High-Occupancy-Vehicle Treatments on Toll Facilities

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The use of high-occupancy-vehicle (HOV) facilities in North America, especially those located on freeways and in separate rights-of-way, has been examined extensively over the last 20 years. Less consideration has been given, however, to the use of HOV treatments on toll facilities. The provision of priority measures for HOVs on toll facilities is a subject of growing interest among representatives from toll and transportation agencies in the United States, especially those that serve commuters in large urban areas. Like other types of urban transportation facilities, many toll roads, bridges, and tunnels are experiencing peak vehicular demands that exceed their current capacity. HOV treatments represent one potential technique for addressing many of these issues. In an examination of the national experience with priority measures for HOVs on toll facilities, the use of HOV pricing strategies and HOV priority treatments is explored. Information on the toll facilities operated by 21 toll agencies is examined. A total of 24 toll facilities currently utilize some type of HOV pricing strategy, and 14 projects that use HOV priority treatments were identified. Available information on the various projects is examined. The overview of the current use and status of HOV treatments on toll facilities should be of use to transportation professionals interested in exploring potential HOV applications on toll roads, bridges, and tunnels. As such, it represents a significant addition to the developing body of literature related to the application of HOV treatment in the United States.

The provision of priority measures for high-occupancy vehicles (HOVs) on toll facilities is a subject of growing interest among representatives from toll and transportation agencies in the United States, especially those that serve commuters in large urban areas. This paper provides a national overview of the experiences with HOV strategies and treatments on urban toll roads, bridges, and tunnels in the United States.

Like other types of urban transportation facilities, many toll roads, bridges, and tunnels are experiencing peak vehicular demands that exceed their current physical capacity. These demands often result in substantial congestion and delays for motorists. As a result, numerous transportation agencies are focusing on strategies and treatments for maximizing the efficiency of the existing systems, including priority measures for HOVs. There is a growing body of experience with HOV projects on freeways and in separate rights-of-way in cities throughout the United States. The evidence from those projects suggests that HOV priority treatments can be effective when properly planned and implemented (*1–3*).

Priority measures for HOVs on toll facilities are not new. A number of HOV projects undertaken during the past two decades have been on toll facilities (*2,4,5*). However, the experience with HOV strategies and treatments on toll facilities has not been explored extensively in previous studies of HOV projects (*2,4,5*). Thus, the focus of this paper is on HOV projects associated with toll facilities. The results should be of use to groups interested in the application of HOV strategies and treatments on toll roads, bridges, and tunnels.

The information presented in this paper was obtained through two methods. First, a state-of-the-art literature review was conducted to identify examples of HOV measures on toll facilities and to obtain basic information about those projects. A number of projects had been identified through previous research on HOV facilities conducted by the Texas Transportation Institute and other groups. In addition, a telephone survey was conducted of representatives from agencies responsible for toll roads, bridges, and tunnel facilities throughout the country. The survey was intended to verify and update the basic information gathered from the literature, to obtain additional information concerning the experiences with HOV strategies, and to identify other HOV projects that are in the planning stage.

This paper is divided into three major sections. Following this brief introduction, the second section provides more detailed information concerning HOV strategies and treatments on toll facilities in the United States, including a discussion of the characteristics of the HOV projects on different types of toll facilities, the use of HOV pricing strategies, and HOV priority techniques. Information obtained through the literature review and the telephone surveys from the various projects is summarized. The paper concludes with a brief summary of the major elements examined and the identification of areas for further research.

HOV APPLICATIONS ON TOLL FACILITIES

A variety of HOV techniques have been applied on toll roads, bridges, and tunnels in the United States. Reduced travel times and increased travel time reliability can be provided to buses, vanpools, and carpools by altering the design and operation of certain elements of a toll facility. In addition to these design treatments, toll facilities may provide direct financial incentives for HOV use through lower toll charges or free passage. Thus, the various HOV applications on toll roads, bridges, and tunnels can be divided into two general categories: HOV pricing strategies and HOV priority treatments. Although both strategies may be used in combination, they are addressed individually in this section. Facilities using both techniques are also discussed, however.

