**Control Measure:** Carsharing (Combines aspects of measures 500, 505, 506, 507)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

Carsharing is common in Europe, and is being developing in some North American cities. Carshare organizations typically charge $1-2 per vehicle-hour, plus 25-40¢ per mile. Some charge a refundable membership deposit of $300-500. These charges cover all vehicle operating expenses, including fuel and insurance. There are often special rates for extended trips and infrequent users. Carsharing is considered a cost effective alternative to owning a vehicle driven less than about 6,000 miles (10,000 kms) per year. There are typically 8-15 members per vehicle. Some small businesses use Carsharing (Reutter and Bohler, 2000).

*Station cars* are a type of Carsharing (*National Station Car Association*). Station cars are rented at transit stations for travel between terminals and local destinations. This supports transit use, particularly in suburban areas where destinations are too dispersed for convenient pedestrian access. Because they are intended for short trips, station cars can employ small, alternative fuel vehicles, such as battery powered electric cars.

## ANALYSIS

Because Carsharing variable costs are 2-10 times higher than for a personal automobile, users tend to minimize their driving. Overall travel reductions depend on what portion of Carshare participants would otherwise own a personal automobile (they typically reduce their vehicle use by 50-80%)and which portion would otherwise not own an automobile (they typically increase their vehicle use by a small amount). Most studies suggest that Carsharing typical results in a net reduction in per capita driving among participants that averages 40-60%, but this varies depending on the demographics of participants and the quality of travel choices in their community (Steininger, Vogl and Zettl, 1996).

In a study of the San Francisco *City CarShare* program, Cervero and Tsai (2003) find that when people join, nearly 30 percent reduce their household vehicle ownership and two-thirds stated they avoided purchasing another car, indicating that each Carshare vehicle substitutes for seven private cars, and that the average member drives 47% fewer annual miles after joining. However, since Carsharing tends to attract motorists who already drive relatively low mileage, total travel reductions may be relatively small.

In a series of examples presented in the online TDM encyclopedia, the number of vehicles by program ranges from 4 – 40. Unless a program were expanded to thousands of vehicles the effect would hardly be measureable. This analysis assumes a 1,000 car station fleet to provide a benchmark emission reduction easily adjusted to an actual planned program. Based on experience in other areas such as San Francisco, Toronto, Quebec, and Vancouver, it appears that an average of 8 – 15 members per vehicle is common.

**Emissions Analysis**

This analysis assumes 1,000 station cars used by 10 people per car. As it is known that station car users tend to drive less than average, it is assumed that these users previously drove 8,000 miles per year (an average of 21.9 miles per day). As noted above, carsharing has been found to reduce travel by about 47 percent in users. Therefore we would expect that these 10,000 drivers would now drive 11.6 miles per day on average, representing a reduction of 10.15 miles per day per user, or an average of 102,930 miles per day of VMT reduction.

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

**Variables:**

**$EF_A$:** Speed-based composite emission factor after implementation ($NO_x$ , VOC, or CO) grams/mile)

**$EF_B$:** Speed-based running composite emission factor before implementation ($NO_x$ , VOC, or CO) (grams/mile)

**$N_{VA}$:** Number of vehicles after implementation

**$N_{VB}$:** Number of vehicles before implementation

**$TEF_{AUTO}$:** Auto trip-end emission factor ($NO_x$ , VOC, or CO) (grams/trip)

**$TL_A$:** Average auto trip length after implementation (miles)

**$TL_B$:** Average auto trip length before implementation (miles)

**$VT_A$:** Vehicle trips after implementation

**$VT_B$:** **Change in** VMT as a result of implementation

It was assumed that emission factors and trip length before and after implementation are the same. Emissions changes from vehicle trips and associated start emissions are evaluated through the use of composite emission factors and the assumption that access to transit is not through SOV use. Any inaccuracy in this assumption is offset by the larger assumption of frequency of transit use per week, another key unknown factor.

As noted earlier **$VT_B$** is the same as the reduction in VMT by carsharers.

Daily Emission Reduction =

**$C = VT_B * EF_{A} =$**

**102,930 * 0.5 gram/mile VOC/454 = 113 lb/day, and 0.057 tpd VOC**

*and*

**102,930 * 0.4 gram/mile NOx/454 = 90.7 lb/day, and 0.045 tpd NOx.**

### Cost Effectiveness

No data on costs for Dallas is available. Depending on program structure, cost per ton could be as low as $0.

### COMMENTS

*This analysis presents a hypothetical case in which 1,000 cars are provided. If the Dallas-Fort Worth area chooses to pursue such a measure this analysis will provide documentation on expected benefits and can easily be adjusted to an actual proposed program by proportionately raising or lowering the number of vehicles to be shared.*

### SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 500, 505, 506, 507 | Carsharing | 1,000 shared cars | On-Road | 193 tpd | 0.02 | 0.045 | Not available |

### SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 500, 505, 506, 507 | Carsharing | 1,000 shared cars | On-Road | 99 tpd | 0.057% | 0.057 | Not available |

### REFERENCES

Robert **Cervero** and Yu-Hsin Tsai, *San Francisco City CarShare: Travel-Demand Trends and Second-Year Impacts*, Institute of Urban and Regional Development, University of California at Berkeley, Working Paper 2003-05 (www-iurd.ced.berkeley.edu), August 2003.

K. **Steininger**, C. Vogl and R. Zettl, “Car Sharing Organizations,” *Transport* Policy, Vol. 3, No. 4, 1996, pp. 177-185.

**Control Measure:** Congestion (value) pricing (Combines aspects of measures 275, 281, 287, 290, 294)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

At this time the data needed to estimate emissions for this measure is not available. It is recommended that the regional travel model be used to evaluate this measure in any case, once data is available to define which facilities to use congestion pricing on, and the associated pricing structure. The travel and associated emission impacts of Road Pricing depend on the type and magnitude of fees, where it is applied, what alternative routes and modes are available, and what is assumed to be the alternative or Base Case.

According to the EPA, no reliable data or methodology yet exists for projecting the potential emission benefits of a congestion or value pricing program. In a recent website article at http://yosemite.epa.gov/aa/tcmsitei.nsf/0/647e950797e1f217852565d90073f4e6?OpenDocument they say:

> The goal of congestion pricing policies is to mitigate congestion and improve air quality. Because congestion pricing policies are only in the pilot program stage of development in the United States, there is little empirical evidence on the extent to which VMT and emissions are reduced. Theoretically, however, emissions will be reduced considerably because VMT and idling will decrease. The imposed fees will result in people switching from driving single occupancy vehicles (SOVs) to higher occupancy vehicles or mass transit. There will be fewer total VMT, which directly eliminates emissions of harmful pollutants. Fewer VMT during peak periods reduces congestion, which results in less idling. Idling is known to contribute significantly to carbon dioxide emissions, smog, and global warming. One study showed that congestion caused an extra 30 million tons of carbon dioxide to be released into the air in the United States in a recent year. [1]
>
> The few congestion pricing programs operating in the U.S. are still in the demonstration stage, and the evaluation methodologies required to determine emissions reductions from these measures are still being developed. Implementing these policies is risky because of the uncertainty of the price elasticity of automobile travel. Although there is not much practical experience in the U.S., there is evidence that commuter travel demand is relatively inelastic, meaning that price changes may not induce people to substitute mass transit for driving.

**ANALYSIS**

According to Todd Littman of the Victoria Transport Policy Institute and its online TDM encyclopedia (http://www.vtpi.org/tdm/tdm35.htm), several studies have investigated the sensitivity of vehicle travel to road tolls (Transport Elasticities). These indicate a price elasticity of –0.1 to –0.4 for urban highways (i.e., a 10% increase in toll rates reduces vehicle use by 1-4%), although this can vary depending on the type of toll, type of traveler and other factors (TCRP, 2003). Mekky (1999) finds that traffic volumes and trip lengths decline significantly if tolls exceed 10¢ per vehicle kilometer (Canadian dollars). A state-preference survey of suburban automobile long-distance commuters indicates that financial incentives are the most effective strategy for reducing automobile trips. A US$3.00 per round-trip road toll is predicted to reduce automobile commuting by 25% (Washbrook, 2002). One study estimates that congestion pricing can reduce up to 5.7% of VMT and up to 4.2% of vehicle trips in a region (Apogee, 1994).

**BACKGROUND**

Tolls for transportation services have existed for thousands of years, often used as a means of paying for the construction of new transportation infrastructure or controlling who used the infrastructure. For the past 15 years, transportation planners and economists have identified the ability to use tolls as a means of managing the demand for public facilities relative to that of their capacities. This concept, known as "congestion pricing" or "value pricing", offers substantial variation in terms of implementation, however the concept remains the same - using tolls to manage demand.

Demand management through congestion pricing can involve increasing the average vehicle occupancy of facility users, and/or, the time, length, and duration of travel. Congestion pricing can provide a guaranteed non-congested alternative to clogged freeways and arterials. It can provide a financial incentive to carpool or vanpool, while enjoying a more free flow route of travel. And as the primary interest to many, congestion pricing can also provide a new, user fee oriented revenue source, which can be applied to matching obligations or augmentation of known transportation funds.

Congestion pricing recognizes that a person's value of time will vary. How much that person values his or her time depends upon the purpose of the trip and the urgency of the trip. These different values of time lie at the heart of congestion pricing: individuals make the choice to use a congestion priced facility or not based upon their values of travel-time savings. Depending upon that value of time, the traveler may elect to purchase his or her way into an uncongested facility (saving time), or, choose to use a non-priced, but potentially congested facility (saving money). On select facilities where carpools and vanpools are offered either free or discounted use, then ridesharing travelers can enjoy both saving time and saving money.

<u>Variable Pricing on Toll Roads</u>
On variable priced toll roads, toll rates are structured such that higher prices are assessed based either upon time of day concurrent with typical periods of congestion (a "Fixed

Variable Rate Schedule") or upon actual levels of congestion (a "Dynamically Priced Schedule"). Despite the nature of the program, tollway users will experience higher charges during the peak periods and lesser charges during off-peak or shoulder periods.

The effect of variable pricing on the toll facilities will be to: 1) help divert some traffic from the peak period to the shoulders of the peak period, and, 2) provide a cost-based encouragement for the use of transportation options (such as transit and ridesharing). Shifts to either off-peak periods or other transportation options will likely reduce the overall congestion on the facility, and, reduce the need for additional capacity on the toll facilities. Both elements have positive air quality benefits.

**History**

Congestion pricing first came into the public eye with the adoption of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. In this Act, the Federal Congestion Pricing Pilot Program was initiated, offering limited grants to state governments willing to experiment with implementing congestion pricing projects. As of the Transportation Equity Act for the 21$^{st}$ Century (TEA-21), congestion pricing is now known as value pricing. However, the principal remains the same, as does the use of Federal grant monies for the adoption of value pricing strategies.

Since 1991, the Federal Highway Administration's Value Pricing Pilot Program has funded implementation projects in four states, including Texas, California, Florida, and New York. Each of these projects are unique, and have various lessons for implementation of congestion pricing in the Dallas area.

Earlier this year the Regional Value Pricing Corridor Evaluation and Feasibility Study was conducted by NCTCOG and the consulting firm URS. In the Dallas-Fort Worth Region, pricing strategies could be used as a demand management strategy to avoid the need to add capacity, or to raise revenue for additional capacity on tollways or freeways, or a combination of both. The existing highway system in the Dallas-Fort Worth Region is composed of three types of roadways: freeways, tollways, and HOV lanes. TxDOT constructs and maintains the freeway network, which includes non-tolled, limited-access facilities. Tollways in this region are owned and operated by the NTTA, which are authorized to raise construction capital through the issuance of bonds, and to collect tolls to repay those bonds and to operate and maintain the facility. The HOV lanes are operated by DART and are open to transit vehicles and HOVs, with the goal of improving
transit travel times and encouraging ridesharing.

The study looked at three options for congestion pricing in the Dallas area:

1. Pricing Existing HOV Lanes: "Selling" excess capacity on existing HOV facilities;
2. Applying Value Pricing on Tollways: Implementing variable tolls (by time of day, vehicle classification, congestion level, etc.) on an existing toll facility or designing a new tollway with variable tolls; and

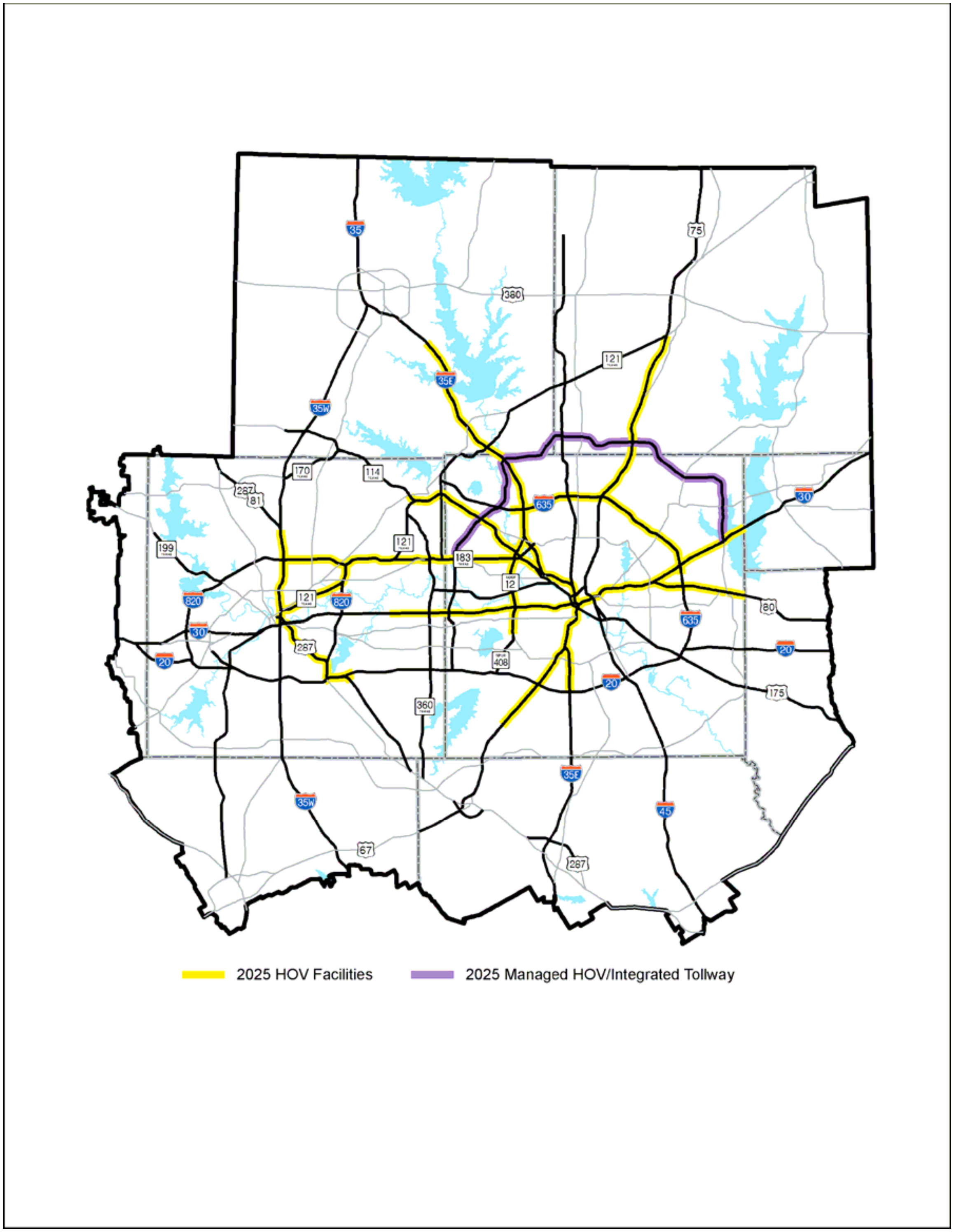
3. Pricing New Capacity on Freeways: Adding new priced lanes to existing freeways or constructing a partially managed new roadway.

It should be noted that RTC does not support converting existing free non-HOV/Managed lanes to Toll Roads (October 2003).
This analysis focuses on the use of variable pricing for tollways. The transportation network in the Dallas-Fort Worth Region includes several important toll facilities, including the President George Bush Turnpike (PGBT) and Dallas North Tollway (DNT), which are owned and operated by the North Texas Tollway Authority (NTTA). Several additional toll facilities are currently the subject of NTTA planning studies, including SH 121/Southwest Parkway in Tarrant and Johnson Counties, the Trinity Parkway, and extensions of both
the PGBT and DNT.

If the effect of tolls is sufficiently elastic to affect the departure-time choice of drivers, some users can be shifted from peak periods to off peak periods. This effectively "flattens" the peak period and decreases the volume during the most congested hours, with no required increase in capacity. This congestion relief is the main benefit of implementing a value pricing program on a tolled facility. Observations of existing value pricing projects indicate that changes in peak pricing clearly influence the temporal distribution of trips, shifting traffic away from periods with the highest charges.

The study suggested using the regional travel model to determine the impact on the tolled facility and the adjacent non-tolled facilities. The overall evaluation process would focus on the change in travel time and vehicle trips within the area of influence of the facility. As an initial step, the model would be used
to determine the impacted area using time savings for individual origin-destination zonal pairs as a mechanism to identify the area of influence. This
analysis would be conducted separately by time period (peak and off-peak)
so that the impacts can be quantified for both the peak period and overall daily levels of travel.

The study also suggested conducting a short-term demonstration project.




The study identified the following six facilities likely to be open to traffic within five years (i.e., by 2010) and could support new, priced lanes.

1. I.H. 30 (Tom Landry Freeway);
2. I.H. 35E/U.S. 67 (South R.L. Thornton/Martin D. Love Freeway):

3. S.H. 121/S.H. 183 (Airport Freeway):
4. President George Bush Turnpike – Segment IV ("Superconnector"):
5. I.H. 635 East (Lyndon B. Johnson Freeway)' and
6. U.S. 75 (Central Expressway)

**COMMENTS**

No quantitative analysis can be conducted until there are estimates of VMT and speed on specific facilities identified below, as well as specific tolls to be charged. This qualitative report summarizes congestion pricing studies with a focus on the recently (June 2005) completed value pricing study conducted for the Dallas area. That study recommended evaluating these measures by using the travel demand model.

**Control Measure:** Employer Trip Reduction Program: Vanpooling (Combines aspects of measures 496, 497, 499, 501, 503, 504, 508, 462, 471, 480, 483, 485, 489, 492, 463, 464, 465, 468, 470, 472, 476, 481, 482, 484, 493)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

**DESCRIPTION**

The Dallas Fort Worth area has been operating an employer trip reduction program (ETR) since fiscal year 2001; the vanpool program has been operating since 1997. The ETR program is designed to reduce employee commute vehicle trips through implementation of rideshare, telecommuting, and flexible work-hour programs, transit pass subsidies, bicycling, and similar strategies. Currently the program is primarily operated through the Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (the “T”) with the support of NCTCOG. Supporting programs include the Best Workplaces for Commuters (BWC) program, park and ride lots, guaranteed rides home, general public education and outreach programs and other programs that encourage and support alternative commute modes. The year-round ETR program is voluntary and is aimed at public and private employers in the region with more than 100 employees although many employers with fewer employees are participating.

**ANALYSIS**

Earth Matters conducted an evaluation of the current program based on discussions with and data from NCTCOG, DART and the “T”. The program as a whole currently primarily focuses on transit, vanpooling and carpooling although telecommuting, alternative work schedules and similar measures are also included. The vanpooling portion of the DART program had, as of August 2005 (the latest month in report made available for this analysis), 731 vanpoolers. The vanpooling portion of the “T” program had, as of June, 2005 (the latest available report), 827 vanpoolers.

NCTCOG is expanding the ETR program. Through the RTC and the North Texas Clean Air Coalition, the North Central Texas Council of Governments (NCTCOG) will review current program practices and continue to market the ETR program to large public and private employers in the North Central Texas region. Additionally, NCTCOG will work with interested parties, including environmental groups, to draft a policy for consideration by large public and private employers to offer employees a pre-tax benefit to pay for appropriate commuting alternatives. A clear financial incentive, such as a pre-tax benefit, is essential to obtain employee participation in ETR programs. Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (The T) are currently operating effective pre-tax programs for local employers. The RTC will fund the program up to $1,000,000 for staff time and contracts. One contract will develop a computer program that employees can use to fill out information on the alternative modes they use and how frequently so that additional data will be available for estimating and tracking program benefits in the future.

This expanded program is the basis for assuming the continued growth and associated emission reductions that are discussed below.

**Approach and Associated Assumptions**

Both the DART and the "T" provide monthly updates regarding the number of vans, vanpoolers and other information.

Number of new vanpoolers

It was assumed that vanpooling participation in DART grew at the annual rate of growth for participating employees documented since 2000. The year 2000 is used at the suggestion of NCTCOG since in that year the plan policy changed to a 50% public/private split where public sector funds for vanpool subsidies were not to exceed 50% of the operating cost. The DART program grew from 621 vanpoolers in February 2000 to 731 in August 2005, or 17.71% growth over that 5.5 year period. This is equivalent to a simple growth rate of 3.22 percent per year. The DART[1] as well as some NCTCOG personnel agreed that it would be reasonable to assume that the program would grow at the same rate through 2009. Therefore in 2009 it is projected that there will be 825 DART vanpoolers. In 2005 there is an average of 11.25 passengers per van; therefore it is projected that there will be 73 DART vans.

The "T" is constrained to a maximum of 132 vanpool groups[2] and is projecting 132 vanpool groups in 2009. Currently there is an average of 7.38 passengers per vanpool; this is interpreted to mean that there will be 974 "T" vanpoolers in 2009.

Based on the above, the total projected 2009 vanpoolers from DART and the "T" is 1,799. The total number of vans is 205.

Based on DART and "T" statistics, vanpoolers typically commute to work via vanpool every day unless they are on vacation, sick, or on a holiday. This would imply an average daily number of vanpoolers from this program is also 1,799. Because there are vanpool drivers, actual trips per day reduced would be 1,799 – 205 vanpool drivers, or 1,594.

According to NCTCOG the average home-to-work trip length is 14.11 miles and the average speed is about 37 mph. The average daily VMT reduction due to vanpoolers is therefore 2 * (14.11) * 1,799) = 50,768 miles per day. It is also assumed that there is an additional 205 vanpool trips per day, representing 205 * 28.22 miles, or 5,785 vanpool miles per day. The total emission reduction from vanpoolers will be offset slightly by the emission increase caused by the vanpool drivers and use of heavier vehicles (vans) relative to passenger vehicles.

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[1] Personal and email communication Tony Mendoza, DART, 11/7/05.
[2] Personal and email communication, Betty Battles, the "T" 11/7/05.

Emission factors were obtained from the NCTCOG based on 2009 estimated emission factors for the ozone episode being evaluated in the attainment analysis. Emission factors for vanpool passengers are for light duty vehicles only. Composite emission factors for Dallas County for each of the nine light duty vehicle classes were weighted by the VMT by each of those vehicle classes to obtain a light duty vehicle composite gram per mile emission rate. Emission factors for medium duty vehicles were used for the vanpool emissions.

