Vehicle Use Limitations/Restrictions

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■ Introduction

Section 108(f)(1)(A)(vii) defines the following transportation control measure:

> "programs to limit or restrict vehicle use in downtown areas or other areas of emission concentration particularly during periods of peak use;"

A broad array of techniques can be employed to limit or restrict the use of various types of vehicles in a given geographic area or during a specific time period. Examples include route diversions (e.g., auto restricted zones, pedestrian malls, and residential traffic controls), no-drive days, and controls of truck movements (e.g., designated truck routes, scheduling of truck operations, incident management). In implementing programs that limit or restrict vehicular access, it is customary to simultaneously implement improvements to other travel models (or to take equivalent other mitigating actions) so that overall access to an area is not inhibited.

Auto restricted zones (ARZs) have been found to be most effective for reducing emission "hot spots." In Boston, the Downtown Crossing ARZ resulted in a forty to forty-five percent reduction in carbon monoxide levels within the restricted area with no corresponding or off-setting increase outside the area.

Analysis of **no-drive day programs** reveals that, in the U.S., these programs are voluntary, and generally are one component of a larger program to improve air quality. Denver and Phoenix are two cities that have implemented no-drive day campaigns during the three to four winter months when air quality is at its worst. The no-drive day campaigns have been credited with reducing emissions by approximately two percent in these two cities.

The section of this chapter that deals with **controls of truck movements** focuses on traffic management and truck restrictions of highways. The California Department of Transportation (Caltrans) recently conducted a study to evaluate how four different strategies – traffic management, incident management, night shipping and receiving, and peak period truck bans – would reduce freeway congestion and potentially reduce emissions. The traffic management, incident management and night shipping and receiving strategies are all estimated to reduce emissions. The impact of freeway peak period truck bans on emissions levels is less clear and requires further study.

This chapter discusses each of these three types of vehicle use restrictions. Each restriction is defined and the objectives behind its implementation are identified. Examples of each are then detailed, followed by discussion of the transportation and air quality effectiveness of each, and the costs and benefits of the specific programs.

Guidelines for implementing each type of program are also provided. For each type of restriction, experience has shown that it is important to be sensitive to the legal authority under which the particular measures are being implemented, and especially to the relationships of applicable local, state, and federal laws.

Auto Restricted Zones

Definition and Objectives

Auto restricted zones refer to any area where vehicular traffic is restricted in some manner. Auto restricted zones can refer to the complete closure of streets, such as **pedestrian malls, parking controls, neighborhood parking permits, turn restrictions, exclusive bus lanes, and restrictions on delivery trucks.** Most auto restricted zones are implemented in downtown areas or center city areas.

Generally, auto restricted zones are implemented to achieve at least one of the following three objectives: (1) revitalization of downtown retail districts; (2) reduce congestion; or (3) reduce air pollution in specific localized areas or "hot spots." Frequently, auto restricted zones are part of a larger program to accomplish one of these three objectives. For example, auto restricted zones put in place to revitalize the downtown retail district will likely be accompanied by the creation of a downtown merchant association and marketing committee. Zones put in place to help reduce air pollution in specific hot spots may also be accompanied by the creation of new bus service to the area, or the addition of parking spaces outside of the restricted area.

Auto restricted zones can range from a complete ban of automobiles and motor vehicles from an area, to the restriction of movements of certain types of vehicles within an area. The various types of auto restricted zones are defined as follows.

- **Pedestrian malls** generally restrict all vehicular traffic. They are set up to allow pedestrians free range of both the streets and sidewalks. Pedestrian malls are most common in busy downtown areas.

- **Parking controls** generally refer to the elimination of parking from streets in the zone. The purpose of parking restrictions is to both discourage people from driving to the zone in private automobiles, and to facilitate circulation throughout the zone by eliminating on-street parking.

- **Neighborhood parking permits** are used to discourage on-street parking by non-residents. Residents are given stickers which allow them to park on the streets in their neighborhood. Vehicles without stickers are ticketed. Neighborhood parking restrictions can totally ban non-residential vehicles from parking in the area, or more commonly, allow non residents to park in a neighborhood for short periods of time.

- **Turning restrictions** are used to prevent easy circulation within a designated zone. By preventing easy circulation, circulation within the zone is discouraged. This technique both alleviates congestion within the area, and thus will reduce some air pollution emissions.

- **Exclusive bus lanes** are provided in designated auto restricted zone to encourage the use of transit to the zones. Exclusive bus lanes facilitate bus movements within zones by taking buses out of the main flow of traffic. Buses generally will flow freely through the zones while personal automobile traffic remains congested.

- **Restrictions on delivery trucks** generally are used to prevent delivery trucks from accessing a busy retail area during normal business hours. The purpose of these restrictions is to prevent traffic jams and congestion due to the blockage of major roads by trucks delivering or loading goods.

Several of these types of auto restricted zones can be combined. For example, it is not uncommon for a community to have exclusive bus lanes together with restrictions on delivery trucks. Certainly, pedestrian malls are the most restrictive of the auto restricted zones, and by their very nature they incorporate many of the other types of auto restricted zone features.

Example

Auto restricted zones have been implemented in numerous cities throughout the United States and Europe. Implementation of auto restricted zones was most common in the late 1960s and early 1970s. They were most frequently implemented in downtown areas which needed revitalization. However, auto restricted zones and, most notably, pedestrian malls have been taken out in many communities because they failed to produce the vitalization that was expected. This is because these communities did not have enough activity in their downtown to attract pedestrian traffic.

