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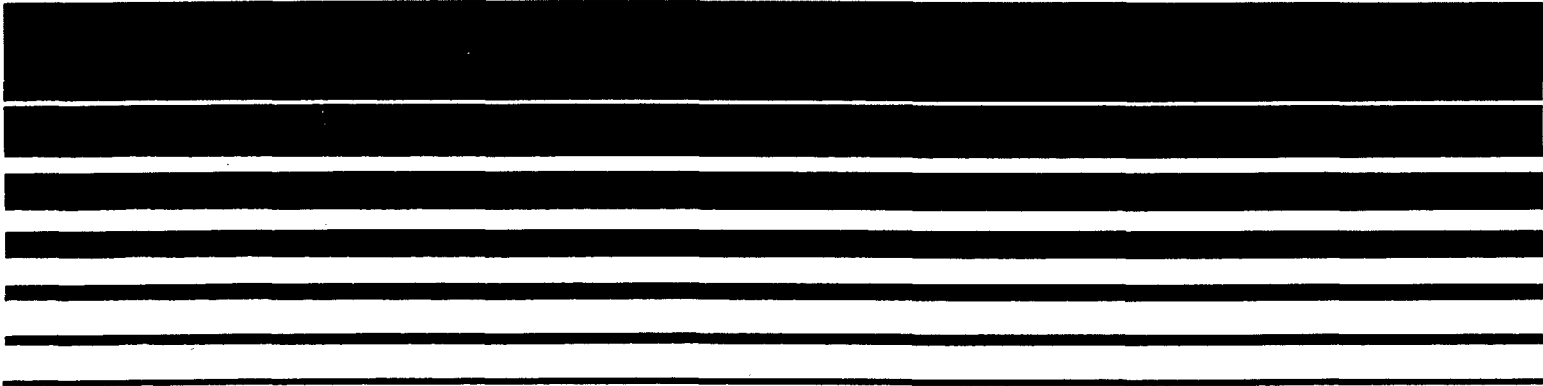
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Transportation Control Measure Information Documents



Prepared for

U.S. Environmental Protection Agency
Office of Mobile Sources

March 1992

Transportation Control Measure Information Documents

Prepared by



Cambridge Systematics, Inc.

TRANSPORTATION CONTROL MEASURE
INFORMATION DOCUMENTS

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Prepared for
U.S. Environmental Protection Agency
Office of Mobile Sources

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Preface

The Environmental Protection Agency is required under Section 108(f) of the Clean Air Act, as amended in 1990, to prepare information "regarding the formulation and emission reduction potential of transportation control measures related to criteria pollutants and their precursors." These information documents have been developed "in consultation with the Secretary of Transportation, and after providing public notice and opportunity for comment."

This report constitutes information documents for the following sixteen categories of transportation control measures:

1. Trip Reduction Ordinances
2. Employer-Based Transportation Management Programs
3. Work Schedule Changes
4. Area-wide Rideshare Incentives
5. Improved Public Transit
6. High Occupancy Vehicle Facilities
7. Traffic Flow Improvements
8. Parking Management
9. Park-and-Ride/Fringe Parking
10. Bicycle and Pedestrian Programs
11. Special Events
12. Vehicle Use Limitations/Restrictions
13. Accelerated Retirement of Vehicles
14. Activity Centers
15. Extended Vehicle Idling
16. Extreme Low-Temperature Cold Starts

This Preface is immediately followed by a table identifying examples of the kinds of transportation control measures that can be included in each of the sixteen categories. The report then follows with a Summary section that includes a discussion of implementation experience with transportation control measures, along with summaries of each of the individual TCMs. A Transportation/Air Quality Background Information

chapter then summarizes pertinent background information on the relationships between transportation and air quality. This section defines basic technical considerations important to the development, analysis, and evaluation of transportation control measures.

Each individual transportation control measure is described using the following basic structure:

1. Definition and major variations of measure.
2. Summary description of pertinent examples.
3. Transportation, emissions, and air quality impacts. This discussion is quantitative in nature whenever possible, and identifies key factors that determine the magnitude of expected impacts.
4. An estimate of expected capital and operating costs, other important impacts, and principal travel markets affected. Major areas of uncertainty also are identified.
5. Requirements to achieve effective implementation, including an assessment of major institutional and political considerations and a discussion of factors affecting the transferability of findings among urban areas.
6. Bibliography of selected references.

The trip reduction ordinance information document contains, in addition, a model ordinance that can be used as the basis for developing area-specific regulations.

Several individuals and organizations have contributed to the development of these documents, including the following:

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Preliminary drafts of these Section 108(f) information documents were reviewed by the Transportation Control Measure Panel of the National Association of Regional Council's Clean Air Project. The following individuals participated in this review and are responsible for many of the changes incorporated in this March, 1992 publication:

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Transportation Control Measure (TCM) Typology

- I. Trip Reduction Ordinances**
 - A. Special Use Permits**
 - B. Negotiated Agreements**
 - C. Trip Reduction Goals**
 - D. Mandated Ridesharing and Activity Programs**
 - E. Transportation Management Funds and Districts**
 - F. Requirements for Adequate Public Facilities**
 - G. Conditions of Approval for New Construction**
 - H. Applicability**
 - 1. New Development versus Existing Employers**
 - 2. Variation by Employment Size**
 - 3. Phase-In-Provisions**

- II. Employer-Based Transportation Management Programs**
 - A. On-site Employer Transportation Coordinator**
 - B. Transit/Rideshare Services**
 - 1. Provide HOV Shuttle Services Between Company Facilities**
 - 2. Centralized Vanpool/Carpool Matching Service**
 - 3. Rideshare/Transit Marketing/Information Programs**
 - 4. Designated Transportation Coordinator**
 - 5. HOV Priority Parking**
 - 6. Vanpool/Subscription Bus Financing**
 - 7. Subscription Buses or Buspooling**
 - 8. Midday and Park-and-Ride Shuttles**
 - 9. Guaranteed Ride Home**
 - C. Bicycle and Walking**
 - D. Employee Financial Incentives**
 - 1. Subsidize Transit Use**
 - 2. Transportation Allowances**
 - 3. Eliminate Employee Parking Subsidies**
 - 4. Charge for Drive-Alone Parking**

- III. Work Schedule Changes**
 - A. Telecommuting**
 - 1. Home**
 - 2. Satellite Work Center**
 - 3. Neighborhood Work Center**