To obtain current information on the status of HOV projects on toll facilities, a telephone survey was conducted with representatives from the agencies throughout the country responsible for planning and operating toll roads, bridges, and tunnels. The *1992*

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Membership Director (*6*) of the International Bridge, Tunnel and Turnpike Association was used to identify both the agencies and the individuals included in the survey. In addition, literature on HOV projects and toll facilities (*2,4,7*) was reviewed to help ensure the inclusion of all relevant projects. Table 1 gives the toll agencies contacted and the current status of HOV applications on toll facilities in the United States. A total of 21 toll agencies were examined. As shown in Table 1, eight toll agencies are currently using some type of HOV pricing strategies and six are utilizing HOV priority treatments. Of these, four agencies are currently using both approaches.

The current use of both types of HOV techniques on toll facilities is examined in more detail in this section. As discussed, HOV pricing strategies are more commonly found with different types of toll facilities than HOV priority treatments. Then a brief overview that summarizes the extent of current applications is provided. The limited information available on project experiences is also reviewed.

HOV Pricing Strategies

HOV pricing strategies provide lower toll charges or eliminate the toll charge altogether for HOVs. Thus, this approach gives a financial incentive to commuters to use buses, carpools, and vanpools. Pricing strategies also may be combined with other HOV priority treatments at toll plazas to provide both monetary and travel time benefits to HOV users.

Although they may not be explicit, toll facilities in general provide financial incentives for using multiple-occupant vehicles. Toll charges usually are collected on a per-vehicle basis, regardless of the number of occupants in a vehicle of a given type. Thus, in most cases, the toll per person drops as the occupancy of a vehicle using a toll facility increases. In this way, commuters who carpool or vanpool can reduce their daily out-of-pocket costs. It does not appear that this feature of toll facilities has been widely promoted or marketed, however, as a means to encourage the use of HOVs.

The general pricing strategies—reduced toll rates and toll-free access—are being applied to encourage greater use of carpools and vanpools on some toll facilities in the United States. With reduced toll rates the toll collected from qualifying HOVs is significantly lower than that for similar vehicles that do not have a sufficient number of occupants. With toll-free access, toll charges are not applied to qualifying HOVs.

Table 2 provides a summary of HOV pricing strategies on toll facilities in the United States, including agency, facility, route and location, year the HOV strategy was implemented, and the current status of the project. A total of 8 agencies and 24 toll facilities are listed. All but one of the projects are currently in operation.

As shown by Table 2, HOV pricing strategies are most common with toll facilities in California, Delaware, and New York. In addition, one toll facility in Massachusetts utilizes HOV pricing.

TABLE 1 U.S. Toll Agency Experience with HOV Pricing and Priority Treatments

Agency	HOV Pricing	HOV Treatments	Neither
California Department of Transportation	X	X	-
Connecticut Department of Transportation[a]	-	-	X
Delaware River Port Authority	X	-	-
Delaware Turnpike Administration	X	X	-
E-470 Public Highway Authority - Denver, Colorado	-	-	X
Florida Department of Transportation	-	-	X
Golden Gate Bridge, Hwy. & Transp. District	X	-	-
Illinois State Toll Highway Authority	-	-	X
Indiana Department of Transportation	-	-	X
Maryland Transportation Authority	-	X	-
Massachusetts Port Authority	-	-	X
Massachusetts Turnpike Authority	X	-	-
New Jersey Expressway Authority	-	-	X
New Jersey Highway Authority	-	-	X
New York State Thruway Authority	X	X	-
Ohio Turnpike Commission	-	-	X
Oklahoma Turnpike Authority	-	-	X
Port Authority of New York & New Jersey	X	X	-
Triborough Bridge & Tunnel Authority	X	-	-
Pennsylvania Turnpike Commission	-	-	X
Virginia Department of Transportation	-	X	-

[a]Connecticut operated toll facilities until the mid-1980's.