**Emissions Analysis**

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

**Variables:**

**$EF_A$:** Speed-based composite light duty vehicle emission factor after implementation ($NO_x$ , VOC, or CO) grams/mile)

**$EF_B$:** Speed-based running composite emission factor before implementation ($NO_x$ , VOC, or CO) (grams/mile)

**$EF_{mdv}$** Speed-based composite emission factor for medium duty vehicles after implementation

**$N_{VA}$:** Number of vehicles after implementation

**$N_{VB}$:** Number of vehicles before implementation

**$TEF_{AUTO}$:** Auto trip-end emission factor ($NO_x$ , VOC, or CO) (grams/trip)

**$TL_A$:** Average auto trip length after implementation (miles)

**$TL_B$:** Average auto trip length before implementation (miles)

**$VT_A$:** Vehicle trips after implementation

**$VT_B$:** **Change in** Vehicle trips as a result of implementation

It was assumed that emission factors and trip length before and after implementation are the same. Emissions changes from vehicle trips and associated start emissions are evaluated through the use of composite emission factors and the assumption that access to the vanpools is not through SOV use.

As noted earlier $\mathbf{VT}_B$ is the same as the number of new and non-driving vanpoolers in this case.

**Emissions Benefit**

Daily Emission Reduction From Vanpoolers =

$$C = VT_B * TL_B * 2 * EF_A =$$

**1,799 * 14.11 * 2 * 0.513 gram/mile VOC/454 = 57 lb/day, and 0.029 tpd VOC**

*and*

**1,799 * 14.11 * 2 * 0.496 gram/mile NOx/454 = 55.5 lb/day, and 0.028 tpd NOx.**

Daily Emission Increase from Vanpools =

$$C = VT_B * TL_B * 2 * EF_{mdv} =$$

**205 * 14.11 * 2 * 0.36 gram/mile VOC/454 = 4.6 lb/day, and 0.002 tpd VOC**

*and*

**205 * 14.11 * 2 * 0.7 gram/mile NOx/454 = 8.9 lb/day, and 0.004 tpd NOx.**

**Therefore the total emission reduction from the vanpool program is estimated to be 0.026 tpd VOC and 0.023 tpd of NOx.**

**Cost Effectiveness**

The cost of this program was provided by NCTCOG through discussions with DART and the "T". Provided was an ETR budget for the DART, a vanpool budget for DART, and total ETR budget for the "T". The vanpool budget provided is $1,539,295.

Total annual NOx emission reductions are 5.98 (daily multiplied by the numb of work-days per year). Therefore cost effectiveness is $257,407.

**COMMENTS**

This evaluation is based on data from other areas in the U.S. as well as upon current data and projections from the Dallas area and may be considered for use in ozone plan after review of key assumptions.

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 496, 497, 499, 501, 503, 504, 508, 462, 471, 480, 483, 485, 489, 492, 463, 464, 465, 468, 470, 472, 476, 481, 482, 484, 493 | Vanpool Programs | Continue and increase Vanpool programs projects under ETR programs | On-Road | 193 tpd | 0.01 | 0.023 | $257,407 |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 496, 497, 499, 501, 503, 504, 508, 462, 471, 480, 483, 485, 489, 492, 463, 464, 465, 468, 470, 472, 476, 481, 482, 484, 493 | Vanpool Programs | Continue and increase vanpool projects under ETR programs | On-Road | 99 tpd | 0.026% | 0.026 | Not applicable; all costs attributed to NOx |

**Control Measure:** Employer Trip Reduction Program: Best Workplaces For Commuters (combines aspects of 475, 486, 487, 488, 490, 463, 464, 465, 468, 470, 472, 476, 481, 482, 484, 493)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

The Dallas Fort Worth area has been operating an employer trip reduction program (ETR) since fiscal year 2001. A growing portion of this program is the more recent Best Workplaces for Commuters (BWC) program, operated by the North Texas Clean Air Coalition. The program is designed to reduce employee commute vehicle trips through implementation of rideshare, telecommuting, and flexible work-hour programs, transit pass subsidies, bicycling, and similar strategies.

The BWC program helps both commuters and employers, and improves air quality through reductions in vehicular travel. Studies show that employers offering commuter benefits improve employee recruiting and retention, increase employee job satisfaction, and save money on parking and federal taxes while providing improvements to air quality. Because the ETR program is primarily operated through the efforts of DART and the "T", both transit companies with a focus more toward transit subsidies, vanpooling and some carpooling, the BWC program may be more effective at its core objective of reducing commute travel through encouraging alternative work schedules such as telecommuting and compressed work weeks as well as encouraging ridesharing, transit, bicycle and pedestrian options or flexible work hours.

As of September 2005, there were 72,303 employees working at BWC worksites in the Dallas-Fort Worth region. Many employers were recruited using the DART and "T" employer lists from the ETR program; however some 19,741 employees have been recruited from companies not participating in the DART and "T" programs. This is an encouraging number, supporting the strenuous efforts of the NTCAC for this program. The 2005 conformity analysis projected 3.7 million employees in 2007 (the earliest year reported). The current total employee BWC participants therefore represent approximately 2 percent of area employees.

## ANALYSIS

Earth Matters conducted an evaluation of the current program based on discussions with and data from NCTCOG and the NTCAC, a recent EPA survey of the effects of BWC programs, and experience evaluating this program for other areas such as Houston. The program as a whole encourages telecommuting, alternative work schedules, carpooling, vanpooling, transit use and bicycle pedestrian options for commuting. If funding for the programs continues through expansion of the ETR program or other means, NTCAC expects that it could reasonably double the employee participants by 2009.

EPA conducted a survey of the BWC program at the end of 2004 and the findings from that survey, together with NTCAC's and NCTCOG's agreement that it could be reasonable to expect the program would double by 2009, are used as the principal means of estimating the potential travel reductions resulting form this program in the Dallas area.

**Approach and Associated Assumptions**

Number of BWC employees in 2009

Based on discussions with NTCAC and NCTCOG it appears realistic that BWC employees could double by 2009 if funding for this program continues or is increased. This would represent 144,606 employees at participating companies.

A draft research article by the EPA (Results of the Fall 2004 Best Workplaces for Commuters Survey, Herzog e. al, 2005) planned for presentation at the January 2006 Transportation Research Board meeting found a 15 percent reduction in vehicle trips and related VMT occurring in BWC employees compared with trip and travel activity in the 2000 census. Both NCTCOG and NTCAC believed this value was higher than they would have expected. In addition, many of the employees at BWC companies are also companies participating in the ETR programs, which are quantified separately under the categories (1) transit subsidies; (2) vanpooling; and (3) carpooling. However many employees in BWC programs are telecommuting, participating in compressed work week programs, alternative work schedule programs, or other activities that significantly reduce commute travel. These activities are not being explicitly quantified as part of the ETR program; instead, because the BWC program explicitly encourages these other programs (in addition to transit, vanpooling and carpooling), the BWC program is being used here to estimate the benefits of these other activities.

This analysis uses a change of 7.5 percent. This lower value is arbitrary due to a lack of actual data but is intended to present the lower amount the experience of NTCAC and NCTCOG would suggest, as well as to leave out benefits from vanpooling and transit subsidies, which are evaluated separately, and to account for any overlap between the DART and "T"ETR programs.

The 144,606 employees at BWC companies represent 3.73% of 2010 employment (3,871,731). The change in VMT is calculated by multiplying 3.73% by total 2009 commute VMT (home-to-work) reported by the NCTCOG travel demand model (67,848,838) and by 7.5% (the estimated reduction for participating employees). This change is 189,807 miles per day.

**Emissions Analysis**

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

**Variables:**

**$EF_A$:** Speed-based composite emission factor after implementation ($NO_x$ , VOC, or CO) grams/mile)

**$EF_B$:** Speed-based running composite emission factor before implementation ($NO_x$ , VOC, or CO) (grams/mile)

**$N_{VA}$:** Number of vehicles after implementation

**$N_{VB}$:** Number of vehicles before implementation

**$TEF_{AUTO}$:** Auto trip-end emission factor ($NO_x$ , VOC, or CO) (grams/trip)

**$TL_A$:** Average auto trip length after implementation (miles)

**$TL_B$:** Average auto trip length before implementation (miles)

**$VMT_A$:** Vehicle trips after implementation

**$VMT_B$:** **Change in** VMT as a result of implementation

It was assumed that emission factors and trip length before and after implementation are the same. Emissions changes from vehicle trips and associated start emissions are evaluated through the use of composite emission factors and the assumption that access to alternative modes is not through SOV use.

In this analysis **$VMT_B$** is the same as the number of new and non-driving carpoolers in this case.

**Emissions Affected**

According to NCTCOG estimates, on-road NOx emissions in 2009 are 193.4 tons per day and VOC emissions are 99.7 tons per day.

**Emissions Benefit**

Equation**:**

Daily Emission Reduction =

$$C = VMT_B * EF_A =$$

**189,807 * 0.513 gram/mile VOC/454 = 214 lb/day, and 0.107 tpd VOC**

*and*

**189,807 * 0.496 gram/mile NOx/454 = 207 lb/day, and 0.104 tpd NOx.**

**Cost Effectiveness**

The North Texas Clean Air Coalition provided details of the portions of their annual budget directed toward the Best Workplaces program. The NTCAC portion is $10,199. There is also a media, advertising and outreach budget for EnviroMedia of $77,973. The total cost of the Best Workplaces program is $88,172.

The annual emission reductions would be 76.285 tons of NOx and VOC combined and 38 tons per day of NOx only (the emission reduction has been adjusted for work days and non-work days through the use of average daily commute travel rather than average daily work-day commute travel). It is the practice of NCTCOG to evaluate cost effectiveness for NOx only instead of NOx plus VOC and/or other emission reductions such as carbon monoxide, carbon dioxide, or particulate matter. Therefore the total emission reduction for the purpose of evaluating cost effectiveness is considered to be 38 tons per day of NOx.

The total estimated cost effectiveness is $88,172/38 = $2,320 per ton.

**COMMENTS**

This evaluation is based on data from other areas in the U.S. as well as upon current data and projections from the Dallas area and may be considered for use in ozone plan after review of key assumptions.

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 475, 486, 487, 488, 490 | Best Workplaces Program | Continue and increase BWC projects | On-Road | 193 tpd | 0.05% | 0.104 | $2,320 |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | tpd | |
| 475, 486, 487, 488, 490 | Best Workplaces Program | Continue and increase BWC projects | On-Road | 99 tpd | 0.11% | 0.107 | Not applicable; all costs attributed to NOx |

**Control Measure:** Employer Trip Reduction Program: Carpool (Combines aspects of measures 460, 461, 469, 473, 496, 497, 499, 501, 503, 504, 508)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

The Dallas Fort Worth area has been operating an employer trip reduction program (ETR) since fiscal year 2001. The program is designed to reduce employee commute vehicle trips through implementation of rideshare, telecommuting, and flexible work-hour programs, transit pass subsidies, bicycling, and similar strategies. Currently the program is primarily operated through the Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (the "T") with the support of NCTCOG. Supporting programs include the Best Workplaces for Commuters (BWC) program, park and ride lots, guaranteed rides home, general public education and outreach programs and other programs that encourage and support alternative commute modes. The year-round ETR program is voluntary and is aimed at public and private employers in the region with more than 100 employees although many employers with fewer employees are participating.

As of September 2005, there were 381 employer participants in the various DART ETR programs (representing 63,378 employees) and 681 employer participants in the various "T" ETR programs (representing 53,478 employees). Therefore 1,062 employers representing 116,856 employees are currently participating. The 2005 conformity analysis projected 3.7 million employees in 2007 (the earliest year reported). The current employee participants therefore represent approximately 3 percent of area employees.

## ANALYSIS

Earth Matters conducted an evaluation of the current program based on discussions with and data from NCTCOG, DART and the "T". The program as a whole currently primarily focuses on transit, vanpooling and carpooling although telecommuting, alternative work schedules and similar measures are also included. The carpooling portion of the program has 184 carpools reported by DART. The number of carpools assisted through the "T" is 1,095.

NCTCOG is expanding the ETR program. Through the RTC and the North Texas Clean Air Coalition, the North Central Texas Council of Governments (NCTCOG) will review current program practices and continue to market the ETR program to large public and private employers in the North Central Texas region. Additionally, NCTCOG will work with interested parties, including environmental groups, to draft a policy for consideration by large public and private employers to offer employees a pre-tax benefit to pay for appropriate commuting alternatives. A clear financial incentive, such as a pre-tax benefit, is essential to obtain employee participation in ETR programs. Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (The T) are currently operating effective pre-tax programs for local employers. The RTC will fund the program up to $1,000,000 for staff time and contracts. One contract will develop a computer program that employees can use to fill out information on the alternative modes they use and how frequently so that additional data will be available for estimating and tracking program benefits in the future.

This expanded program is the basis for assuming the continued growth and associated emission reductions that are discussed below.

**Approach and Associated Assumptions**

No estimate is available from either transit agency on the number of carpooling employees in the other portions of the program, or on the frequency of participation by any of the employees. Therefore assumptions about these were necessary.

<u>Number of new carpoolers</u>
It was assumed that carpooling participation in programs grew at the annual rate of growth for participating employees documented since the programs began in earnest in 2002. The DART program has grown from 35,245 to 63,378 employees, or an average of 26.6% per year (not compounded). If these growth rates continue it could be expected that in 2009 there would be 380 carpools in the DART program. The "T" projects there will be 1,605 carpools in 2009.[1] The total therefore will be 1,985 carpools. This growth is attributed to the expanded ETR program and the efforts of the BWC program.

It is assumed that the carpools consist of an average of 2.2 passengers per vehicle. Studies of carpooling such as (EPA, 2005) showed that 2.2 to 2.27 carpoolers per vehicle was typical. As with the transit subsidy program it was assumed that carpoolers typically carpool three times per week.

This would mean that there are assumed to be 1,985 carpools in 2009 if we consider only the DART and "T" programs. While there are others, the only formal ETR-based ridesharing program is that administered by DART and the "T" and therefore it is difficult to claim credit for any other programs at this time.

If there are 1,985 carpools with an average of 2.2 riders per vehicle, then there are 2,382 one-way vehicle trips removed as a result of this program, (because one carpooler is driving only 1.2 people per vehicle are actually reducing a trip). According to NCTCOG the average home-to-work trip length is 14.11 miles and the average speed is about 37 mph. The average daily VMT reduction is therefore 2 * (14.11) * 2,382 * 3/5) = 40,332 miles per day. Note that the 3/5 in the equation is to adjust for the weekly frequency (three times) of carpooling.

Emission factors were obtained from the NCTCOG based on 2009 estimated emission factors for the ozone episode being evaluated in the attainment analysis. Emission factors are for light duty vehicles only. Composite emission factors for Dallas County for each

[1] Personal communication, Betty Battles, the "T", November 7, 2005.

of the nine light duty vehicle classes were weighted by the VMT by each of those vehicle classes to obtain a light duty vehicle composite gram per mile emission rate.

**Emissions Analysis**

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

| | | |
|---|---|---|
| **Variables:** | $\mathbf{EF}_A$: | Speed-based composite emission factor after implementation ($NO_x$ , VOC, or CO) grams/mile) |
| | $\mathbf{EF}_B$: | Speed-based running composite emission factor before implementation ($NO_x$ , VOC, or CO) (grams/mile) |
| | $\mathbf{N}_{VA}$: | Number of vehicles after implementation |
| | $\mathbf{N}_{VB}$: | Number of vehicles before implementation |
| | $\mathbf{TEF}_{AUTO}$: | Auto trip-end emission factor ($NO_x$ , VOC, or CO) (grams/trip) |
| | $\mathbf{TL}_A$: | Average auto trip length after implementation (miles) |
| | $\mathbf{TL}_B$: | Average auto trip length before implementation (miles) |
| | $\mathbf{VT}_A$: | Vehicle trips after implementation |
| | $\mathbf{VT}_B$: | **Change in** Vehicle trips as a result of implementation |

It was assumed that emission factors and trip length before and after implementation are the same. Emissions changes from vehicle trips and associated start emissions are evaluated through the use of composite emission factors and the assumption that access to the carpool is not through SOV use. Any inaccuracy in this assumption is offset by the larger assumption of frequency of carpooling per week, another key unknown factor.

As noted earlier $\mathbf{VT}_B$ is the same as the number of new and non-driving carpoolers in this case.

**Emissions Affected**

According to NCTCOG estimates, on-road NOx emissions in 2009 are 193.4 tons per day and VOC emissions are 99.7 tons per day.

**Emissions Benefit**

Daily Emission Reduction =

$$C = VT_B * TL_B * 2 * EF_A =$$

**2,382 * 14.11 * 2 * 3/5 * 0.513 gram/mile VOC/454 = 45.6 lb/day, and 0.02 tpd VOC**

*and*

**2,382 * 14.11 * 2 * 3/5 * 0.496 gram/mile NOx/454 = 44.06 lb/day, and 0.02 tpd NOx.**

**Cost Effectiveness**

Estimated cost effectiveness is $4,158 per ton for the transit subsidy portion of the program. Since the costs are not broken out between the transit subsidies and carpooling it is assumed that the budget is split between the two programs in proportion to their emission benefits, therefore the cost effectiveness is equal to tat calculated for transit subsidies.

**COMMENTS**

This evaluation is based on data from other areas in the U.S. as well as upon current data and projections from the Dallas area and may be considered for use in ozone plan after review of key assumptions.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 460, 461, 469, 473, 496, 497, 499, 501, 503, 504, 508 | Carpooling programs | Continue and increase carpooling projects under ETR programs | On-Road | 193 tpd | 0.01% | 0.02 | $4,158 |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | tpd | |
| 460, 461, 469, 473, 496, 497, 499, 501, 503, 504, 508 | Carpooling programs | Continue and increase carpooling projects under ETR programs | On-Road | 99 tpd | 0.02% | 0.02 | Not applicable; all costs attributed to NOx |

**Control Measure:** Employer Trip Reduction Program: Transit Subsidies (Combines aspects of measures 462, 471, 480, 483, 485, 489, 492, 460, 461, 469, 473)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

The Dallas Fort Worth area has been operating an employer trip reduction program (ETR) since fiscal year 2001. The program is designed to reduce employee commute vehicle trips through implementation of rideshare, telecommuting, and flexible work-hour programs, transit pass subsidies, bicycling, and similar strategies. Currently the program is primarily operated through the Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (the "T") with the support of NCTCOG. Supporting programs include the Best Workplaces for Commuters program, pedestrian and bicycle programs, HOV programs, and other programs that encourage and support alternative commute modes. The year-round ETR program is voluntary and is aimed at public and private employers in the region with more than 100 employees.

As of September 2005, there were 381 employer participants in the various DART ETR programs (representing 63,378 employees) and 681 employer participants in the various "T" ETR programs (representing 53,478 employees). Therefore 1,062 employers representing 116,856 employees are currently participating. The 2005 conformity analysis projected 3.7 million employees in 2007 (the earliest year reported). The employee participants therefore represent approximately 3 percent of area employees.

## ANALYSIS

Earth Matters conducted an evaluation of the current program based on discussions with and data from NCTCOG, DART and the "T". The program as a whole currently primarily focuses on transit, vanpooling and carpooling although telecommuting, alternative work schedules and similar measures are also included. The transit portion of the program has the following components for DART:

1. Gold/Platinum program: for employers that purchase transit passes for 100% of their employees.
2. Silver/Bronze program: for employers that purchase transit passes for at least one employee;
3. Pass-by-mail (PBM) program available to employers who purchase 5 - 10 passes per month;
4. M-PASS program available to the public or through employers;
5. Vanpool Program
6. Carpool program

At this time there is data on the number of employees at participating employers, and the number of transit passes provided for companies[1] in the DART Gold/Platinum and Silver/Bronze programs. The Pass-by-Mail (PBM) program and the M-PASS program track the number of employees at the participating companies but not the number of passes sold. The rate of use is not tracked. DART estimates 40 – 50% use of passes in the gold/platinum program.

The "T" operates similar programs called E-Pass and TransiCheck. The number of employers participating is known and projected but not the number of participating employees.

NCTCOG is expanding the ETR program. Through the RTC and the North Texas Clean Air Coalition, the North Central Texas Council of Governments (NCTCOG) will review current program practices and continue to market the ETR program to large public and private employers in the North Central Texas region. Additionally, NCTCOG will work with interested parties, including environmental groups, to draft a policy for consideration by large public and private employers to offer employees a pre-tax benefit to pay for appropriate commuting alternatives. A clear financial incentive, such as a pre-tax benefit, is essential to obtain employee participation in ETR programs. Dallas Area Rapid Transit (DART) and the Fort Worth Transportation Authority (The T) are currently operating effective pre-tax programs for local employers. The RTC will fund the program up to $1,000,000 for staff time and contracts. One contract will develop a computer program that employees can use to fill out information on the alternative modes they use and how frequently so that additional data will be available for estimating and tracking program benefits in the future.

This expanded program is the basis for assuming the continued growth and associated emission reductions that are discussed below.

**Approach and Associated Assumptions**

As noted above, approximately 3 percent of employees are working for companies that are participating in the transit subsidy portion of the program. The number of employees participating is estimated by DART to be 40 – 50 percent at the gold/platinum companies. No estimate was available from the "T". No estimate is available from either transit agency on the number of participating employees in the other portions of the program, or on the frequency of participation by any of the employees. Therefore assumptions about these were necessary.

<u>Number of participants and new transit trips</u>
It was assumed that employee participation in DART and the "T" programs grew at the annual rate of growth documented since the programs began in earnest in 2002. The DART program has grown from 35,245 to 63,378 employees, or an average of 26.6% per

[1] Data on the number of employees in the Gold/Platinum program is available as employers in this program must have 100 percent participation in the program. The number of employees who use it, however, is not known.

year (not compounded). Growth has slowed, though; between 2004 and 2005 growth was 16.6 percent. If this latter growth rate continued[2] it could be expected that in 2009 there would be 105,461 employees in the DART program. The “T” program had 54,101 employees in 2002 and has 53,478 employees now. It is assumed that this program is able to maintain the 2002 number through 2009 (and that any growth will be captured by increases in the Best Workplaces for Commuters program). This assumption will produce a more conservative value for participation but at this time there is no data upon which to support an assumption of growth. Therefore in 2009 it is projected that 159,562 employees will be working at companies participating in the ETR program.

It is assumed that 25 percent of these employees participate in the transit pass program and that they utilize transit as a means of getting to work an average of three times per week. The 25 percent figure is intended to use the 40 – 50% participation rate believed to be in effect for gold/platinum companies and a lower rate for the rest of the companies for which no data is available but for which it is known that a much lower value than 40 – 50% is allowed (eg as low as less than one percent). The three times per week assumption is based on studies such as one quoted in the Online TDM Encyclopedia (Littman, 2005) regarding the San Francisco Bay Area’s Commuter Check program in which employees who responded to the survey said they increased their transit trips by an average of 3.24 times per week. It is further assumed that all of these employees were driving alone to work on the days that they now utilize transit.

This means there are 39,890 new transit users taking transit three times per week, or 3/5 = 60% of the work-week, or an average of 23,934 new transit work trips per average work-day. According to NCTCOG the average home-to-work trip length is 14.11 miles and the average speed is about 37 mph. The average daily VMT reduction is 2 * (14.11) * 23,934 = 675,417 miles.

Emission factors were obtained from the NCTCOG based on 2009 estimated emission factors for the ozone episode being evaluated in the attainment analysis. Emission factors are for light duty vehicles only. Composite emission factors for Dallas County for each of the nine light duty vehicle classes were weighted by the VMT by each of those vehicle classes to obtain a light duty vehicle composite gram per mile emission rate.

**Emissions Analysis**

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

**Variables:** **$EF_A$:** Speed-based composite emission factor after implementation ($NO_x$ , VOC, or CO) grams/mile)

[2] Based on a conversation with NCTCOG October 12 2005 and conversation and email with Tony Mendoza of DART on November 7, 2005, it appears reasonable to assume historic growth rates to project future participation since there are no other data.