- B. Flextime
 - 1. Daily Start/End Time
 - 2. Number of Hours Worked
 - a. Per Day
 - b. Per Week
 - c. Per Pay Period
 - C. Compressed Work Week
 - 1. 4 Day Week, 10 Hour Work Day
 - 2. 5/4-9 Plan (80 Hours in 9 Days)
 - D. Staggered Work Hours
- IV. Area-wide Rideshare Incentives
- A. Areawide Commute Management Organizations (Third Party Brokerage)
 - 1. Carpool Matching Programs
 - 2. Vanpool Programs
 - 3. Shared Ride Taxi
 - 4. Guaranteed Ride Home
 - B. Transportation Management Associations (TMAs)
 - 1. Operation of Ridesharing and Other Transportation Management Programs
 - 2. Education
 - 3. Informational Materials
 - 4. Advocacy
 - 5. Transportation Service Coordinators
 - 6. Employee Surveys
 - 7. Organization
 - a. Independent, Non-Profit Corporations
 - b. Existing Business Organizations
 - C. Tax Incentives and Subsidy Programs
 - 1. State/Local Tax Exemptions for Vanpool or Transit Subsidies
 - 2. Exemption of Ridesharing Vehicles from "Common Carrier" Status
 - 3. Safety Regulations for Vanpools, Buspools, Subscription Buses
 - 4. Insurance Coverage
 - 5. Liability Responsibility
 - 6. Accelerated Depreciation Allowance for Employer-Provided Vanpools and Bicycle Facilities
 - 7. State/Local Gas Tax Exemptions for Provision of Vanpool Benefits
- V. Improved Public Transit
- A. System/Service Expansion
 - 1. Fixed Guideway Transit
 - 2. Fixed Route and Express Bus Services
 - 3. Circumferential and Local Bus Service
 - 4. Paratransit Programs

- B. System/Service Operational Improvements
 - 1. Feeder Bus Service
 - 2. Express Bus Service
 - 3. Bus Route and Schedule Modifications
 - 4. Improved Transfers
 - 5. Schedule Coordination
 - 6. Bus Traffic Signal Preemption
 - 7. Road Operational Changes
 - 8. Operations Monitoring
 - 9. Maintenance Improvements
 - 10. Park/Ride Service
 - 11. Subscription Bus Service
 - C. Demand/Market Strategies
 - 1. Employer Offered Incentives
 - 2. Marketing and Information Programs
 - 3. Peak/Off-peak Transit Fares
 - 4. Simplified Fare Collection
 - 5. Reduced Fares
 - 6. Monthly Passes
 - 7. Uniticket Programs
 - 8. Passenger Amenities
 - 9. Joint Development Activities
- VI. High Occupancy Vehicle Lanes
- A. Freeways
 - 1. Exclusive, in a separate right of way
 - 2. Barrier or buffer-separated
 - 3. Concurrent-flow (no physical separation)
 - 4. Contra-flow
 - 5. Queue bypass
 - B. Arterials
 - 1. Concurrent-flow
 - 2. Contra-flow
 - 3. Median
 - 4. Bus Street
 - 5. Bus Tunnel
 - C. Entrance Ramp Priority
 - D. Parking Facilities
 - E. Applicability
 - 1. Buses
 - 2. Carpools
 - a. 2+ occupants
 - b. 3+ occupants
 - 3. Vanpools
 - 4. Other
 - 5. Time Periods
 - a. Peak Periods
 - b. Entire Day

- VII. Traffic Flow Improvements**
 - A. Traffic Signalization**
 - 1. Local Intersection Signal Improvements
 - 2. Interconnected Arterial Signal System
 - 3. Area Signal System
 - 4. Equipment or Software Updating
 - 5. Eliminate Unnecessary Signals and Stop Signs
 - B. Traffic Operations**
 - 1. Intersection and Roadway Widening
 - 2. One-Way Streets
 - 3. Turn Lane Installation
 - 4. Turning Movement and Lane Use Restrictions
 - 5. Reversible Lane System
 - 6. Strengthen Curb Cut Controls
 - C. Enforcement and Management**
 - 1. New Freeway Lane Using Shoulders or Reduced Lane Widths
 - 2. Incident Management Systems
 - 3. Freeway Diversion and Advisory Signing
 - 4. Ramp Metering
 - 5. Surveillance and Control
 - 6. Enforcement
 - D. Intelligent Vehicle and Highway Systems (IVHS)**

- VIII. Parking Management**
 - A. Preferential Parking for High Occupancy Vehicles**
 - 1. Garages and Lots
 - 2. Metered Spaces
 - B. Public Sector Parking Pricing**
 - 1. Alter Rates
 - 2. Long vs. Short Term Parking
 - 3. Impose New Prices
 - 4. Tax the Provision of Free Private Parking
 - C. Parking Requirements in Zoning Codes**
 - 1. Revise Maximum and Minimum Requirements
 - 2. Allow Reductions in Minimum Requirements for Traffic Mitigation Actions
 - D. On-Street Parking Controls**
 - 1. Curb Parking Restrictions
 - 2. Residential Parking Controls
 - 3. Peak Hour Parking Ban and Enforcement
 - 4. Reduced Legal Parking Spaces in High Congestion Areas
 - 5. Increase Meter Fees
 - 6. Increased Enforcement and Towing
 - E. Commercial Vehicles**
 - 1. On-Street Loading Zones
 - 2. Off-Street Loading Areas
 - 3. Peak Hour On-Street Loading Prohibition

- F. Control of Parking Supply**
 - 1. Limit Construction of New Parking Facilities in Areas Served by Mass Transit
 - 2. Limit Number of On- and Off-Street Parking Spaces in Designated Areas
 - 3. Use of Zoning and Parking Regulations to Limit Capacity

- IX. Park-and-Ride/Fringe Parking**
 - A. Construct New/Enlarged Dedicated Facilities on Public Property
 - B. Use of Direct Ramps to Connect Park-and-Ride Lot with Freeway System
 - C. Locate Personal Business Support Services at Park-and-Ride Lots including Day-Care Centers, Financial Services, Convenience Stores, and Dry Cleaners
 - D. Joint Use of Theater, Shopping Center, Church, Stadium Parking Facilities, as Available
 - E. Parking at all Major Transit Stations
 - F. Locate Fringe Parking to Serve Major Highway Facilities/Interchanges Near Central Business District
 - G. Provide Transit/Shuttle Services to Park and Ride/Fringe Parking
 - H. Priority Parking for HOV's at Major Parking Facilities
 - I. Provide Bicycle Lockers/Storage at Parking Facilities

- X. Bicycle and Pedestrian Programs**
 - A. Bicycle Facilities
 - 1. Bicycle Routes, Lanes, and Paths
 - 2. Bicycle Plans and Maps
 - 3. Bicycle Coordinators
 - 4. Lockers, Racks, and Other Storage Facilities
 - 5. Showers and Clothing Lockers
 - 6. Integration with Transit
 - 7. Ordinances
 - 8. Education
 - 9. Media and Promotion
 - B. Pedestrian Facilities and Programs
 - 1. Sidewalks and Walkways
 - 2. Safe Facilities
 - a. Crosswalks
 - b. Walk Signals
 - c. Median Strips
 - d. Speed Ramps
 - e. Lighting
 - f. Clear Sight Lines
 - 3. Sidewalk Environment/Furniture
 - a. Benches
 - b. Street Level Shops
 - c. Amenities
 - 4. Connections with Transit
 - 5. Education