TABLE 2 U.S. Toll Facilities with HOV Pricing Strategies

Facility	Route/Location	Year Implemented	Project Status
California Department of Transportation			
Antioch Bridge	SR 160, San Joaquin River	1991	current
Benicia-Martinez Bridge	I-680, Carquinez Strait	1991	current
Carquinez Bridge	I-80, Carquinez Strait	1991	current
Dumbarton Bridge	SR 84, San Francisco Bay	1982	current
Richmond-San Rafael Bridge	I-580, San Francisco Bay	1989	current
San Diego-Coronado Bridge	SR 75, San Diego Bay	1977	current
San Francisco-Oakland Bay Bridge	I-80, San Francisco Bay	1970, 1971[a]	current
San Mateo-Hayward Bridge	SR 92, San Francisco Bay	1989	current
Vincent Thomas Bridge	SR 47, Los Angeles Harbor	Prior to 1989	current
Delaware River Port Authority			
Benjamin Franklin Bridge	I-676, New Jersey/Philadelphia	1971	current
Betsy Ross Bridge	SR 90, New Jersey/Philadelphia	1971	current
Commodore John Barry Bridge	US 322, New Jersey/Philadelphia	1971	current
Walt Whitman Bridge	I-76, New Jersey/Philadelphia	1971	current
Delaware Turnpike Administration			
Kennedy Memorial Highway	I-95, Newark, Delaware	Oct. 1, 1993	planned
Golden Gate Bridge, Hwy. & Transp. District			
Golden Gate Bridge	US 101, San Francisco Bay	1975	current
Massachusetts Turnpike Authority			
Massachusetts Turnpike	I-90, Boston/New York State	1992	current
New York State Thruway Authority		HOV Rate-1980	current
Tappan Zee Bridge	I-87, Hudson River	MOV Rate-1990[b]	current
Port Authority of New York & New Jersey			
Bayonne Bridge	SR 440, New Jersey/Staten Island	1975	current
George Washington Bridge	I-95, New Jersey/Manhattan	1975	current
Goethals Bridge	I-278, New Jersey/Staten Island	1975	current
Lincoln Tunnel	SR 495, New Jersey/Manhattan	1970[c], 1975	current
Outerbridge Crossing	SR 440, New Jersey/Staten Island	1975	current
Tri-Borough Bridge & Tunnel Authority			
Verrazano Narrows Bridge	I-278, New Jersey/Staten Island/N.Y.C.	1986	current

[a]The pricing strategy on the San Francisco-Oakland Bay Bridge was initiated for buses in 1970 and extended to other HOVs in 1971.
[b]The MOV Rate applies to vehicles with 2 or more people and the HOV rate applies to vehicles with of more people.
[c]The contraflow bus lane was implemented in 1970 and the short HOV lane approaching the toll plaza was implemented in 1975.

Further, the majority of HOV pricing projects is on toll bridges. Of the toll facilities using HOV pricing strategies, 20 are located on bridges, 2 are associated with tunnels, and 2 are on highways. Information in Table 2 also indicates that HOV pricing strategies have been in effect on most of the toll facilities for many years, including those in Delaware, the New York and New Jersey area, and California, which were all implemented in the 1970s.

Table 3 provides additional information on the operating characteristics associated with each of the HOV toll pricing projects. Information is provided on the normal toll rate, the HOV toll charge, the definition and vehicle occupancy requirements for HOVs, and the hours that HOV pricing is in effect. The information indicates that a variety of pricing strategies are utilized on the 24 facilities. Five of the California toll bridges provide free passage for HOVs, whereas five give reduced rates for commuter buses. All of the other 14 toll facilities provide reduced rates for HOVs. The reduction in the toll charges for HOVs varies among the different facilities, however. For example, the four toll facilities operated by the Delaware River Port Authority provide a $0.50 savings for HOV users, whereas the six facilities operated by the Port Authority of New York and New Jersey provide a $3.50 savings for HOV users.

The purchase of prepaid tickets or tokens is required by many toll agencies to take advantage of the lower HOV rates. For example, an advance-purchase carpool ticket is required for HOV users on the six toll facilities operated by the Port Authority of New York and New Jersey. For $30 carpoolers may purchase 60 tickets for use over a 6-month period. This equates to a $0.50 charge for HOVs compared with the normal $4.00 toll.