A good example of an auto restricted zone put in place to stimulate a downtown economy as well as to reduce congestion and air pollution is the Downtown Crossing auto restricted zone in Boston. The Boston ARZ includes a .7 square mile area in the Boston Central Business District. The area is a major retail center, and adjacent to the busy financial center of the city. Approximately 126,300 persons were employed in the area incorporated by the ARZ in 1982. The ARZ includes the major downtown department stores of Filene's and Jordan Marsh. It is a major shopping destination for residents of and visitors to the greater Boston metropolitan area.

The Boston ARZ included busway improvements, contra flow lanes, the closure of two major streets to all traffic, resurfacing of some streets with brick, restrictions of traffic on additional streets adjacent to the zone, elimination of on-street parking in many areas around the zone, changes in circulation patterns within the zone and areas adjacent to the zone, and promotional efforts. There were two main goals of the ARZ created in downtown Boston. One was to improve the shopping experience in the area by

restricting traffic and eliminating congestion. The second was to improve air quality in downtown Boston. Between 1978 and 1980, traffic volumes in the ARZ decreased by five percent. Over eighty-five percent of the reductions in trips were attributed to changes in mode. The remaining trips were accounted for by people who were simply avoiding the area all together.

Because air quality improvements were a major goal of the ARZ in Boston, pollution levels were measured before and after the zone was created. Measurements at the center of the ARZ (on Winter street near Jordan Marsh) showed dramatic improvements in carbon monoxide levels after the ARZ was established. The maximum one hour CO level fell from 26.3 to 12 ppm, while the maximum eight-hour average fell from 15.2 to 5.0 ppm. The latter was a sixty-seven percent decrease in the maximum eight-hour average CO level. Thus, the eight-hour average CO level at the Winter Street site was brought within the EPA standard of 9 ppm as of a result of the implementation of the ARZ.

Air pollution measurements also were taken at Arch Street, a site just outside the ARZ which was expected to see increases in CO because of increased bus routes passing the area. It also was expected to be a diversion route for vehicles that would generally travel through the ARZ. Surprisingly, CO levels also fell dramatically on Arch Street. One-hour levels fell from 15.7 ppm in 1978 to 6.4 ppm in 1980. The maximum eight-hour levels fell from 7.4 ppm in 1978 to 4.4 ppm in 1980, representing a forty percent decrease.

Unfortunately, no before and after measures of CO levels were taken at sites significantly removed from the zone, so it is difficult to identify how CO levels were effected in the region as a whole. This is one of the major concerns regarding auto restricted zones. That is, frequently auto restricted zones may reduce air pollution within a localized area, but that vehicle emissions are simply transferred outside the area.

Effectiveness

The effectiveness of auto restricted zones can be measured in several ways. If the goal of an auto restricted zone is to stimulate downtown revitalization, a good measure of its effectiveness is changes in retail sales after the auto restricted zone is put in place. A 1977 U.S. Department of Transportation Report, entitled Auto Restricted Zones: Background and Feasibility, lists fifteen different U.S. cities that implemented restricted auto zones between 1959 and 1973. In twelve of these cities, retail sales in the ARZ increased after the zone was put in place. In one city, retail sales were stagnant, while sales in the rest of the city declined. One city realized a slight decline in retail sales in the ARZ, but the decline was much less than the decline experienced in the rest of that city. (No data is available for the remaining city in this study.)

While the ITE, Congestion Toolbox Report provides fairly upbeat results with regard to the retail sales impacts of auto restricted zones, evidence suggests that some cities have not realized the revitalization benefits expected from improvements such as pedestrian

malls. In fact, in the 1980s there were a large number of communities with pedestrian malls which spent considerable amounts of money to tear up pedestrian malls and replace them with free-flowing traffic streets. This was most common in smaller communities which did not have major activity centers in the downtown. To be successful, an auto restricted zone, particularly a pedestrian mall, must have significant pedestrian traffic and major activity centers in the zone area. Otherwise, there is not enough person traffic to patronize the shops and businesses in the restriction area. In smaller communities, automobile traffic passing by shops in the downtown area frequently provides the exposure necessary to attract riders and drivers into stores.

In the Boston example, a decrease in traffic congestion was realized through the implementation of an ARZ. To effectively reduce traffic both within the ARZ and in the streets immediately surrounding the ARZ, it is necessary to implement a good circulation pattern within the area around the ARZ. In addition, traffic congestion can be alleviated through the introduction of improved transit service to the area around the ARZ, and by eliminating parking both within the ARZ as well as in areas immediately adjacent to the ARZ.

Effectiveness at Reducing Emissions

ARZs are most effective at reducing emissions within well-defined, localized areas. They may not be a particularly effective measure for reducing regional emissions if they result in the diversion of through traffic to other routes. In addition, since ARZs typically are relatively small in size compared to the geography of the entire metropolitan region, the size of the travel market directly affected by an ARZ and the corresponding regional emissions reduction also are relatively small on a regional basis. The best way to achieve emissions reduction from an auto restricted zone is to both completely eliminate traffic from within the zone and to provide sufficient transit access and other transportation alternatives to the ARZ. One reason the Boston example had positive results for reducing emissions is the fact that it is very well served by the MBTA's redline service, as well as by several MBTA bus routes. Parking costs in downtown Boston are also substantial, and thus discourage the use of automobiles to access the downtown area.

The Boston case is an example in which reductions of forty to fifty percent of carbon monoxide were achieved through the implementation of a well coordinated and fairly restrictive auto restricted zone. The extent to which an auto restricted zone can reduce emissions depends on the combination of restrictions imposed within the zone. Certainly, the best results will come from complete exclusion of automobiles from the zone area. Exclusive bus lanes will help to reduce emissions from diesel fuel as buses will no longer be stalled in congested traffic. Restrictions on delivery trucks will reduce emissions somewhat by alleviating traffic congestion caused by delivery trucks which block traffic, as well as trucks that leave their motors running while they are loading and unloading.