XI. Special Events

1. Remote Parking with Shuttle Service
2. Public Transportation
3. Highway Improvements
4. Signage, Communication and Public Education/Information
5. Traffic Flow Improvements
6. Parking Management
7. Pedestrian Access/Circulation
8. Public and Private Coordination Committee
9. Operations Response Teams
10. Alternate Travel Schedules
11. Rescheduling of Truck Travel

XII. Vehicle Use Limitations/Restrictions

- A. Route Diversion
 1. Auto Restricted Zones
 2. Pedestrian Malls
 3. Traffic Controls
- B. No-Drive Days
 1. Voluntary
 2. Required (e.g., License Plate)
- C. Control of Truck Movements
 1. Designated Truck Routes
 2. Truck Management Strategies
 - a. Sign Placement
 - b. Variable Message Signs
 - c. Speed Restrictions
 - d. Additional Lanes
 - e. Lane Restrictions
 - f. Mobile Safety Inspection Teams
 3. Scheduling of Shipping/Receiving
 4. Peak Period Truck Bans on Freeways or Major Arterials
 5. Freight and Delivery Consolidation

XIII. Accelerated Retirement of Vehicles

- A. Vehicle Eligibility
- B. Dollar Value of Payment
- C. Program Duration
 1. Length of Buy-Back Period
 2. One Time Program
 3. Sequential Program
- D. Limitations on Number of Vehicles Bought
 1. None
 2. Maximum Number
- E. Retirement vs. Tune Up
- F. Administration
 1. Public Sector
 2. Private Sector
 3. Use of Credits in Emissions Banking and Trading

- XIV. Activity Centers
 - A. Design Guidelines/Regulations
 - 1. Transit
 - 2. Carpooling and Vanpooling
 - 3. Pedestrian
 - 4. Bicycling
 - B. Parking Regulations and Standards
 - C. Mixed Use Development Ordinances and Zones
 - D. Site Plan Review Ordinances

- XV. Extended Vehicle Idling
 - A. Controls on Drive-Through Facilities
 - 1. New Facilities
 - 2. Existing Facilities
 - B. Limitations on Idling of Heavy-Duty Vehicles
 - 1. Trucks
 - 2. Buses
 - 3. Locomotives and Other Mobile Sources
 - C. Vehicle Modifications

- XVI. Extreme Low-Temperature Cold Starts
 - A. Vehicle Modifications
 - 1. Block Heaters
 - 2. Intake Manifold Heaters
 - 3. Monolithic Catalysts
 - 4. Start or Warm-up Catalysts
 - 5. Multipoint Fuel Injection Systems
 - B. Parking Facility Electrical Outlets
 - 1. Public Facilities
 - 2. Private Employers
 - C. Transit Use Incentives
 - D. No-Drive Days
 - E. Vehicle Fleet Operations

Summary

Summary

■ Purpose

This report contains the transportation control measure information documents prepared under Section 108(f) of the Clean Air Act. Each of the sixteen measures identified in Table 1 is described in terms of its objectives, variations in the ways it may be applied, representative examples of actual usage, expected transportation and emissions impacts, other potentially important considerations, and a set of implementation guidelines that can be followed by state, regional, and local agencies.

The term "transportation control measure" or TCM encompasses elements of both "transportation system management" (TSM) and "transportation demand management" (TDM). Transportation system management strategies generally refer to the use of low capital intensive transportation improvements to increase the efficiency of transportation facilities and services. These can include carpool and vanpool programs, parking management, traffic flow improvements, high occupancy vehicle lanes, and park-and-ride lots. The TSM term also is applied to techniques used to reduce the demand for travel within an area. Transportation demand management generally refers to policies, programs, and actions that are directed towards increasing the use of high occupancy vehicles (transit, carpooling, and vanpooling) and the use of bicycling and walking. TDM also can include activities that encourage commuting outside the congested peak period, and that encourage telecommuting as an alternative to driving. In practice, there is considerable overlap among these three concepts and the terms TCM, TSM, and TDM often are used interchangeably.

The Clean Air Act Amendments of 1990 were strongly influenced by a recognition that mobile sources are major contributions to air quality problems in nonattainment areas. The substantial reductions in tailpipe emissions achieved during the 1970s and 1980s, largely through catalytic converters and improvements in fuel efficiency, were rendered less effective in their net impact by increases in vehicle trips and vehicle miles traveled (VMT). Changes in demographics and employment patterns during the 70s and 80s have resulted to increases in vehicle ownership and VMT that are higher than growth rates in population. As a result, net emissions reductions from mobile sources generally have been lower than originally anticipated despite significant technological advances.

This report provides basic information on transportation control measures for local elected officials, private employers and other public and private sector decision-makers who will need to assess the applicability of different strategies for solving the mobile source emission problem in their area. These information documents also provide

**Table 1. Section 108(f) Transportation Control Measure
Information Documents**

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1. Trip Reduction Ordinances
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 6. High Occupancy Vehicle Lanes
 7. Traffic Flow Improvements
 8. Parking Management
 9. Park-and-Ride/Fringe Parking
 10. Bicycle and Pedestrian Measures
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-

information to non-transportation professionals who wish to gain a greater understanding of the potential impacts of TCM strategies.

The report begins with a general discussion of the interrelationships between transportation and air quality, providing basic background information that is important in understanding the manner in which transportation activities can effect emissions. For the person who already has an extensive background in transportation air quality, this chapter may not be necessary reading. For the person who is relatively new to the field, however, this chapter provides background that is not contained in the subsequent individual TCM chapters.

This summary consists of two parts. This first part summarizes important transportation related provisions of the 1990 amendments to the Clean Air Act, and synthesizes the extensive national experience in implementing TCM type programs. The second section provides a brief introduction to each of the Section 108(f) transportation control measures, including examples, key issues, and implementation considerations.

■ Transportation Provisions of the 1990 Clean Air Act

The 1990 amendments to the Clean Air Act add significantly to the potential importance of transportation measures both as elements of a state implementation plan and as potential contingency measures. In reviewing these TCM information documents and assessing the potential implementation of TCM programs, it is important to have a sound understanding of both the many transportation-related requirements now contained in the Clean Air Act and the air quality-related provisions of the Intermodal Surface Transportation Efficiency Act of 1991. The following is a very brief summary of some of the more important of these provisions. Amplification and important details, however, are not provided in the interest of conciseness. A careful reading of the relevant sections of the Clean Air Act and the Intermodal Surface Transportation Efficiency Act is recommended.