**$EF_B$:** Speed-based running composite emission factor before implementation ($NO_x$ , VOC, or CO) (grams/mile)

**$N_{VA}$:** Number of vehicles after implementation

**$N_{VB}$:** Number of vehicles before implementation

**$TEF_{AUTO}$:** Auto trip-end emission factor ($NO_x$ , VOC, or CO) (grams/trip)

**$TL_A$:** Average auto trip length after implementation (miles)

**$TL_B$:** Average auto trip length before implementation (miles)

**$VT_A$:** Vehicle trips after implementation

**$VT_B$:** **Change in** Vehicle trips as a result of implementation

It was assumed that emission factors and trip length before and after implementation are the same. Emissions changes from vehicle trips and associated start emissions are evaluated through the use of composite emission factors and the assumption that access to transit is not through SOV use. Any inaccuracy in this assumption is offset by the larger assumption of frequency of transit use per week, another key unknown factor.

As noted earlier **$VT_B$** is the same as the number of new transit users in this case.

**Emissions Benefit**

Daily Emission Reduction =

**$C = VT_B * TL_B * 2 * EF_A =$**

**23,934 * 14.11 * 2 * 0.513 gram/mile VOC/454 = 763.2 lb/day, and 0.38 tpd VOC**

*and*

**23,934 * 14.11 * 2 * 0.496 gram/mile NOx/454 = 737.9 lb/day, and 0.37 tpd NOx.**

**Cost Effectiveness**

The cost of this program was provided by NCTCOG through discussions with DART and the "T". Provided was an ETR budget for the DART, a vanpool budget for DART, and total ETR budget for the "T". The ETR budget provided is $399,972 ($177,750 for DART and $222,222 for the "T") and is applied to the transit subsidy portion of the program because that is the majority of the cost relative to the carpooling portion.

The daily NOx emission benefit is multiplied by 260 (number of work-days per year) to obtain annual emission reductions of 96.2 tons.

Estimated cost effectiveness is $4,158 per ton.

## COMMENTS

This evaluation is based on data from other areas in the U.S. as well as upon current data and projections from the Dallas area and may be considered for use in ozone plan after review of key assumptions.

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 462, 471, 480, 483, 485, 489, 492, 460, 461, 469, 473 | Transit Subsidy Programs | Continue and increase transit subsidy projects under ETR programs | On-Road | 193 tpd | 0.19 | 0.37 | $4,158 |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 462, 471, 480, 483, 485, 489, 492, 460, 461, 469, 473 | Transit Subsidy Programs | Continue and increase transit subsidy projects under ETR programs | On-Road | 99 tpd | 0.38% | 0.38 | Not applicable; all costs attributed to NOx |

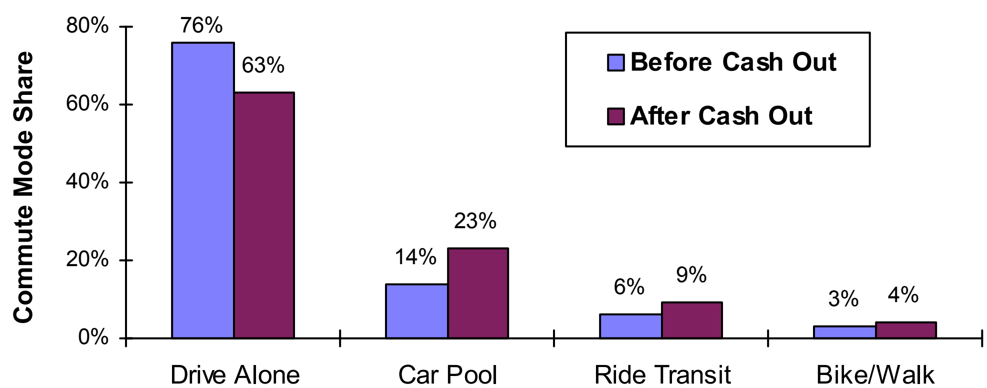
**Control Measure: Parking Cash-Out** (Combines aspects of measures 223, 224, 225, 233, 234, 263, 264, 268, 269, 227, 228, 229, 230, 231, 232, 241, 242, 249, 250, 253)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

Parking cash-out is a program where certain employers who provide subsidized parking for their employees can offer a cash allowance in lieu of a free or subsidized parking space. California enacted a parking cash-out law after studies showed cash allowances in lieu of parking encourage employees to find alternate means of commuting to work, such as public transit, carpooling, vanpooling, bicycling, or walking. Parking cash-out offers the opportunity to improve air quality and reduce traffic congestion by reducing vehicle trips and emissions.

According to the online TDM encyclopedia (http://www.vtpi.org/tdm/tdm8.htm) Don Shoup (1997) found that total vehicle trips declined by 17% after Parking Cash Out was introduced at various urban and suburban worksites, as illustrated in Figure 1 (from the online encyclopedia). These automobile trip reductions tend to increase over time: one employer found that solo commuting continued to decline each year after Parking Cash Out was introduced, as more employees found opportunities to reduce their driving and take advantage of the benefit.

***Figure 1*** **Cashing Out Impacts on Commute Mode** (Shoup, 1997)




*Parking Cash Out results in reduced automobile commuting and increases in carpooling, transit and nonmotorized travel.*

In a later report, (Shoup, 2001), Shoup notes that employer-paid parking is the most common tax-exempt fringe benefit offered to workers in the United States, and that 95 percent of American automobile commuters park free at work. He notes that case studies and statistical models suggest that, compared with driver-paid parking, employer-paid parking increases the number of cars driven to work by about 33 percent.

**ANALYSIS**

At this time there is no data upon which to support an analysis for the Dallas-Fort Worth area. The number of employees who have free or subsidized parking at their worksites is unknown. In addition, the number of employers who offer free or subsidized parking and could be eligible for this program is unknown. Therefore this analysis uses a hypothetical example in which 10 percent of area employees are offered a cash payment in lieu of free parking. It is also assumed that the results in California are applicable to Dallas, since there are no other case studies available. Therefore it is suggested that this analysis not be used as a formal control measure until there is some basis upon which to support a projected emission reduction.

There are 3,871,731 employees projected for the Dallas-Fort Worth region in 2010. If ten percent, or 387,173 of them are provided with parking cash out payments and there is a 13 percent reduction in their drive-alone travel to work, the following emission reductions could be achieved.

**Emissions Analysis**

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

**Variables:**

- **$EF_A$:** Speed-based composite emission factor after implementation ($NO_x$ , VOC, or CO) grams/mile)
- **$EF_B$:** Speed-based running composite emission factor before implementation ($NO_x$ , VOC, or CO) (grams/mile)
- **$N_{VA}$:** Number of vehicles after implementation
- **$N_{VB}$:** Number of vehicles before implementation
- **$TEF_{AUTO}$:** Auto trip-end emission factor ($NO_x$ , VOC, or CO) (grams/trip)
- **$TL_A$:** Average auto trip length after implementation (miles)
- **$TL_B$:** Average auto trip length before implementation (miles)
- **$VMT_A$:** Vehicle trips after implementation
- **$VMT_B$:** **Change in** VMT as a result of implementation

It was assumed that emission factors and trip length before and after implementation are the same. Emissions changes from vehicle trips and associated start emissions are evaluated through the use of composite emission factors and the assumption that access to alternative modes is not through SOV use.

In this analysis $\mathbf{VMT}_B$ is derived by multiplying the number of employees offered parking cash-out (387,173) by their average round trip work length (28.22 miles) and applying a 13 percent reduction for an average of 4 out of 7 days per week (to account for weekends, holidays, vacations, and that few alternative mode users use alternative modes every day; this part of the calculation assures that the estimate is an average daily reduction over ay day of the week.

**Equation:**

Daily Emission Reduction =

$$\mathbf{C = VMT_B * EF_A =}$$

**811,647 * 0.496 gram/mile NOx/454 = 887 lb/day, and 0.443 tpd NOx**

*and*

**811,647 * 0.513 gram/mile VOC/454 = 917 lb/day, and 0.46 tpd VOC.**

**Cost Effectiveness**

No data on costs for Dallas is available. Depending on program structure, cost per ton could be as low as $0.

**COMMENTS**

This evaluation is based on hypothetical assumptions and data for this program and may be considered for use in ozone plan after review of key assumptions

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 223, 224, 225, 233, 234, 263, 264, 268, 269, 227, 228, 229, 230, 231, 232, 241, 242, 249, 250, 253 | Parking Cash-Out | Cash-Out for 10% of area employees | On-Road | 193 tpd | 0.23 | 0.443 | Not available |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 223, 224, 225, 233, 234, 263, 264, 268, 269, 227, 228, 229, 230, 231, 232, 241, 242, 249, 250, 253 | Parking Cash-Out | Cash-Out for 10% of area employees | On-Road | 99 tpd | 0.46% | 0.46 | Not available |

**REFERENCES**


Shoup, 2001. "**Parking Cash Out (Chapters 1 and 22-28 from the manuscript of) The High Cost of Free Parking".** Donald Shoup, Chair, Department of Urban Planning Director, Institute of Transportation Studies.

Shoup, 1997. Donald **Shoup**, "Evaluating the Effects of California's Parking Cash-out Law: Eight Case Studies," *Transport Policy*, Vol. 4, No. 4, 1997, pp. 201-216.

**Control Measure:** Pay As You Drive Insurance Programs (Combines aspects of measures273, 274, 278, 280, 283, 284, 286, 288, 289, 291, 298)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

**DESCRIPTION**

**Mileage based vehicle insurance programs permit drivers to pay their auto premiums on a variable scale, dependent on how much they drive each vehicle. Studies based on individual's response to changes in the price of auto use show that significant travel and associated emission reductions can be realized through these programs. Pay As You Drive (PAYD) programs are operating in Oregon, Britain, Holland, Australia, Israel and South Africa.**

One major benefit of this and other pricing programs is that it affects all categories of travel. Most measures aimed at reducing travel and associated emissions focus on commute travel, which represents about 25 – 30 percent of total travel in a given region. In 2001 the Texas legislature passed House Bill 45 that allowed Texas insurance companies to offer mileage-based insurance.

According to NCTCOG's website at www.dfwcleanair.com/programs/payd.html, a Pay-As-You-Drive (PAYD) pilot program is under development at this time, with RTC providing up to $1,500,000 in federal funding for the implementation phase of the pilot program.

This analysis evaluates the potential effect of this program were it offered to 10 percent of Dallas area drivers

Our best estimate is that in the short term, a 9.7 percent reduction in passenger auto and truck VMT per insured participant could be realized. If 10 percent of area drivers were offered the program, NOx emissions would decrease by 0.917 tons per day and VOC emissions would decrease by 0.948 tons per day. In the longer term, twice these reductions could be achieved, as individuals' response to price changes generally become more pronounced the longer the change is in effect. The estimate is based on VMT changes occurring as a result of cents per mile charges developed by Harvey and Deakin (1997) and updated by Littman (2001).

There have been a number of estimates of the potential benefits of mileage programs and similar programs involving changes in the price of driving. These estimates range from 1.8 to about a 20 percent reduction in driving per individual in the program. The sources of these estimates include:

1. Todd Littman's "*Distance-Based Vehicle Insurance Feasibility Costs and Benefits"*, 2001, Victoria Transport Policy Institute;

2. Harvey and Deakin's 1997 Appendix to the report "*Technical Methods for Analyzing Pricing Measures to Reduce Transportation Emissions*" by EPA and FHWA; and
3. Baker and Barrett's "*The feasibility of Pay by the Mile Auto Insurance", 1999* Economic Policy Institute.

Harvey and Deakin utilized a modified transportation model called the STEP model initially developed for the San Francisco Bay Area to evaluate a variety of pricing measures on driving behavior. The model was applied to four different areas in California, based on 1990 land use and price data. Table B-21 of their above-referenced appendix contains a list of cents per mile charges and associated percent travel reduction. For example these range from 2.3 to 19.7 percent changes in VMT for mileage fees ranging from one to ten cents for 1991 in Los Angeles.

These values were updated by Todd Littman (see http://www.vtpi.org/tdm/tdm79.htm, Table 1) to account for inflation between 1991 and 2001, as follows:

**Table 1. Mileage Fees and Percent Travel Reduction**

| Mileage Fee (cents) | Travel Reduction (percent) |
|---|---|
| 1 | 1.8 |
| 2 | 3.5 |
| 3 | 5.1 |
| 4 | 6.7 |
| 5 | 8.2 |
| 6 | 9.7 |
| 7 | 11.2 |
| 8 | 12.5 |
| 9 | 13.8 |
| 10 | 15.2 |

While the values were originally developed for California using a transportation model, they may be applicable to other areas. The Appendix written by Deakin and Harvey does not contain details about assumptions regarding elasticities, the number of people subject to a given measure, base prices, base transportation network characteristics and other inputs necessary for replicating the analysis for another area such as Houston. The values are reportedly based on generalized elasticity coefficients that include combined values of travel time, vehicle costs, toll prices, fuel taxes, transit fares, and parking prices. Some researchers quoted by Littman in http://www.vtpi.org/tdm/tdm11.htm such as Lee (2000) estimated the elasticity of vehicle travel with respect to total price (including fuel, vehicle wear and mileage-related ownership costs, tolls, parking fees and travel time, which is equivalent to generalized costs) is –0.5 to –1.0 in the short run, and 1.0 to –2.0 over the long run. The project team found that the Harvey Deakin estimates were equivalent to a price elasticity of 0.4, which is slightly below the lower range noted above by Lee ("Demand Elasticities for Highway Travel," *HERS Technical Documents*, FHWA (www.fhwa.dot.gov), 2000).

**ANALYSIS**

The methodology uses the cents per mile changes noted by Littman (2001) and quoted in Table 1 above.

Assumptions include the following:

- Emission factors for MOBILE6 for 2009 are used;
- Insurance prices observed in 2001 are applicable to 2009 on a cent per mile basis;
- Only light duty passenger vehicles are affected by the program – delivery vehicles, line haul trucks and the like are not;
- Daily light duty vehicle miles traveled in 2009 for the Dallas-Fort Worth nonattainment area are 173,003,248
- NOx emission factor for light duty vehicles is 0.496 grams per mile;
- VOC emission factor for light duty vehicles is 0.513 grams per mile;
- VOC and NOx emissions include all categories of emissions, including start, tailpipe, evaporative, etc.

All results are expressed as tons per day reduction and percent of total on-road vehicle emissions reduced.

We evaluated the cents per mile for an average annual auto insurance price of $696.24. At the average driving rate of 12,000 miles per year[1], this cost is effectively 5.8 cents per mile. A value of 6 cents per mile is often used as an average insurance cost. More detailed information from the Texas Department of Insurance was requested but was not available[2]. It is important to note that if the insurance prices were higher, as would be expected in 2009, a higher cents per mile figure would be used. For example if insurance prices rose by 2 percent per year, by 2009 rates would be 6.3 cents per mile. Unfortunately there was no basis upon which to reliably estimate future insurance prices. Use of the lower rates provides more conservative results than would likely be achieved in practice. In addition, the two values (5.8 and 6.3 cents) both round to the often-used rate of 6 cents per mile.

In a PAYD program a non-driver who never drove would not pay anything for insurance. If a program were structured such that the current average of 6 cents per mile was charged for driving through insurance prices, according to Table 1, this per mile charge will result in a 9.7 percent reduction in VMT for each participant. If 100 percent of drivers in the Dallas-Fort Worth nonattainment area were insured through a PAYD

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[1] According to the 2001 National Personal Transportation Survey (http://nhts.ornl.gov/2001/html_files/trends_ver6.shtml) national average vehicle miles are 11,186 miles per year per vehicle. This value was calculated by dividing total household vehicle miles traveled by total household vehicles. Based on comments from reviewers of this report, who expected annual miles driven to be somewhat higher, a more typically used value of 12,000 miles is used in these calculations.

[2] In discussions with the Texas Department of Insurance, they agreed that the values provided by insurance,com appeared reasonable.

program structured to achieve a 6 cents per mile charge and all of them participated in the program, driving in the region would drop by about 9.7 percent (out-of-area drivers such as tourists would presumably not change their behavior). This analysis assumes that changes in driving behavior would be limited to light duty vehicles only. This assumption is made because the majority of medium and heavy-duty travel is for business purposes and are more sensitive to demand than to a pricing incentive such as insurance.

Of course, it is not reasonable to assume that 100 percent of insured would participate initially, therefore a range of participation is considered, as shown in Table 2, below. It should also be noted that estimates of light duty vehicle emissions in the Dallas area assume that some driving and related emissions is by vehicles from out of the area.

In this analysis, total light duty travel in 2009 is estimated by the NCTCOG transportation model to be 173,003,247.

**Table 2. Estimated VMT, NOx and VOC Reductions Possible For A Range of Participation Rates Using a "Cent-per-Mile" charge approach (2009)**

| Participation (percent of drivers) | Daily VMT Reduction | NOx Reduction (tons per day) | VOC Reduction (tons per day) |
|---|---|---|---|
| 10 | 1,678,131 | 0.917 | 0.948 |
| 25 | 4,195,329 | 2.29 | 2.37 |
| 50 | 8,390,657 | 4.58 | 4.74 |

As the results show, such a program can achieve significant benefits when implemented on a broad scale.

It is important to note that these results are based upon a transportation model developed for different areas of the United States with different circumstances, prices, population, land use, geographic characteristics and assumptions that may or may not apply in this case. However that model has been adapted for use in other areas of the country and has estimated similar results for these other areas.

**Cost Effectiveness**

PAYD insurance programs may actually produce a net savings in money, meaning they are exceptionally cost effective. No data on the cost of these programs was found, with the exception that the state of Oregon provides a $100 tax credit for each policy applying PAYD principles. However there is believed to be a significant cost savings with these programs because of reduced accident rate. According to a May, 2003 the Environmental Defense Fund letter to the Senate Environment and Public Works Committee regarding the reauthorization of ISTEA, recent research suggests that PAYD insurance is likely to save consumers money while cutting air pollution and traffic congestion by 10% or more and accidents by up to 15%. A recent study by the Federal Highway Administration showed that by converting fixed motorist costs of car insurance, taxes, and fees to variable costs that allow motorists to save money if they drive less, consumers would save billions of dollars a year and experience substantially less traffic delay.

**COMMENTS**

This evaluation is based on a combination of hypothetical assumptions and data for this program and may be considered for use in ozone plan after review of key assumptions and review of the impact of the upcoming pay-as-you-drive insurance pilot program.

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 273, 274, 278, 280, 283, 284, 286, 288, 289, 291, 298 | Parking Cash-Out | Cash-Out for 10% of area employees | On-Road | 193 tpd | 0.48 | 0.917 | Not available |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 273, 274, 278, 280, 283, 284, 286, 288, 289, 291, 298 | Parking Cash-Out | Cash-Out for 10% of area employees | On-Road | 99 tpd | 0.96% | 0.948 | Not available |

**Control Measure:** Speed Limit Decrease For Heavy Duty Diesel Trucks
(Measures 308, 307, 311, 312)
**Category:** On-Road
**Author**: Barbara Joy, Earth Matters Inc

## DESCRIPTION

Heavy duty trucks emit more NOx at higher speeds than they do at lower speeds. This analysis explores potential emission reductions from enforcing a 55 mile per hour speed limit for heavy duty trucks. One measure suggested for consideration by TCEQ was to evaluate a speed reduction from 70 to 65 mph. However there are no emission factors for speeds at above 65 mph. In addition, data on travel speeds in the area show that few counties have off-peak speeds of 65 mph and no counties have peak period speeds as high as 65 mph. Therefore this analysis evaluates a change limiting truck speeds to 55 mph.

## ANALYSIS

Emission factors were obtained from the NCTCOG based on 2009 estimated emission factors for the ozone episode being evaluated in the attainment analysis. Composite emission factors for heavy duty diesel trucks class 8b were used.

Truck VMT for each highway facility in the region was provided for 1999 and 2025 by NCTCOG. After discussion with NCTCOG it was agreed that the VMT could be linearly projected to 2009 based on the growth rate between 1999 and 2025. Total truck VMT for 1999 was 2,883,511 and for 2025 it was 3,970,079. Estimated 2009 daily truck VMT is 3,274,676.

Estimates of peak and off-peak speeds for 2010 and peak and off-peak total travel were provided by NCTCOG for each county in the region. Peak speeds range from 46 to 55 mph, with the majority of peak travel occurring at speeds less than 50 mph. Off-peak speeds range from 54 to 62 mph in the core counties. The distribution of peak to off-peak travel shows 56 percent of travel occurring during off-peak hours. It is assumed that a speed limit will only affect off-peak travel since the data do not show travel above 55 mph. With a daily estimate of 3,274,676 miles per day of truck travel and 56 percent of travel occurring in off-peak hours, there are 1,833,818 miles of truck travel that could be affected by a speed limit decrease.

Ideally truck VMT would be used to weight the emission factors by individual truck vehicle class. However there was not any data on truck VMT by truck class so heavy duty diesel trucks, class 8a were used as representative of the emissions that would be affected by this measure.

**Emissions Analysis**

The emissions analysis utilized the basic process suggested by the MOSERs methodology, as follows:

**Variables:** **$EF_A$:** Speed-based composite emission factor before implementation ($NO_x$ , VOC, or CO) grams/mile). Based on the data showing that nearly no off-peak travel occurs at speeds above 62 miles per hour and the availability of emission factors for 5 mph "bins" at 55, 60 and 65 mph, emission factors for 55 and 60 mph are used here.

**$EF_B$:** Speed-based running composite emission factor after implementation ($NO_x$ , VOC, or CO) (grams/mile)

**$N_{VA}$:** Number of vehicles after implementation

**$N_{VB}$:** Number of vehicles before implementation

**$VT_B$:** **Truck** Vehicle miles travelled

**Equation:**

Daily Emission Reduction From speed limit decrease =

$$C = VT_B * (EF_A - EF_B) =$$

**1,833,818 * (10.92 – 9.31) = 6,503 pounds per day and 3.25 tons per day NOx reduction**

*and*

**1,833,818 * (.29 - .299) = 36 pounds per day *increase in VOC* (0.018 tpd)**

**Cost Effectiveness**

The primary cost of this measure is in enforcement and signage. According to salary.com, the average salary for a highway patrol officer in the U.S. is about $41,000. If two additional highway patrol officers for each county were assigned to enforce the 55 mph speed limit for trucks, annual costs for the nine county region would be $738,000.

The peed limit decrease would be enforced 7 days a week so the emission reduction would occur each day of the year. Total annual NOx emission reductions would be 1,186 tons per year. Cost effectiveness is $622/ton.

**COMMENTS**

This evaluation is based on data from other areas in the U.S. as well as upon current data and projections from the Dallas area and may be considered for use in ozone plan after review of key assumptions.

Assumptions to be particularly aware of include the implicit assumption of 100 percent compliance with the speed limit. It may be more appropriate to assume that approximately 50 percent of trucks will comply. However, the analysis also assumes that *no* travel is occurring at speeds higher than 60 mph and no travel during peak periods is 60 mph or over when modeling and observed data show that it does. This assumption tends to lower the estimated emission benefits and may offset the implicit enforcement assumption.

