are more complex and less studied. Nevertheless, researchers have derived emissions impacts from the wealth of travel/traffic impact data. Los Angeles, San Francisco, Washington DC, and Portland are some cities that have documented emissions impacts from their HOV projects. Assessments of the effectiveness of HOV lane facilities in reducing system-wide emissions have generally found reductions amounting to less than one percent. [4]

HOV lanes may reduce air pollution emissions by reducing running emissions and by reducing trip-end emissions. Running emissions may be reduced because the increased use of buses, vanpools, and carpools results in fewer vehicle miles traveled, and because of higher speeds associated with uncongested operations in HOV lanes. If additional trips are not taken, then HOV lanes will also reduce trip-end emissions. Trip-end emissions result from the initial inefficient engine operation when the trip begins (cold start) and evaporation of fuel from a hot engine at the end of the trip (hot soak). Cold starts and hot soaks occur for even short auto trips and trip end emissions comprise the following:

- **75 percent** of a 5-mile auto trip
- **61 percent** of a 10-mile trip
- **45 percent** of a 20-mile trip

If, however, users of HOV lanes meet their pool or bus through a park-and-ride arrangement, these trip-end emissions may offset the reduced air emissions benefits. When calculating effectiveness of HOV lanes in reducing emissions, one must account for trip-end emissions resulting from the use of linkages.

3. Implementation

HOV lanes are typically implemented by a state DOT due to their substantial physical and financial requirements. HOV lanes typically require three to eight years for planning, design, and construction. Although HOV facilities are generally public works facilities, the potential exists for private or non-profit authorities to construct and operate these facilities along the lines of a toll road (these are also called "High Occupancy Toll" or HOT lanes). Operators may use discriminatory pricing strategies such as granting toll discounts to HOVs. There are no known instances in which HOV facilities have been built or operated by individual employers or developers, but the potential exists for these private initiatives (e.g., operating exclusive ramps or interchanges).

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4. Keys to Success

HOV facilities pose low risks compared to other fixed transit improvements and provide flexibility in that they allow for staged implementation. Operators may start with modest minimum occupancy requirements that can be adjusted over time to provide the appropriate balance between efficiency and utilization. If an HOV lane is not sufficiently utilized, it may be converted to other uses such as mixed-flow operation or emergency shoulders.

Many HOV projects have used education and marketing tools to:

- **Advertise** the opening of HOV lanes
- **Educate** drivers in the use of HOV lanes
- **Promote** immediate use of HOV lanes
- **Create** awareness of support facilities
- **Provide** updated accounts of HOV lane time savings and usage

HOV lanes can be more effective if implemented along with transit improvements or rideshare incentives. [6] One of the most critical components of implementing a successful HOV program is enforcement. Surveys show that early and substantial enforcement of HOV rules on a new facility is the best determinant of long-term public compliance. For example, projects that allow police to pull violators over without impeding the flow of HOV lanes, along with suitably structured system of fines, have proven successful. [4]

5. Barriers to Implementation

The potential need to acquire land to implement the HOV lanes often determines the facility's feasibility and the time required to implement the project. Further, HOV project planning and design involves various agencies and interest groups, including political leaders, business groups, and citizen groups.

6. Equity Issues

HOV facilities generally provide the most benefit to commuters whose travel occurs during weekday peak periods. The distribution of costs and benefits depends on an area's situation. If existing capacity is redistributed, those who rely on mass transit and are able to join carpools and vanpools will receive time-savings benefits and potential financial benefits (e.g., employers may provide HOV parking subsidies). These HOV facilities may benefit low-income travelers while imposing costs upon high- income travelers. For example, mass transit riders tend to be from lower income groups and value time savings less than high-income individuals. Travelers who lack access to transit services or are unable to join carpools and vanpools, and thus must drive alone, will not benefit from the increased time savings provided by HOV facilities.

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If additional capacity is provided, all travelers should benefit from the reduced congestion and increased time savings. The value of these benefits depends on how travelers value their time. Adding capacity will impose land use impacts upon those in the surrounding area. These impacts may be offset, however, from the benefits received from reduced congestion and improved air quality.

7. Summary of Recent Examples

If we include HOV projects beyond freeways and separate right-of-ways, HOV lanes become the second most frequently implemented TCM, following traffic flow improvements.

As of 1992, some 49 freeway or separate right-of-way HOV projects were operating in North America in 22 metropolitan areas. These projects occur in major metropolitan areas across the U.S. (e.g., Los Angeles, Denver, Houston, Chicago, New York, Washington D.C., and Miami). Most of these HOV facilities are oriented to serve the major downtown core of a metropolitan area along radial corridors. These facilities usually are in operation during the peak morning and afternoon periods and primarily serve the downtown oriented work trip. Some other examples of successful projects include Minneapolis I-394, Hampton Roads I-64, Seattle I-5, and the San Francisco/Oakland Bay Bridge. If we include HOV projects beyond freeways and separate right-of-ways, HOV lanes become the second most frequently implemented TCM, following traffic flow improvements. [5]

HOV lanes are generally more effective when paired with other measures such as park-and-ride lots, employer-based transportation (vanpool and car pool) programs, and commuter parking subsidies. For example, William M. Mercer in Seattle provides its employees HOV parking discounts and preferential HOV parking treatment. Hewlett Packard in Palo Alto also combines TCM strategies by providing its employees with ridematching services, transit information, and preferential HOV parking treatment, including reserved spaces.

8. Sources

[1] *Synthesis of Travel Demand Management Findings: Inventory of Measures and Synthesis of Experience Final Report*, Report No. DOT-T-94-12, U.S. Department of Transportation, Washington, D.C. (September 1993).

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[3] Public Interest Transit Forum Homepage, Washington State (http://www/gt-wa.com/rta).

[4] *Transportation Control measure Information Documents*, Cambridge Systematics, Inc., U.S. Environmental Protection Agency, Washington, D.C. (March 1992).

[5] Personal Communication with Virginia DOT (February 4, 1997).

[6] Turnbull, Katherine F., *High Occupancy Vehicle Project Case Studies Historical Trends and Project Experiences*, Report No. DOT-T-94-18, U.S. Department of Transportation, Washington, D.C. (August 1992).

9. On-Line Resource

The Environmental Protection Agency's Office of Mobile Sources has established the TCM Program Information Directory to provide commuters, the transportation industry, state and local governments, and the public with information about TCM programs that are now operating across the country. This document and additional information on other TCMs and TCM programs implemented nationwide can be found at:

http://www.epa.gov/omswww/transp/traqtcms.htm