

cialso that a constituency for such a program is developed at the local level.

3. The adjudication component of the enforcement process is often a barrier to the overall effectiveness of the program. The courts have other responsibilities that decrease the amount of resources they devote to parking enforcement.

4. Police departments also have other responsibilities that they consider more important than parking enforcement; meter maids can be used effectively in their place to distribute tickets.

5. Revenues from parking enforcement can often be quite substantial, many times more than paying for the costs incurred for program operation.

6. A major obstacle in establishing a parking enforcement program is in obtaining the funds to initiate the program. Currently, the U.S. Department of Transportation provides funds for such a purpose.

In summary, parking management programs are of increasing interest to transportation officials concerned with economic development, congestion, neighborhood amenity, and city finances. The effectiveness of these programs, however, is directly related to the level of enforcement provided during the initial stages and throughout the project's life. To formulate an effective enforcement strategy requires the participation of the police department, local officials, the courts, community groups, and the business community. This process can often be very controversial. However, each of these actors has an important role to play if the enforcement program is to be successful.

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Enforcement Requirements for High-Occupancy Vehicle Facilities

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Enforcement of high-occupancy vehicle (HOV) traffic restrictions forms an integral and sometimes critical element of HOV preferential treatment projects. This paper summarizes the findings of a research study conducted for the Federal Highway Administration. This research (a) reviewed enforcement on HOV facilities, (b) identified effective HOV enforcement techniques, (c) developed model legislation for effective HOV enforcement, and (d) prepared HOV enforcement guidelines. Sixteen projects in the United States, representative of each type of freeway and arterial treatment, were visited to gain in-depth operational and enforcement data on each project. These projects exhibited varying enforcement programs, deficiencies, and performance levels. Enforcement guidelines have been prepared for each type of freeway and arterial priority treatment of HOVs. In order to improve enforcement of HOV facilities, innovative techniques, involving photographic instrumentation, mailing of citations, tandem (team) patrol, and paraprofessional officers, have been identified within the context of this research. For these innovative techniques to be effective, a compatible legal environment is necessary. This research conducted a legal review of six prominent legal issues posed by these techniques. Model legislation is drafted to provide the proper legal environment for effective HOV enforcement.

A number of high-occupancy vehicle (HOV) projects

have suboptimal levels of enforcement. This is due in part to a lack of engineering concern with enforcement, even though the enforcement issue has a considerable impact on the operational and safety characteristics of HOV projects. As diversification in the design of HOV preferential treatment projects continues, the issue of enforcement of HOV facilities takes on greater importance and the need for developing enforcement strategies becomes essential.

ENFORCEMENT PLANNING PROCESS

In selecting a final HOV design strategy for implementation, the enforceability of that concept should be taken into consideration. For each HOV design strategy, the project planning and design team should ask, "How difficult will it be to enforce the restrictions associated with each of these strategies?" Possible modifications to the HOV design strategies should be explored to alleviate as many

potential enforcement problems as possible.

Traffic law enforcement personnel should be intimately involved in the planning effort so that their valuable insight into the nature of possible enforcement problems may be encountered and also to gain their support for and sensitivity to the constraints within which the transportation engineer has to work. In many cases, compromises may have to be made in terms of the final design concept or the desired enforcement program.

Once the HOV design concept has been selected from a number of candidate strategies, a comprehensive enforcement program should be developed. Several enforcement strategies may be applicable to the realistic enforcement objectives of an HOV project. A careful review of the local legal environment and state statutory requirements should be made, particularly if innovative enforcement practices are under consideration. There are two basic criteria that can be used to judge the performance of the various enforcement options. These are (a) the projected violation rate and (b) the projected cost of the enforcement program. The selection of the alternative that produces the best results per dollar invested can be made in a straightforward manner. Unfortunately, detailed statistical information is lacking to forecast the violation rate.

In view of the lack of precise data on which to base the design of the final enforcement program, an evaluation plan should be developed to ensure a continuous flow of empirical data and feedback for program optimization. Specific areas related to HOV lane and enforcement operations that should be quantified include the following:

1. Relation between the number of citations issued and the number of violations that occur;
2. Interrelations among the violation rate, apprehension rate, and the travel time savings of the HOV lane; and
3. Changes in the violation rate due to changes in the quantitative, qualitative, or substantive aspects of the enforcement program.

A detailed enforcement manual is recommended for effective management of a complex HOV program. This manual should provide descriptions of the HOV project, system operations, enforcement procedures, and reference information.