An important consideration in developing auto restrictive zones for the purpose of reducing air pollution is the extent to which air pollutants are simply transferred to another area as opposed to being completely eliminated. When measuring the emissions impact of auto restrictive zones, it is important to not only measure changes in emissions in the zone area itself, but also in adjacent areas.

Other Benefits and Costs

There are several costs and benefits associated with auto restricted zones besides those related to downtown revitalization, congestion management, and emissions reduction. Some of these benefits include:

- Auto restricted zones frequently include beautification programs. These may include store-front improvements, unification of signage, banners, etc. These beautification programs make the auto restrictive zone a pleasant place to be and provide a good environment for downtown employees and shoppers. Frequently, benches provide good locations for employees to eat lunch or relax. The improvements also help to present a good image of the city to tourists and other outsiders, and can thus result in an improved image of the community outside of the immediate metropolitan area.

- Auto restricted zones are frequently accompanied by a unified effort by the merchants in the effected zone area to promote business activities and other festivals. The unification of the business community, and the ability to get the business community in the auto restricted zone to work towards a common end is very difficult to achieve in most communities. The zone provides a structure that enhances the ability to create merchant associations and to help coordinate marketing and promotional efforts. Generally, these merchant associations and business associations help to enhance the business climate and the environment in the downtown area.

- Auto restricted zones help to provide a recognized destination for both work and recreational trips. This recognized destination will be a larger draw for trips and should thus provide better opportunity for achieving critical levels of ridership to support transit to the area.

Auto restricted zones are not without costs. Some of the costs associated with auto restricted zones include the following:

- Restriction of trucks from auto restricted zones during certain hours can increase costs to downtown merchants. Most trucking firms charge higher costs for delivery of goods during evening hours. In addition, if goods delivery is restricted to hours when the retail activity is not in operation, retailers must pay additional wages to employees who must work longer hours, or they must hire additional employees to work after hours to receive and to ship goods. These costs are passed on to the

consumer through the costs of the retail goods, and it may, in fact, force some companies out of business.

- If an auto restrictive zone is established in an area that is not a major activity center, the auto restrictive zone can frequently lead to loss of business due to a decrease in convenient access to the area. It is important that any community interested in establishing an auto restrictive zone in their retail core look hard at the current activity level to determine whether or not it has the pedestrian traffic necessary to support the businesses in the zone.

- Many of the improvements identified for auto restrictive zones (e.g., new signage, bricking of the streets, construction of exclusive bus lanes, and other physical improvements) can require a large capital investment. The costs of auto restrictive zones varies considerably from place to place, depending on the size of the ARZ, the type of restrictions imposed, whether or not pedestrian areas are beautified, etc. In the fifteen examples listed in the referenced U.S. DOT publication, the costs ranged from $112,000 in Honolulu, to $3,000,875 in Minneapolis.

- If one aspect of the auto restricted zone is the addition of transit service to the area, the cost of the service must be factored in. These costs will vary considerably depending on the type of transit service provided. Costs for additional transit service includes potential construction costs, the cost of rolling stock, and operating costs.

- Enforcement can be an additional cost, particularly in areas where parking restrictions are a main component of the auto restricted zone. For example, in areas where neighborhood parking permits are utilized, it is important that tickets are issued regularly to discourage abuse of the parking restriction. This requires, at a minimum, salaries of meter monitors.

Guidelines for Achieving Effective Implementation

Auto restricted zones have been in existence for over two decades and many lessons have been learned for those who are considering implementing auto restricted zones. It is important from the outset to have very clear objectives for creating an auto restricted zone in any given community. It is appropriate to create auto restricted zones where there are emissions hot spots, so as to alleviate emissions in a particular area in either peak periods or throughout the day. It is also important that any area selected for an auto restricted zone be a vital activity center. Evidence suggests that zones created in areas where pedestrian activity is not significant generally fail to achieve their purpose.

Listed below are several features which are recommended in order to insure that an auto restricted zone is as effective as possible:

- The ARZ must have a stable base of attractions to insure continued economic activity after closure of streets, or traffic restrictions are imposed. Economic activity must continue throughout the day. Thus, retail activity and other general business and

office activity is suggested both with and adjacent to the ARZ in order for it to be most effective. It should include areas for outside entertainment, festivals, and other special events which can draw people to the zone.

- The auto restricted zone should be well served by transit alternatives for accessing the area. Access must be maintained if the zone is to function effectively. This means additional buses and perhaps fixed rail transit. The most successful zones have both excellent bus service and fixed rail transit service to the zones.

- The most functional auto restricted zones are aimed at retail revitalization and severally limit private automobile access. This allows for a free flow of pedestrians throughout the zone area and eliminates the need to be concerned with motor vehicles when crossing the streets. Bus service through the zone, if not included with other motor vehicles transportation, does not significantly impact the function of an auto restricted zone.

The U.S. Department of Transportation provides several useful implementation steps for auto restricted zones. These include :

- Focus the auto restricted zone on facilitation of existing pedestrian and transit patterns. This kind of focus mitigates confusion related to the transportation and circulation pattern changes associated with the creation of the zone.

- Specific attention should be given to design of the auto restricted zone, including pedestrian amenities, goods delivery, security, utility locations, landscaping, access, and lighting. All of these attributes make the auto restricted zone a more comfortable and environmentally enticing place to be. The zone should be aimed at attracting people to it because of its amenities and its desirability as a place to spend time.

- It is important that new circulation patterns developed as a result of the zone are not confusing. Confusing circulation patterns will discourage people from entering the zone area, and could cut down on retail sales in the area.