The HOV definition also varies among the various projects. As noted previously, five of the California toll bridges provide lower toll charges only to buses, with carpools and vanpools paying the same rates as other automobiles. A 3+ carpool definition is used on most of the other 19 toll facilities. The two exceptions to this are the Tappan Zee Bridge in New York and the Kennedy Memorial Highway in Delaware. The Tappan Zee Bridge uses two different classifications for HOVs: multioccupant vehicles (MOV), which are classified as 2+ carpools, and HOVs, which are carpools with three or more occupants (3+). Both groups may purchase a toll ticket option that allows 60 trips within 105 days, which equates to a $1.00 charge—a significant savings over the regular $2.50 toll. An additional option of 20 tickets over a 30-day period may be purchased by HOVs.

The hours for which the reduced tolls for HOVs are in effect differ among the projects. On six facilities, the reduced tolls are provided to HOVs on a 24-hr basis. Facilities using the 24-hr designation include the Coronado Bridge in San Diego, the four bridges operated by the Delaware River Port Authority, and the Verrazano Narrows Bridge in New York City. Of the remaining 19 toll facilities, 11 offer the reduced HOV charges in both the morning and afternoon peak periods, whereas 7 provide the lower charges only in the morning peak period.

HOV Priority Treatments

HOV priority treatments with toll facilities take a number of forms. These include HOV lanes over the length of the facility, HOV lanes at the approach to toll plazas, and toll booths reserved for use only by HOVs. An HOV lane on a toll facility represents a treatment similar to those commonly found on freeways. The HOV treatment could be an exclusive, concurrent, or contraflow lane. This approach provides travel time savings and travel time reliability to HOVs in congested travel corridors. The primary function of reserved lanes on the approach to a toll plaza is to allow HOVs to bypass the queues that form at toll plazas. Reserving specific toll plazas for HOVs provides a similar benefit by allowing HOVs to bypass queues and move more quickly through the toll plaza.

Table 4 gives the seven toll agencies reporting the use of HOV priority treatments; 12 priority treatments are currently in operation on toll facilities, although one project—the Kennedy Memorial Highway in Maryland—operates only when traffic conditions warrant. One project, encompassing the section of the Kennedy Memorial Highway in Delaware, is in the planning stage. Finally, the future of the Dulles Toll Road HOV lane, which was discontinued in 1992 after only a few months of operation, is unclear at this point.

Additional information on the types of priority treatments utilized with the various toll facilities and the operating characteristics of each are contained in Table 5. Of the 14 projects, 5 provide an HOV lane, 1 includes just an HOV toll booth, and 8 provide both reserved HOV toll booths and HOV lanes. Three of the toll road HOV lanes represent major HOV facilities. The HOV lanes on the San Francisco–Oakland Bay Bridge and the contraflow lane on SR-495 on the approach to the Lincoln Tunnel in New York City have been in operation since 1970. They represent two of the oldest and most heavily utilized HOV facilities in the country. Further, the HOV lanes on both the Bay Bridge and SR-495 connect with exclusive HOV toll booths, providing additional travel time savings to HOV users. In addition, the Bay Bridge provides financial incentives for HOV users because HOVs do not pay a toll. The 3.3-mi HOV lane on the Virginia Beach–Norfolk Expressway, which connects with the 8-mi HOV lane on I-64, provides a more recent example of a new HOV lane on a toll road.

As shown in Table 5, a toll booth reserved for HOV use without any other supporting HOV treatments is in the planning stage on the Kennedy Memorial Highway in Delaware. One toll both would be provided for carpools, vanpools, and buses during the morning and afternoon peak periods. The remaining eight toll facilities provide both reserved approach lanes and toll booths for HOVs. Although the hours of operation vary among the facilities, most are oriented toward the morning and afternoon peak periods.