Public awareness is essential for any new enforcement program. If the public understands the HOV operating strategy and its restrictions, the tendency to violate may be reduced. Furthermore, enforcement agencies concur that a public awareness program that notifies the public of enforcement activities increases the effectiveness of the enforcement effort. Inexpensive public education techniques available include news releases and conferences, public service advertising, transit advertising, speakers' bureaus, pamphlets or handouts, and banners over the roadway. More expensive techniques include paid television, radio, and newspaper advertising, as well as roadside billboards. The primary message that should be transmitted about HOV enforcement should be a simple statement of (a) what the law states and what is prohibited, (b) what will be done if a violation of that law occurs, and (c) what the consequences are if a violator is apprehended or cited.

HOV ENFORCEMENT PROGRAMS

A number of interrelated elements may comprise the HOV enforcement program. These elements are

1. Enforcement strategies,

2. Enforcement procedures,
3. Objectives of the enforcement program,
4. Priority assigned to the HOV enforcement program,
5. Assignment of enforcement personnel,
6. Enforcement equipment,
7. Enforcement budget and funding,
8. Enforcement planning, and
9. Legal and judicial environment.

Enforcement strategies related to HOV projects can be organized into three broad categories: routine, special, or selective. Routine enforcements are those enforcement activities that are randomly conducted in concert with the normal assortment of a uniformed police officer's duties. Special enforcement involves police activities planned and applied specifically to the HOV project on a continuing basis. Selective enforcement is a combination of both routine and special approaches, to the extent that special enforcement is applied periodically by officers in conjunction with a routine enforcement program. Routine enforcement can be an effective approach if the HOV project's geometric or operational features result in an acceptable (or tolerable) violation rate. If it does not, then special or selective enforcement would be required, provided funds are available.

Enforcement procedures may vary among HOV projects because accepted traffic law enforcement practices consist of a myriad of procedures. HOV enforcement programs consist of procedures for

1. Surveillance and detection, such as foot patrol, mobile patrol, stationary patrol, and hidden patrol;
2. Apprehension and citation, such as standard pursuit, stationary apprehension, wave-off, mail-out warnings, and team approach; and
3. Management approach, such as interagency approach, public information campaign, and enforcement manual.

The enforcement objective, whether stated formally or informally, is generally described as maintenance of the integrity of the HOV project. Once the HOV project gains operating experience, some enforcement programs establish a specific enforcement objective by defining a tolerable violation rate.

The level of relative priority assigned by the enforcement agency to the HOV enforcement program is usually indicated by the type of enforcement program selected for deployment. Special enforcement indicates relatively high priority because additional resources are required to execute such strategies. The extra enforcement personnel associated with a special enforcement program are assigned to detect, apprehend, and cite the violators of the HOV restrictions.

The number of personnel assigned to each HOV project is dependent on many factors, the most significant of which include the following:

1. Project length,
2. Project operation,
3. Project restrictions,
4. Enforcement strategy, and
5. Availability of enforcement personnel and funds.

The number of enforcement personnel assigned to cover an HOV project can vary greatly between similar projects. The motor vehicle is the primary equipment item.

HOV enforcement programs are usually funded

through the enforcement agency's existing budget. This is especially true for enforcement programs that involve routine patrol and selective patrol strategies. The enforcement agency may be unable to allocate special funds for special or selective enforcement of an HOV project, and thus the HOV project must operate with routine enforcement. HOV enforcement should not necessarily be considered a drain on public funds. Each time a traffic citation is issued for an HOV violation, a fine is usually paid. The dollar amount of these fines is then allocated in some manner to the local or state treasury. The dollar amount of fines collected for HOV citations could exceed the costs of enforcement for the HOV project.

One of the most-significant factors in achieving a successful enforcement program is the early involvement in the planning process by representatives of the enforcement agencies affected. This is especially true for HOV projects that will require either special or selective enforcement. The advantages of the early involvement of the enforcement agency in the planning process of an HOV project centers on these areas:

1. Provision of technical advice,
2. Promotion of cooperative relations, and
3. Personnel planning and budgeting.

In general, the HOV violation is cited either as a failure to obey a traffic control device if the project is based on general legislation or as a specific offense of the HOV designation if the legal statute or ordinance is more specific. The fine is dependent on the fine schedule established within the jurisdiction responsible for the project.

A good enforcement program can be undermined by the judicial branch of government if the judicial branch does not uphold the citations issued. An HOV project is susceptible to misinterpretation by the judicial branch. Briefings for traffic court judges regarding the HOV project can have an important influence on court attitudes. Judicial appreciation of the project's merits helps develop the proper judicial support for the project. Specifically, the judges should be informed of

1. Objectives of the HOV project,
2. Traffic regulations applied to achieve the objectives,
3. Enforcement approach,
4. Previous court rulings on similar projects, and
5. Legal basis for the restrictions and enforcement procedure.