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 308, 307, 311, 312 | Speed Limit Decrease for Heavy Duty Diesel Trucks | Decrease and enforce and 55 mph speed limit for heavy duty diesel trucks | On-Road | 193 tpd | 1.7 | 3.25 | $1,186 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 308, 307, 311, 312 | Speed limit decrease for heavy duty trucks | Decrease and enforce and 55 mph speed limit for heavy duty diesel trucs | On-Road | 99 tpd | 0.0 | 0.018 increase | Not applicable; all costs attributed to NOx |

# DRAFT

**Control Measure:** Fare-Free Transit, System-Wide on Ozone Action Days, Measures #TCEQ
**Category:** Onroad
**Author:** Chad Edwards, North Central Texas Council of Governments

## DESCRIPTION

Would require sponsorship and /or commitment of significant public funds. This policy should by itself generate long-term increases in ridership. To be effective, this would require expanded transit fleet and possibly support facilities. Funds could come from peak-hour commuter parking space tax.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty emissions (91.71 tpd $NO_x$, 93.02 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

The cost elasticity strategy is approximately -0.2 for fare changes. Assuming 2009 transit ridership of 332,098, 100 percent decrease in fare on specific days; this would result in approximately a 20 percent increase in ridership or 66,420 additional riders on ozone days. However, elasticities do not function well at the extremes so this could be a little high or low. DART estimates that when they've provided reduced fares on ozone action days in the past, it resulted in approximately 10 percent increase in ridership. So the 20 percent increase for free fares seems somewhat reasonable.

For the counties of Collin, Dallas, Denton, Rockwall, and Tarrant, VMT and speeds were estimated using a link-based methodology for each time period and episode day for the year 2009. For the Counties of Ellis, Johnson, Kaufman, and Parker VMT and speeds were estimated using Texas Department of Transportation (TxDOT) highway performance monitoring system (HPMS) data and population forecast for each of the counties in a top down approach. EPA's MOBILE6.2 Mobile Source Emission Factor Model is used to develop 2009 vehicle emission factors for this analysis.

An estimated of 66420 ridership (33210 new people) was introduced to the transit service due to the free-fare system in ozone season. Each rider makes 2 trips that make a total of 66420 trips through out the nonattainment region decreased from single occupancy drivers. The average trip length is assumed as 20 miles, so a total VMT of 1,328,400 miles per day is saved by people using free fare transit system. Each ozone season has an average of 53 ozone watch days. Emission factors for this analysis were calculated dividing total emissions by total vehicle activity by respective vehicle class. The daily 2009 emission summary is shown in Exhibit A.

# DRAFT

## Exhibit A

| TRANSIT FREE FARE EMISSION QUANTIFICATION | | | | | | |
|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | EMISSION FACTOR (grams/mile) | | VMT FRACTION | VMT* (miles) | EMISSION (tons/day) | |
| | NOx | VOC | | | NOx | VOC |
| **LDGV** | 0.4281 | 0.4727 | 69.9% | 928,871 | 0.438 | 0.484 |
| **LDGT1** | 0.4699 | 0.5674 | 5.1% | 68,039 | 0.035 | 0.043 |
| **LDGT2** | 0.6876 | 0.5985 | 17.1% | 226,503 | 0.172 | 0.149 |
| **LDGT3** | 0.5019 | 0.3351 | 5.0% | 66,500 | 0.037 | 0.025 |
| **LDGT4** | 0.7336 | 0.3692 | 2.3% | 30,581 | 0.025 | 0.012 |
| **LDDV**[1] | 0.4266 | 0.2043 | 0.1% | 850 | 0.000 | 0.000 |
| **LDDT12**[1] | 2.5482 | 2.5955 | 0.0% | - | 0.000 | 0.000 |
| **LDDT34**[1] | 0.4364 | 0.2295 | 0.5% | 7,056 | 0.003 | 0.002 |
| **TOTAL** | | | 100.0% | 1,328,400 | **0.711** | **0.715** |

* 66,420 ridership was increased, when free transit for Ozone season was introduced
* All the increased riderships were assumed to be single drivers, so we have 66,420 trips
* From 2009 model run, average trip length for HBW, NHW and HBN is 20 miles
[1] EPA default diesel fraction used

### Cost Effectiveness

398,000 trips/day * $1.50 * 53 days/year = $31,641,000/year

$31,641,000/year / (37.683 tons/year NOx) = $839,662/ton NOx

### COMMENTS

**Likely Ozone Directional Effect**
Reduce ozone through NOx reduction.

**Responsible Agency for Implementation**
Transit Agencies

**Political/Social/ Public Acceptance**
Acceptance from the Public would be high due to fare-free travel. The additional expense would be difficult to obtain due to the fluctuation of high ozone days and the limited funds available to provide transit system operations.

**SUMMARY OF RESULTS: $NO_x$**

**DRAFT**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| TCEQ | Fare-Free Transit, System-Wide on Ozone Action Days | Transit Incentive | Onroad | 91.71 tpd | 0.77 | 0.71 | $839,662 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| TCEQ | Fare-Free Transit, System-Wide on Ozone Action Days | Transit Incentive | Onroad | 93.02 tpd | 0.77 | 0.72 | Cost effectiveness is based upon NOx reductions. |

**RESOURCES**


Dallas Area Rapid Transit (DART). www.dart.org

Fort Worth Transit Authority (The-T). www.the-t.org

North Central Texas Council of Governments. Dallas Fort Worth Region Travel Model, 2009 Network.

# DRAFT

**Control Measure:** Transit, Measures #373, 374, 375, 377, 381, 382, 384, 386, 390, 405, 407, 426, 427, 428, 429, 431
**Category:** Onroad
**Author:** Chad Edwards, North Central Texas Council of Governments

## DESCRIPTION

Transit provides an efficient, reliable, cleaner means of travel than Single Occupant Vehicle (SOV) travel. Strategies, which encourage travelers to use transit or HOV rather than SOV, provide Air Quality Benefits. Strategies, which make driving less attractive, more costly, will draw drivers to transit or HOV and will also provide Air Quality Benefits. Strategies such as making transit more convenient and reliable through additional light rail and commuter rail lines, exclusive bus lanes, easily understood fare structures and transfers, and subsidized transit service. In addition, strategies to improve transit amenities such as business class service, more comfortable and attractive bus and rail stops, increased security can be used to make travel more pleasant and convenient. Strategies to make automobile travel less attractive will also be beneficial to transit such as increased parking cost, higher fuel cost, higher vehicle registration fees, and more toll roads.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty emissions (91.71 tpd $NO_x$, 93.02 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

New Transit service between 2007 and 2009 will provide an additional estimated 10,000 bus riders and 14,000 rail riders. The new service will be composed of DART light rail in the northwest from Victory to Inwood and in the southeast from east of downtown Dallas to Hatcher. The northwest segment will be 4.2 miles and the southeast segment will be 4.1 miles. Due to increased access for numerous businesses and riders throughout the transit system an estimated total regional transit system boardings of 325,820 in 2007 and 332,098 in 2009 is anticipated.

For the counties of Collin, Dallas, Denton, Rockwall, and Tarrant, VMT and speeds were estimated using a link-based methodology for each time period and episode day for the year 2009. For the Counties of Ellis, Johnson, Kaufman, and Parker VMT and speeds were estimated using Texas Department of Transportation (TxDOT) highway performance monitoring system (HPMS) data and population forecast for each of the counties in a top down approach. EPA's MOBILE6.2 Mobile Source Emission Factor Model is used to develop 2009 vehicle emission factors for this analysis.

# DRAFT

An estimated of 6278 ridership (3139 new people) was introduced due to the new transit service by DART light rail in the northwest from Victory to Inwood and in the southeast from east of downtown Dallas to Hatcher. Each rider makes 2 trips that make a total of 6278 trips decreased from single occupancy drivers. The average trip length is assumed as 20 miles, so a total VMT of 125,560 miles per day is saved by people using transit system. Emission factors for this analysis were calculated dividing total emissions by total vehicle activity by respective vehicle class. The daily 2009 emission summary is shown in Exhibit A.

**Exhibit A**

| NEW TRANSIT SYSTEM EMISSION QUANTIFICATION | | | | | | |
|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | EMISSION FACTOR (grams/mile) | | VMT FRACTION | VMT* (miles) | EMISSION (tons/day) | |
| | NOx | VOC | | | NOx | VOC |
| LDGV | 0.4281 | 0.4727 | 69.9% | 87,797 | 0.041 | 0.046 |
| LDGT1 | 0.4699 | 0.5674 | 5.1% | 6,431 | 0.003 | 0.004 |
| LDGT2 | 0.6876 | 0.5985 | 17.1% | 21,409 | 0.016 | 0.014 |
| LDGT3 | 0.5019 | 0.3351 | 5.0% | 6,286 | 0.003 | 0.002 |
| LDGT4 | 0.7336 | 0.3692 | 2.3% | 2,891 | 0.002 | 0.001 |
| LDDV[1] | 0.4266 | 0.2043 | 0.1% | 80 | 0.000 | 0.000 |
| LDDT12[1] | 2.5482 | 2.5955 | 0.0% | - | 0.000 | 0.000 |
| LDDT34[1] | 0.4364 | 0.2295 | 0.5% | 667 | 0.000 | 0.000 |
| TOTAL | | | 100.0% | 125,560 | **0.067** | **0.068** |

* 6278 ridership was increased, when new transit was introduced
* All the increased riderships were assumed to be single drivers, so we have 6278 trips
* From 2009 model run, average trip length for transit riders is 20 miles
[1] EPA default diesel fraction used

## Cost Effectiveness

0.067 tons NOx/day * 365 days/year * 25 year project life = 611.38 tons NOx project life

Capital Cost of Project (this does not include maintenance for 25 years) = $104,400,000 (Source: Mobility 2025, Amended April 2005, p XIV-9, Northwest to Southeast Corridor)

$104,400,000 / 611.38 tons NOx project life = $170,761.23/ton NOx

## COMMENTS

**Likely Ozone Directional Effect**
Reduce ozone through NOx reduction.

**DRAFT**

**Responsible Agency for Implementation**
Transit Agencies

**Political/Social/ Public Acceptance**
The acceptance of additional transit alternatives is very high. The transit agencies in the Dallas-Fort Worth area continue to plan for and implement additional transit capacity through light rail, commuter rail and buses.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 373, 374, 375, 377, 381, 382, 384, 386, 390, 405, 407, 426, 427, 428, 429, 431 | Transit | Additional implementation | Onroad | 91.71 tpd | 0.08 | 0.07 | $170,761 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 373, 374, 375, 377, 381, 382, 384, 386, 390, 405, 407, 426, 427, 428, 429, 431 | Transit | Additional implementation | Onroad | 93.02 tpd | 0.08 | 0.07 | Cost effectiveness is based upon NOx reductions. |

**REFERENCES**


Mobility 2025, Amended April 2005, p XIV-9, Northwest to Southeast Corridor

Dallas Area Rapid Transit (DART). www.dart.org

Fort Worth Transit Authority (The-T). www.the-t.org

North Central Texas Council of Governments. Dallas Fort Worth Region Travel Model, 2009 Network.

# DRAFT

**Control Measure:** Additional Taxi Fleet Emissions Testing, Measures #589, 591, 605, 607, 608, 613
**Category:** Onroad
**Author:** Shannon Stevenson, North Central Texas Council of Governments

## DESCRIPTION

Require taxi fleets operating in the nine county nonattainment area to submit all fleet vehicles for State inspections every four months including both the safety and emissions tests. Given their sustained levels of high-mileage, congested, city driving, taxi fleets represent a component of the commercial fleet that provides ample opportunities for reductions because the average taxi travels 80 thousand miles per year. Any reduction strategies aimed at reducing emissions from the 2,500 vehicles authorized to operate as taxis in the Dallas-Fort Worth area can be magnified over the course of a year. By adopting local ordinances requiring taxis to pass a State inspection test every four months, noncompliant vehicles will be identified earlier and brought into compliance thus achieving greater air quality benefits.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty gasoline emissions (91.22 tpd $NO_x$, 92.76 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

The average failure rate for all On Board Diagnostic vehicles, model years 1996 and newer, in the nine county nonattainment area is 5%. Applying this same failure rate for the 2,500 taxis authorized to operate in the Dallas-Fort Worth area would yield that 125 vehicles will fail every four months. This is a rather conservative number because the 5% average failure rate is based on the average vehicle traveling only 16-18 thousand miles per year. The average taxi travels 80 thousand miles per year, therefore the failure rate is likely higher than 5%, but with the vehicles being subjected to a State inspection every four months, or every 26,667 miles, the 5% failure rate can be assumed.

Currently, the average taxi in the Dallas-Fort Worth area is four years old; therefore in 2009, the average taxi will be model year 2005. According to the US EPA Federal Light-Duty Vehicle Emissions Standards, the average emissions factor for model year 2005 vehicles, Bin 5 standard, is 0.07 grams of NOx per mile. Using a sample data set of vehicles repaired under the AirCheck Texas Repair and Replacement Assistance Program, the average vehicle fails the emissions test at 1.88 times the standard. According to that same sample data set, vehicles repaired as a result of failing the initial emissions test under experience, on average, a 70% reduction in nitrogen oxide (NOx) emissions.

Failing Emissions Factor for One Vehicle:

$$\frac{0.07\ \text{g}}{\text{mi}} \times 1.88 = \frac{0.1316\ \text{g}}{\text{mi}}$$

NOx Reduction Due to Repairs:

$$\frac{0.1316\ \text{g}}{\text{mi}} \times 0.70 = \frac{0.09212\ \text{g}}{\text{mi}}$$

$$\frac{0.1316\ \text{g}}{\text{mi}} - \frac{0.09212\ \text{g}}{\text{mi}} = \frac{0.03948\ \text{g}}{\text{mi}}$$

$$\frac{0.03948\ \text{g}}{\text{mi}} \times 26{,}667\ \text{mi} \times 125(\text{vehicles}) = 131{,}601.63\ \text{g} \times \frac{2(\text{additional inspections})}{\text{year}} = \frac{263{,}203.26\ \text{g}}{\text{year}}$$

NOx Reduction:

$$\frac{263{,}203.26\ \text{g}}{\text{year}} = \frac{0.2901\ \text{tons}}{\text{year}} = \frac{0.001\ \text{tons}}{\text{day}}$$

**Cost Effectiveness**

Minimal costs are associated with this control strategy since the inspection and maintenance program is already fully operational. Possible costs may include administrative costs associated with adopting local ordinances requiring authorized taxi fleets in the nine county nonattainment area to subject all vehicles to a State inspection every four months. Other potential costs may be attributed to enforcement of the adopted ordinance, but could possibly be rolled in with other enforcement oversight. By implementing a taxi fleet emissions policy of requiring all taxis to be inspected every four months, the program would actually generate additional revenue for the State.

Each emissions inspection generates approximately $8 for the State, therefore a total of $40,000 could be generated from implementing a taxi fleet emissions policy of requiring all taxis to be inspected every four months from the Dallas-Fort Worth area.

$$\frac{-\ \$40{,}000}{\text{year}} \times \frac{1\ \text{year}}{0.2901\ \text{tons}} = \frac{-\ \$137{,}883}{\text{ton}}$$

**COMMENTS**

**Technical Implementation Feasibility and Ranking**

The inspection and maintenance program is currently operational – only need local ordinances for adoption and implementation.

**Responsible Agency for Implementation**
The Texas Commission on Environmental Quality, Department of Public Safety, North Central Texas Council of Governments, cities, counties, airport boards

**Political/Social/Public Acceptance**
High because the program would be easy to implement and would generate revenue for the State

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 589, 591, 605, 607, 608, 613 | Additional Taxi Fleet Emissions Testing | More frequent testing | Onroad | 91.22 tpd | 0.001 | 0.001 | - $137,883 |

**REFERENCES**

MOBILE6 Default Annual Mileage Accumulation Rates by Vehicle Type, Environmental Protection Agency

Summary of Light-Duty Vehicle Emissions Standards, US EPA Federal Light-Duty Vehicle Emissions Standards for Air Pollutants; Environmental Protection Agency

Dallas-Fort Worth Metro Fleet as of 06-01-04; DFW Airport inventory of taxis, limousines, and hotel shuttles

Capitalization Loans for Taxi Fleet Hybrid Upgrades: High-mileage fleet-based emissions reduction strategy; Texas Commission on Environmental Quality

# DRAFT

**Control Measure:** Lower Reid Vapor Pressure (RVP), Measure #118
**Category:** Onroad
**Author:** Madhusudhan Venugopal, North Central Texas Council of Governments

## DESCRIPTION

RVP is a measure of volatility of gasoline and impacts of VOC emissions only. Dallas Fort Worth region currently has a maximum RVP of 6.8 for Collin, Dallas, Denton, Tarrant and 7.6 for Ellis, Johnson, Kaufman, and Parker Counties. This strategy would investigate the benefits of lowering the maximum RVP in Dallas Fort Worth nine-county nonattainment area to 6.8 and 6.5 for 'Run A' and 'Run B' respectively. The nation wide range for testing RVP for reformulated gasoline under MOBILE6 model is 6.5 to 15.2 psi.

## ANALYSIS

### Emissions Affected

This measure would affect on-road gasoline emissions (99.56 tpd $NO_{x,}$ 94.95 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

For the counties of Collin, Dallas, Denton, Rockwall, and Tarrant, VMT and speeds were estimated using a link-based methodology for each time period and episode day for the year 2009. For the Counties of Ellis, Johnson, Kaufman, and Parker VMT and speeds were estimated using Texas Department of Transportation (TxDOT) highway performance monitoring system (HPMS) data and population forecast for each of the counties in a top down approach. EPA's MOBILE6.2 Mobile Source Emission Factor Model is used to develop 2009 vehicle emission factors for this analysis.

Initially Core Counties (Collin, Dallas, Denton and Tarrant) were modeled at RVP set to 6.8 psi and Perimeter Counties (Ellis, Johnson, Kaufman, Parker, Rockwall) were modeled at RVP set to 7.6 psi. In 'Run A' all the counties were modeled for RVP set to 6.8 psi. Since there was no change in Core County RVP no emission benefits were observed in Exhibit I. Emission reduction for VOC's for Perimeter Counties are shown in Exhibit I. In 'Run B' all the counties were modeled for RVP 6.5 psi. Emission benefits were observed for all the counties as shown in Exhibit I.

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EXHIBIT I

| COUNTIES | SUMMARY OF 2009 EMISSIONS TESTS FOR RVP | |
|---|---|---|
| | RUN A | RUN B |
| | VOC | VOC |
| **Collin** | 0.00% | -0.80% |
| **Dallas** | 0.00% | -0.77% |
| **Denton** | 0.00% | -0.97% |
| **Ellis** | -4.17% | -5.00% |
| **Johnson** | -4.39% | -4.88% |
| **Kaufman** | -4.80% | -5.68% |
| **Parker** | -3.93% | -5.06% |
| **Rockwall** | -3.85% | -4.81% |
| **Tarrant** | 0.00% | -0.85% |
| **TOTALS** | **-0.41%** | **-1.23%** |

Analysis year 2009 modeled emissions for the Initial run, Run A and Run B are shown in Exhibit II. When the fuel RVP was reduced to 6.8 psi for all counties, 0.41 tpd decrease in VOC emissions was observed. Reducing fuel RVP to 6.5 psi reduced VOC emission by 1.23 tpd.

EXHIBIT II

| COUNTIES | 2009 RVP EMISSION TEST | | | | | |
|---|---|---|---|---|---|---|
| | FUEL RVP FOR CC = 6.8 and PC = 7.6 | | FUEL RVP FOR CC = 6.8 and PC = 6.8 | | FUEL RVP FOR CC = 6.5 and PC = 6.5 | |
| | VOC (tpd) | NOx (tpd) | VOC (tpd) | NOx (tpd) | VOC (tpd) | NOx (tpd) |
| **Collin** | 8.75 | 17.01 | 8.75 | 17.01 | 8.68 | 17.01 |
| **Dallas** | 45.4 | 77.6 | 45.4 | 77.6 | 45.05 | 77.6 |
| **Denton** | 8.28 | 16.72 | 8.28 | 16.72 | 8.2 | 16.72 |
| **Ellis** | 2.4 | 8.43 | 2.3 | 8.43 | 2.28 | 8.43 |
| **Johnson** | 2.05 | 4.94 | 1.96 | 4.94 | 1.95 | 4.94 |
| **Kaufman** | 2.29 | 5.91 | 2.18 | 5.91 | 2.16 | 5.91 |
| **Parker** | 1.78 | 5.26 | 1.71 | 5.26 | 1.69 | 5.26 |
| **Rockwall** | 1.04 | 3.36 | 1 | 3.36 | 0.99 | 3.36 |
| **Tarrant** | 28.32 | 50.06 | 28.32 | 50.06 | 28.08 | 50.06 |
| **TOTALS** | **100.31** | **189.29** | **99.90** | **189.29** | **99.08** | **189.29** |

CC = Core Counties
PC = Perimeter Counties
tpd = tons/day

# DRAFT

**Cost Effectiveness**

The estimated cost to lower the RVP value is an additional $0.01 to $0.03 per gallon. Increase in gasoline cost is directed to the consumers, so federal and state dollars are not spent. Exhibit III shows the cost associated in decreasing RVP for DFW region.

EXHIBIT III

| **REID VAPOR PRESSURE (COST ESTIMATION)** | | | | |
|---|---|---|---|---|
| **EPA VEHICLE TYPE** | **VMT** | **MILES/GALLON** | **GALLONS/DAY** | **COST/DAY* ($)** |
| **LDGV** | 124,726,947 | 24.1 | 5,175,392 | 103,508 |
| **LDGT1** | 8,355,715 | 18.5 | 451,660 | 9,033 |
| **LDGT2** | 27,816,331 | 18.5 | 1,503,585 | 30,072 |
| **LDGT3** | 7,520,421 | 14.2 | 529,607 | 10,592 |
| **LDGT4** | 3,458,378 | 14.2 | 243,548 | 4,871 |
| **LDDV** | 114,233 | 32.2 | 3,553 | 71 |
| **LDDT12** | 6,376 | 22.1 | 289 | 6 |
| **LDDT34** | 866,571 | 17 | 50,975 | 1,019 |
| **TOTAL** | | | **7,958,609** | **159,172** |

* $0.02 was considered as average cost/gallon to decrease RVP

Cost-Benefit Ratio = $159,172/day/1.23 tpd = **$ 129,408/ton of VOC**

**COMMENTS**

**Likely Ozone Directional Effect**
Reduce ozone through VOC reduction

**Responsible Agency for Implementation**
TCEQ

**SUMMARY OF RESULTS: $NO_x$**

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| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 118 | Lower Reid Vapor Pressure (RVP) | Lower the maximum RVP in Dallas Fort Worth nine-county nonattainment area | Onroad | 99.56 tpd | 0 | 0 | Cost effectiveness is based upon VOC reductions. |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 118 | Lower Reid Vapor Pressure (RVP) | Lower the maximum RVP in Dallas Fort Worth nine-county nonattainment area | Onroad | 94.95 tpd | 0.01 | 0.01 | $129,408 |

**REFERENCES**

U.S. Environmental Protection Agency, Office of Transportation and Air Quality, User's Guide to MOBILE6.1 and 6.2: Mobile Source Emission Factor Model Assessment and Standards Division, (August 2003).

Texas Commission on Environmental quality, Air Quality Planning and Implementation Division, cost per gallon for decreasing Reid Vapor Pressure.

# DRAFT

**Control Measure:** Military Ground Equipment Emissions Testing, Measure # 607
**Category:** Onroad
**Author**: Shannon Stevenson, North Central Texas Council of Governments

## DESCRIPTION

Require that all military ground equipment pass the annual State safety and emissions inspection test. Preliminary investigations reveal that ground equipment on military bases including tactical and non-tactical vehicles is not inspected.