- An implementation plan is to include enforceable control measures, including time schedules and compliance procedures (Section 110(a)(2)). These control measures can include economic incentives.
- Plans should provide for the implementation of all reasonably available control measures as expeditiously as practical (Section 172(c)).
- Sixteen categories of transportation control measures are identified (Section 108(f)). Severe and extreme ozone areas must adopt specific and enforceable transportation control strategies as necessary to demonstrate attainment (Section 182(d)(1)(A)). A parallel requirement exists for serious carbon monoxide nonattainment areas. (Section 187(b)(2)).

- Reasonable further progress is required in the achievement of air quality deadlines. Specifically, annual incremental reductions in emissions as may reasonably be required for ensuring attainment of the standard by the applicable date must be demonstrated (Section 171(1)).
- Ozone nonattainment areas classified as moderate and above must submit implementation plan revisions that demonstrate a 15 percent reduction in VOC emissions by November 15, 1996 (Section 182(b)(1)).
- Severe and above ozone areas must utilize transportation strategies to offset the growth in emissions due to growth in vehicle miles of travel and vehicle trips (Section 182(d)(1)(A)).
- Employers with 100 or more employees in severe ozone nonattainment areas are required to implement trip reduction programs designed to reduce commute-related VMT and vehicle trips by employees sufficiently that the average vehicle occupancy of employee work trips is at least 25 percent above the area average (Section 182(d)(1)(B)).
- Nonattainment areas that fail to demonstrate compliance or to meet a milestone must implement additional control measures from an approved contingency plan. These additional measures can include transportation control measures, or economic incentives implemented in conjunction with transportation control measures (Section 182(g)).
- Serious CO nonattainment areas failing to meet a milestone are required to implement a transportation control program (Section 187(d)).
- Serious ozone nonattainment areas are to conduct a monitoring program to demonstrate whether current aggregate vehicle mileage, vehicle emissions, and congestion levels are consistent with those assumed for the area's demonstration of attainment (Section 182(c)(5)). Where these criteria are found to be in exceedance, a plan revision must be developed that contains transportation control measures drawn from but not limited to the Section 108(f) list.

In summary, transportation control measures must be systematically considered and evaluated in the development of implementation plan revisions. These TCM information documents provide a starting point for these evaluations. Final decisions, though, should be based on the results of local consultation and a determination of what is reasonably available, effective, and feasible within the context of an area's transportation system and the ongoing transportation planning/programming process.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) represents landmark transportation legislation with potentially far reaching implications for helping to achieve the objectives of the Clean Air Act. The Act provides significantly increased funding flexibility with respect to how monies can be used for highway, transit, and other transportation improvements. A \$6 billion Congestion Mitigation and Air Quality Improvement Program is created to help implement projects and programs

that will contribute to achieving attainment of the National Ambient Air Quality Standards. Eligible projects include Clean Air Act Section 108(f) transportation control measures and projects contained in a State Implementation Plan (SIP). Urbanized areas over 200,000 population are designated as Transportation Management Areas. Each such area is to have a congestion management system that provides for "use of travel demand reduction and operational management strategies." The long-range transportation plan for metropolitan areas which are nonattainment for either ozone or carbon monoxide is to be coordinated with the process for developing transportation control measures for the Clean Air Act's State Implementation Plan (SIP).

The Intermodal Surface Transportation Efficiency Act requires coordination between the transportation and air quality planning processes, with flexible funding being provided to help states and urban areas develop and implement the transportation portions of a State Implementation Plan.

■ TCM Implementation Experience

There is extensive experience throughout the country in planning, designing, and implementing the kinds of transportation control measures identified in Section 108(f) and listed in Table 1. The following paragraphs synthesize this experience into a series of overall conclusions regarding the status of transportation control measures.

The majority of TCMs, but not all, are being routinely implemented across the country for a wide variety of objectives, many as part of corridor and regional congestion management plans. These kinds of measures should not be considered as being either controversial or even innovative, but as being feasible and routinely available.

The implementation of TCMs most often requires a cooperative process involving state, regional, and local agencies. In addition, experience has shown the critical role that employers have in increasing the effectiveness of an overall TCM program.

While some TCMs can be planned and implemented over a relatively short time period, many require 3 to 5 years to be effectively developed and implemented. Others such as rail transit programs should be considered as long range, in terms of both their planning requirements and their expected benefit period.

Area-wide effectiveness (whether VMT or emissions) is critically dependent upon the size of the market segment affected. Many TCMs may be directed only at peak period or work trips, or to a particular geographic area. Such measures may be highly effective within their target market, but have only a limited impact when expressed in overall regional terms. Work trips, for example, typically constitute only about 30 percent of total travel. However, work trips are the most amenable to control since they constitute the most regular set of trips. In addition, employers can exert considerable influence over work trip modes. The peak periods also represent the highest concentration of

mobile source emissions and therefore remain an important control target. Additional benefits accrue to the region because work trips taken by alternative modes result in vehicles being left at home (or in park-and-ride lots) where they are unavailable for mid-day trips. Furthermore, reductions in peak period trips have added benefits in eliminating congestion-related emissions.

In many nonattainment areas, analyses have shown that additional stationary, area, and non-TCM mobile sources will not be sufficient to achieve attainment of the air quality standards within the legislatively mandated time schedules. In these cases, it is not a question of whether or not to use TCMs, but what TCMs are needed in addition to these other measures.

TCMs can be thought of in three broad categories: voluntary or incentives, regulatory, and market based (or pricing). Ideally, a TCM program should contain incentives as well as disincentives, and elements of all three categories. Programs consisting only of voluntary incentives consistently have been shown to have lower levels of effectiveness than when combined with mandatory requirements and pricing measures.

Section 182(g)(4) of the new Clean Air Act discusses economic incentive programs and states that such programs may include emission fees along with incentives and disincentives to reduce vehicle emissions and vehicle miles of travel. Pricing incentives include employer subsidized transit passes and provision of various ridesharing services. Other possible employer-based pricing strategies include elimination of free or low cost parking for employees, or the provision of a transportation benefit that an employee can choose to use for parking, ridesharing, or transit. These Clean Air Act provisions are supported by the Intermodal Surface Transportation Efficiency Act of 1991 which creates a \$25 million per year Congestion Pricing Pilot Program.

The potential transportation impacts of TCMs include changes in vehicle miles of travel, the number of trips, vehicle speed, the time of day in which a trip occurs, the destination of auto trips, and even the number and type of automobiles which a household chooses to own. For example, trip reductions in the range of 15 to 20 percent as result of employer-based transportation management programs are not uncommon. The impacts of TCM measures and programs are sufficiently large to consider worthwhile and worth the effort.