Problems and Deficiencies

A number of HOV enforcement problems and deficiencies are created by geometric, operational, or institutional factors. The problems are as follows:

1. The lack of a safe and easily accessible refuge area bordering the HOV lane that can be used to apprehend and cite HOV violators;
2. The absence of any vantage point from which enforcement can observe the HOV facility while keeping out of view may cause enforcement to be inefficient and too visible,
3. Some concurrent-flow HOV projects do not have the HOV lane physically separated by barriers, traffic posts, or other implements from the general traffic lanes and thereby provide the motorist with an infinite number of locations to violate the HOV regulation;
4. If an HOV facility does not have a paved

surface, clear of obstructions, for passing, then apprehension maneuvers can be difficult because general traffic lanes, especially on freeways, are usually congested;

5. On HOV systems where carpools are permitted, the determination of the number of occupants in a vehicle is made difficult by young children, vans and mobile homes, mirrored glass, hours of darkness, and inclement weather;

6. Most HOV projects have a speed differential between the HOV lane and the general traffic lanes, which presents a significant safety concern for all traffic and especially enforcement;

7. For HOV projects where refuge areas are not adjacent to the HOV lane, the citing of HOV violators is less visible to the motorists;

8. Certain HOV restrictions require judgment decisions on the part of the enforcement personnel; the primary judgment situation faced by enforcement personnel focuses on curb bus lanes and the use of the bus lane by vehicles turning right;

9. A good enforcement program for an HOV project requires proper coordination and cooperation between project management, enforcement, and judicial interests; if the cooperation between any two participants deteriorates, for whatever reason, then the enforcement program will suffer;

10. Traffic law may limit the effectiveness of potential HOV enforcement programs; because of geometric or operational problems associated with an HOV project, it may be extremely difficult for the officer who witnesses the offense to be the officer who apprehends the offender;

11. Many enforcement agencies have personnel constraints that hinder the traffic enforcement requirements imposed on the agency; and

12. A low probability of being cited, especially when combined with a low fine, offers little incentive toward compliance with HOV restrictions.

Program Performance

The primary measure of effectiveness of an HOV enforcement program is the violation rate achieved. On most projects, and for the purposes of this report, the violation rate is defined as the percentage of the total number of vehicles that use the HOV lane that fail to meet eligibility criteria for the HOV lane. The violation rates for the HOV projects encompass a wide range of percentages--from a nearly 0 percent violation rate to a violation rate of greater than 50 percent. The latter percentage means that the majority of vehicles that use the HOV lane are violators.

That an HOV project experiences a relatively high violation rate may not necessarily indicate failure of the objectives of the HOV project. The intent of employing a certain enforcement strategy is, in part, to achieve a violation rate that is considered tolerable to project management, enforcement personnel, motorists, or the general public. A high violation rate could very well be considered to be tolerable by the determinant group.

A number of factors affect the violation rate. These include the following:

1. HOV lane signing,
2. Bus versus carpool HOV lane restriction,
3. Travel time benefits,
4. Probability of apprehension,
5. Accessibility to the HOV lane,
6. Operating period,
7. Occupancy restriction,
8. Visibility, and
9. Weather conditions.

One of the objectives of HOV projects is to improve traffic flow on the particular facility; however, enforcement of the HOV projects often disrupts traffic flow. The directly related traffic flow problems are mainly associated with an apprehension procedure that results in hazardous weaving maneuvers performed by the enforcement vehicle alone or the enforcement-violator tandem. Once an HOV violator is escorted to a refuge area, the enforcement effort can be indirectly involved in disrupting traffic flow and contributing to traffic accidents through the phenomenon known as rubber-necking, which is associated with the curiosity of motorists and the presence of enforcement of any kind.

ENFORCEMENT OF HOV PRIORITY TREATMENT PROJECTS ON FREEWAYS

Certain recommendations for enforcement of HOV priority treatment projects are common to all freeway applications:

1. Enforcement requirements should be included in the earliest stages of project planning, and enforcement personnel should be active members of the planning team;
2. To the maximum extent possible, HOV priority projects should be designed, constructed, or modified in strict conformance to American Association of State Highway and Transportation Officials (AASHTO) and Manual of Uniform Traffic Control Devices (MUTCD) standards;
3. Officials of the traffic court system should be briefed prior to the project start-up about the project's operational goals, traffic restrictions, enforcement program, and legal basis;
4. On a project that has as its operational goal travel time savings, the HOV restrictions should be imposed only during those time periods when these savings can be achieved;
5. The entire project should be opened at one time;
6. Enforcement should be supported by extensive public education and publicity of the seriousness of the HOV restrictions; and
7. Aggressive enforcement should begin immediately to instill a degree of respect for the HOV restrictions.