- Finally, it is very important that attention is given to working with the business community affected by the ARZ. They must be involved from the beginning of the design of the auto restricted zone, through implementation and operations. This insures that the business community understands the changes that are being made, and is prepared to react to the changes in a positive way. It will also help to develop support for the ARZ from the business community, a most critical group in assuring that a auto restricted zone is effective. In Boston, a downtown merchants association was formed, and its members were included in the development of the Downtown Crossing project.

■ No-Drive Days

Definition and Objectives

No-drive days refer to programs aimed at restricting the use of vehicles on specific days of the week. In the United States to-date, no-drive day programs have been voluntary in nature, and aimed at private automobile users. The programs urge automobile users to utilize alternatives to the single occupancy vehicle on a specific day of the week. Generally, no-drive day programs in the United States tie the no-drive day program to license plate numbers. That is, individuals whose private automobile license plate number ends with the numbers one or two are asked not to drive alone on Mondays. Those whose license plates end with three or four are asked not to drive alone on Tuesdays, and so on. In addition, some cities ask residents to use alternative modes of transportation on days during which air quality is forecast to be particularly poor.

Several foreign cities, such as Athens, Mexico City, Santiago and Singapore, have established mandatory no-drive days, or severe restriction on driving into certain congested areas during specific time periods (e.g., during the morning peak period). These programs frequently restrict vehicles with odd numbered license plates from driving on odd numbered days, and vehicles with even numbered license plates from driving on even numbered days. In Singapore, special licenses are required for driving into the central business district during the morning peak period for all vehicles except busses, emergency vehicles, motorcycles, and vehicles with four or more occupants.

An explicit objective of no-drive days, whether mandatory or voluntary, is to reduce air pollution. All of the programs in the United States are part of larger programs aimed at reducing air pollution, or Better Air Campaigns, which generally include ridesharing campaigns, campaigns to encourage bus ridership, improvements to bicycle lanes, oxygenated fuels programs, etc. Some also include programs to eliminate the use of woodburning stoves on days of poor air quality.

When included in SIP submittals, the emission reduction credit for proposed voluntary programs can be difficult to determine. Credit is most easily supported where reliable evaluations and data for such programs demonstrate trip/emission reductions over multiple years and where sustained funding commitments for continuing operations are provided. Inclusion of such programs in SIPs – together with a schedule to obtain documented results and necessary commitments – can be used to increase support and accelerate implementation at the local/State level.

Examples

The greatest number of communities that have implemented voluntary no-drive days in the United States are found in the southwest and Rocky Mountain states. The two best examples of no-drive day programs are found in Phoenix, Arizona and Denver,

Colorado. These two examples provide background on how the programs are set up and operated, as well as some assessment of their effectiveness.

The ***Denver, Colorado No-Drive Day Program*** has received the most attention nationwide. The program was established through the Colorado Department of Health in 1986 as part of a broader effort to address the City's major air quality problems. The program operates for the months of November, December and January, the months when carbon monoxide levels are highest. It is voluntary, and asks that persons whose private automobile license plate ends in zero or one travel by means other than single occupancy vehicles on Mondays, those with license plates ending in two or three select alternative means of transportation on Tuesdays, etc. The program was coupled with a campaign urging people not to use woodburning stoves on the same days they changed their driving habits.

The Department of Public Health undertook an aggressive media campaign to both familiarize the public with the no-drive day campaign, and to keep the program continually visible. The media worked very closely with the program coordinators. Radio and television announcers issued reminders daily, and newspaper articles about the program appeared regularly. Employers participated in advertising the program to employees by issuing written reminders with paychecks. The program coordinators prepared brochures and posters that were widely distributed to employers, other organizations, and transportation providers.

Another important aspect of the program was market research aimed at tracking the program's success. This included a survey of the population to identify the degree of awareness of the program and program participation. The survey found that ninety-eight percent of the population was aware of the program, and eighty-seven percent believed it was achieving its goal of reducing air pollution in the Denver region.

An additional part of the market research was an analysis of the effectiveness of the program conducted by the Colorado Department of Transportation. Colorado DOT based conclusions about the effectiveness of the program on recorded reductions in VMT. Over the first four years of the program, the DOT reported significant positive impacts associated with the program. However, in the fifth year of analysis, a problem with the base year data was identified, which, when corrected, significantly reduced the effectiveness of the program. Overall, the program is believed to have resulted in no more than a two percent reduction in emissions in the Denver metropolitan area. The significant reductions in CO in the Denver area that have been realized are primarily attributed to the oxygenated fuels program, the inspection and maintenance program, a ban on wood burning on days when pollution levels are high, and the turnover in the fleet to more fuel efficient vehicles.

The cost of the Denver no-drive day program, including advertising, market research, staff, and other administrative costs totaled $500,000 annually.

The ***Phoenix, Arizona No-Drive Day Program*** has been in place for three years. The program is administered by the Regional Public Transportation Authority, and is in

effect for four months of the year, from November through February. These are the months when air pollution reaches the highest levels.

Similar to the Denver program, the Phoenix program is voluntary and suggests that residents use the license plate technique to determine which days not to drive alone. However, the Phoenix program also encourages participation on any day possible during the work week.

The Phoenix no-drive day campaign is marketed through both media campaigns and direct contact with employers. Television and radio stations run daily spots reminding people about the program. All ads are produced free by the radio and television stations. Posters, brochures and novelty items such as buttons are also used to promote the program.

Significant attention is given to marketing the program through employers. The Transportation Authority has published an "idea book" that is distributed to employers to provide ideas on how to implement the program. Workshops are held with employers with over 100 employees to help them set up a system to encourage alternative transportation options.