VMT should not be relied upon exclusively, or even primarily, as a transportation proxy for emissions reductions. It is important that changes in vehicle trips and operating speed also be examined. Analyses have shown that cold start and the various evaporative emissions are more significant than previously thought, and need to be explicitly considered in a transportation emissions analysis. An objective, therefore, should be to reduce vehicle trips, rather than just to reduce VMT.

The non-air quality benefits of TCMs need to be explicitly recognized as part of an air quality analysis. These include reduced congestion, improved safety, reduced travel time and cost, and the reduced need for new highway construction. Implementation decisions in both the public and private sectors are based on a consideration of all potentially relevant issues, rather than just a single factor such as air quality. When

properly calculated, the vast majority of TCMs have been shown to have benefit/cost ratios greater than one, and frequently as great as ten or higher. Expressed in terms of cost/effectiveness, this implies a negative cost/effectiveness ratio since the value of the non-air quality benefits will exceed program costs.

Developing effective mechanisms for administering, maintaining, and enforcing TCMs is a critical element of long-term success. Many programs have enjoyed a short-run effectiveness, only to see their impacts erode after two or three years. Certain programs have proven difficult to enforce, thereby inviting a high level of violations and generally leading eventually to abandonment. Developing these mechanisms means involving those organizations that will be involved in administering, maintaining, or enforcing a measure in the planning and design of that measure. It also means that adequate staff and funding resources need to be allocated, and a meaningful array of violation penalties needs to be in place.

■ Developing a Program of Transportation Control Measures

There is a need for TCM programs that are carefully designed rather than merely representing a collection of individual measures. This design process needs to consider:

- Issues of equity;
- Providing area-wide measures such as transportation management associations that can reinforce more localized measures such as employer-based trip reduction targets;
- Enhancing the supply of transit, ridesharing, bicycling, and walking options rather than just restricting or discouraging the use of drive alone travel;
- Incorporating elements of pricing and market-based incentives, with particular attention paid to the distribution of public and private travel subsidies;
- Including marketing, education, and public awareness as well as more traditional technical activities;
- Incorporating longer range, permanent measures as well as short run measures that are capable of being quickly implemented and producing immediate impacts but which also may be more temporary in character; and
- Assuring adequate intergovernmental involvement, cooperation and commitment.

A carefully designed, inter-related program may include 15 to 20 individual measures and be three to four times as effective as any of the measures taken individually.

Developing an effective monitoring mechanism also is an important element of good program design. Benefits may take several years to develop, and it is necessary to monitor the changes in the full array of program impacts over a period of several years. Monitoring also provides an invaluable evaluation feedback mechanism that can be used to improve the design of both individual measures and overall programs. Experience has demonstrated that many TCMs can be improved by "learning while doing." Despite the best intentions, it is extremely difficult to anticipate all possible consequences of an action. A mechanism, therefore, needs to be built into a program's administration that allows adjustments and enhancements over time. A cautionary note, though, is in order. The style of monitoring that is being recommended is not one that is oriented primarily to promotion, public relations, and marketing. Rather the objective is to improve the understanding of program operations and impacts. Expressed in terms of an area-wide ridesharing organization, information is wanted on the number of trips and vehicle miles of travel eliminated, not just the number of carpool matching applications processed.

A systematic process should be followed to identify, screen, evaluate, and develop an implementation program for potential TCMs. This process should include but not be limited to the following activities:

- Defining local baseline travel conditions for both the current inventory year and a future target year against which program measures will be designed;
- Identifying other available and planned transportation infrastructure that will either support or serve as a barrier to the development of effective TCMs;
- Identification of other local, regional, and state objectives that are compatible with programs to improve transportation-related air quality;
- Develop realistic target levels of effectiveness based on the local baseline travel conditions;
- Estimate capital and operating costs, and necessary administrative requirements;
- Determine the availability of funding and other necessary program resources, considering private as well as traditional public mechanisms; and
- Involve business and other community groups, gradually developing an understanding of all relevant issues and gaining acceptance of the developed program.

There are variations in the effectiveness of TCMs by urban area, depending upon the density and distribution of population and employment, the form of existing highway and transit systems, and population/employment demographics. It is difficult, indeed dangerous, to apply a single effectiveness number (or even a narrow range) to different urban areas. This is true for travel measures such as VMT; it is especially true for estimates of emissions which are in addition highly sensitive to temperature and composition of the vehicle fleet.

It is useful and even necessary, therefore, to quantitatively analyze the effectiveness of TCM programs. The standard four stage urban transportation analysis process can serve as a base for this analytical capability, but generally needs to be refined and extended if it is to be successfully applied for air quality analysis purposes. A variety of "sketch planning" analysis approaches also are available, and can be considered as feasible alternatives to use of the full and standard UTPS-style analysis systems. EPA is preparing separate information on methodologies to analyze changes in travel activity due to TCMs.

■ TCM Approval Criteria

Before a program of TCMs can be approved, the program must meet federal State Implementation Plan (SIP) submittal requirements. The EPA has prepared a SIP Submittal Completeness Checklist (40 CFR, Part 51, Federal Register, February 15, 1990, p. 5824), to guide the preparation and review of SIP submittals. Where applicable, TCMs included in a SIP will be subject to these criteria. In addition, at a minimum, the SIP must provide evidence of adequate financial and human resources for each TCM, and must describe the process of implementation, enforcement, monitoring and maintenance of the program. Note that, depending on the measure, some of these criteria may not be applicable. Also, individual states may have additional criteria, such as quantifying economic impacts, which must be addressed. In any case, the documentation for a program of TCMs should be discussed with the EPA Regional Office prior to formal incorporation into a SIP.

■ Summaries of Individual Transportation Control Measures

The effectiveness of transportation control measures can be enhanced through a consideration of their synergistic effects. In general, an integrated program of TCMs should be implemented so as to achieve the full travel and emissions reduction potential of the individual strategies. It is important to understand, therefore, that some TCMs are mutually supportive, while others are potentially in conflict. For example:

- **Trip reduction ordinances can be significantly enhanced by offering alternatives to single-occupant vehicle travel such as improved public transit, bicycle and pedestrian improvements, and area-wide ridesharing.**
- **Park-and-ride and fringe parking strategies can support the provision of HOV lanes and improved public transit.**

- **Vehicle use limitations/restrictions** can be reinforced through **parking management and strategies** to address congestion at **major activity centers**.

At the same time, certain strategies may conflict with one another and still other strategies may have few, if any, synergistic or countervailing effects.

Trip Reduction Ordinances

Definition: Requirements designed to encourage use of alternative transportation modes, rather than single-occupant vehicles. Enacted through local or regional government regulations or ordinances, such as zoning ordinances or building codes. Can establish performance goals or limitations on volume of trips generated from specific employment sites or developments.