The location of the HOV toll booths or toll approaches, or both, varies among the different toll facilities. Some use the outside lane, some use the inside lane, and some use different combinations. The George Washington Bridge and the Massachusetts Turnpike both use the outside lane for HOVs. On the other hand, the HOV lane is on the inside lane on the Kennedy Memorial Highway and the Virginia Beach–Norfolk Expressway. The Bay Bridge and the Tappan Zee Bridge use a combination of inside and outside lanes for the HOV treatments.

Project Experience and HOV Utilization Levels

Little information is available through either the published literature or the telephone survey of toll agency representatives on the number of HOVs that use the different HOV pricing mechanisms and priority facilities, the impact these measures have had on influencing a change in commuting behavior, and the financial impacts of lower or free HOV rates on the toll agencies. Available

TABLE 3 Operating Characteristics of HOV Pricing Strategies on U.S. Toll Facilities

Facility	Normal Toll Rate ($) auto	HOV Toll Rate ($) auto	HOV Definition	Hours of Operation
California Department of Transportation				
Antioch Bridge	1.00	0.10	bus[a], 3+ carpool, motorcycle, vanpool	5:00-10:00 a.m. 3:00-7:00 p.m.
Benicia-Martinez Bridge	1.00	0.10	bus[a], 3+ carpool, motorcycle, vanpool	5:00-10:00 a.m. 3:00-7:00 p.m.
Carquinez Bridge	1.00	0.10	bus[a], 3+ carpool, motorcycle, vanpool	5:00-10:00 a.m. 3:00-7:00 p.m.
Dumbarton Bridge	1.00	free	bus[b], 2+ carpool, motorcycles, vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
Richmond-San Rafael Bridge	1.00	free	bus[a], 3+ carpool, motorcycle, vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
San Diego-Coronado Bridge	1.00	free	bus[b], 2+ carpool, motorcycle, trucks	24 hours
San Francisco-Oakland Bay Bridge	1.00	free	bus[b], 3+carpool, motorcycle[c], vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
San Mateo-Hayward Bridge	1.00	free	bus[b], 2+carpool, motorcycle[c], vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
Vincent Thomas Bridge	0.50	0.50	bus[d]	24 hours
Delaware River Port Authority				
Benjamin Franklin Bridge	2.00	1.50	bus, 3+ carpool	24 hours
Betsy Ross Bridge	2.00	1.50	bus, 3+ carpool	24 hours
Commodore John Barry Bridge	2.00	1.50	bus, 3+ carpool	24 hours
Walt Whitman Bridge	2.00	1.50	bus, 3+carpool	24 hours
Delaware Turnpike Administration				
Kennedy Memorial Highway, Newark, DL.	1.25	$25.00/40 Passes/30 Days	bus, 2+ carpool	6:30-10:00 a.m. 3:30-6:00 p.m.

Golden Gate Bridge, Hwy. & Transp. District				
Golden Gate Bridge	3.00[e]	free	bus[f], 3+ carpool	5:00-9:00 a.m. 4:00-6:00 p.m.
Massachusetts Turnpike Authority				
Massachusetts Turnpike: Brighton-Alston Facility	0.50	$25.00/year[g]	bus[h], 3+carpool	7:00-9:00 a.m. 3:30-5:30 p.m.
New York State Thruway Authority				
Tappan Zee Bridge	2.50	MOV=1.00 HOV has book option[i]	bus, MOV=2+, HOV=3+ carpool	7:00-9:00 a.m.
Port Authority of New York & New Jersey				
Bayonne Bridge	4.00	0.50[j]	bus[k], 3+ carpool	7:00-9:30 a.m.
George Washington Bridge	4.00	0.50[j]	bus[k], 3+ carpool	7:00-9:30 a.m.
Goethals Bridge	4.00	0.50[j]	bus[k], 3+ carpool	7:00-9:30 a.m.
Holland Tunnel	4.00	0.50[j]	bus[k], 3+ carpool	7:00-9:30 a.m.
Lincoln Tunnel	4.00	0.50[j]	bus[k], 3+ carpool	7:00-9:30 a.m.
Outerbridge Crossing	4.00	0.50[j]	bus[k], 3+ carpool	7:00-9:30 a.m.
Tri-Borough Bridge & Tunnel Authority				
Verrazano Narrows Bridge	6.00	1.25[l]	bus, 3+ carpool	24 hours