Each year a week long competition is held in which firms compete to see who can get the most employees to participate in the program. In 1989, the competition was organized to allow for winners in different size categories so that large firms did not have an advantage over smaller firms. Prizes and plaques are distributed to the winners. The program will be changed in 1991 so that the competition is for the entire four month period, not just for a single week.

Other events are staged in conjunction with the no-drive day program. During the four month winter season, there is always one free bus day. Bus ridership usually increases by 32-34 percent on this day. A bike to work day is promoted during the period, and a county-wide challenge is held. There is also a transportation management ordinance in place that requires employers to assist employees with identifying commuter alternatives to single occupancy vehicles.

The goal of the Phoenix program is to achieve a four percent reduction in average daily VMT. In the 1988-1989 season, there was a 2.8 percent reduction in average daily VMT, equalling a reduction of 1.4 million miles traveled per day. This translates into a twenty-seven ton daily reduction in carbon monoxide, a 4.3 ton daily reduction in nitrogen oxide, and a 3.5 ton daily reduction in hydrocarbons. During the 1989-1990 winter season, traffic counts showed an estimated three percent reduction in traffic. Information on vehicle miles travelled in the 1989-1990 season is only available for the peak period, during which VMT was reduced by 630,000 miles. This translated into a peak period decrease in carbon dioxide of eleven tons, a decrease of 1.4 in hydrocarbons, and a 1.8 ton decrease in nitrogen oxide. The emission impacts reported should be viewed as approximate because California, as opposed to Federal, emissions factors were used. The percentage of people using modes other than a single occupant vehicle increased from twenty percent to thirty-six percent.

The cost of the Phoenix program, including two staff persons, marketing, coordination with other programs, and market research, is $325,000 annually. The marketing budget, which includes printing, public relations and advertising, is $135,000 of the total. The market research budget, which covers program evaluation, is $29,000.

One particularly interesting aspect of the Phoenix program is that it was sponsored by the Chamber of Commerce in the first year, and was not very successful. The current program operators believe that, to be successful, a no-drive day campaign must be run by a transportation agency.

Effectiveness

No-drive days are a relatively new concept in the United States, and have yet to be widely applied. Because no-drive days are not yet widespread, and because they are frequently part of a larger program to reduce air pollution, it is difficult to measure accurately the effectiveness of the programs. Clearly, effectiveness relies on a number of factors, such as the availability and quality of the mass transportation system, the relationship between residential neighborhoods and employment centers, the extent to which the program is publicized, and the perceived significance of the air quality problem in the community in which the program is being implemented. In addition, the point at which a program is considered to be effective varies considerably from place to place, and is tied to the effectiveness of other programs, and the expectations the community has for reducing emissions as a result of the no-drive day program.

The voluntary nature of no-drive days inherently limits their potential effectiveness. It is difficult to convince individuals to change travel behavior unless they perceive that they accrue a direct benefit from the program. In addition, voluntary programs tend to garner public support, such as the Denver program, but supporters may not also be participants. The lack of participation by people surveyed in the Denver region attests to this.

It is noteworthy that voluntary no-drive day programs have the most participation during "challenge" periods. This is because participants receive recognition and prizes for participation during these time periods. It is clear that programs such as no-drive campaigns are most successful when participants perceive a direct individual benefit, such as the recognition that comes with winning the challenge. Because the "challenge" periods tend to attract more participants than average, the Phoenix program will expand the challenge period in 1991 to cover the entire four month period.

This "challenge" phenomenon also may indicate that the effectiveness of voluntary programs may be highest during their early years, after people have become familiar with them and when they are still perceived as new and novel. Long-term effectiveness may wane as the excitement of the program becomes routine.

No-drive day programs will not be effective without a broad array of transportation support programs. These include the availability of good transportation connections

serving large parts of the region. The alternative transportation programs should include, at a minimum, good transit access, and a well-organized and efficient ride-sharing program. High occupancy vehicle lanes will further encourage ridesharing. Positive reinforcement through advertising and employer participation in the programs will also work to increase the effectiveness of the programs. Special promotional events will help to keep the programs visible and in the minds of commuters. Participation by the local media is also essential for keeping the program in the minds of potential participants.

One of the most important local requirements for participation in voluntary no-drive days is an obvious, well-recognized air pollution problem. Unless a problem is perceived and acknowledged, few people can be expected to give up use of their private automobile. Even with recognition of a problem, residents of a region may look to others to participate, while they continue to drive alone each day of the week.

Effectiveness at Reducing Emissions

The degree to which voluntary no-drive days can reduce emissions is dependent upon their effectiveness in changing peoples's commute behavior once each week. In Denver, analysts estimate that the reduction in emissions resulting from the voluntary no-drive day program has been no more than two percent. In Phoenix, it is estimated that the voluntary no-drive day has resulted in a 2.8 percent reduction in VMT. This would translate into a reduction in emissions somewhere between two and two and one half percent. Since it is difficult to separate the impact of the no-drive day campaign from supporting trip and emission reduction measures, these estimated emission reduction effects must be utilized with caution.

Other Benefits and Costs

It is important to recognize that no-drive days have associated costs and benefits other than emissions reductions. Some additional benefits are:

- No-drive day campaigns can work to draw the community together toward a common purpose. They tend to draw support from the media and can help to unify a community or region towards solving important regional problems. Because they are voluntary instead of mandatory, they may be more acceptable than programs in which citizens are forced to participate.

- The constant reminders provided by good media coverage keep the no-drive day programs visible. People who cannot participate weekly may be more compelled to participate on an occasional basis if reminders are continual and friendly, and if they do not have to make a permanent commitment to an alternative mode of transportation.

- Because the programs are voluntary in nature, there are no costs associated with monitoring and enforcement.