Examples: Policies to encourage provision of commute alternatives information and incentives at workplace; trip reduction requirements through negotiations over rezoning; trip reduction activities as quid pro quo for reductions in parking space requirements; imposition of impact fees to fund transportation improvements; incorporation of trip reduction measures as condition of approval of new development; requirements that development or employers over a specified size develop and implement demand management programs.

Have been in existence, initially in California municipalities, for over a decade. Applications have spread in recent years. Currently, at least 60 TROs (in various forms) exist nationwide.

Key Issues: Allows for systematic management of travel behavior, particularly in areas experiencing new development; provides a tool to local governments to plan and control for effects of new development on transportation infrastructure; latitude for TRO design allows for wide range of options and applications; requirements can be voluntary and/or mandatory; can be designed to target specific trip types.

Considerations: May be viewed as anti-growth or as imposing added costs to development; emphasis should be on encouragement of socially beneficial travel choices rather than direct control of travel behavior.

Employer-Based Transportation Management Programs

Definition: Various programs implemented by employers to manage the commute and travel behavior of employees, with the objective of reducing the number of single occupant automobiles used for commuting.

Examples: Alternative travel modes (such as vanpooling and carpooling, subscription buses, bicycling, walking, shuttle services, guaranteed rides home), alternative work

schedules, financial incentives and disincentives (including transit pass subsidies, subsidized vanpools, transportation allowances), and on-site support (such as on-site sale of transit passes, transportation coordinators, information dissemination).

Have been used primarily by large employers, those having more than 100 employees at a single worksite. Examples include the 3M Company in Minneapolis – St. Paul; the Nuclear Regulatory Commission in Montgomery County, Maryland; and public, private, and non-profit employers in urban areas such as Seattle, Los Angeles, San Francisco, Washington, Boston, and Hartford. Some programs began as early as the 1920's. Many of the newer programs began with the energy crises of the mid- and late-1970's. Congestion management currently is an important motivation.

Key Issues: Programs can consist of both voluntary and mandatory measures; generally, a "package" of various complementary measures produces greatest impacts.

Considerations: Must obtain cooperation of majority of employers within target area in order to effectively reduce area-wide commute trips; most effective programs result from motivation of employer to reduce demand for limited parking or to assure accessibility of employees to workplace.

Work Schedule Changes

Definition: Changes in work schedule to provide greater flexibility in work schedule and reduce volume of commute travel during peak periods. This, in turn, can facilitate and encourage the development of ridesharing arrangements, off-peak commuting, and/or reductions in total commute trips.

Examples: Telecommuting, flexible work hours ("flextime"), compressed work weeks, staggered work hours.

There is much current interest in telecommuting, with a number of pilot and demonstration programs existing in the western portion of the country. Examples include the Puget Sound (Washington State) Telecommuting Demonstration Project, the State of California Telecommuting Project, and the Los Angeles County program in which 1,700 employees telecommute at least one day a week.

Flexible work schedules are in widespread use by many employers, both large and small, on a national scale. An example of a citywide program is the San Francisco California Flextime Demonstration Project. Many federal employees participate in compressed work week programs.

Key Issues: Can support ridesharing activities by providing greater flexibility in coordination of arrival and departure schedules by potential pool partners. Fears that reductions in work trip VMT would be offset by increased non-work travel generally have not been realized.

Considerations: A number of important organizational and personnel issues need to be considered and work schedule changes may not be applicable to employers involved in certain businesses or industries whose production processes require adherence to strict schedules. These programs, however, should be acceptable to most employers and employees if carefully developed.

Area-Wide Rideshare Incentives

Definition: Promotion and assistance through state, regional, or local efforts aimed at encouraging commuters to use alternatives to driving alone to work and encouraging employers to provide in-house programs that promote ridesharing, transit, bicycling, and walking among employees.

Examples: Three broad categories of area-wide rideshare incentive programs are: 1) area-wide commute management organizations (or third-party brokerages), 2) transportation management associations, and 3) state and local tax incentive and subsidy programs. Services provided include: computerized carpool matching; vanpool matching; provision of vanpool vehicles; marketing of ridesharing; technical assistance to employers; tax credits; and financial subsidies.

Many examples of rideshare incentives and promotional programs exist on a national scale. Promotion and computerized matching is often provided by commute management organizations. Examples include Sacramento Rideshare (Caltrans), Montgomery County (Maryland) Rideshare and CARAVAN for Commuters (Boston, MA). Subsidy of vanpool participation and/or vehicle costs have been in effect in various locations nationally. California also provides tax incentives to employers and employees who participate in rideshare programs. Numerous transportation management associations have been established throughout the country, including at least 50 within the State of California.

Key Issues: Can effectively facilitate employer/developer-based transportation management programs; recent studies have identified availability of HOV priority treatment and guaranteed ride home programs as significant incentives to encourage ridesharing.

Considerations: Area-wide commute management programs, transportation management associations, and tax incentives support employer-based transportation management programs. They are particularly effective in enhancing the efforts of smaller and mid-size employers. In evaluating the impacts of area-wide programs, though, care needs to be taken not to double count the effectiveness of these programs with the benefits credited to employer programs. In addition, the roles and responsibilities of various public, non-profit, and for-profit organizations involved in promoting ridesharing and other travel alternatives within a region need to be carefully delineated so that the various efforts are not perceived as either duplicative or conflicting by employers and individuals.

Improved Public Transit

Definition: Implementation of new or expanded public transit services relevant to all transit modes such as paratransit, buses, rapid transit, and commuter rail.

Examples: System or service expansion (new or extended routes, higher service frequencies); system/service operational improvements (route and schedule modifications, improved transfer procedures, schedule coordination, operations monitoring, improved maintenance practices), and strategies to enhance market demand (marketing programs, reduced fares, employer provided transit fringe benefit, monthly pass programs, passenger amenities, parking).

Transit services are available in virtually every urban and many non-urban areas in the U.S. Examples of improvements range from low-cost measures such as schedule coordination to more capital intensive programs such as provision of new or extended services.

Key Issues: Serves as the primary alternative mode to automobile use in most urbanized areas; must successfully compete with automobile use in terms of cost and/or travel times in order to attract new ridership.

Considerations: Effectiveness is closely tied to land use patterns in service area and extent to which transit services have adapted to changes in local, residential, employment, and travel patterns over time. Expansion of services can have high capital and/or labor costs; low cost improvements are feasible through operational changes. Because transit services seldom break even financially, a stable source of funding support is essential. In evaluating the air quality impacts of improved transit services, it is necessary to consider the travel mode that otherwise would be used (e.g., riders on a new rail transit line may have previously ridden a transit bus) and the mode of access to transit (e.g., use of a car to drive to a park-and-ride lot may eliminate vehicle miles of travel but still incurs the vehicle start-up or cold start emissions).