## ANALYSIS

### Emissions Affected

In order to quantify this control strategy, a detailed fleet inventory of all military ground equipment in the nine county nonattainment area is needed before proper quantifications are possible. The fleet inventory should include tactical vehicles (hummers, jeeps, and other vehicles that may be included for various deployments but not necessarily for combat) and non-tactical vehicles (general service administration, GSA, vehicles such as minivans, sedans, and other vehicles for non-combat personnel, recruiters, etc.).

The fleet inventory should include the following parameters:

- Average number of vehicles per military base/unit
- Number of Vehicles for the nine county nonattainment region
- Make
- Model
- Fuel type – gasoline, diesel, propane, etc.
- Year
- Number of miles traveled each year
- Maintenance schedules – how often are vehicles subjected to oil changes, tune ups, etc.

### Emissions Benefit

To be determined once complete fleet inventory has been identified for the nine county nonattainment area.

### Cost-Effectiveness

Minimal costs are associated with this control strategy since the inspection and maintenance program is already fully operational. Possible costs may include personnel costs associated with time spent actually inspecting the vehicles.

Actual cost is to be determined once complete fleet inventory has been identified for the nine county nonattainment area and personnel costs associated with inspecting the vehicles can be applied.

## COMMENTS

**Technical Implementation Feasibility and Ranking**
The inspection and maintenance program is currently operational – may need legislation for actual implementation.

**Responsible Agency for Implementation**
The Texas Commission on Environmental Quality, Department of Public Safety, military bases

**Political/Social/Public Acceptance**
High because the program would be fairly easy to implement

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 607 | Military Ground Equipment Emissions Testing, Measure | Expand I/M Program to include additional vehicles | Onroad | | | | |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 607 | Military Ground Equipment Emissions Testing, Measure | Expand I/M Program to include additional vehicles | Onroad | | | | |

# DRAFT

**REFERENCES**

None

# DRAFT

**Control Measure:** Light-Duty Vehicle Idling Restriction and Policy, Measures #568, 569, 570, 571, 572, 573, 574 ,575, 576, 577, 578, 579, 585
**Category:** Onroad
**Author:** Amanda Brimmer, North Central Texas Council of Governments

## DESCRIPTION

Develop city and/or regional ordinance to restrict idling for both public and private light-duty vehicles. Restrictions may be determined by area, such as airport curbsides, downtown event areas, school zones, loading zones, and off-street parking lots, or by specific vehicle types. An extended idling tax and/or a shortened truck stop stay could be implemented to detract from idling. Implementation would include signage, public advertisement, and enforcement.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty emissions (91.71 tpd $NO_x$, 93.02 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

Methodology for calculating emission reductions was tailored from the 2003 TxDOT Mobile Source Emission Reduction Strategies Handbook, section 12.1. The "Daily Emission Reduction" equation was modified slightly, because it was missing a pair of parentheses in the original formula. MOSERS handbook states that "Daily Emission Reduction = A – B + C", but calculations determined it needs to be "= A – (B + C)" due to the fact that the variable C (increase in hot start emissions) should not be added to the reduction, but subtracted from it since it is an increase in emissions.

**Variables:**

- **EF*I*:** Idling emission factor (NOx, VOC, or CO) (grams/vehicle*hour)
- **F*PARK*:** Percent of vehicles that turn-off engine when parked instead of idling due to imposed control measure (decimal)
- **N*V*:** Average number of vehicles that use facilities where idling will be enforced (vehicles/day)
- **t*B*:** Time spent idling before implementation of control measure (seconds)
- **t*A*:** Time spent idling after implementation of control measure (seconds)
- **TEF*AUTO*:** Auto trip-end emission factor (NOx, VOC, or CO) (grams/trip)

**DRAFT**

**Equation:**

**Daily Emission Reduction = A – (B + C)**

**A = N*V* * t*B* * EF*I***
*Idling exhaust emissions generated before the control.*
**B = (1 – F*PARK*) * N*V* * t*A* * EF*I***
*Idling exhaust emissions after the control is in place.*
**C = F*PARK* * N*V* * (TEF*AUTO*)**
*Increase in start exhaust emissions resulting from consumers now parking their vehicles in lieu of idling their vehicle.*

**Assumptions:**

All vehicles are light-duty passenger vehicles & trucks model year 1983-2007
Emission factors are for Dallas County
Number of vehicles using facilities where idling will be enforced (**N*V***) = 100000
Time idling before policy (**t*B***) = 10 minutes
Time idling after policy (**t*A***) = 30 seconds (**t*A*** is negligible with 100% compliance)
The percent of vehicles that park as a result of the policy (**F*PARK-1***) = 100%
**EF*I-NOx*** = 1.0867 g/mile, **EF*I-VOC*** = 4.0587 g/mile
**TEF*AUTO-NOx*** = 0.0060 g/start, **TEF*AUTO-VOC*** = 0.0091 g/start

**Calligations:**

<u>NOx</u>
A = (100000 vehicles/day) * (**600 sec** * (1 hr/3600 sec)) * (1.0867 gram/mile) * (2.5 mile/hr) / (453.6 gram/lb) = 99.822 lb/day
B = (1-1) * (100000 vehicles/day) * (30 sec * (1 hr/3600 sec)) * (1.0867 gram/mile) * (2.5 mile/hr) / (453.6 gram/lb) = 0.0 lb/day
C = (1) * (100000 vehicles/day) * ((0.0060 gram/start) / (453.6 gram/lb)) * (1 start/vehicle) = 1.323 lb/day

**Daily Emission Reduction** = 99.822 lb/day – 0.0 lb/day – 1.323 lb/day = 98.5 lb/day → = **0.049 tpd**

<u>VOC</u>
A = (100000 vehicles/day) * (**600 sec** * (1 hr/3600 sec)) * (4.0587 gram/mile) * (2.5 mile/hr) / (453.6 gram/lb) = 372.8 lb/day
B = (1-1) * (100000 vehicles/day) * (30 sec * (1 hr/3600 sec)) * (1.0867 gram/mile) * (2.5 mile/hr) / (453.6 gram/lb) = 0.0 lb/day
C = (1) * (100000 vehicles/day) * ((0.0091 gram/start) / (453.6 gram/lb)) * (1 start/vehicle) = 2.000 lb/day

**Daily Emission Reduction** = 372.8 lb/day – 0.0 lb/day – 2.000 lb/day = 98.5 lb/day → = **0.186 tpd**

# DRAFT

Emission Factors[1]:

| IDLE RESTRICTION EMISSION QUANTIFICATION (100 % COMPLIANCE) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | START EMISSION FACTOR (grams/start) | | IDLING EMISSION FACTOR (grams/mile) | | VMT FRACTION | VEHICLES / DAY | BEFORE SCENARIO IDLING EMISSIONS (pounds/day) | | START EMISSIONS (pounds/day) | | EMISSION BENEFITS (pounds/day) | |
| | NOx | VOC | NOx | VOC | | | NOx | VOC | NOx | VOC | NOx | VOC |
| LDGV | 0.005 | 0.008 | 1.053 | 4.149 | 69.9% | 69,924 | 67.634 | 266.525 | 0.772 | 1.208 | 66.862 | 265.316 |
| LDGT1 | 0.007 | 0.011 | 0.912 | 4.325 | 5.1% | 5,122 | 4.293 | 20.350 | 0.079 | 0.123 | 4.214 | 20.226 |
| LDGT2 | 0.009 | 0.012 | 1.297 | 4.439 | 17.1% | 17,051 | 20.313 | 69.523 | 0.357 | 0.454 | 19.956 | 69.068 |
| LDGT3 | 0.007 | 0.010 | 0.942 | 2.362 | 5.0% | 5,006 | 4.334 | 10.861 | 0.074 | 0.106 | 4.260 | 10.755 |
| LDGT4 | 0.010 | 0.011 | 1.347 | 2.485 | 2.3% | 2,302 | 2.849 | 5.255 | 0.049 | 0.057 | 2.800 | 5.197 |
| LDDV | 0.002 | 0.015 | 0.726 | 0.509 | 0.1% | 64 | 0.043 | 0.030 | 0.000 | 0.002 | 0.042 | 0.028 |
| LDDT12 | 0.009 | 0.065 | 3.997 | 4.473 | 0.0% | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| LDDT34 | 0.002 | 0.018 | 0.710 | 0.626 | 0.5% | 531 | 0.346 | 0.306 | 0.003 | 0.021 | 0.344 | 0.284 |
| TOTAL | | | | | 100.0% | 100,000 | **99.8** | **372.8** | **1.3** | **2.0** | **98.5** | **371** |

### Cost Effectiveness

Cost-effectiveness is based on the number of facilities affected by policy, number of signs needed to publicize restriction policy, and the number of personnel needed to enforce policy.

## COMMENTS

### Technical Implementation Feasibility and Ranking

Many areas are already implementing and enforcing anti-idling policies, such as New York City and areas across Canada. The New York City Local Law enforcing idling is located at http://webdocs.nyccouncil.info/textfiles/Int%200110-2004.htm?CFID=891180&CFTOKEN=20101735 This measure may be most feasible for facilities that have longer queue times, such as school waiting areas, airport curbsides, and pharmacy drive-thrus.

### Responsible Agency For Implementation

NCTCOG

### Political/Social/Public Acceptance

There may be higher public acceptance when implemented in areas near children or other large groups of people. However, there are exceptions in existing policies stating that vehicles may idle due to safety and extreme temperatures conditions. In Texas, it may be hard to implement this control measure, particularly in the summer/ozone season, when temperatures are regularly above the limit of 81°F (Idling By-Law, 2004).

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 568, 569, 570, 571, 572, 573, 574 ,575, 576, 577, 578, 579, 585 | Light-Duty Vehicle Idling Restriction and Policy | Develop city and/or regional ordinance to restrict idling for both public and private light-duty vehicles | Onroad | 91.71 tpd | 0.05 | 0.05 | Unknown |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 568, 569, 570, 571, 572, 573, 574 ,575, 576, 577, 578, 579, 585 | Light-Duty Vehicle Idling Restriction and Policy | Develop city and/or regional ordinance to restrict idling for both public and private light-duty vehicles | Onroad | 93.02 tpd | 0.20 | 0.19 | Cost effectiveness is based upon NOx reductions. |

**REFERENCES**

City of Burlington, Ontario, Canada, “Idling By-Law”. June 2004. http://www.burlington.ca/Clerks/By-laws/html/71-2004.htm

McKenzie-Mohr Associates and Lura Consulting, “Turn It Off: Reducing Vehicle Idling”, January 2001, http://oee.nrcan.gc.ca/idling/downloads/turn_pdf.zip

Natural Resources of Canada , “Idling Calculator – CO2 Reduction”, October 2004, http://oee.nrcan.gc.ca/idling/calculator/co2_calculator_step2.cfm?intProvinceID=9&printview=N&text=N

Natural Resources of Canada, “Towards an Idle-Free Zone in the City of Mississauga”, October 2001.http://oee.nrcan.gc.ca/transportation/idling/material/reports-research/Mississauga-survey-report.cfm?attr=16

New York City Council, “Local Law-Int. No. 110-A”, May 2004. http://webdocs.nyccouncil.info/textfiles/Int%200110-2004.htm?CFID=891180&CFTOKEN=20101735

[1]North Central Texas Council of Governments. MOBILE 6 Model Run. November 18, 2005.

QSR Magazine, “The Best Drive-Thru in America 2003”. http://www.qsrmagazine.com/drive-thru/2003/charts/average_service_time.html

TTI and TxDOT, “ Mobile Source Emission Reduction Strategies Handbook”, August 2003.http://moser.tamu.edu/Texas%20Guide%20to%20Accepted%20Mobile%20Source%20Emission%20Reduction%20Strategies%20-%20August%202003.pdf. pp. B.12-2

# DRAFT

**Control Measure:** Intelligent Transportation Systems, Measures #205, 211, 201, 203, 209, 210, 202, 206, 207, 212, 133, 134, 139, 141, 144, 145, 309, 84, 88, 89, 94, 92, 90, 93, 95, 97, 98, 99, 101, 100, 103, 300, 302, 310, 329, 330, 333, 346, 347, 348, 349, 353, 354
**Category:** Onroad
**Author:** Sonya Jackson, North Central Texas Council of Governments

## DESCRIPTION

The Dallas-Fort Worth Metropolitan area is currently involved in the planning, programming, and implementation of Intelligent Transportation System (ITS) programs and projects. Using the National ITS Architecture as a model, the region is defining a Regional ITS Architecture to guide future deployment and to build consensus for multi-agency systems integration. Traffic monitoring and incident detection and response systems are operating on portions of the freeway system in Collin, Dallas, Denton and Tarrant Counties.

## ANALYSIS

### Emissions Affected

This measure would affect freeway emissions (107.21 tpd $NO_x$, 40.12 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

Equations:

Estimated $NO_x$ Emissions caused by peak hour non-recurrent congestion (tons/day)
= Total $NO_x$ generated in tons per day x Percentage of freeway emissions caused by peak hour non-recurrent congestion x Percentage of freeway coverage with ITS deployment x Percentage of non-recurrent congestion eliminated on freeways with ITS deployment

Estimated $NO_x$ Emissions caused by peak hour recurrent congestion (tons/day)
= Total $NO_x$ generated in tons per day x Percentage of improved traffic flow for recurrent congestion x Percentage of freeway coverage with ITS deployment

Estimated Total $NO_x$ Emissions caused by peak hour congestion (tons/day)
= Estimated $NO_x$ Emissions caused by peak hour non-recurrent congestion (tons/day)
+
Estimated $NO_x$ Emissions caused by peak hour recurrent congestion (tons/day)

Estimated VOC Emissions caused by peak hour non-recurrent congestion (tons/day)
= Total VOC generated in tons per day x Percentage of freeway emissions caused by peak hour non-recurrent congestion x Percentage of freeway coverage with ITS deployment x Percentage of non-recurrent congestion eliminated on freeways with ITS deployment

Estimated VOC Emissions caused by peak hour recurrent congestion (tons/day)
= Total VOC generated in tons per day x Percentage of improved traffic flow for recurrent congestion x Percentage of freeway coverage with ITS deployment

Estimated Total VOC Emissions caused by peak hour congestion (tons/day)
= Estimated VOC Emissions caused by peak hour non-recurrent congestion (tons/day)
+
Estimated VOC Emissions caused by peak hour recurrent congestion (tons/day)

Estimated $NO_x$ Emissions Reduced from non-recurrent congestion (tons/day)
= Total $NO_x$ emissions x Percentage of freeway emissions caused by non-recurrent congestions x Total percentage of freeway coverage with ITS deployment x Total percentage of non-recurrent congestion eliminated on freeways with ITS deployment

Estimated $NO_x$ Emissions Reduced from recurrent congestion (tons/day)
= Total $NO_x$ emissions x Total percentage of improved traffic flow for recurrent congestion x Total percentage of freeway coverage with ITS deployment

Estimated Total $NO_x$ Emissions Reduced (tons/day)
= Estimated $NO_x$ Emissions Reduced from non-recurrent congestion (tons/day)
+
Estimated $NO_x$ Emissions Reduced from recurrent congestion (tons/day)

Estimated VOC Emissions Reduced from non-recurrent congestion (tons/day)
= Total VOC emissions x Total percentage of freeway emissions caused by non-recurrent congestions x Total percentage of freeway coverage with ITS deployment x Total percentage of non-recurrent congestion eliminated on freeways with ITS deployment

# DRAFT

Estimated VOC Emissions Reduced from recurrent congestion (tons/day)
= Total VOC emissions x Total percentage of improved traffic flow for recurrent congestion x Total percentage of freeway coverage with ITS deployment

Estimated Total VOC Emissions Reduced (tons/day)
= Estimated VOC Emissions Reduced from non-recurrent congestion (tons/day)
+
Estimated VOC Emissions Reduced from recurrent congestion (tons/day)

Assumptions:

Total emissions ($NO_x$ and VOC) generated in the four county areas are developed through the Texas Mobile Source Emission Software.

Percentage of freeway coverage with ITS deployment is obtained from DFW ITS Map (total centerline miles with ITS deployment / total centerline miles).

Percentage of freeway emissions caused by peak hour non-recurrent congestion = 0.049 (49% of urban freeways are congested due to an incident and 10% of daily traffic is assumed to occur during the peak hour)

Percentage of non-recurrent congestion eliminated on freeways with ITS deployment = 50%

Percentage of recurrent congestion eliminated on freeways with ITS deployment = 5%

| | |
|---|---|
| ITS Design Life = | 10 years |
| Percent ITS Coverage = | 72 % |
| Percent Emission (Non-recurrent) = | 4.9 % |
| Percent Improved Traffic Flow (Recurrent) = | 5 % |
| Percent Non-recurrent Congestion Eliminated = | 50 % |
| Percent Recurrent Congestion Eliminated = | 5 % |
| Total NOx Emissions Generated = | 90.71 tons/day |
| Total VOC Emissions Generated = | 37.06 tons/day |
| Total Project Cost = | $21.69 M |
| Week Days per Year = | 260 |

Results:

Estimated $NO_x$ Emissions caused by peak hour non-recurrent congestion = 1.609 tons/day

Estimated $NO_x$ Emissions caused by peak hour recurrent congestion = 4.214 tons/day

Estimated Total $NO_x$ Emissions caused by peak hour congestion = 5.822 tons/day

# DRAFT

Estimated VOC Emissions caused by peak hour non-recurrent congestion = 0.657 tons/day

Estimated VOC Emissions caused by peak hour recurrent congestion = 1.340 tons/day

Estimated Total VOC Emissions caused by peak hour congestion = 1.997 tons/day

Estimated Total $NO_x$ Emissions Reduced from non-recurrent congestion = 1.600 tons/day

Estimated Total $NO_x$ Emissions Reduced from recurrent congestion = 3.266 tons/day

Estimated Total $NO_x$ Emissions Reduced = 4.866 tons/day

Estimated Total VOC Emissions Reduced from non-recurrent congestion 0.654 tons/day

Estimated Total VOC Emissions Reduced from recurrent congestion = 1.334 tons/day

Estimated Total VOC Emissions Reduced = 1.988 tons/day

**Cost Effectiveness**

Total Project Reduction (tons/year)
= NOx Emissions x Week days per year x ITS design life

Project Cost Effectiveness ($)
= Total Project Cost / Total Project Reduction

Total Project Reduction = 12,651.6 tons/year

Project Cost Effectiveness = $1,714 per ton

**COMMENTS**

**Responsible Agency For Implementation**
North Central Texas Council of Governments (NCTCOG) or DFW Region

**Political/Social/Public Acceptance**
Highly acceptable

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**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 205, 211, 201, 203, 209, 210, 202, 206, 207, 212, 133, 134, 139, 141, 144, 145, 309, 84, 88, 89, 94, 92, 90, 93, 95, 97, 98, 99, 101, 100, 103, 300, 302, 310, 329, 330, 333, 346, 347, 348, 349, 353, 354 | Intelligent Transportation Systems | Further system implementation | Onroad | 107.21 tpd | 4.5 | 4.87 | $1,714 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 205, 211, 201, 203, 209, 210, 202, 206, 207, 212, 133, 134, 139, 141, 144, 145, 309, 84, 88, 89, 94, 92, 90, 93, 95, 97, 98, 99, 101, 100, 103, 300, 302, 310, 329, 330, 333, 346, 347, 348, 349, 353, 354 | Intelligent Transportation Systems | Further system implementation | Onroad | 40.12 tpd | 4.96 | 1.99 | Cost effectiveness is based upon NOx reductions. |

# DRAFT

## REFERENCES

Dallas Area Wide ITS Plan, page 6-26.

Fort Worth Regional ITS Plan, page 116.

# DRAFT

**Control Measure:** Stricter I/M Policy Enforcement, Measure # 591, 605, 608, 613
**Category:** Onroad
**Author**: Shannon Stevenson, North Central Texas Council of Governments

## DESCRIPTION

The Dallas-Fort Worth (DFW) nonattainment area implemented an enhanced inspection and maintenance program in 2002 to reduce mobile source emissions. Enforcement of partially implemented strategies such as license plate renewal tied to current emissions inspections, enforcement on I/M certification to operate in nonattainment counties, and test on resale enforcement will yield greater compliance. Stricter enforcement of already existing laws would result in greater compliance of the law resulting in greater emissions testing compliance.

According to the 2000 Census, over 61,000 commuters from counties outside the I/M region travel into the nonattainment area, most without having their vehicles inspected. State law requires that a vehicle traveling in an I/M county for a minimum of 60 days per year must pass an emissions test. The State's Remote Sensing Program was designed prior to implementation of the AirCheck Texas Repair and Replacement Assistance Program and although the Remote Sensing Program served a purpose, it has outgrown the original scope set forth. To reflect existing program needs and goals, an Enhanced Remote Sensing Program would augment and modernize the State's existing Remote Sensing Program by developing and implementing various elements utilizing remote sensing technology and also provide greater enforcement of vehicles traveling in an I/M county for more than 60 days a year.

Section 548.3011 of the Texas Transportation Code (TTC), titled Emissions Test on Resale, resulted from Texas House Bill 2134 during the 77$^{th}$ Legislature. The TTC requires emissions testing on resale of a vehicle in order to be eligible for a certificate of title or vehicle registration in a nonattainment county. The emissions test must be performed no earlier than the 90$^{th}$ day before the date on which the application is filed. The requirement applies to gasoline vehicles that are 2-24 years old. However, there is suspicion that vehicles are being purchased and registered in nonattainment counties without first passing an emissions test or simply not being registered to avoid the emissions test.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty gasoline emissions (91.22 tpd $NO_x$, 92.76 tpd VOC) in the nine-county ozone nonattainment area.

# DRAFT

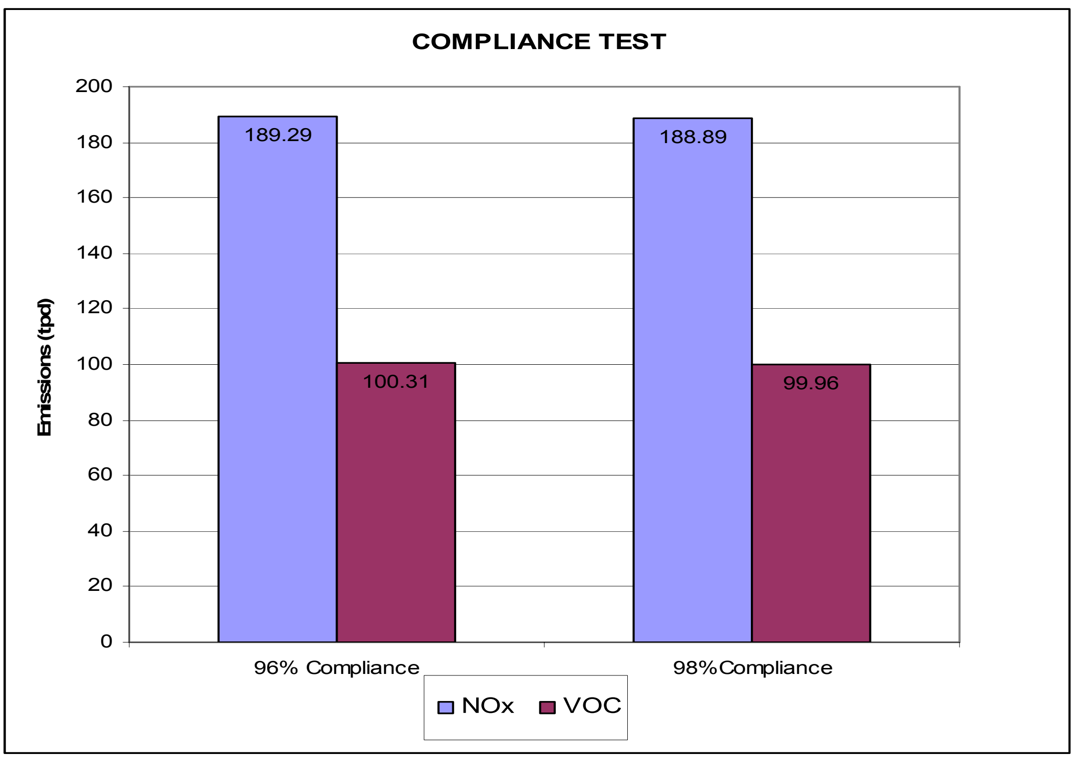
**Emissions Benefit**

For the counties of Collin, Dallas, Denton, Rockwall, and Tarrant, VMT and speeds were estimated using a link-based methodology for each time period and episode day for the year 2009. For the counties of Ellis, Johnson, Kaufman, and Parker, VMT and speeds were estimated using Texas Department of Transportation (TxDOT) highway performance monitoring system (HPMS) data and population forecast for each of the counties in a top down approach. EPA's MOBILE6.2 Mobile Source Emission Factor Model is used to develop 2009 vehicle emission factors for this analysis based on regional fleet characterization and emission controls in place by 2009.