There are also costs associated with no-drive day programs. These include:

- Strong and constant promotional activity is required for an effective no-drive day campaign. The greatest costs associated with no-drive day campaigns are attributed to marketing and promotion. This includes staff time as well as the cost of producing brochures, posters, flyers, TV spots, etc. The promotional activity is necessary for a successful program.

- Another cost associated with no-drive day campaigns is market research. Some level of funding is required to track the effectiveness of the programs.

- The no-drive day campaigns cannot be successful unless accompanied by a broad array of support programs and transportation alternatives. Ridesharing programs, transit alternatives, bicycle lanes, and HOV facilities are just a few of the support programs that will help to ensure success of no-drive day campaigns. These programs and transit alternatives are costly.

- The no-drive day campaigns further require intensive coordination between other transportation programs and alternatives. There are substantial costs associated with coordination that should not be ignored when calculating the cost of administering a no-drive day campaign.

- The campaigns can have the effect of convincing people that the program is helping to reduce pollution, even when it is not (e.g. the Denver case). This can result in support for the program, but gradual reduction in participation over time.

Guidelines for Achieving Effective Implementation

Evidence suggests that voluntary no-drive days, while not a sufficient stand alone program for reducing air pollution emissions, can contribute to the overall effectiveness of a coordinated Clean Air Campaign. Several features are recommended in order to achieve the greatest benefit from voluntary no-drive days:

- Media cooperation and participation is essential if a voluntary no-drive day campaign is to be effective. This includes coverage of special promotional activities, daily TV reminders regarding whose turn it is not to drive alone, feature articles about the program, etc.

- The no-drive day campaign should be administered by a transit agency or body, with knowledge of all transportation options.

- The program should include some incentives, such as the "challenge" periods in order to induce participation.

- Constant marketing is necessary, including everything from the media coverage discussed above, to gimmicks such as "campaign buttons", to brochures, posters, and other materials displayed at transportation agencies, the work place, and at other public places.

- Marketing should include work place visibility, such as reminders handed out with pay checks. The employer handbook developed by the Regional Public Transportation Authority in Phoenix also has been useful in stimulating employer participation.

- The program should be monitored, with regular market research conducted to identify the extent to which people are participating, and the extent to which people know about the program.

■ Control of Truck Movements

Definition and Objectives

Trucks can be major contributors to air quality and congestion problems in urban areas, particularly in the peak period. Some efforts have been made to mitigate negative impacts by restricting trucks from certain areas of the central business district during peak periods, restricting loading zones, and scheduling deliveries. Trucks also contribute to air pollution resulting from congestion on freeways. Proposals are being made to remove trucks from freeways to help reduce congestion. The idea is that trucks make up a substantial percentage of peak period traffic, and also are responsible for many of the accidents causing delays on the freeways. The consolidation of freight deliveries is another idea. As an example, separate businesses could consolidate the delivery of their products to a single carrier as opposed to each business delivering its own goods.

The issue of restricting or banning large trucks from highways during peak periods is difficult because most trucking companies avoid using freeways during peak periods unless absolutely necessary. Those large trucks found on major highways during peak periods are usually there because of strict, inflexible delivery schedules.

Section 182(e)(4) of the 1990 Clean Air Act which applies to extreme ozone nonattainment areas (currently only the Los Angeles area) states that such areas "...may contain provisions...applicable during heavy traffic hours to reduce the use of polluting...or heavy duty vehicles notwithstanding any other provision of law." This provision is, however, discretionary with extreme areas because restrictions on heavy duty vehicles "may" be implemented; they are not required by the Act.

Example

Recently, several jurisdictions have begun to explore options for restricting truck movement on freeways in an effort to reduce congestion and reduce emissions. None of these programs have been implemented as of yet, so there is no available empirical evidence of the impact of truck restrictions on eliminating emissions. However, the California Department of Transportation (Caltrans) recently studied four alternative strategies for reducing freeway congestion through regulating or restricting truck movement on the freeways (5). This study provides insight into the potential for reducing air pollution through regulated truck movement.

The impetus for the study was a growing concern about freeway congestion; its effect on travel time, accident rates, and air pollution; and proposals to reduce freeway congestion by regulating and/or restricting large trucks on highways. The study focused on the role of large trucks on freeway congestion in Los Angeles, San Diego, and San Francisco.

While the identification of the emissions impacts of regulated truck movements was not the main focus of the study, several of the study findings shed light on this issue. In addition, the study identified economic impacts associated with restricting truck movements that merit attention by any agency considering restricting truck movements. A thorough review of the Caltrans study is advised in order to understand the assumptions used which generated the results summarized in this chapter.

The four approaches to truck management studied by Caltrans were: (1) traffic management strategies; (2) incident management; (3) night shipping/receiving; and (4) peak-period truck bans. Each of these approaches is summarized below, and the potential impacts are noted.

Truck Management Strategies

Six separate traffic management techniques were considered in the Caltrans work. The first technique was **sign placement.** Large trucks on highways, which tend to travel in the far-right lane, frequently block road signs from the vehicles traveling behind the trucks. These vehicles may not see exit signs, caution warnings, etc., until they are on top of the sign, or they miss the sign altogether. This can lead to sudden lane changes by vehicles that are about to miss an exit, or other accident inducing maneuvers. Accidents can result that create significant delays on the freeway, adversely affecting air quality.

A second technique researched by Caltrans was the use of **variable message signs.** These signs can be used to identify temporary road conditions, warn motorists of accidents or congestion ahead, etc. Variable message signs provide motorist with an opportunity to alter their route based on the travel conditions and thus avoid congestion, and reduce emissions.