[a]Commuter buses pay only $0.10/crossing and are paid with commute bus scrip ticket(s) only.
[b]Commuter Bus service is allowed to pass free at any time of the day in designated lanes. Passage through staffed lanes requires toll-free commuter bus tickets.
[c]Motorcycles are required to display special permits to receive the HOV pricing on these bridges.
[d]Commuter buses pay only $0.20/crossing and are paid with commute bus scrip ticket(s) only.
[e]Non-HOV commuters may purchase an advance book option that allows 16 passages for $40.00 at an average cost of $2.50.
[f]Buses allowed to pass free during HOV hours of operation.
[g]May be as high as $75.00/year depending on length of travel prior to arriving to toll facility. HOV's receive a lower toll charge through the Car Pass Program.
[h]Bus pricing dependant upon number axles.
[i]Both MOV and HOV users may purchase a ticket option that allows 60 trips for 105 days at essentially a $1.00 a commute and HOV users may also purchase a smaller option of 20 tickets that are eligible for 30 days at $10.00.
[j]HOV discount requires the use of an advance-purchase carpool ticket that is eligible for 6 months for $30.00 and 60 tickets.
[k]Buses pay a straight fee of $3.00.
[l]Only Staten Island dwellers may be eligible for the Staten Island HOV Book Token that allows 24 trips for $30.00.

TABLE 4 U.S. Toll Facilities with HOV Priority Treatments

Facility	Route/Location	Year Implemented	Status
California Department of Transportation			
Carquinez Bridge	I-80, Carquinez Strait	1991	current
Dumbarton Bridge	SR 84, San Francisco Bay	1982, 1989	current
San Diego-Coronado Bridge	SR 75, San Diego Bay	1977	current
San Francisco-Oakland Bay Bridge	I-80, San Francisco Bay	1970, 1971	current
San Mateo-Hayward Bridge	SR 92, San Francisco Bay	1989	current
Delaware Turnpike Administration			
Kennedy Memorial Highway	I-95 in Newark	1993	planned
Maryland Transportation Authority			
Kennedy Memorial Highway	I-95 in Baltimore	January 1993	only when traffic warrants
Massachusetts Turnpike Authority			
Massachusetts Turnpike	I-90, Brighton-Alston in Downtown Boston	1992	current
New York State Thruway Authority		HOV Rate - 1980	
Tappan Zee Bridge	I-87, Hudson River	MOV Rate - 1990	current
Port Authority of New York & New Jersey			
George Washington Bridge[a]	I-95, New Jersey/Manhattan	1973, prior to 1980	current
Holland Tunnel	I-78, New Jersey/Manhattan	1985	current
Lincoln Tunnel[b]	SR 495, New Jersey/Manhattan	1970, 1975	current
Virginia Department of Transportation			
Dulles Toll Road	Dulles Airport/Washington, D.C.	1992	suspended 1992[c]
Virginia Beach-Norfolk Expressway	SR 44, Virginia Beach/Norfolk	1988, 1992[d]	current

[a]HOV treatments are only on Upper Level approach. Police can operate a second lane when traffic warrants.
[b]1 Toll booth approach lane for buses and 3+ carpools and 1 contraflow bus lane.
[c]HOV facilities on the Dulles Toll Road may be re-instated in mid-1994.
[d]The HOV lanes on SR 44 were initially opened in 1988. After a temporary suspensions to allow for the completion of the HOV lanes on I-64, the lanes were re-opened in 1992

TABLE 5 Operating Characteristics of HOV Priority Treatments on U.S. Toll Facilities