Separate Facilities

Separate freeway facilities for HOVs include separate roadways and exclusive ramps. These facilities are designated for exclusive use by specified HOVs and all other vehicles are expressly prohibited. Separate facilities possess many of the operational characteristics of tunnel facilities, one of which is an irrevocable commitment to using the facility. This attribute makes separate facilities generally easy to enforce.

Separate HOV roadways characteristically have low violation rates, which vary from 0 to 6 percent where separation is permanent and from 5 to 10 percent where violators can gain access or egress by crossing partial separations.

The following specific recommendations are offered for separated HOV facilities:

1. The facility should have full right and left shoulders;
2. On partly separated facilities that have common shoulders, the shoulders should be flush and easily accessible by disabled vehicles but they should also be well delineated to discourage crossing the median shoulder;
3. On reversible facilities, access control must

be positive; use of lane control signals is suggested by MUTCD and AASHTO, and gates or barricades should also be provided; and

4. Access locations should be designed to meet the traffic demand but should also be upstream of bottleneck locations if possible.

Except for some project-specific reason, the enforcement strategy should involve mobile patrol of the general traffic lanes with officers also conscious of the HOV facility. When the incidence of violations appears to be increasing, patrols should be stationed at strategic points on the shoulder of the HOV roadway. This surveillance should vary by timing and should use inconspicuous locations. Apprehension should generally be made on the HOV lane shoulder, unless a convenient exit can be safely reached.

Concurrent-Flow Lanes

Concurrent-flow HOV lane-priority projects on freeways generally involve the designation of the median lanes for use by buses alone or by buses and carpools. Access to the restricted lane is most often continuous; that is, there is no physical separation or other barrier between the HOV lane and general lanes. This feature makes concurrent-flow lanes among the most difficult HOV treatment to enforce. Concurrent-flow HOV lanes can be created by either reserving an existing lane for HOVs or, more commonly, by constructing new lanes in the median. These two approaches have differing effects from an enforcement point of view. First, the addition of lanes often eliminates or reduces median shoulders or refuge areas that otherwise might be used as vantage points for police patrols and for issuance of citations. Second, the taking of a lane for HOVs most likely will increase the congestion in the general travel lanes, thus making it more desirable for a motorist to violate. The public acceptance of this type of HOV treatment has been much better when new lanes are constructed for the HOVs.

Violation rates among concurrent-flow-lane projects can vary dramatically, ranging from 10 to 60 percent. The following specific recommendations are offered for concurrent-flow HOV lane projects:

1. The facility should have median shoulders and refuge areas; these are needed both for public safety and to provide an area for officers to monitor HOV operations effectively;
2. On projects that operate in both directions during the same hour, median barrier cuts should be motorized (if there is a median barrier) to enable motorcycle officers to enforce in both directions; and
3. Signing and markings should conform rigidly to MUTCD standards, and special supplemental signs should be used as needed; limits of the HOV priority section should be clearly defined [special demarcation between the HOV lane and general traffic lanes can be provided by wider skip lines (8 in) or by a continuous row of mountable buttons].

The enforcement strategy should involve monitoring by motorcycle officers in the median. If not possible, mobile patrols in adjacent general lanes should then be used. Apprehension and detention should not generally be made in the median. Offenders should be pursued to the outside of the freeway and then off the facility in order to minimize disruption to traffic flow. If congestion is heavy in general lanes, extreme care should be exercised in escorting violators off the freeway. Where left-hand exits exist downstream, violators

should be escorted in the HOV lane to these exits.

Contraflow Lanes

The common application of contraflow HOV lanes is to assign the inside (median) lane in the opposing (off-peak) direction to a special class of vehicles. The contraflow lane is separated from the other travel lanes by insertable plastic posts. If sufficient capacity remains in the off-peak direction, an additional lane can be taken for use as a buffer lane. The vehicles qualified to use the contraflow lane are usually buses. Buses (and other vehicles if permitted) enter the lane via a median crossover or by a special ramp and proceed in the peak direction against the flow of off-peak-direction general traffic, and thereby bypass congested traffic in the peak direction. The output terminal depends on the site and may be a crossover merge with the general freeway or it may terminate at a bridge, tunnel, or toll facility.

Violation rates on contraflow HOV lane projects approach 0 percent.