Better enforcement of existing laws including I/M certification to operate in nonattainment counties and test on resale would result in greater compliance, and allow the region to utilize an higher compliance rate in the EPA's MOBILE6.2 Mobile Source Emission Factor Model. The compliance rate is defined as the level of compliance with the inspection program. Currently, an area planning to implement an I/M program using a registration denial system that automatically generates compliance documents that uniquely identify the complying vehicle and that are serially numbered and accounted for, that relies on centralized processing by government clerks with management oversight, may assume a 96% rate for modeling purposes. If greater enforcement occurs with this proposed strategy, then a greater compliance rate of 98% may be assumed for the model.

Emissions summary from Exhibit A shows that 0.4 tons/day of NOx and 0.35 tons/day of VOC was reduced in Dallas-Fort Worth area through adopting a 98% compliancy rate for the I/M program within the 9 participating counties. Exhibit B shows a breakdown of the benefits gained by county.

**EXHIBIT A**



# DRAFT

**EXHIBIT B**

| **COMPLIANCE TEST (2009 ANALYSIS)** | | | | | |
|---|---|---|---|---|---|
| | | **96% Compliance** | | **98% Compliance** | |
| **COUNTIES** | | **NOx** | **VOC** | **NOx** | **VOC** |
| **Collin** | | 17.01 | 8.75 | 16.97 | 8.72 |
| **Dallas** | | 77.60 | 45.4 | 77.42 | 45.24 |
| **Denton** | | 16.72 | 8.28 | 16.69 | 8.25 |
| **Ellis** | | 8.43 | 2.40 | 8.42 | 2.39 |
| **Johnson** | | 4.94 | 2.05 | 4.93 | 2.04 |
| **Kaufman** | | 5.91 | 2.29 | 5.90 | 2.28 |
| **Parker** | | 5.26 | 1.78 | 5.26 | 1.78 |
| **Rockwall** | | 3.36 | 1.04 | 3.35 | 1.04 |
| **Tarrant** | | 50.06 | 28.32 | 49.95 | 28.22 |
| **Total** | **(tpd)** | **189.29** | **100.31** | **188.89** | **99.96** |

NOx Benefit = 189.29 – 188.89 = 0.4 tpd
VOC Benefit = 100.31 – 99.96 = 0.35 tpd

**Cost Effectiveness**

Limited costs are associated with this control strategy since the inspection and maintenance program is already fully operational. Possible costs may include administrative costs associated with stricter enforcement, better tracking of registered vehicles in the nine county nonattainment area, and more updated records for registration denial on vehicles that have not passed an emissions test within the past twelve months. Other potential costs may be attributed to enforcement, but could possibly be rolled in with other enforcement oversight.

Restructuring the State's Remote Sensing Program would not require any additional costs, but simply a reorganization of the current program would yield greater results and compliance of vehicles currently violating the law that requires a vehicle traveling in an I/M county for a minimum of 60 days per year must pass an emissions test.

**EXHIBIT B**

| **COST ANALYSIS (STRICTER POLICY ENFORCEMENT RE: I/M PROGRAM)** | | | |
|---|---|---|---|
| **Description** | **Cost/year ($)** | **Number** | **9 county total ($)** |
| Cost of 1 DPS staff per I/M county (for greater enforcement) | $60,000 | 9 people | $540,000 |
| Cost of TCEQ and TXDOT | $60,000 | 2 people | $120,000 |
| **TOTAL COST OF PROGRAM** | | | $660,000 |

**DRAFT**

**EXHIBIT C**

| EMISSION COST BENEFIT ANALYSIS | | |
|---|---|---|
| **POLLUTANT** | **EMISSION BENEFIT (tons/year)** | **COST/TON ($)** |
| NOx | 146.0 | $4,521 |
| VOC | 127.75 | $5,166 |

**COMMENTS**

**Technical Implementation Feasibility and Ranking**
The inspection and maintenance program is currently operational – only need better enforcement to achieve 98% compliance rate.

**Responsible Agency for Implementation**
The Texas Commission on Environmental Quality and the Department of Public Safety

**Political/Social/Public Acceptance**
High because the is already operational, just needs better or more enforcement of current laws

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 591, 605, 608, 613 | Stricter I/M Policy Enforcement | Additional enforcement of I/M policies | Onroad | 91.22 tpd | 0.44 | 0.40 | $4,521 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 591, 605, 608, 613 | Stricter I/M Policy Enforcement | Additional enforcement of I/M policies | Onroad | 92.76 tpd | 0.38 | 0.35 | $5,166 |

## REFERENCES

U.S. Census Data, 2000

U.S. Environmental Protection Agency, Office of Transportation and Air Quality, User's Guide to MOBILE6.1 and 6.2: Mobile Source Emission Factor Model Assessment and Standards Division, (August 2003).

# DRAFT

**Control Measure:** Idle Reduction Infrastructure, Measures #583, 584, 586
**Category:** Onroad
**Author:** Tamara Hollowell, North Central Texas Council of Governments

## DESCRIPTION

Implement idle reduction electrification projects at commercial truck parking facilities such as truck stops, rest stops and truck terminals to help heavy-duty vehicles reduce idling. Implement idle reduction electrification projects at private facilities, such as goods movement terminals, airports, hospitals and ambulance stations. Implement truck stop policy for the North Texas Region that requires newly constructed truck stops have some portion of their truck spaces fitted with stationary idle-reduction technology.

## ANALYSIS

### Emissions Affected

This measure would affect on-road heavy-duty diesel emissions (93.50 tpd $NO_x$, 4.18 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

Emissions reductions were estimated using the Texas Commission on Environmental Quality's (TCEQ) Texas Emissions Reduction Plan (TERP) methodology for determining idle-reduction infrastructure emissions reductions. The analysis for determining the 0.0629 tons/day of reduction is shown in the results section of this paper.

In order to determine the emissions reductions from idle-reduction infrastructure, the amount of spaces where this technology could be installed must be known. Based on NCTCOG's staff previous efforts, it is estimated there are around 4,000 truck stop spaces in the nine-county nonattainment area.[1] In addition, staff roughly estimates about 45,000 truck spaces in the nonattainment area that are located at freight facilities, rail yards, industrial parks, airports, rail operation centers, and parcel delivery hubs.[2]

The calculations in this analysis use the current amount of funding of $1,000,000 that is available to idle-reduction projects in the North Texas Region and divides that by the cost of an idle-reduction technology equipped space to get a rough estimate of the number of spaces that can be accomplished with current funding.

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[1] NCTCOG staff estimates about 4,000 truck stop spaces based on 2003 truck stop data available via Internet and calling truck stops.
[2] NCTCOG staff estimates about 45,000 truck spaces based on 2001 aerial views.

In addition, the hours of idling and usage rate must be known to calculate emissions reductions. In previous idle-reduction technology joint partnerships with the TCEQ's TERP program, NCTCOG found the estimated number of hours spent idling were different for each applicant. For this quantification, a conservative number of 8 hours of idling reduced is used. This quantification also uses a usage rate of 365 days/year. This usage rate was recommended and used by TCEQ's TERP program in a Calculation for Stationary Idle Reduction Technology spreadsheet sent to NCTCOG. Furthermore, the calculations include a conservative five-year activity life for the use of the idle-reduction equipment.

Using the TERP provided methodology for calculating emissions reduction for stationary idle-reduction technology, the net NOx Emissions Reductions is 0.0629 tons NOx/day. The TERP methodology is based on the Environmental Protection Agency Final Guidance from January 2004.

**Number of Parking Spaces** = 56

**Activity Life** = 5

**Estimated Idling Hours Per Day Reduced** = 8

**Baseline NOx Emissions Factor (g/hr)** = 135.0

**Percent of Reduction Factor due to Texas Low Emissions Diesel (TxLED)** = 5.7%

**Total months of activity life** = 60 (5years *12 months)

**TxLED Correction Factor** = 0.943 (1-.057)

**Adjusted Basline NOX Emissions Factor (g/hr)** = 135.0 g/hr * 0.943 = 127.305 g/hr

**Idling Hours Per Day (hr)** = 8

**Baseline Idling NOx Emissions (g/day)** = 127.305 g/hr * 8 hr/day = 1,018.400 g/day

**Total NOx Reductions for All Units (g/day)** = 56 units * 1,018.400 g/day = 57, 032.64 g/day

**Net NOx Emission Reduction (tons/day)** = 57,032.64 g/day / 907200 g/ton = 0.0629 ton NOx/day

**Estimated Total NOx Emission Reduction (tons/year)** = 0.0629 ton/day * 365 days/year = 22.96 tons/year

# DRAFT

**Example 1:**
**Idle-Reduction Infrastructure Project**

The deployment of idle-reduction infrastructure at potential new staging areas in the North Texas region, such as the Dallas/Fort Worth (D/FW) International Airport.*

*D/FW International Airport:

North Foreign Trade Zone (#39)
West Cargo Area
East Cargo Area
International Air Cargo Center

The example D/FW International Airport project would have an estimated 100 spaces equipped with IdleAire Technology and would remove 0.112 ton/day of NOx emissions reduced or 40.9 tons/year NOx reduced based on the calculations and assumptions from above.

**Cost Effectiveness**

The cost effectiveness of this measure was estimated by using TERP's methodology for determining cost-effectiveness of idle-reduction infrastructure. The cost-effectiveness of this measure is estimated at $8,723/ton of NOx removed. The cost-effectiveness computation is shown in the Results section of this paper.

In order to calculate cost-effectiveness the cost of the technology must be known. The cost of technology varies depending on what electrification technology system will be utilized. IdleAire Technologies has an average cost per unit installed of $18,000. For this cost-effectiveness calculation, the IdleAire technology is used because it costs more than other systems and has been used and installed successfully at several applications throughout the United States.

The cost-effectiveness or $/ton NOx reduced is found by dividing the total cost by the total tons of NOx reduced over the life of the project.

**Total funding available for idle-reduction projects:** $1,000,000.00

**Activity Life** = 5 years

**Estimated Total NOx Emission Reduction (tons/year)** = 22.96 tons/year
**Total NOx Emission Reductions (tons)** = 5 years * 22.96 tons/year = 114.80 tons

**Cost per ton ($/ton)** = $1,000,000.00 / 114.80 tons = $8,710.80

## COMMENTS

**Technical Implementation Feasibility and Ranking**
Technical feasibility is high because the technology is already proven, reliable, and available on the commercial market.

**Responsible Agency for Implementation**
Dallas-Fort Worth Region

**Political/Social/Public Acceptance**
High political, social, and public acceptance because of rising fuel costs, visibility of heavy-duty trucks in the region, and acceptance from trucking industry.

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 583, 584, 586 | Idle Reduction Infrastructure | Electrification projects | Onroad | 93.50 tpd | 0.06 | 0.06 | $8,711 |

## REFERENCES

Texas Commission on Environmental Quality. Texas Emissions Reduction Plan. "Calculation for Stationary Idle Reduction Technology" provided by TCEQ to NCTCOG, Summer 2005.

Texas Commission on Environmental Quality. Texas Emissions Reduction Plan "On-Site Electrification and Idle Reduction Infrastructure (TCEQ-10430g) Chapter 11 Guidelines." Accessed October 13, 2005.
http://www.tceq.state.tx.us/assets/public/implementation/air/terp/guidelines/ch11.pdf

# DRAFT

**Control Measure:** Higher Vehicle Occupancies, Measures #150, 151, 152, 153, 161, 162
**Category:** Onroad
**Author:** Jeff Neal, North Central Texas Council of Governments

## DESCRIPTION

Higher vehicle occupancies can be encouraged through incentives such as free or reduced tolls for HOVs on managed facilities, express type travel on restricted lanes for HOV/transit use only, or increasing vehicle occupancy requirements.

As growth in the Dallas-Fort Worth Metropolitan Area continues to outpace the region's ability to add additional roadway capacity at a comparable rate, the strategy of managing major roadway capacity more efficiently becomes more and more critical, particularly as a method to improve regional air quality. HOV and Managed Lanes offer the general public a more convenient and reliable form of transportation, and they help increase the use of transit, as well as encourage the formation of carpools and vanpools. This conversion improves air quality by decreasing the number of single-occupant vehicles (SOV) that would otherwise be traveling on congested general-purpose lanes on freeways.

As of this writing, five freeway corridors in Dallas County utilize HOV lanes. Though each of these facilities is an interim design, all are highly successful in terms of ridership and air quality benefits. By 2007, HOV facilities in two of those existing corridors will be significantly expanded, and two new corridors on U.S. Highway 75 north of Interstate Highway (I.H.) 635 and I.H. 30 west of I.H. 35E will begin operation. The I.H. 30 corridor will have the distinction of being the Dallas-Fort Worth region's first multi-lane reversible HOV facility, as well as its first managed facility, allowing SOV operation via tolls where capacity is available during the peak travel periods.

## ANALYSIS

### Emissions Affected

This measure would affect on-road freeway emissions (107.21 tpd $NO_x$, 40.12 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

The methodology below outlines the calculation of air quality emissions benefits for the 2009 attainment year. By 2009, the region's first concurrent-flow multi-lane managed facility is expected to open in northeastern Tarrant County and far western Dallas County along State Highway (S.H.) 183. The new corridor will have three managed lanes in each direction, and will stretch from I.H. 820 in Hurst to S.H. 161 in Irving, a distance of approximately eleven miles.

A TransCAD model run was prepared to simulate projected traffic on S.H. 183 managed facility in 2009. The model calculated an average daily HOV volume of 19,179 vehicles. This volume was the input data for the table in Exhibit 1, shown below.

**Exhibit 1**

| ADDITIONAL HOVs IN DFW METROPLEX EMISSION QUANTIFICATION | | | | | | |
|---|---|---|---|---|---|---|
| **EPA VEHICLE TYPE** | **EMISSION FACTOR (grams/mile)** | | **HOV VMT FRACTION** | **VMT* (miles)** | **EMISSION (tons/day)** | |
| | **NOx** | **VOC** | | | **NOx** | **VOC** |
| **LDGV** | 0.4281 | 0.4727 | 72.7% | 374,126 | 0.177 | 0.195 |
| **LDGT1** | 0.4699 | 0.5674 | 4.8% | 24,732 | 0.013 | 0.015 |
| **LDGT2** | 0.6876 | 0.5985 | 16.0% | 82,334 | 0.062 | 0.054 |
| **LDGT3** | 0.5019 | 0.3351 | 4.1% | 20,984 | 0.012 | 0.008 |
| **LDGT4** | 0.7336 | 0.3692 | 1.9% | 9,650 | 0.008 | 0.004 |
| **LDDV** | 0.4266 | 0.2043 | 0.1% | 342 | 0.000 | 0.000 |
| **LDDT12** | 2.5482 | 2.5955 | 0.0% | - | 0.000 | 0.000 |
| **LDDT34** | 0.4364 | 0.2295 | 0.5% | 2,565 | 0.001 | 0.001 |
| **TOTAL** | | | 100.0% | 514,733 | **0.273** | **0.277** |

**ASSUMPTIONS:**

1. **Average trip length for Home-Work Based (HBW) trips is 14.11 miles in 2009.**
2. **Each additional vehicles makes 2 trips/day using the HOV facility (AM/PM Peak Period)**
3. **Average daily HOV lane occupancy = 2.21 persons/vehicle**
4. **Average daily general-purpose lane vehicle occupancy = 1.25 person/vehicle**

The average HOV volume of 19,179 vehicles per day on the proposed S.H. 183 managed lanes translated to a daily average of 514,733 vehicle-miles of travel. This resulted into an average emissions savings of 0.273 tons/day in NOx and 0.277 tons/day in VOC for the Dallas-Fort Worth region.

**Cost Effectiveness**

Funding estimates from the Mobility 2025 Plan – Amended April 2005 indicate that the construction cost for the S.H. 183 managed lanes will be approximately $270 million in 2005 dollars. The benefit-cost calculation for emissions savings is as follows:

**NOx:** 0.273 tons/day * 260 days/year = 70.98 tons/year
70.98 tons/year * 40-year design life = 2,839.20 tons

$270,000,000 / 2,839.20 tons = **$95,097.21/ton**

**VOC:** 0.277 tons/day * 260 days/year = 72.02 tons/year
72.02 tons/year * 40-year design life = 2,880.80 tons
$270,000,000 / 2,880.80 tons = **$93,723.96/ton**

**COMMENTS**

As of this writing, formal environmental clearance of the S.H. 183 corridor has not been attained. A Finding of No Significant Impact (FONSI) is expected by Fall 2006 and the corridor has received funding through the Texas Department of Transportation's (TxDOT) recently approved 2006 Unified Transportation Plan (UTP). The corridor is also being evaluated through public-private partnership proposals in the form of Comprehensive Development Agreements (CDA).

**Likely Ozone Directional Effect**
Reduce ozone through NOx reduction.

**Responsible Agencies For Implementation**
Texas Department of Transportation (TxDOT), Transit agencies, North Texas Tollway Authority (NTTA)

**Political/Social/Public Acceptance**
The acceptance of additional HOV/managed lane alternatives is very high. NCTCOG and its partner agencies will continue to research, promote, and fund additional corridors for HOV/managed lane implementation.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 150, 151, 152, 153, 161, 162 | Higher Vehicle Occupancies | Additional HOV implementation | Onroad | 107.21 tpd | 0.25 | 0.27 | $95,097 |

**DRAFT**

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 150, 151, 152, 153, 161, 162 | Higher Vehicle Occupancies | Additional HOV implementation additional vehicles | Onroad | 40.12 tpd | 0.70 | 0.28 | $93,724 |

**REFERENCES**

Mobility 2025, Amended April 2005

# DRAFT

**Control Measure:** Freeway and Arterial Bottleneck Program, Measure #102
**Category:** Onroad
**Author:** Natalie Bettger, North Central Texas Council of Governments

## DESCRIPTION

The Dallas-Fort Worth Metropolitan Area has initiated a Freeway Interchange/Bottleneck Program and an Arterial Bottleneck Program in an effort to advance projects that increase mobility and safety, and improve air quality. The Freeway Interchange/Bottleneck Improvement Program is designed to fund interchange and bottleneck improvements on the highway system and interchange improvements at highway/arterial crossings. The Arterial Bottleneck Program is designed to fund arterial intersections and bottleneck improvements that reduce travel time, delay, and/or accidents due to implementation of low-cost projects that include multiple transportation modes.

## ANALYSIS

### Emissions Affected

This measure would affect on-road freeway (107.21 tpd $NO_x$, 40.12 tpd VOC) and arterial (64.11 tpd $NO_x$, 41.54 tpd VOC) emissions in the nine-county ozone nonattainment area (total 171.32 tpd $NO_x$, 81.66 tpd VOC) .

### Emissions Benefit

<u>Variables:</u>

$DR_{OP}$: Estimated delay reduction during the off-peak period (minutes)
*Freeway = 10 minutes*
*Arterial = 5 minutes*

$DR_P$: Estimated delay reduction during the peak period (minutes)
*Freeway = 20 minutes*
*Arterial = 10 minutes*

$EF_I$: Idling emission factor (grams/hour)
Freeway and Arterial NOx = 0.99
VOC = 3.96

$EF_{A,OP}$: Speed-based running exhaust emission factor during the off-peak period after implementation (grams/mile)

*Freeway (60 mph)* *NOx = 0.40*
*VOC = 0.42*
*Arterial (25 mph)* *NOx = 0.42*
*VOC = 0.52*

$EF_{A,P}$: Speed-based running exhaust emission factor during the peak period after implementation (grams/mile)

*Freeway (50 mph)* *NOx = 0.39*
*VOC = 0.43*
*Arterial (18 mph)* *NOx = 0.46*
*VOC = 0.59*

$EF_{B,OP}$: Speed-based running exhaust emission factor during the off-peak period before implementation (grams/mile)

*Freeway (35 mph)* *NOx = 0.38*
*VOC = 0.47*
*Arterial (15 mph)* *NOx = 0.52*
*VOC = 0.64*

$EF_{B,P}$: Speed-based running exhaust emission factor during the peak period before implementation (grams/mile)

*Freeway (30 mph)* *NOx = 0.39*
*VOC = 0.49*
*Arterial (10 mph)* *NOx = 0.63*
*VOC = 0.79*

$I_{OP}$: Off-peak hour reduction in idling emissions (hours)

$I_P$ Peak hour reduction in idling emissions (hours)

L: Length of affected roadway (miles)

*Freeway Length = 0.25 miles*
*Arterial Length = 0.1 miles*

$N_{OPH}$: Number of off-peak hours = 17 hours

$N_{PH}$: Number of peak hours = 7 hours

$VMT_{OP}$: Off-peak hour reduction in speed emissions

$VMT_{PH}$: Peak hour reduction in speed emissions

$V_{H,OP}$: Number of vehicles that pass through the intersection per hour during the off-peak period

$V_{H,P}$: Number of vehicles that pass through the intersection per hour during the peak period

Equation:

Daily Emission Reduction = A+B+C

$A = (I_P+I_{OP}) * EF_I$

*Change in idling exhaust emissions from improved traffic flow during the peak and off-peak periods.*

$B = (EF_{B,P} – EF_{A,P}) * VMT_{PH}$

*Change in running exhaust emissions from improved traffic flow during the peak period.*

$C = (EF_{B,OP} – EF_{A,OP}) * VMT_{OP}$

*Change in running exhaust emissions from improved traffic flow during the off-peak period.*

*Where,*

$I_P = (N_{PH} * V_{H,P} * DR_P)/60$ minutes per hour

$I_{OP} = (N_{OPH} * V_{H,OP} * DR_{OP})/60$ minutes per hour

*Reduction of idling in the peak and off-peak period*

$VMT_{PH} = N_{PH} * V_{H,P}*L$

$VMT_{OP} = N_{OPH} * V_{H,OP} * L$

*VMT affected by the strategy in the peak and off-peak periods*

Results:

Freeway Bottlenecks

$I_P = (7 * 9232 * 20)/60 = 21,541$

$I_{OP} = (17 * 5702 * 10)/60 = 16,164$

$VMT_{PH} = 7 * 9232*0.25 = 16,156$

$VMT_{OP} = 17 * 5702 * 0.25 = 24,234$

*NOx Emission*

A = (21,541 + 16,164) * 0.99 = 37,328

.