A third technique, **speed restrictions,** would include better posting of speed limits for trucks on entry and exit ramps. In addition, variable message signs could be used to

alert large trucks, which can not slow or stop quickly, to congestion and stop-and-go traffic ahead. This would reduce the potential for accidents involving large trucks, and would reduce congestion on the freeway. The reduced congestion would lead to reductions in emissions.

The traffic management techniques also included **additional lanes and lane restrictions** for trucks. Trucks are required to use the right-most lane of the freeway. When the portion of trucks in these lanes are high, they create a physical and physiological barrier for vehicles trying the merge onto the freeway from entry ramps. This often results in accidents. One way to mitigate this is additional contiguous merge lanes along the breakdown lane where possible. Large trucks would be excluded from this lane except to enter and exit the freeway.

The final traffic management technique explored by Caltrans was the implementation of **mobile traffic safety inspection teams.** These would operate on freeways prone to a high proportion of truck travel and accidents. Trucks would be stopped randomly for safety inspections similar to those conducted at inspection stations on inter-city freeways.

The Caltrans study found that the combination of truck management strategies discussed above could reduce the recovery hours of delay caused by congestion by fifteen percent. As shown in Table 1, it would result in direct benefits in travel time savings equal to approximately $133.2. While specific air quality benefits were not measured, researchers expect that modest positive air quality impacts would be realized due to decreases in congestion associated with accidents.

Incident Management

Four techniques for managing freeway traffic incidents involving heavy trucks were explored. These were: (1) improved surveillance and communications; (2) improved equipment and procedures; (3) systems operations management; and (4) organization and coordination.

Improved surveillance and communications, and **improved equipment and procedures** included the use of closed circuit television and data links (along the freeway or mounted in planes or helicopters) to bring information to incident management teams before they are dispatched. This would allow the team to make decisions about the proper type of equipment and personnel to dispatch to the site, thus reducing potential further delay in responding to an incident. The third technique, **systems operations management,** would include using computers to monitor system traffic flows, test incident management plans, and evaluate the effectiveness of the program. Improved **organization and coordination** between the organizations involved in incident management could cut down on the time required to respond and clean up an incident. This would result in a reduction in congestion and a corresponding reduction in emissions.

Table 1. Estimated Annual Value of Time and Truck Operating Cost Impacts Due to a Major Traffic Management Program ($ Millions)

	Los Angeles	San Francisco	San Diego	Total
Heavy Trucks:				
Time savings	$ 5.4	$ 2.4	$ 0.32	$ 8.12
Change in truck operating costs	-0.5	-0.1	-0.02	-0.62
Total savings	**$ 4.9**	**$ 2.3**	**$ 0.30**	**$ 7.5**
All Vehicles:				
Time savings	$77.2	$44.8	$11.2	$133.2
Change in vehicle operating costs	-2.7	-1.2	-0.5	-4.4
Total savings	**$74.5**	**$43.6**	**$10.7**	**$128.8**

Source: (5)

The Caltrans study estimated that the incident management techniques discussed above could reduce the hours of delay caused by truck involved accidents by twenty-five percent, and by accidents caused by all vehicles by fifty-two percent. This has significant direct benefit in time savings and operating costs, as shown on Table 2. It was estimated that modest positive impacts on air quality could be achieved through these incident management techniques.

Night Shipping/Receiving

A night shipping and receiving strategy was also explored by Caltrans. This strategy would reduce congestion by requiring that businesses do most of their shipping and receiving at night. The program could be applied best to large businesses which could more easily absorb the extra expense associated with night shipping. Other types of businesses that might be included in the regulation would be businesses that are open sixteen to twenty-four hours per day. Smaller businesses, and businesses that only operate during regular business hours, would find it difficult to comply with the ban because of increased costs associated with night shipping. These costs include building operations costs associated with operating more than eight hours per day, and labor costs associated with employees working in non-traditional work hours.

The Caltrans study estimated that night shipping and receiving restrictions would have modest impacts on congestion. Some positive air quality impacts would result due to this decrease in congestion. Some negative impacts could accrue to businesses, leading to reductions in employment and business sales.

Peak Period Freeway Truck Ban

The final alternative assessed in the Caltrans study was banning trucks completely from freeways during the peak period. This approach would prohibit large trucks from using the freeways between 7 a.m. and 9 a.m., and between 4 p.m. and 6 p.m. The ban would force motor carriers to use parallel routes, shift operations to off-peak hours, or increase the use of trucks not embargoed by the ban. The ban would effect only those carriers currently using the freeways during peak periods. Generally, only carriers who must travel during the peak periods are currently shipping during these times. Others prefer to ship during off-peak hours. The effect of the ban would be to increase speeds on the highway by approximately two miles per hour. However, about eighty percent of the trips would be shifted to parallel roads, and this could increase congestion on these routes. As shown in Table 3, this strategy would cost motor carriers approximately $42.9 million annually. In addition, because congestion was estimated to increase on parallel roads, and some trucks would likely increase miles traveled because of the rerouting, it was anticipated that this alternative could result in a slight negative air quality impact.