The following specific recommendations are offered for contraflow HOV lane projects:

1. Delineation of the HOV lane should include removable safety posts and barricades, changeable message signs at access points, and lane control signals (red X and green arrows) over the contraflow, buffer, and adjacent general lanes;
2. Spacing of lane control devices should have at least one, and preferably more, devices in view of opposing traffic; spacing of delineators should be close enough to discourage lane changes and a 40-ft maximum spacing is recommended;
3. A buffer lane should be provided if possible;
4. Full right and left shoulders should exist for emergency stops in both the contraflow lane (median shoulder) and opposing general traffic (right shoulder);
5. If the output terminal is not inherently suitable for detaining violators (such as a toll plaza), a refuge area should be provided, preferably in the median;
6. Speed limits on both HOV and opposing general lanes should be lowered as necessary to reduce relative speeds; and
7. Quick-reaction incident detection and removal systems should be incorporated into the project; if possible, median cuts should be provided if there is no buffer lane so emergency vehicles can approach in the proper direction.

The most-effective enforcement strategy is to have officers stationed at the access point to divert nonqualified vehicles from using the lane. Depending on the site-specific requirements of the project, the preferred strategy can be selective or continuous special enforcement. Routine freeway patrols should be extremely observant for violators and, more importantly, for incidents. Even accidents in the opposing general lanes can cause swerves into the contraflow lane by vehicles trying to avoid rear-end collisions. Violators detected in the contraflow lane should be apprehended in the terminal area if possible.

Ramp-Metering Bypass

Ramp metering has been used for nearly two decades to improve general operations on freeways by limiting access onto the mainline of the freeway. As an incentive to HOVs, bypass lanes have been constructed that allow these vehicles free access to the freeway without the delays encountered by low-

occupancy vehicles at the ramp signal. The ramp-metering-bypass (RMB) technique can be used at isolated ramps or can be incorporated into a series of ramps that collectively form an RMB-HOV priority system. RMB lanes are generally constructed by widening existing ramps or redesignating one lane of existing multilane ramps.

Violation rates among RMB projects can vary dramatically and range from 0 to 40 percent.

The following specific recommendations are offered for RMB projects:

1. Provide a physical separation between the RMB lane and the general ramp lane, if space and funding resources permit; if there is no physical separation, then there should be a solid white-line demarcation between the lanes, supported by raised pavement buttons for additional emphasis;
2. A vantage point should be provided for a stationary officer to monitor the RMB lane out of view of the motorists; adequate shoulders should be provided for the apprehension and ticketing of violators; and
3. The selection of right or left lanes as the HOV lanes is important, particularly on nonseparated RMB ramps; consideration should be given to access to the ramp, position of signals, relation to the stopped queue, and how the two lanes will merge.

Because of the isolated nature of this priority treatment, continuous enforcement is impractical, particularly if a large number of ramps is involved. Bus-only RMB ramps are less prone to violations but still require periodic attention. A selective enforcement system should be established so that each ramp is targeted on a periodic, but random, pattern. The enforcement assignment should be dependent on violation levels, which requires some type of data-collection scheme.

Patrols, preferably motorcycle mounted, should station themselves where they can observe the HOV lane and the ramp signal and observe for violators. Preferably, the position is hidden from view. Once a violator is detected, he or she should be pursued or (if possible) waved over to the shoulder. Tickets should be issued in view of the ramp traffic for maximum effect because the disruption to ramp traffic is not as detrimental as it is on the mainline.

Exclusive Toll Plaza Lanes

A toll plaza is inherently a bottleneck on a freeway. Exclusive toll plaza lanes serve several purposes. They allow HOVs to (a) bypass queues on the approach, (b) move through the toll station with minimal delay, and (c) gain preferential access to the toll facility itself.

Exclusive toll plaza lanes for HOVs can operate efficiently and with relatively few violations. Selective enforcement, when used periodically, can maintain a sustained violation rate that is lower than 10 percent.

The following specific recommendations are offered for exclusive toll plaza lanes:

1. Provide special areas, such as a refuge area or shoulder, adjacent to the HOV lanes in order for officers to monitor the HOV lane and conduct the enforcement operations;
2. Provide a physical separation, such as a barrier wall or raised curb, between the HOV lanes and general lanes so long as such a barrier does not pose safety hazards itself; and
3. Where the facility is not metered, the capability of informing toll attendants to halt traffic should be included (this would clear the downstream

roadway and allow police vehicles to pursue violators and, more importantly, allow emergency vehicles to travel unimpeded).