B = (0.39– 0.39) * 16,156 = 0

C = (0.38 – 0.40) * 24,234 = -485

NOx Daily Emission Reduction =37,328 + (0) + (-485) = 36,843 grams/day

NOx Daily Emission = (36,595/454)/2000 = 0.04 tons/day/location

Estimated Project Life = 25 years

Estimated number of locations = 5
Total NOx = 0.04 * 5 = 0.2 tons/day
Similarly, Total VOC = .837 tons/day

<u>Arterial Bottlenecks</u>

$I_P$ = (7 * 1,334 * 10)/60 = 1,556

$I_{OP}$ = (17 * 1,000 * 5)/60 = 1,417

$VMT_{PH}$ = 7 * 1,334*0.1 = 934

$VMT_{OP}$ = 17 * 1,000 * 0.1 = 1,700

*<u>NOx Emission</u>*
A = (1,556 + 1,417) * 0.99 = 2,943

B = (0.63– 0.46) * 933 = 159

C = (0.52 – 0.42) * 1,700 = 170

NOx Daily Emission Reduction =2,943 + 159 + 170 = 3,272 grams/day
NOx Daily Emission = (3,255/454)/2000 = 0.004 tons/day/location
Estimated Project Life = 12 years
Estimated number of locations = 13
Total NOx = 0.004 * 13 = 0.05 tons/day
Similarly, Total VOC = .174 tons/day

**Cost Effectiveness**

**NOx**

<u>Freeway</u>

Average Annual Project Cost per Location * Total Locations/Annualized NOx Emission
Average Annual Cost = $11,139,456/25 years = $445,579/year
Annualized NOx Emission = 0.2 tpd *265 days/year = 53 tons/year
= ($445,579* 5 locations)/53 tpy = $42,036/ton of NOx → **$8,407/ton/location**

<u>Arterial</u>

Average Annual Project Cost per Location * Total Locations/Annualized NOx Emission
Average Annual Cost = $6,637,581/12 = $553,132/year
Annualized NOx Emission = 0.05 tpd *265 days/year = 13.3 tons/year
= ($553,132 * 13 locations)/13.3 tpy = $540,655 /ton of NOx → **$41,589/ton /location**

# DRAFT

**VOC**

Freeway

Average Annual Project Cost per Location * Total Locations/Annualized VOC Emission

Average Annual Cost = $11,139,456/25 years = $445,579/year

Annualized VOC Emission = 0.837 tpd *265 days/year = 221.8 tons/year

= ($445,579* 5 locations)/221.8 tpy = $10,045/ton of VOC → **$2009/ton/location**

Arterial

Average Annual Project Cost per Location * Total Locations/Annualized VOC Emission

Average Annual Cost = $6,637,581/12 = $553,132/year

Annualized VOC Emission = 0.174 tpd *265 days/year = 46.1 tons/year

= ($553,132 * 13 locations)/46.1 tpy = $155,947 /ton of VOC → **$11,996/ton /location**

**COMMENTS**

**Responsible Agency For Implementation**

Local agencies in the Dallas-Fort Worth Region

**Political/Social/Public Acceptance**

Highly acceptable

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 102 | Freeway and Arterial Bottleneck Program | Freeway interchange and arterial intersection improvements | Onroad | 171.32 tpd | 0.15 | 0.25 | $8,407- $41,589 |

**SUMMARY OF RESULTS: VOC**

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| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 102 | Freeway and Arterial Bottleneck Program | Freeway interchange and arterial intersection improvements | Onroad | 81.66 tpd | 1.24 | 1.01 | $2,009- $11,996 |

**REFERENCES**

None

# DRAFT

**Control Measure:** Expanding I/M to Surrounding Counties, Measure #587, 590
**Category:** Onroad
**Author**: Madhusudhan Venugopal, North Central Texas Council of Governments

## DESCRIPTION

Dallas-Fort Worth (DFW) nonattainment counties have implemented inspection and maintenance (I/M) programs to reduce the mobile source emissions. There are commuters from counties outside the I/M counties traveling into nonattainment area without getting their vehicles inspected. It is required by the state law, if a vehicle is traveling in an I/M county for a minimum of 60 days/year, it has to go through an I/M program. This strategy would quantify benefits in terms of emissions by expanding I/M program statewide.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty gasoline emissions (91.22 tpd $NO_x$, 92.76 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

For the counties of Collin, Dallas, Denton, Rockwall, and Tarrant, VMT and speeds were estimated using a link-based methodology for each time period and episode day for the year 2009. For the counties of Ellis, Johnson, Kaufman, and Parker, VMT and speeds were estimated using Texas Department of Transportation (TxDOT) highway performance monitoring system (HPMS) data and population forecast for each of the counties in a top down approach. EPA's MOBILE6.2 Mobile Source Emission Factor Model is used to develop 2009 vehicle emission factors for this analysis based on regional fleet characterization and emission controls in place by 2009.

Only light duty gasoline vehicles were analyzed in this strategy as I/M testing is currently conducted for light duty gasoline vehicles in the region. Emission factors shown in the Exhibit A are the difference between the emission factors developed with and without I/M and anti-tampering program for the model year 2009 using MOBILE6 model. External trips were estimated from the commuters traveling from outside the nine nonattainment counties into the DFW nonattainment area as shown in Exhibit B. From census 2000 it was estimated that 71,321 commuters traveled into the nonattainment area from surrounding counties. The surrounding counties include Clay, Montague, Cooke, Grayson, Fannin, Lamar, Delta, Hopkins, Hunt, Wise, Jack, Palo Pinto, Erath, Hood, Somervell, Bosque, Hill, Navarro, Henderson, Van Zandt, and Rains. Each commuter makes two work trips per day (one to work and one to home), so a total of 142,642 home based work (HBW) trips per day. From the model we have a total of 487,576

**DRAFT**

external auto trips of which 142,642 was HBW estimated from census 2000; 227,681 trips were estimated as home non-work (HNB); and 117,253 trips estimated as non-home based (NHB). It is assumed that only 70 percent of the VMT is traveled in DFW nonattainment area. Emission summary from Exhibit A shows that 0.78 tons/day of NOx and 0.88 tons/day of VOC was reduced in Dallas-Fort Worth area through implementing I/M program within these 21 surrounding counties.

**EXHIBIT A**

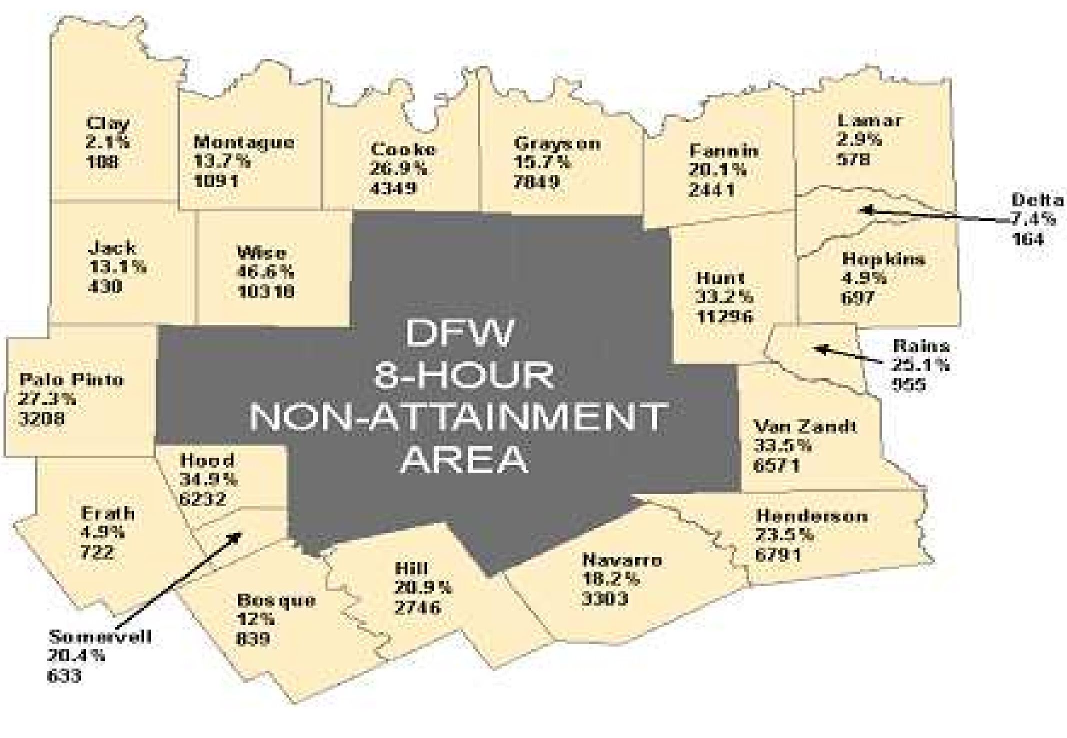
**REGION WIDE INSPECTION AND MAINTENANCE EMISSION QUANTIFICATION**

| EPA VEHICLE TYPE | EMISSION FACTOR (grams/mile) | | VMT FRACTION | HBW VMT* (miles) | HNW VMT* (miles) | NHB VMT* (miles) | EMISSION (tons/day) | |
|---|---|---|---|---|---|---|---|---|
| | NOx | VOC | | | | | NOx | VOC |
| LDGV | 0.0811 | 0.0871 | 70.3% | 1,701,135 | 2,715,302 | 1,398,348 | 0.520 | 0.558 |
| LDGT1 | 0.1156 | 0.1275 | 5.2% | 124,606 | 198,893 | 102,428 | 0.054 | 0.060 |
| LDGT2 | 0.1060 | 0.1325 | 17.2% | 414,817 | 662,118 | 340,983 | 0.166 | 0.207 |
| LDGT3 | 0.0680 | 0.0804 | 5.0% | 121,788 | 194,395 | 100,111 | 0.031 | 0.037 |
| LDGT4 | 0.0627 | 0.0845 | 2.3% | 56,006 | 89,395 | 46,038 | 0.013 | 0.018 |
| **TOTAL** | | | | | | | **0.784** | **0.880** |

* 142,642 of total trips are external work trips from 2009 model
* From 2009 model run, average trip length for external trip is 24.22 miles
* 70% of the VMT occur in nonattainment area and 30% outside nonattainment area.

**EXHIBIT B**

COMMUTERS TO 9 URBAN COUNTIES FOR WORK PURPOSES



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**Cost Effectiveness**

Most of the cost incurred by shop owners in establishing an inspection and maintenance station is buying the equipments like on-board diagnostic (OBD) scanner, acceleration-simulation mode testing units etc. In Exhibit C minimum revenue collected by state by selling I/M stickers was based on 71,321 commuters. From Exhibit D 4,022 dollars would be spent to decrease one ton of NOx and 3,586 dollars will be spent to decrease one ton of VOC.

**EXHIBIT C**

| COST ANALYSIS<br>(EXPANDING I/M PROGRAM) | | | |
|---|---|---|---|
| **Description** | **Cost/year ($)** | **Number** | **21 county total ($)** |
| **Cost of staff per new I/M station (2 people / county)** | $41,000 | 42 people | $1,722,000 |
| **Revenue earned by state per inspection sticker** | $8 | 71,321 vehicles | - $570,568 |
| **TOTAL COST OF THE PROGRAM** | | | **$1,151,432** |

**EXHIBIT D**

| EMISSION COST BENEFIT ANALYSIS | | |
|---|---|---|
| **POLLUTANT** | **EMISSION BENEFIT (tons/day)** | **COST/TON ($)** |
| NOx | 0.78 | $4,044 |
| VOC | 0.88 | $3,586 |

**COMMENTS**

**Likely Ozone Directional Effect**
Reduce ozone through VOC and NOx reduction

**Responsible Agency for Implementation**
Texas Commission on Environmental Quality

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 587, 590 | Expanding I/M to Surrounding Counties | Expand I/M Program to include additional vehicles | Onroad | 91.22 tpd | 0.86 | 0.78 | $4,044 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 587, 590 | Expanding I/M to Surrounding Counties | Expand I/M Program to include additional vehicles | Onroad | 92.76 tpd | 0.95 | 0.88 | $3,586 |

**REFERENCES**

U.S. Environmental Protection Agency, Office of Transportation and Air Quality, User's Guide to MOBILE6.1 and 6.2: Mobile Source Emission Factor Model Assessment and Standards Division, (August 2003).

**DRAFT**

**Control Measure:** Enhanced AirCheck Texas Repair and Replacement Assistance Program, Measure #172, 173, 179, 183, 185, 186, 130, 191, 192, 620
**Category:** Onroad
**Author:** Shannon Stevenson, North Central Texas Council of Governments

## DESCRIPTION

Administer an enhanced emissions repair and replacement assistance program to individuals not eligible for assistance under the existing AirCheck Texas Repair and Replacement Assistance Program guidelines. Local agencies will administer a program targeting high emitting vehicles by partnering with aftermarket manufacturers, retail and wholesale parts suppliers, Recognized Emission Repair Facilities, salvage facilities, auto manufacturers and dealerships, and other interested parties. The Enhanced AirCheck Texas Program will assist vehicle owners with emission repairs by offering coupons, rebates, and other various incentives. The Enhanced AirCheck Texas Program proposes to offer assistance with diagnostic and repair expenses, up to $300, to vehicle owners whose household income falls between 200 percent and 300 percent of the federal poverty rate. The Enhanced AirCheck Texas Program will also provide vehicle owners the ability to retire and replace their high emitting vehicles through partnerships established with auto manufacturers and area dealerships and also work to provide assistance to nonprofit organizations. The Enhanced AirCheck Texas Program will enable local agencies the ability to optimize aftermarket partnerships by concentrating on individual segments of the emissions repair and replacement markets.

The establishment of a Regional Smoking Vehicle Program for North Central Texas will support an Enhanced AirCheck Texas Repair and Replacement Assistance Program. The integration of the Smoking Vehicle Program into the current AirCheck Texas Repair and Replacement Assistance Program would create one seamless high emitting vehicle program yielding a more efficient process by which the local agency would provide solutions on how to bring high emitting vehicles into compliance. By utilizing the existing infrastructure for the AirCheck Texas Repair and Replacement Assistance Program, the incorporation of the Smoking Vehicle Program would encourage greater participation by providing local solutions to vehicle owners.

The expansion of the pilot constable enforcement program in Dallas County to a region-wide program for inspecting, diagnosing and possibly repairing high emitting vehicles that remain unclaimed after being removed from the roadways due to fictitious or counterfeit state inspection and/or registration stickers would also support various components of the current and enhanced AirCheck Texas Repair and Replacement Assistance Programs.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty gasoline emissions (91.22 tpd $NO_x$, 92.76 tpd VOC) in the nine-county ozone nonattainment area.

# DRAFT

**Emissions Benefit**

Acceleration Simulation Mode (ASM) vehicles repaired under the AirCheck Texas Repair and Replacement Assistance Program experience, on average, a 70 percent reduction in nitrogen oxide (NOx) emissions. This reduction can be found by calculating the difference in NOx concentrations from the failing and passing inspections. The passing inspection reflects emissions repairs being performed on the vehicle prior to that inspection. Similar NOx reductions are anticipated with the Enhanced AirCheck Texas Program as well and are assumed as such for quantification.

Emissions reductions were estimated using a sample data set of vehicles repaired under the AirCheck Texas Repair and Replacement Assistance Program. An estimate of the average NOx and hydrocarbon (HC) reductions in tons per day can be calculated using the following parameters:

- Pre and post-repairs emissions readings; and
- Horsepower used at the time of the inspection; and
- Average exhaust conditions provided by an on-board vehicle emissions study by the University of Texas at Arlington; and were used in converting the concentrations of parts per million into grams/cubic meters
- Based on the dynamometer set horsepower and the methodology used by the National Center For Vehicle Emissions Control And Safety at Colorado State University to calculate the exhaust flow rate.

$$Tons / year = \frac{A * B * C}{453.6 * 2000}$$

$$A = \frac{P}{RT} * \frac{M.W}{10^6} * C_{ppm}$$ ---------------------------------------→ Grams/cubic meter

$$B = HP\,(1.1) * 1.75 * 0.0283 * \frac{60}{S}$$ --------------------------------→ Cubic meter/mile

$$C = \frac{Miles}{Year}$$

P = Exhaust Pressure in Pascal
T = Temperature in Kelvin
R = Universal gas constant
M.W = Molecular weight
Cppm = Concentration of pollutant in parts per million
HP = Dyno set horse power measured at the time of testing
1.1 = correction factor recommended by Colorado National Labs
1.75 = Constant conversion factor (cubic feet/HP-min)
S = Vehicle testing speed (miles/hour)
C = Miles/year calculated for each vehicle (odometer reading / (Testing year-Model year))

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$$\text{NOx Reduction} = \frac{0.1666 \text{ tons}}{\text{day}} \text{ or } \frac{60.81 \text{ tons}}{\text{year}}$$

$$\text{HC Reduction} = \frac{0.0092 \text{ tons}}{\text{day}} \text{ or } \frac{3.36 \text{ tons}}{\text{year}}$$

**Cost Effectiveness**

Based on current AirCheck Texas participation levels and 2000 U.S. Census data, the Enhanced AirCheck Texas Program projects to repair an average of 200 vehicles per month. The average repair cost for a vehicle repaired under the current AirCheck Texas Program is $455. The Enhanced AirCheck Texas Program assumes a similar average repair cost. However, the Enhanced AirCheck Texas Program proposes only provide up to $300 for emissions related repairs if the vehicle owner's household income falls between 200 percent and 300 percent of the federal poverty rate. Therefore, the average annual cost for repairing 2,400 vehicles under the Enhanced AirCheck Texas Program is expected to $720,000. Under the current AirCheck Texas Program, 67 percent of the funds are spent repairing NOx emissions failures and 33 percent of the funds are spent repairing HC failures. Similar breakdowns are expected for the Enhanced AirCheck Texas Program as well. Therefore, $482,400 will be directed towards repairing NOx emissions failures and $237,600 will be directed towards repairing HC emissions failures.

<u>Cost</u>

NOx:

$$\frac{\$482{,}400}{\text{year}} \times \frac{1 \text{ year}}{60.81 \text{ tons}} = \frac{\$7{,}933}{\text{ton}}$$

HC:

$$\frac{\$237{,}600}{\text{year}} \times \frac{1 \text{ year}}{3.36 \text{ tons}} = \frac{\$70{,}714}{\text{ton}}$$

**COMMENTS**

A sample set of vehicles was reviewed to determine the failure rates for vehicles failing NOx, HC, or both pollutants from the current AirCheck Texas Program. The analysis is based on the benefit received each year for the vehicles repaired in that year. However, 98 percent of the vehicles repaired remain compliant in successive years and benefits are still being achieved. Therefore, with each progressive year, the benefits from the vehicles repaired in that year plus the previous years' benefits may be claimed, though the previous years' benefits would diminish over time as the vehicle ages and emissions slowly increase. Some type of rate needs to be established that incorporates the accumulation rate the benefits achieved versus the deterioration rate of the vehicle's repair effectiveness.

Similar to the current AirCheck Texas Repair and Replacement Assistance Program, the Enhanced AirCheck Texas Program is designed to target NOx emissions reductions and the analysis reveals that the majority of vehicles, 67 percent, failed NOx. Another important fact is that vehicles emit up to ten times more NOx emissions than HC emissions in general, so the NOx reduction will inherently be at least ten times more than the HC reduction. Also, since NOx emissions are inversely proportionate to HC emissions, the NOx reduction is achieved at the expense of an increase in HC emissions.

Future work includes the following investigations:

The analysis only considers benefits achieved from vehicles repaired under the AirCheck Texas Repair and Replacement Assistance Program. However, additional NOx reductions can be expected from vehicles that are retired and replaced. Further analyses are needed to quantify the benefits received from the vehicle replacement component of the program.

Evaluation of a larger sample size of vehicles: sample an even number of vehicles that fail on NOx emissions with an even number of vehicles that fail on HC emissions and an even number of vehicles that fail on both, NOx and HC emissions to gain a better average emission reduction per pollutant.

Investigate how much credit is accounted for in the model, State Implementation Plan, and emissions inventory for the AirCheck Texas Repair and Replacement Assistance Program to determine whether additional credit can be received.

**Technical Implementation Feasibility and Ranking**
The Enhanced AirCheck Texas Program is currently under development and close to implementation.

**Responsible Agency for Implementation**
The Texas Commission on Environmental Quality, participating counties, North Central Texas Council of Governments

**Political/Social/Public Acceptance**
High because the program is already in effect, therefore no additional cost is expected.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 172, 173, 179, 183, 185, 186, 130, 191, 192, 620 | Enhanced AirCheck Texas Repair and Replacement Assistance Program | Financial assistance program to for out of compliance vehicles | Onroad | 91.22 tpd | 0.19 | 0.17 | $7,933 |

# DRAFT

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 172, 173, 179, 183, 185, 186, 130, 191, 192, 620 | Enhanced AirCheck Texas Repair and Replacement Assistance Program | Financial assistance program to for out of compliance vehicles | Onroad | 92.76 tpd | 0.01 | 0.01 | $70,714 |

**REFERENCES**

E-mails and telephone calls with Mr. Mike Cole and Mr. Joe Beebe (Emissions Lab) with the National Center For Vehicle Emissions Control And Safety at Colorado State University, August – October 2005.

The Aftermarket Technology and Fuel Additive Research Program being conducted by Dr. Melanie Sattler of the University of Texas at Arlington's Department of Civil & Environmental Engineering, September 2005, provided on-road data.

# DRAFT

**Control Measure:** Drive-Thru Service Restrictions, Measure #366
**Category:** Onroad
**Author:** Amanda Brimmer, North Central Texas Council of Governments

**DESCRIPTION**

Part 1: Prohibit drive thru service during ozone season. This applies to, at minimum, fast food restaurants, banks, pharmacies, and dry cleaners.

Part 2: Invest in electronic display technology to inform customers of average wait-time and potential fuel savings by parking if wait-time exceeds the calculated number of minutes deemed necessary for an emission benefit.

**ANALYSIS**

**Emissions Affected**

This measure would affect on-road light-duty emissions (91.71 tpd $NO_x$, 93.02 tpd VOC) in the nine-county ozone nonattainment area.

**Emissions Benefit**

Methodology for calculating emission reductions was tailored from the 2003 TxDOT Mobile Source Emission Reduction Strategies Handbook, section 12.1. The "Daily Emission Reduction" equation was modified slightly, because it was missing a pair of parentheses in the original formula. MOSERS handbook states that "Daily Emission Reduction = A – B + C", but calculations determined it needs to be "= A – (B + C)" due to the fact that the variable C (increase in hot start emissions) should not be added to the reduction, but subtracted from it since it is an increase in emissions. Also, **t*A*** in equation (B) has been changed to **(1 – F*PARK*) * t*B*** to take into account the fact that the drive-thru line time will be shorter in proportion to the number of vehicles now parking.