High Occupancy Vehicle Lanes

Definition: Travel lanes designated for use by high occupancy vehicles (HOV) such as carpools, vanpools, and transit vehicles.

Examples: HOV lane in a separate highway right-of-way or within freeway right-of-way; contra-flow lane located in "off-peak" direction.

Widespread applications on freeways and arterials in many larger urban areas with severe peak period congestion. In 1989, there were 38 freeway HOV facilities operating in 18 U.S. metropolitan areas. New York City has implemented an extensive bus lane program throughout the city on arterial streets.

Key Issues: HOV facilities are mutually supportive with many other TCM programs (Area-wide ridesharing, employer-based transportation management programs, trip reduction ordinances, etc.) by facilitating higher average travel speeds and travel time reliability for HOVs in comparison to travel via private automobile.

Considerations: HOV lanes need to operate at higher speeds relative to normal mixed flow highway lanes in order to serve as a desirable alternative. Freeflow highway conditions are a disincentive to HOV use. Enforcement of HOV restrictions is critical to maintaining integrity of facilities. Support facilities such as park-and-ride lots, employer rideshare programs, and downtown preferential parking are desirable components of program. Separate HOV facilities should be developed so as to form an overall regional system.

Traffic Flow Improvements

Definition: A range of actions that enhance the person-carrying capacity and efficiency of the roadway system, without adding significantly to the width of the roadway.

Examples: Improved traffic signalization (such as changes to signal timing, signal coordination, removal of signals); improved traffic operations (such as turn restrictions, median strips, channelized roadways/intersections, roadway/intersection widening or reconstruction) and, enforcement and management improvements (such as increased police surveillance, incident management, and ramp metering).

Traffic flow improvements are widely applied by both state and municipal transportation agencies, primarily to reduce congestion and improve travel times at specific locations. Examples of coordinated, area-wide programs include the Back Bay (Boston, Massachusetts) Traffic Operations and Management Study and the Sacramento, California Signal System Improvement Program.

Key Issues: Reduced congestion and improved vehicle travel speeds result in reduced emission rates per vehicle mile of operation. Reduced delay at intersections can effectively control CO "hotspot" conditions. With ramp metering, it is important to consider the emissions which may occur during excessive queuing and under high levels of acceleration when a vehicle enters the freeway traffic stream.

Considerations: Traffic engineering measures do not necessarily reduce VMT, although they may cause a shift of VMT from specific areas or corridors to other locations. Measures which substantially reduce delay and improve travel speeds may attract higher traffic volumes to the affected corridor and/or roadways, thereby offsetting benefits of the measures.

Parking Management

Definition: The management of parking supply and demand; including public and private parking facilities, and both on- and off-street parking. Strategies can include pricing, zoning actions, and usage.

Examples: Preferential parking pricing programs favoring HOV's, provision of preferential or reserved spaces for HOV's; fee structures which discourage long-term (commuter) parking; increased parking fees or taxes; zoning regulations controlling magnitude of parking in conjunction with new development; limitations on the development of new public or private parking spaces.

Preferential parking for HOVs has been offered in numerous cities at municipally controlled parking facilities. Parking pricing strategies have been applied, on a limited scale, at selected parking facilities. Availability of parking spaces is generally regulated by most municipalities in local zoning codes and rates have been adjusted in various cities to discourage single-occupant vehicle use. Controls on parking supplied have been applied in Boston, Portland, Oregon, and San Francisco.

Key Issues: Cost and availability of parking is a key variable in determining travel mode to work. Increases in parking costs and/or decreases in availability produce shifts to alternative modes. Individual municipalities may have limited ability to influence parking supply and prices at privately-operated parking facilities.

Considerations: Parking management strategies are most effective when implemented in dense central business districts or activity centers that have limited available parking. Patterns of dispersed development diminish the effectiveness of parking strategies. In addition, if there is an excess of parking supply, then implementing parking actions that only affect a portion of the spaces may simply result in a reallocation of where people choose to park rather than in a change of mode of travel.

Implementation of parking management strategies is most successful in areas having very high land values and a strong economic development climate that result in disincentives for devoting land to parking. Relatively good transit access that provides an alternative to automobile usage also is important.

Park and Ride/Fringe Parking

Definition: Parking facilities designed to facilitate transfer to transit services, carpooling, and vanpooling.

Examples: Automobile and bicycle parking at transit locations (commuter rail, rapid transit, bus stops) remote from the downtown core or major activity centers; remote or fringe parking facilities at highway interchanges or in heavily travelled commuting corridors.

Most large transit systems provide parking in conjunction with transit services. Park-and-ride facilities can be informally designated or formally established by state or local transportation agencies. Examples include the California Department of Transportation (Caltrans) and the Connecticut Department of Transportation (ConnDOT) Park-and-Ride Programs.

Key Issues: Can be significant incentive in formation of rideshare arrangements and use of transit services. Provides means of intercepting vehicles before they enter congested or core areas. Success of a given site is closely tied to the level of transit and ridesharing service provided and the location of the site in relation to travel corridors and final trip destinations.

Considerations: Planning of facilities should account for local traffic conditions in vicinity of potential parking sites to avoid exacerbation of local traffic or air quality problems, particularly as result of increased cold starts in vicinity of parking site. Lots should be developed with consideration given to pedestrian and bicycle access, and the availability of personal support systems such as banking, convenience stores and day-care.

Bicycle and Pedestrian Programs

Definition: Measures to encourage bicycle and pedestrian travel as viable alternative transportation modes to the private automobile.

Examples: Bicycle paths; secure bicycle parking/storage facilities; increased enforcement of traffic regulations relevant to pedestrian and bicycle movements; enhancement of pedestrian crossing signalization or pavement markings; bicycle commute education programs; removal of barriers restricting bicycle and pedestrian movements; roadway and site design compatible with pedestrian and bicycle accessibility.

Several cities have incorporated bicycling programs into their transportation plans. Many successful bicycling programs have been implemented. Examples of citywide programs include Tucson, AZ, Seattle, WA, Madison, WI, Washington, D.C., and Boulder, CO. Many examples of specific facilities such as bike paths and storage facilities nationally. Limited examples of comprehensive pedestrian programs although appropriate design to accommodate pedestrian movement is standard in most urban design criteria.

Key Issues: Non-motorized transportation provides non-polluting mobility; well-suited for short distance trips and light loads. Low user costs compared to other modes.

Considerations: Extent of participation is sensitive to trip length, topographical and climatic factors, as well as demographics of population. Concern over personal safety due to conflicts with motorized vehicles and security of bicycle while parked can be major disincentives.

Special Events

Definition: Special plans to manage travel demand in effect during special events, defined as destinations for a large number of vehicle trips which occur on a one-time, infrequent, or scheduled basis (such as athletic events, festivals, fairs, political rallies, and major entertainment performances).