Mobile patrols should provide routine enforcement by monitoring the HOV lane operations from stationary positions, preferably adjacent to the lanes. The toll booths are an excellent location for detection, but apprehension is disruptive. When warranted by increasing violation rates, selective enforcement teams should be called in to set up shunt lanes (if refuge areas do not exist) in which to store violators while they are being ticketed.

ENFORCEMENT OF HOV PRIORITY TREATMENT PROJECTS ON ARTERIALS

The nine recommendations for enforcement of HOV priority treatment projects, which are presented as being common to all freeway applications, are also common to all arterial street and highway applications.

Separate Facility

Separate facilities on an arterial street system are commonly referred to as transitways because the transit coach is often the only type of vehicle that is permitted to travel on such a facility. A transitway may serve as a major transit collection-distribution route and provide benefits of transit accessibility and separation of different classes of vehicles. Also, a transitway may serve the line-haul portion of transit service and provide the more traditional HOV benefits of travel time savings and increased total person throughput.

Transitways tend to be easily enforced and violations of the restrictions are virtually nonexistent.

The following specific recommendations are offered for separate facility HOV lane projects:

1. Appropriate pedestrian controls should be instituted if pedestrian crossing is considered to be a safety problem (these controls include pedestrian cross-walks, pedestrian signals, and strict enforcement of jay-walking);

2. Procedures regarding bus operations on the transitway should include reduced bus speeds and increased driver awareness and courtesy;

3. Cross-streets across the transitway should be eliminated whenever possible; when the elimination of cross-streets is impossible, the turning movements between the transitway and the cross-streets should be restricted; and

4. Terminal areas and any other access areas should be well signed and marked and the traffic appropriately channeled.

The use of routine enforcement in either mobile or pedestrian modes should be satisfactory for HOV enforcement purposes.

Concurrent-Flow Lane

Concurrent-flow priority applications on arterial highways involve reservation of either the curbside lane or the median lane for HOVs. Curbside lanes have historically been installed to provide better transit circulation in the central business district (CBD) or to improve downtown traffic flow through the segregation of buses and automobiles. A second objective may be to provide a travel time improvement (not advantage) for buses. Taxicabs, other vehicles that load and unload passengers, vehicles turning right, motorcycles, and bicycles may also be permitted to travel in the curb HOV lane. Enforce-

ment requirements on the curbside concurrent-flow lanes address illegal stopping, parking, or ineligible vehicular travel in this lane. Median lanes are generally intended to provide HOVs with travel time advantages by bypassing traffic congestion in the general traffic lanes. Enforcement requirements address the illegal travel in the lane as well as possible illegal turning movements across the median HOV lane.

Concurrent-flow lane projects can be operated effectively with reasonably few violations; however, this may require a special enforcement program. Without special enforcement, the number of violations may interfere with the operations of the HOV lane. The following specific recommendations are offered for concurrent-flow HOV lane projects:

1. Enforcement of HOV lanes may have an additional concern with parking and turning restrictions; these restrictions may require more enforcement attention than will violations of the HOV lane itself;

2. For a median lane HOV treatment, use of bays for left turns (closed off due to left-turn restriction) have proved to be an effective area for enforcement vantage points and detention areas, when coupled with a special enforcement program;

3. Signing and markings should conform rigidly to standards, but special supplemental signs should be used as needed; limits of the HOV priority section should be clearly defined;

4. For a median lane HOV treatment, cones or safety posts should not be employed to separate the HOV lane and general travel lanes (these implements can pose safety problems and do not favorably affect the violation rate);

5. For a curbside lane HOV treatment, locations should be available or provided where officers can apprehend and issue citations to violators without encroaching onto the main roadway; the use of cross-streets may be an appropriate detention area; and

6. For a curbside lane HOV treatment, the signing to permit right turns should specifically state the point at which a vehicle that is turning right may enter the priority lane.

Median lane HOV treatments should be enforced by selective or special enforcement efforts. On curbside HOV lane treatments, routine patrols (mobile or foot) could be justified as capable of producing a tolerable violation environment.

Contraflow Lanes

A contraflow HOV lane is commonly a lane in the off-peak direction reserved for HOV vehicles traveling in the peak direction. It can incorporate the median lane or the curb lane of a highway facility. A contraflow HOV lane that operates in the median lane is commonly associated with express-bus service that operates in a through mode or on a line-haul trip. A contraflow HOV lane that operates in the curb lane occurs on a facility that otherwise serves one-way traffic. This type of operation is commonly associated with local bus service that makes periodic stops for loading and unloading passengers.