Table 2. Estimated Annual Value of Time and Truck Operating Cost Impacts Due to a Major Incident Management Program ($ Millions)

	Los Angeles	San Francisco	San Diego	Total
Heavy Trucks:				
Time savings	$ 2.80	$ 1.23	$ 0.16	$ 4.19
Change in truck operating costs	0.03	0.02	0.00	0.05
Total savings	**$ 2.83**	**$ 1.25**	**$ 0.16**	**$ 4.24**
All Vehicles:				
Time savings	$26.0	$15.0	$ 4.0	$ 45.0
Change in vehicle operating costs	1.6	0.9	0.2	2.7
Total savings	**$27.6**	**$15.9**	**$ 4.2**	**$47.7**

Source: (5)

Table 3. Estimated Annual Value of Time and Truck Operating Cost Impacts Due To a Heavy Truck Ban on Core Area Freeways ($ Millions)

	Los Angeles	San Francisco	Total
Heavy Trucks:			
Time loss due to 80% diversion to arterials	$ 24.4	$ 11.4	$ 35.8
Truck operating cost increase	3.9	3.2	7.1
Total cost increase	**$ 28.3**	**$ 14.6**	**$ 42.9**
Other Vehicles:			
Time savings on freeways	-$19.1	-$ 7.8	-$26.9
Vehicle operating cost changes on freeways	0.0	0.0	0.0
Subtotal, freeways	-$19.1	-$ 7.8	-$26.9
Time loss on arterials	$ 8.8	$ 4.9	$13.7
Vehicle operating cost increases on arterials	3.7	2.1	5.8
Subtotal, arterials	$12.5	$ 7.0	$19.5
Total, other vehicles	**-$ 6.6**	**-$ 0.8**	**$- 7.4**
Total Cost Changes, All Vehicles	**$21.7**	**$13.8**	**$35.5**

Note: Negative values are savings in costs; all others are cost increases.

Source: (5)

Effectiveness

The truck management strategies discussed above would each reduce congestion on the freeways. The strategies also would result in increased traffic capacity on the highways, resulting from decreases in delays due to accidents. Each would improve safety on the freeways, although safety benefits were not quantified.

Some of the truck management studies included in the Caltrans report would have negative impacts on motor carriers or shippers and receivers. The peak-period freeway ban in particular could potentially cost motor carriers $43 million, while the night shipping and receiving strategy could cost shippers and receivers $2,200 million. Indirect negative impacts on business sales could also result from these two strategies, as shipping costs are passed on to businesses and consumers.

Effectiveness at Reducing Emissions

The Caltrans study did not quantify the emissions reduction associated with the truck movement controls analyzed. However, some qualitative assessments of the emissions reduction were identified. Overall, traffic management strategies and incident management strategies provided the greatest benefit in terms of reducing emissions. One reason for this is that they affect all truck movements and, in fact, much of the auto traffic on freeways. It is estimated that incidents account for 50 percent of the vehicle-hours lost to congestion.

The night shipping and receiving strategy will only affect large businesses or businesses which operate sixteen to twenty-four per day. Because a small percentage of all businesses will be affected, the impact on congestion reduction and, ultimately, emissions reduction, will be less than if the program affected all vehicles or at least all trucks on the highway. A program aimed at reducing emissions and congestion through night shipping and receiving must be structured to impact the greatest number of vehicles, while maintaining the economic viability of the businesses in the community.

The Caltrans truck study found that peak period freeway truck bans result in only limited reductions in emissions. One reason for this is that most trucks currently operating in peak periods do so because they have no choice. Most motor carriers prefer to transport goods during off peak hours, and will do so if shipping schedules and customer demands permit. Therefore, trucks banned from freeways during peak periods may select alternate routes rather than changing the time of day during which the trip is made. The air quality implications of a peak period freeway ban, though, are less clear than the other three truck management strategies. Additional study and perhaps a pilot program could help identify the actual emission reduction impact of such a ban.

Other Benefits and Costs

There are several benefits associated with the different truck management strategies, including:

- Travel time for vehicles other than motor carriers is reduced under each strategy. Travel time is also reduced for motor carriers under the traffic management and incident management strategies.

- Safety on the freeways would be improved under each of these strategies.

- Under the traffic and incident management strategies, economic benefits in the form of increased sales could accrue to businesses throughout the economy as a result of reduced operating costs.

As documented in the Caltrans report, "Urban Freeway Gridlock Study" (5), there also are costs associated with each strategy, including:

- The traffic management strategy was estimated to cost approximately $20-40 million annually to operate and monitor.

- The incident management strategy was estimated to cost approximately $3-5 million annually.

- Both the night shipping and receiving and peak-period freeway ban strategies would cost approximately $2-3 million annually to administer.

- The night shipping and receiving strategy would result in some costs to shippers and receivers, as they would have to operate longer hours and hire staff to work during off hours.

- The peak-period freeway ban would result in additional costs to motor carriers due to operating cost increases associated with congestion and slower operating times on parallel roads.

- Consumers would be forced to absorb any increased cost accruing to shippers, receivers, and motor carriers in the form of higher prices for goods.

Guidelines for Achieving Effective Implementation

The following guidelines are recommended for jurisdictions interested in implementing strategies to limit or control the movement of trucks:

- Evaluate the legal grounds for implementation. Some jurisdictions may have legislation that prevents any restrictions on truck movements.

- Seek cooperation and support from the trucking industry. The industry must be brought along throughout the process so that they are not taken by surprise when strategies are proposed or implemented. The support of the trucking industry is crucial to successful implementation.

- Consider the overall economic impacts of each strategy to determine which strategy makes most sense for an individual community.

- Conduct a cost-benefit analysis along affected corridors to determine if the cost is justified by the program.

- Identify and involve all affected agencies in developing an incident management program.

In addition, any jurisdiction considering a peak period ban of trucks on freeways should be aware that under the 1984 Surface Transportation Assistance Act (STAA), trucks must be allowed to operate on the Interstate Highway System twenty-four hours per day and be allowed reasonable access to services and terminals. A number of states have tried to impose restrictions on the types of trucks that operate within the state and their time of operation. With the exception of a few cases where safety was an issue, these challenges have all been defeated.

While heavy duty trucks are an important contributor to emissions in urban areas, strategies to reduce these emissions have just begun to be considered in recent years. Much work remains to be done. The bibliography for this chapter includes resource documents which should be considered by agencies contemplating strategies to reduce heavy duty truck emissions.

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