Examples: Parking management; remote parking; signage to direct motorists to appropriate routes and destinations; highway improvements; public information and communications systems; enhanced public transportation and shuttle services; increased police presence.

These measures are an important consideration for any event likely to draw unusually large crowds which exceed normal capacity of existing transportation systems. Specific examples include mega-events such as the Knoxville, Tennessee World's Fair, Expo 86 in Vancouver, British Columbia, and the 1984 Summer Olympics in Los Angeles; roadway reconstruction projects such as Boston's Southeast Expressway; and, neighborhood street fairs and parades.

Key Issues: Success of measures is highly dependent upon advance planning and anticipation of transportation needs and problems. Due to short-term nature of demand, emphasis should be on transportation systems management (TSM) approaches, rather than capital-intensive strategies.

Considerations: Uncertainty in predictions of attendance at event can complicate planning. Also, uncertainty involved in anticipating willingness of attendees to utilize alternative transportation services and systems management measures.

Vehicle Use Limitations/Restrictions

Definition: Techniques to limit or restrict the use of certain types of vehicles in a given geographic area or specified time period (such as peak travel periods).

Examples: Route diversions (such as auto restricted zones or ARZs, pedestrian malls, and residential traffic controls), no-drive days, and controls on truck movements (such as designation of truck routes, scheduling of truck operations).

Auto restricted zones and pedestrian malls have been implemented in many downtown areas in U.S. and Europe. No-drive day programs have been implemented in Denver, Colorado and Phoenix, Arizona. Cities have traditionally regulated the movement of trucks on local streets by restricting trucks from certain areas of central business district during peak hours, restricting loading zones, and scheduling deliveries. Proposals now are being made for more aggressive truck management strategies and for broader limitations on truck movements during peak periods.

Key Issues: The development of auto restricted zone programs requires coordination with area businesses, careful consideration of the area's economic strengths and weaknesses, and development of alternative means of providing access to and circulation within the area. No-drive day programs should be integrated with other programs which provide viable alternative transportation on affected days; no-drive day programs require significant marketing efforts and cooperation of local media. The control of truck movements involves legal considerations, as well as the cooperation and support of the trucking industry.

Considerations: All programs should be designed to accommodate needs of commercial interests which would require accessibility by customers/clients for goods delivery. Auto restricted zones have been successful where there already is a stable base of economic activity, but may not be sufficient by themselves to rejuvenate an economically decaying area. In U.S., no-drive days are currently all voluntary. The implementation of controls on truck movements needs to consider the time periods and routes actually being used for current movements, the direct costs to businesses of the controls, and the indirect costs to the economy of different patterns of truck movements.

Accelerated Retirement of Vehicles

Definition: Offer to purchase older vehicles having high emission rates in order to remove these vehicles from the active vehicle fleet.

Examples: Unocal Corp. operated a program of this type in the Los Angeles metropolitan area during the summer of 1990. The South Coast Recycled Auto Project (SCRAP) offered \$700 for pre-1971 model year cars that met a set of requirements to ensure that active vehicles were being removed. Eight thousand, three hundred and fifty autos were bought and crushed. Policy decisions include definition of the target vehicle population to be removed, the dollar amount of the payment to be made, and the duration of the program.

Key Issues: Program design variables include the age and eligibility of vehicles, the duration of the buy-back period, and whether the program is a one-time effort or repeated periodically.

Considerations: The average remaining life of the removed vehicle affects the number of years over which emission reductions can be credited. Assumptions regarding the age of replacement vehicles and the additional mileage driven by either replacement or other vehicles affects the net magnitude of the estimated emissions to be eliminated.

Activity Centers

Definition: Urban design and transportation measures designed to reduce automobile trips and to promote non-automobile travel associated with the use of cohesive activity

centers such as office parks, shopping centers, mixed-use developments, and other centers of vehicle activity.

Examples: Transit friendly design guidelines and ordinances; vanpool and carpool considerations; pedestrian and bicycle design considerations; parking standards and regulation; mixed-use development ordinances and zones; site plan review ordinances.

A number of developments planned and built in the U.S. since 1930 illustrate examples of design guidelines intended to reduce auto dependency. Sacramento County, California, is developing comprehensive "Transit-Oriented Development" guidelines as part of that area's comprehensive plan.

Key Issues: By incorporating opportunities for alternative travel modes such as transit, HOVs, bicycles, and walking into overall design of new development, the desirability of these alternative modes is enhanced. Higher density of development makes use of HOVs and transit more feasible. Mix of appropriate land uses within a development can reduce the need for certain types of trips if need can be met in immediate vicinity of residence or place of work.

Considerations: Rate at which measures can be implemented is directly related to rate of new development. Generally considered a long-term strategy. Can have administrative implications for public sector due to requirements for implementing and enforcing urban design codes and providing services/infrastructure for higher density development. Economic trade-offs for private sector involve potentially higher development costs and correspondingly increased market value and revenues.

Extended Vehicle Idling

Definition: Measures to reduce amount of time which vehicles spend in idle mode as part of their overall operation.

Examples: Controls on construction and operation of drive-thru facilities such as banks and fast food restaurants; controls on extended vehicle idling during layover time, particularly of diesel engines used by transit vehicles and delivery trucks.

Programs to limit heavy truck idling are being considered in California. Sacramento Metropolitan Area regulates the number and design of new drive-up window facilities.

Key Issues: Implementation of controls on vehicle operations should be at regional or state level, rather than local. Restrictions on drive-thru facilities are local responsibility, enforced through zoning code. Public education regarding idling emissions and their control can be further option.

Considerations: The trade-off between idling emissions and hot start/hot soak emissions generated by vehicles which have been shut off and restarted; dependent upon vehicle age and type.

Extreme Low-Temperature Cold Starts

Definition: Actions that can be taken by states and local areas over and above the new Federal cold temperature carbon monoxide standard and that are applicable under extremely cold conditions; e.g., temperatures in the range of 0 degrees F to -20 degrees F, or even colder. These measures normally are directed at reducing vehicle start-up emissions during these extremely cold temperature episodes. Other possibilities include incentives that would entirely eliminate the need for low occupancy vehicle use during these periods, thereby eliminating the entire cold start phase altogether.

Examples: Mechanical devices to control CO emissions during cold starts include block heaters, intake manifold heaters, monolithic catalysts, and multipoint fuel injection systems. Other options include traditional transportation control measures to reduce auto use.

Experience is limited primarily to State of Alaska. A voluntary program to encourage use of block heaters at the workplace was initiated by the Fairbanks North Star Borough.

Key Issues: Retrofit of vehicles can typically cost \$100-300 per vehicle. Also can involve cost to operators of parking facilities to install and provide electrical power to electrical outlets to operate block heaters.

Considerations: Technical feasibility of measures has been demonstrated for cold climates but practical applications have been limited.