Enforcement of both types of contraflow-lane treatments are concerned with (a) violators of the HOV restrictions and (b) violators of the supplemental traffic restrictions necessary to operate the contraflow lane. The violators of the supplemental traffic restrictions are frequently of much greater concern to enforcement officials. Supplemental traffic restrictions may involve turning movements across the HOV lane and parking or stopping in the HOV lane.

Violations of the bus-only restriction are uncommon because bus volumes in the contraflow lane can be high and this provides a self-enforcing feature. Also, a non-bus vehicle in the contraflow lane is very conspicuous to police officers. Another deterrent is that the general lane traffic is moving in the opposite direction of the contraflow lane. With a bus-carpool contraflow lane, violations may be more prevalent because a violating vehicle is no longer as conspicuous as in the case with a bus-only restriction.

The following specific recommendations are offered for contraflow HOV lane projects:

1. In addition to HOV lane violations, enforcement also needs to focus on turning and parking restrictions; these restrictions may pose greater responsibilities for enforcement;
2. Geometric and traffic control techniques intended to eliminate or physically impede access at intermediate intersections greatly enhances enforcement on contraflow facilities and should be deployed where possible;
3. Overhead lane-use signals and signs should be used, especially where extensive visual clutter decreases the effectiveness of roadside signing;
4. The use of temporary traffic control devices (such as cones, gates, and signs on stanchions) has proved to be effective in eliminating illegal turns across the contraflow lanes on projects that have physical medians; the elimination of illegal crossing turns on projects that do not have physical medians will require site-specific enforcement;
5. If possible, curbside contraflow lanes should be wide enough for a bus to pass a disabled bus safely; wide lanes enhance enforcement by providing an enforcement vantage point, a passing lane for violator apprehension, and a detention-citation area; and
6. If possible, median contraflow lanes should have a median from which enforcement officers can monitor the project's operation; without this median, enforcement will be increasingly difficult and police will be required to cross the general traffic lanes.

Routine line patrols should be adequate for enforcing many contraflow HOV projects. However, extensive turning restrictions when coupled with very little geometric or physical control of such restrictions can produce a significant amount of illegal and hazardous turning maneuvers. Therefore, selective and special enforcement strategies should be considered in such situations. Specific selective or special enforcement may include stationary or mobile patrols.

INNOVATIVE ENFORCEMENT TECHNIQUES

Readily available innovative techniques that could benefit HOV enforcement include the following:

1. Use of photographic systems and instrumentation to detect HOV violations and identify the violators,
2. Use of law enforcement paraprofessionals to detect HOV violations and identify the violators,
3. Mailing of traffic citations and warning letters to the registered owner (identified through the license plate) of a vehicle that violates the HOV facility, and
4. Mass screening of license tags to identify habitual violators.

Two separate research projects sponsored by the U.S. Department of Transportation have studied

photographic instrumentation for enforcement purposes. These projects are the Mobile ORBIS III speed enforcement demonstration project in Arlington, Texas, and a photographic system for obtaining automobile occupancy counts. The Federal Highway Administration is extending this latter research, in part to produce a photographic system specifically for the various needs associated with enforcement of HOV facilities. This photographic system consists of a camera, a stroboscopic light source, and a vehicle-actuated triggering mechanism.

The use of paraprofessionals removes the enforcement responsibility from a valuable resource in short supply--the law enforcement officer. The use of such personnel or civilian observers for non-arresting activities, such as development of a data base, could enhance the efficiency of the enforcement process.

The legal environment required to mail HOV citations to the owner of a vehicle that violates the HOV facility would exist if two legal concepts, decriminalization and presumption, are included in the jurisdiction's statutes or ordinances. Inclusion of these two legal concepts should preclude challenges made against citations mailed to the registered owner.

A mass screening technique for license tags uses a small portable computer that stores information on vehicles that have been involved in certain types of unlawful activity. The data base is used by entering the license tag number of each vehicle encountered at an apprehension point. The system responds by indicating whether or not the driver should be detained. This concept could be adapted to HOV enforcement by defining the data base to include only those vehicles identified as repeat (but unapprehended) violators of HOV regulations.

LEGAL ISSUES

For many of the HOV projects that were surveyed, changes in law are necessary prior to the incorporation into the enforcement process of any innovative techniques. Certainly, a better understanding of the capabilities of traffic enforcement to execute such techniques within the existing legal environment is highly desirable. This research has identified five key legal issues associated with the innovative enforcement techniques.