Facility	Treatments: Total # of Toll Booths	Treatments: HOV Booths	Treatments: HOV Toll Booth Approach Lanes	HOV Lanes/ (Kilometres)	HOV Definition	Hours of Operation
California Department of Transportation						
Dumbarton Bridge	7	1	1	1/(3.2)	bus, 2+ carpool, motorcycle, vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
Richmond-San Rafael Bridge	5	1	1	1/(8.0)	bus, 3+ carpool, motorcycle, vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
San Diego-Coronado Bridge	7	1	0	0	bus, 2+ carpool, trucks, motorcycle	24 hours
San Francisco-Oakland Bay Bridge	20	2	2[a]	4/(4.8)	bus, 3+ carpool, motorcycle[b], vanpool	5:00-10:00 a.m. 3:00-6:00 p.m.
San Mateo-Hayward Bridge	8	1	1	1/(3.2)	bus, 2+ carpool, motorcycle[b], vanpool	5:00-10:00 a.m. 3:00–6:00 p.m.
Delaware Turnpike Administration						
Kennedy Memorial Highway	8	1[c]	0	0	bus, 2+ carpool	6:30-10:00 a.m. 3:30-6:00 p.m.
Maryland Transportation Authority						
Kennedy Memorial Highway	9	0	0	1	yet to be determined	when traffic warrants
Massachusetts Turnpike Authority						
Massachusetts Turnpike	14	1[d]	1[e]	0	bus, 3+ carpool	7:00-9:00 a.m. 3:30-5:30 p.m.

TABLE 5 *Continued*

New York State Thruway Authority						
Tappan Zee Bridge	13	2	3-4	0[f]	bus, 2+ carpool, 3+carpool	7:00-9:00 a.m.
George Washington Bridge	12[g]	1	1	1/(0.4)	bus, 3+ carpool	7:00-9:30 a.m.
Holland Tunnel	9	1	1	1/(0.2)	bus, 3+ carpool	7:00-9:30 a.m.
Lincoln Tunnel	13	2	2[h]	2[h]/(0.16[i]), (4.8[j])	bus, 3+ carpool	4:00-6:00 a.m.[i] 6:30-10:00 a.m.[j]
Virginia Department of Transportation						
Dulles Toll Road[k]	7	1	1[c]	1/(19.3)	bus, 3+ carpool	6:30-9:00 a.m. 4:00-6:30 p.m.
Virginia Beach-Norfolk Expressway (SR-44)	7	0	0	1/(4.8)	bus, 2+ carpool	5:00-8:30 a.m. 3:00-6:00 p.m.

[a]2 Bypass lanes for HOV use during defined HOV hours of operation.
[b]Motorcycles are required to display a special permit.
[c]Planned.
[d]Another toll booth is planned to be implemented as reserved for HOV use.
[e]Approach lane is approximately 100 yards in length and is delineated with cones.
[f]The New York State Thruway Authority is planning an exclusive HOV lane but it is many years away from being implemented.
[g]Number of booths may vary somewhat depending on traffic conditions.
[h]Includes both the Contraflow Bus Lane and the HOV approach lane to the toll plaza.
[i]Bus lane that is open to 3+ carpools.
[j]Contraflow Bus Lane.
[k]Suspended in 1992.

Conversion Factor Used: 1km = 0.62 miles

information obtained through the literature review and the telephone surveys with representatives from toll agencies is briefly reviewed in this section.

It appears that the use of HOV pricing and priority measures on toll facilities varies greatly among the different projects. For example, the HOV lanes on the Bay Bridge and SR-495 carry a significant number of vehicles and passengers. In 1992 the four HOV lanes on the Bay Bridge carried some 2,426 vehicles and 11,808 passengers during the morning peak hour (*2*). The contraflow bus lane on SR-495 carries an average of 725 buses and 34,685 passengers during the morning peak hour. Further, the new HOV lane on the Virginia Beach–Norfolk Expressway currently carries approximately 800 vehicles and 1,520 passengers (*2*).

Table 6 provides a summary of the monthly use of the free HOV toll booths on four toll bridges in California. The monthly number of HOVs ranges from a low of approximately 1,275 vehicles to a high of 370,989 vehicles. Table 6 also shows the total number of vehicles using the toll bridge and the percentage of free HOVs. The percentage of HOVs ranges from a high of 37 percent on the San Diego–Coronado Bridge in San Diego to 1 percent on the San Mateo–Hayward Bridge. However, it is important to note that these are monthly totals and that HOVs probably represent a higher percentage of total vehicles during the peak periods.