Admissibility of Photographic Evidence

Courts recognize that photographs may be relevant to the issues and so they may be introduced as evidence to establish identities. It is highly unlikely that photographic evidence would be denied by the courts because of invasion of privacy, right to equal protection, or freedom of association. Use of photographs for other than HOV enforcement may constitute illegal surveillance. Destruction of HOV photographs may also hinge on whether they are considered an exception to the public record statutes or ordinances.

Instrumentation and Certification Requirements

An HOV photographic instrumentation technique would undoubtedly need to undergo the process of securing judicial acceptance of the technique. Credentials of a judicially unestablished scientific device must be proved by expert witness testimony. Given sufficient training, police officers and paraprofessionals could be trained as experts in the workings of the HOV equipment so that their testimony would satisfy the expert witness requirement. After judicial acceptance, the need for repetitious expert

verification will no longer be necessary.

Visibility of Occupants

The basis for the visibility of occupants issue is that fulfillment of the requirement for number of occupants in a vehicle in the HOV lane will be related solely to their visibility. It would be necessary to write into the legislation a presumption clause that, unless the required number of persons is visible, the vehicle is in violation. This visibility presumption may be a rebuttable presumption so that the driver of the vehicle could present proof of the existence of the required number of occupants. The importance of this statutory language is that the burden of proof is initially on the motorist not the citing officer.

Mailing of Citations to Owner of Vehicle

HOV citations may be mailed to the owner of a vehicle in violation of the HOV facility if two legal concepts, decriminalization and presumption, are included in the jurisdiction's statutes or ordinances. Inclusion of these two legal concepts should preclude challenges made against citations mailed to the registered owner. Most states have established prima facie evidence presumptions in municipal parking ordinances whereby the registered owner is presumed to be the violator. These prima

facie presumptions have been found to be valid and constitutional. Where moving violations are treated as noncriminal infractions, they may be considered no different from parking violations. This is especially true where no points are assessed against a driver's record for the violation and the only penalty is a fine.

Citation Issued by Nonwitnessing Officer

Speed devices such as radar and air surveillance have been used extensively to allow nonwitnessing officers to cite the violator. Where the appropriate statutes or ordinances have been passed or judicial precedent has allowed, such citations issued by nonwitnessing officers have been consistently upheld by the courts.

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Transit Lane Enforcement in the Central City

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Transit lanes in crowded urban core streets are potentially effective for improving transit operations when they are available to transit vehicles. Concurrent-flow transit lanes are susceptible to violation by motorists. Police enforcement is often costly and inconsistent. A 2-year demonstration grant, from the Urban Mass Transportation Administration to San Francisco, tested the concept of self-enforcing lanes by using improved lane markings to heighten motorist's awareness and, hence, voluntary compliance. A separate study of nontraditional enforcement techniques was included within the grant funding. The results of the test showed negligible change in motorist's behavior, but the research uncovered valuable information about more significant contributors to transit delay, namely, double-parked vehicles and a spotty parking enforcement program. Subsequent implementation of new transit lanes on a downtown San Francisco street reflected the lessons learned on design techniques and enforcement priorities.

Enforcement has always been cited as a key factor in the design and operation of transit priority treatments. In the central city, enforcement of transit lanes, malls, and other transit preferential features is both important and difficult. In San Francisco, effective enforcement of transit lanes in the central city poses a problem of unique complexity.

The central city area of San Francisco was originally laid out during California's gold rush era. As a result, the area is characterized by short blocks and narrow streets that are well suited for pedestrians. Today, however, transit vehicles, trucks and commercial vehicles, private automobiles, and bicycles all compete with the pedestrian for use of the streetscape. In this environment, the curb has become a valuable commodity. The central city

largely lacks alleys and serviceways, and as a result, most of the movement of goods and service deliveries occur at the curb. At the same time that transit vehicles require use of the curb to load and unload, private automobile drivers similarly desire to use the curb for quick business and shopping stops.

The result of this intense competition for use of the curb space in central San Francisco is frequent double parking and general abuse of curb parking and loading restrictions. These conditions contribute to a congested street environment, particularly during the midday when trucks and service vehicles are most prevalent. The general level of street congestion that prevails in the central area also encourages drivers to violate transit lanes. At the same time the San Francisco Police Department has been constrained by (a) limited resources, (b) a general public attitude that places a low priority on enforcement of traffic and parking, and (c) a need to ensure that the movement of goods and service operations is not unduly hampered.

These factors have combined to result in relatively poor operating conditions for vehicles in central San Francisco. Transit vehicle speeds of 4-8 mph are common on many street sections. Transit drivers often avoid use of transit lanes to stay clear of curb activity and avoid being trapped behind a double-parked vehicle.

BACKGROUND

In 1977, a formal study program, designed to di-