A few other toll agency representatives provided information on the use of reduced HOV pricing strategies. The representative from the Delaware Port Authority, which provides a $0.50 savings for 3+ carpools on four toll bridges, indicated that the carpool tickets were not well utilized by commuters. To receive the $0.50 savings, carpoolers must purchase prepaid tickets, which are good for a 30-day period. The representative noted that the purchase of these tickets had declined over the past year. On the other hand, the Triborough Bridge and Tunnel Authority reported selling over 1 million HOV commuter ticket books to carpoolers on Staten Island last year.

None of the representatives contacted during the telephone survey were able to identify the specific impact of the HOV priority pricing strategies on the general revenue stream of the toll agency. Most indicated that they did not think the HOV pricing programs had a major impact on the revenue collected from the toll facilities. The small impact was noted primarily because of the limited hours of operation for many HOV pricing strategies and the fact that the percentage of commuters taking advantage of the HOV pricing was relatively small.

Further, information was not available on the possible influence of the HOV toll strategies on changing individual commute modes. No before-and-after studies or other evaluations of the impact of implementing an HOV toll pricing project were identified. Thus, it appears that little information exists on the influence toll HOV pricing strategies and toll HOV priority treatments have had on encouraging greater use of buses, vanpools, and carpools.

A number of representatives provided information on the reasons for implementing the HOV toll projects. Many of the projects in California, Delaware, New York, and New Jersey were implemented in the 1970s in response to the energy crisis and the Organization of Petroleum Exporting Countries (OPEC) oil embargo. The focus of these projects was to encourage greater utilization of all forms of HOVs, to reduce gasoline consumption, and to better manage facilities that were at or near capacity. These are the same objectives of most recent projects as well. For example, the implementation of the HOV and MOV pricing strategies on the Tappan Zee Bridge was part of a regionwide transportation system management plan developed to help reduce travel times and congestion in the area. Other elements of the program included park-and-ride lots and ridesharing programs.

Although the experience has not been extensively documented, it appears that a number of the toll HOV projects examined are providing either travel time or financial incentives that are attractive enough to commuters to encourage them to use buses, vanpools, and carpools instead of driving alone. As discussed in the concluding section of this paper, it appears that additional research would be beneficial to further examine the influence of toll HOV strategies on changing commuter behavior and assisting with managing traffic congestion.

CONCLUSION

A review of the national experience with priority measures for HOVs on toll facilities in the United States has been presented. The types of HOV projects examined included HOV pricing strategies and HOV priority treatments. Current examples of both techniques were examined and the limited information available on the experience with different strategies was reviewed.

On the basis of the information examined in this paper, it is evident that HOV pricing strategies and HOV priority treatments are being utilized with a variety of toll facilities in the United States. Although information on utilization levels and the influence on mode choice is limited, it appears that many of the toll HOV strategies are assisting with congestion management at toll plazas and are encouraging greater utilization of buses and car-

TABLE 6 Monthly Use of Four California Toll Bridges

Facility	June 1992 Traffic Count		
	Free (HOV) Vehicles Number	Percent	Total Vehicles
Dumbarton Bridge	86,676	10%	858,852
San Diego - Coronado Bridge	370,989	37%	999,546
San Francisco - Oakland Bay	63,416	2%	3,647,771
San Mateo - Hayward Bridge	1,275	1%	1,073,862

Source: California Department of Transportation

pools in certain corridors. Thus, information contained in this paper helps provide a better understanding of the current use of HOV pricing strategies and HOV priority treatments with toll facilities in the United States.

Further, the analysis also indicates that additional research would be of benefit to better document the experience with HOV strategies on toll facilities and to better understand the influence of the various projects. Areas for further research could include the examination of vehicle and passenger volumes at HOV and non-HOV toll plazas, the use of various HOV pricing methods and pricing levels, surveys of HOV users to determine the influence of the pricing strategies and priority treatments on encouraging a mode change, and the impact of reduced HOV tolls on agency revenue. This paper helps provide the first step for a more detailed examination of HOV treatments on toll facilities.

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