**Variables:**

- **EF*I*:** Idling emission factor (NOx, VOC, or CO) (grams/vehicle*hour)
- **F*PARK*:** Percent of vehicles that turn-off engine when parked instead of idling due to imposed control measure (decimal)
- **N*V*:** Average number of vehicles that use facilities where idling will be enforced (vehicles/day)
- **t*B*:** Time spent idling before implementation of control measure (seconds)
- **TEF*AUTO*:** Auto trip-end emission factor (NOx, VOC, or CO) (grams/trip)

# DRAFT

**Equation:**

**Daily Emission Reduction = A – (B + C)**

**A = N*V* * t*B* * EF*I***
*Idling exhaust emissions generated before the control.*
**B = (1 – F*PARK*) * N*V* * (1 – F*PARK*) * t*B* * EF*I***
*Idling exhaust emissions after the control is in place.*
**C = F*PARK* * N*V* * (TEF*AUTO*)**
*Increase in start exhaust emissions resulting from consumers now parking their vehicles in lieu of idling their vehicle.*

**Assumptions:**

All vehicles are light-duty passenger vehicles & trucks model year 1983-2007
Emission factors are for Dallas County
Number of vehicles using facilities where idling will be enforced (**N*V***) = 100000
Time idling before policy (**t*B***) = 600 seconds (Scenario 1), = 180 seconds (Scenario 2)
The percent of vehicles that park as a result of the policy **F*PARK*** = 100%(Part 1),
= 50% (Part II)

**Calculations:**

Part 1
(Scenario 1)

| DRIVE THROUGH EMISSION QUANTIFICATION (100 % Parking Efficiency) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | START EMISSION FACTOR (grams/start) | | IDLING EMISSION FACTOR (grams/mile) | | VMT FRACTION | VEHICLES / DAY | BEFORE SCENARIO IDLING EMISSIONS (pounds/day) | | START EMISSIONS (pounds/day) | | EMISSION BENEFITS (pounds/day) | |
| | NOx | VOC | NOx | VOC | | | NOx | VOC | NOx | VOC | NOx | VOC |
| LDGV | 0.005 | 0.008 | 1.053 | 4.149 | 69.9% | 69,924 | 67.634 | 266.525 | 0.772 | 1.208 | 66.862 | 265.316 |
| LDGT1 | 0.007 | 0.011 | 0.912 | 4.325 | 5.1% | 5,122 | 4.293 | 20.350 | 0.079 | 0.123 | 4.214 | 20.226 |
| LDGT2 | 0.009 | 0.012 | 1.297 | 4.439 | 17.1% | 17,051 | 20.313 | 69.523 | 0.357 | 0.454 | 19.956 | 69.068 |
| LDGT3 | 0.007 | 0.010 | 0.942 | 2.362 | 5.0% | 5,006 | 4.334 | 10.861 | 0.074 | 0.106 | 4.260 | 10.755 |
| LDGT4 | 0.010 | 0.011 | 1.347 | 2.485 | 2.3% | 2,302 | 2.849 | 5.255 | 0.049 | 0.057 | 2.800 | 5.197 |
| LDDV | 0.002 | 0.015 | 0.726 | 0.509 | 0.1% | 64 | 0.043 | 0.030 | 0.000 | 0.002 | 0.042 | 0.028 |
| LDDT12 | 0.009 | 0.065 | 3.997 | 4.473 | 0.0% | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| LDDT34 | 0.002 | 0.018 | 0.710 | 0.626 | 0.5% | 531 | 0.346 | 0.306 | 0.003 | 0.021 | 0.344 | 0.284 |
| TOTAL | | | | | 100.0% | 100,000 | **99.8** | **372.8** | **1.3** | **2.0** | **98.5** | **371** |

The emission benefit of closing 10-minute drive-thrus is 0.049 tpd NOx and 0.186 tpd VOC.

**DRAFT**

(Scenario 2)

| DRIVE THROUGH EMISSION QUANTIFICATION (100 % Parking Efficiency) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | START EMISSION FACTOR (grams/start) | | IDLING EMISSION FACTOR (grams/mile) | | VMT FRACTION | VEHICLES/ DAY | BEFORE SCENARIO IDLING EMISSIONS (pounds/day) | | START EMISSIONS (pounds/day) | | EMISSION BENEFITS (pounds/day) | |
| | NOx | VOC | NOx | VOC | | | NOx | VOC | NOx | VOC | NOx | VOC |
| LDGV | 0.005 | 0.008 | 1.053 | 4.149 | 69.9% | 69,924 | 20.290 | 79.957 | 0.772 | 1.208 | 19.518 | 78.749 |
| LDGT1 | 0.007 | 0.011 | 0.912 | 4.325 | 5.1% | 5,122 | 1.288 | 6.105 | 0.079 | 0.123 | 1.209 | 5.982 |
| LDGT2 | 0.009 | 0.012 | 1.297 | 4.439 | 17.1% | 17,051 | 6.094 | 20.857 | 0.357 | 0.454 | 5.737 | 20.403 |
| LDGT3 | 0.007 | 0.010 | 0.942 | 2.362 | 5.0% | 5,006 | 1.300 | 3.258 | 0.074 | 0.106 | 1.227 | 3.153 |
| LDGT4 | 0.010 | 0.011 | 1.347 | 2.485 | 2.3% | 2,302 | 0.855 | 1.576 | 0.049 | 0.057 | 0.806 | 1.519 |
| LDDV | 0.002 | 0.015 | 0.726 | 0.509 | 0.1% | 64 | 0.013 | 0.009 | 0.000 | 0.002 | 0.012 | 0.007 |
| LDDT12 | 0.009 | 0.065 | 3.997 | 4.473 | 0.0% | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| LDDT34 | 0.002 | 0.018 | 0.710 | 0.626 | 0.5% | 531 | 0.104 | 0.092 | 0.003 | 0.021 | 0.101 | 0.070 |
| TOTAL | | | | | 100.0% | 100,000 | **29.9** | **111.9** | **1.3** | **2.0** | **28.6** | **110** |

The emission benefit of closing 3-minute drive-thrus is 0.0143 tpd NOx and 0.055 tpd VOC.

Part 2:

(Scenario 1)

| DRIVE THROUGH EMISSION QUANTIFICATION (50 % Parking Efficiency) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | START EMISSION FACTOR (grams/start) | | IDLING EMISSION FACTOR (grams/mile) | | VMT FRACTION | VEHICLES / DAY | BEFORE SCENARIO IDLING EMISSIONS (pounds/day) | | AFTER SCENARIO IDLING EMISSIONS (pounds/day) | | START EMISSIONS (pounds/day) | | EMISSION BENEFITS (pounds/day) | |
| | NOx | VOC | NOx | VOC | | | NOx | VOC | NOx | VOC | NOx | VOC | NOx | VOC |
| LDGV | 0.005 | 0.008 | 1.053 | 4.149 | 69.9% | 69,924 | 67.634 | 266.525 | 16.908 | 66.631 | 0.386 | 0.604 | 50.3 | 199.3 |
| LDGT1 | 0.007 | 0.011 | 0.912 | 4.325 | 5.1% | 5,122 | 4.293 | 20.350 | 1.073 | 5.087 | 0.039 | 0.062 | 3.2 | 15.2 |
| LDGT2 | 0.009 | 0.012 | 1.297 | 4.439 | 17.1% | 17,051 | 20.313 | 69.523 | 5.078 | 17.381 | 0.178 | 0.227 | 15.1 | 51.9 |
| LDGT3 | 0.007 | 0.010 | 0.942 | 2.362 | 5.0% | 5,006 | 4.334 | 10.861 | 1.083 | 2.715 | 0.037 | 0.053 | 3.2 | 8.1 |
| LDGT4 | 0.010 | 0.011 | 1.347 | 2.485 | 2.3% | 2,302 | 2.849 | 5.255 | 0.712 | 1.314 | 0.024 | 0.029 | 2.1 | 3.9 |
| LDDV | 0.002 | 0.015 | 0.726 | 0.509 | 0.1% | 64 | 0.043 | 0.030 | 0.011 | 0.007 | 0.000 | 0.001 | 0.0 | 0.0 |
| LDDT12 | 0.009 | 0.065 | 3.997 | 4.473 | 0.0% | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.0 |
| LDDT34 | 0.002 | 0.018 | 0.710 | 0.626 | 0.5% | 531 | 0.346 | 0.306 | 0.087 | 0.076 | 0.001 | 0.011 | 0.3 | 0.2 |
| TOTAL | | | | | 100.0% | 100,000 | **99.8** | **372.8** | **25.0** | **93.2** | **0.667** | **0.986** | **74.2** | **279** |

The emission benefit of getting 50 percent of drive-thru users to park is 0.037 tpd NOx and 0.140 tpd VOC.

**DRAFT**

(Scenario 2)

| DRIVE THROUGH EMISSION QUANTIFICATION (50 % Parking Efficiency) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | START EMISSION FACTOR (grams/start) | | IDLING EMISSION FACTOR (grams/mile) | | VMT FRACTION | VEHICLES/ DAY | BEFORE SCENARIO IDLING EMISSIONS (pounds/day) | | AFTER SCENARIO IDLING EMISSIONS (pounds/day) | | START EMISSIONS (pounds/day) | | EMISSION BENEFITS (pounds/day) | |
| | NOx | VOC | NOx | VOC | | | NOx | VOC | NOx | VOC | NOx | VOC | NOx | VOC |
| **LDGV** | 0.005 | 0.008 | 1.053 | 4.149 | 69.9% | 69,924 | 20.290 | 79.957 | 6.763 | 26.652 | 0.386 | 0.604 | 13.1 | 52.7 |
| **LDGT1** | 0.007 | 0.011 | 0.912 | 4.325 | 5.1% | 5,122 | 1.288 | 6.105 | 0.429 | 2.035 | 0.039 | 0.062 | 0.8 | 4.0 |
| **LDGT2** | 0.009 | 0.012 | 1.297 | 4.439 | 17.1% | 17,051 | 6.094 | 20.857 | 2.031 | 6.952 | 0.178 | 0.227 | 3.9 | 13.7 |
| **LDGT3** | 0.007 | 0.010 | 0.942 | 2.362 | 5.0% | 5,006 | 1.300 | 3.258 | 0.433 | 1.086 | 0.037 | 0.053 | 0.8 | 2.1 |
| **LDGT4** | 0.010 | 0.011 | 1.347 | 2.485 | 2.3% | 2,302 | 0.855 | 1.576 | 0.285 | 0.525 | 0.024 | 0.029 | 0.5 | 1.0 |
| **LDDV** | 0.002 | 0.015 | 0.726 | 0.509 | 0.1% | 64 | 0.013 | 0.009 | 0.004 | 0.003 | 0.000 | 0.001 | 0.0 | 0.0 |
| **LDDT12** | 0.009 | 0.065 | 3.997 | 4.473 | 0.0% | - | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.0 | 0.0 |
| **LDDT34** | 0.002 | 0.018 | 0.710 | 0.626 | 0.5% | 531 | 0.104 | 0.092 | 0.035 | 0.031 | 0.001 | 0.011 | 0.1 | 0.1 |
| **TOTAL** | | | | | 100.0% | 100,000 | **29.9** | **111.9** | **10.0** | **37.3** | **0.667** | **0.986** | **19.3** | **74** |

The emission benefit of getting 50 percent of drive-thru users to park is 0.010 tpd NOx and 0.037 tpd VOC.

**Cost Effectiveness**

Part I: Cost-effectiveness is based on the number of facilities affected by policy, number of signs needed to publicize restrictions, and the number of personnel needed to enforce policy.
Part 2: Cost-effectiveness is based on the number of drive-thru facilities interested in participating and the cost of display technology to show average wait time & fuel savings of parking.

**COMMENTS**

**Technical Implementation Feasibility and Ranking:**
Part 1 and Part 2 are most promising the longer the original drive-thru time is. As the two scenarios show, there will be a much larger benefit from reducing emissions in a 10 minute drive-thru line than in a 3 minute line, although, there is always a benefit from parking verses using the drive-thru regardless of the line. This may suggest that this strategy should be implemented mainly during peak periods when lines tend to have the longest wait time.

**Responsible Agency For Implementation:**
NCTCOG

**Political/Social/Public Acceptance:**
Part I may not have high public acceptance because of perceived convenience of drive-thru services and businesses may not be accepting of closing drive-thru facilities because they have invested capital in them. Part II may be more acceptable to both the public and businesses

because it will be voluntary, customers will be given information on wait-time and fuel savings, and businesses will be able to manage the indoor and drive-thru facility traffic more efficiently.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 366 | Drive-Thru Service Restrictions | Prohibit drive-thrus during the ozone season/ encourage parking | Onroad | 91.71 tpd | 0.01-0.05 | 0.01-0.05 | Unknown |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 366 | Drive-Thru Service Restrictions | Prohibit drive-thrus during the ozone season/ encourage parking | Onroad | 93.02 tpd | 0.04-0.20 | 0.04-0.19 | Cost effectiveness is based upon NOx reductions. |

**REFERENCES**

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TTI and TxDOT, “ Mobile Source Emission Reduction Strategies Handbook”, August 2003. http://moser.tamu.edu/Texas%20Guide%20to%20Accepted%20Mobile%20Source%20Emission%20Reduction%20Strategies%20-%20August%202003.pdf. pp. B.12-2.

# DRAFT

**Control Measure:** Expanded I/M to Include Diesel Vehicles, Measures #593, 594, 595, 601, 609, 610
**Category:** Onroad
**Author:** Madhusudhan Venugopal, North Central Texas Council of Governments

## DESCRIPTION

Dallas-Fort Worth (DFW) nonattainment counties have implemented inspection and maintenance (I/M) programs to reduce the mobile source emissions. I/M to the current date has concentrated on reducing Nitrogen Oxides (NOx) and Volatile Organic Compounds (VOC) from light duty gasoline vehicles. Substantial emission reduction can be expected by implementing I/M program for light duty diesel vehicle.

## ANALYSIS

### Emissions Affected

Only light duty diesel vehicles were analyzed in this strategy as I/M test is currently conducted for light duty gasoline vehicles in the region. This measure would affect on-road light-duty diesel emissions (0.49 tpd $NO_{x,}$ 0.26 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

There is a trade off between NOx versus VOC, Particulate Matter (PM), and Carbon Monoxide (CO) emissions. Decrease in NOx emissions in greater quantity will increase VOC, PM and CO emissions and vice versa. NOx emissions can be high in the old model vehicles, if they are not in optimal operating mode. DFW fleet consists of diesel vehicles that have old model vehicle. Diesel I/M for light duty diesel vehicles using on board diagnostic equipment has not been tested. This is a one of a kind of program that DFW region is inclined to test. EPA's MOBILE6.2 Mobile Source Emission Factor Model cannot model I/M benefits for diesel-fueled vehicles.

Vehicles tend to emit high if they are not properly maintained or tuned to manufacturers specification. Studies have proved that high emitting diesel vehicles emit three times higher than normal vehicles. Vehicles ranging between 1975 through 1984, 1985 and 1996 and 1997 through 2004 were assumed to have deteriorated and have emission factors three times higher, two times, and one time respectively than normal. Diesel I/M is expected to decrease NOx concentration by 1.42 tons/day as shown Exhibit A.

# DRAFT

## EXHIBIT A

| DIESEL INSPECTION AND MAINTENANCE EMISSION QUANTIFICATION | | | | | |
|---|---|---|---|---|---|
| MODEL YEAR | EPA VEHICLE TYPE | EMISSION FACTOR (grams/mile) | VEHICLE COUNT | AVERAGE MILES/DAY | EMISSION (tons/day) |
| | | NOx | | | NOx |
| 1975 through 1984 | LDDV | 1.2798 | 2,469 | 20 | 0.070 |
| | LDDT12 | 1.3093 | 660 | 20 | 0.019 |
| | LDDT34 | 1.3093 | 662 | 20 | 0.019 |
| 1985 through 1996 | LDDV | 0.8532 | 1,661 | 30 | 0.047 |
| | LDDT12 | 0.8728 | 1,428 | 30 | 0.041 |
| | LDDT34 | 0.8728 | 10,175 | 30 | 0.294 |
| 1997 through 2004 | LDDV | 0.4266 | 5,919 | 40 | 0.111 |
| | LDDT12 | 0.4364 | 1,050 | 40 | 0.020 |
| | LDDT34 | 0.4364 | 41,289 | 40 | 0.795 |
| **TOTAL** | | | **65,313** | | **1.42** |

Most of the cost incurred by shop owners in establishing an inspection and maintenance station is buying the equipments like on-board diagnostic (OBD) scanner, acceleration-simulation mode testing units etc. I/M stations performing tests for light duty gasoline vehicles can be used to test diesel vehicles with other exhaust and OBD equipment compatible to measure diesel emissions. Further research in the testing equipment capabilities is necessary to determine if additional testing equipment for diesel vehicles is required. DFW nonattainment counties have 6000 vehicle inspection stations for gasoline vehicles, depending upon the ratio between gas and diesel it was advised to introduce the program to 90 stations (10 stations per county). In Exhibit B, cost benefit analysis based on purchasing additional equipments (Equipment life is assumed to be 15 years) and is estimated as $34/ton. Higher benefits in NOx emission reduction can be expected if heavy-duty vehicles can go through the program.

## EXHIBIT B

| COST ESTIMATION | | |
|---|---|---|
| **Equipment Description** | **Cost** | **Nine County Total Cost** |
| **Emission Measuring Equipment*** | $90,000 | $8,100,000 |
| **Revenue (selling stickers)** | $8 | -$522,504 |
| **Total** | | **$7,577,496** |

* Estimates 10 stations per county (90 stations total)

# DRAFT

**Cost Effectiveness**

Total NOx Emissions Reduced = 1.42 tpd * 365 day/yr * 15 yr/project = **7,774.5 tons NOx**
$7,577,496 / 7,774.5 tons = **$34 / ton NOx**

## COMMENTS

**Likely Ozone Directional Effect**
Reduce ozone through NOx reduction

**Responsible Agency for Implementation**
Texas commission on Environmental Quality

## SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 593, 594, 595, 601, 609, 610 | Expanded I/M to Include Diesel Vehicles | Expand I/M Program to include additional vehicles. | Onroad | 0.49 tpd | 0.47 | 1.42 | $34 |

## SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 593, 594, 595, 601, 609, 610 | Expanded I/M to Include Diesel Vehicles | Expand I/M Program to include additional vehicles. | Onroad | 0.26 tpd | | | Cost effectiveness is based upon NOx reductions. |

## REFERENCES

None

**Control Measure:** Bicycle and Pedestrian Programs, Measures #2, 3, 4, 8, 13, 31, 39, 40, 41, 42, 43, 44, 46, 47, 48, 7, 16, 23, 24, 25, 26, 27, 32, 33, 34, 35, 1, 18, 19, 20, 21, 22
**Category:** Onroad
**Author:** Jared White, North Central Texas Council of Governments

## DESCRIPTION

To address mounting air quality and congestion concerns, the North Central Texas Council of Governments (NCTCOG) is working with local governments to implement policies and infrastructure to encourage the substitution of vehicle trips with bicycle and pedestrian trips. Three primary focus areas include the on-street bicycle/pedestrian network, regional trails and bicycle/pedestrian supportive policies.

NCTCOG recommendations for the on-street network include:

- Signing bicycle routes on local street or low volume routes that reach destinations. Add bike lanes or wide outside lanes to collectors and arterials.
- Funding the construction of sidewalks and bicycle facilities in the right of way with all new or reconstructed roadways.
- Constructing sidewalks, crosswalks, medians, pedestrian signals, street furniture, and other pedestrian connections.

NCTCOG recommendations for the creation of a regional trail system include:

- Constructing priority segments of the regional Veloweb including routes that connect to transit stations, employment/commercial centers and large residential areas.
- Providing morning and evening lighting along off-street bicycle and pedestrian routes.

NCTCOG recommendations for the creation of a regional trail system include:

- Permitting bicycles on all transit vehicles.
- Expanding bicycle parking at transit.
- Creating a new ordinance, to be endorsed by the Regional Transportation Council and adopted by local governments, that all employment centers with greater than 100 employees shall provide facilities for bicyclists and pedestrians to secure their bicycle, clothes and other items, shower and change for work, and do basic repairs on a bicycle.
- Creating a new ordinance, to be endorsed by the Regional Transportation Council and adopted by local governments that all property owners must provide bicycle parking equal to two percent of available automobile parking.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty emissions (91.71 tpd $NO_x$, 93.02 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

Emission reduction benefits are calculated using the bike needs indices (BNI) and pedestrian needs indices (PNI). The BNI is determined by the percentage of total trips that are five miles or less, employment density, population density, and medium income. The 919 Transportation Analysis Process (TAP) zones within the Dallas-Fort Worth Metropolitan Planning Area are ranked for each factor of the BNI and PNI. These rankings are compared against the regional value to generate an "index-to-region" score. Index-to-region scores greater than 1.00 indicates higher than average levels, and scores lower than 1.00 indicate lower than average levels. A ranking weight is then applied to each index-to-region score and summed for each TAP zone. The TAP zone area, population, and scores are compared against a one-mile radius for each bike/pedestrian facility to quantify the number of trips utilizing the bike/pedestrian facility ($N_{BW}$), with exceptions. Some localized projects may include a smaller radius and vice versa for specific broader projects. Natural and manmade barriers are also considered, including rivers, highways, and other incompatible land uses and street patterns.

The methodology outlined below is a simplified version of MoSERs methodologies outlined in The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, El Paso MPO, August 2003. Input variables that calculate the trips removed due to implementation of the bicycle/pedestrian facility, has been reorganized and quantified as facility users ($N_{BW}$). Quantification of this and other bike/pedestrian variables are calculated from demographic and mode share data generated by the Dallas-Fort Worth Regional Travel Model. As a conservative approach, this methodology only accounts for a one-way trip due to the uncertainty and lack of data regarding facility usage.

$EF_B$: Speed-based running exhaust emission factor for participants' trip before participating in the bike/pedestrian program (NOx, VOC, or CO) (grams/mile)

$TL_B$: Average auto trip length before implementation (miles)

$N_{BW}$: Number of trips utilizing the bike/pedestrian facility per year

Conversion Factor: Convert grams per mile of emissions to pounds per mile of emissions (908000 grams/ton)

Daily Emissions Reduction = ($N_{BW}$ * $TL_B$ * $EF_B$)/Conversion Factor

Currently, the majority of bicycle and pedestrian projects monitored by NCTCOG are classified as Transportation Control Measures and their emission benefits are already accounted for. There is however a set of projects that has been delayed and will be completed in the 2007-2009 timeframe. A sample of these projects, with their associated NOx reductions, is listed below.

| **Multi-Use Trails** | **2010 NOx Reduction (tons/yr)** | **2010 VOC Reduction (tons/yr)** |
|---|---|---|
| Central Park Trail (Richardson) | .14 tons/yr | 0.087 tons/yr |
| Little Bear Creek Trail (North Richland Hills) | .26 tons/yr | 0.17 tons/yr |
| Tenth Street Pedestrian Improvements (Dallas) | .04 tons/yr | 0.027 tons/yr |
| Winters Park Trail (Garland) | .17 tons/yr | 0.11 tons/yr |
| | | |
| **On-Street Bicycle Routes** | | |
| Grand Prairie On-Street Bicycle Routes | 4.2 tons/yr | 2.64 tons/yr |
| Plano On-Street Bicycle Routes | 7.4 tons/yr | 4.71 tons/yr |
| Arlington On-Street Bicycle Routes | 13.3 tons/yr | 8.48 tons/yr |

Total cost for listed projects is $10,723,854
Total NOx emission reductions for listed projects is 25.5 tons/yr / 365 days/yr = 0.07 tons/day
Total VOC emission reductions for listed projects is 16.22 tons/yr / 365 days/yr = 0.04 tons/day

In early 2006, NCTCOG will initiate a Call for Projects notifying local governments of funding available for new bicycle and pedestrian projects. This upcoming Call for Projects will fund a number of bicycle and pedestrian projects providing additional NOx benefits for the Dallas-Fort Worth region.

**Cost Effectiveness**

Cost effectiveness is based on the estimated numbers of users, the number of vehicle trips replaced with non-motorized trips, the type of facility and the associated costs of construction. These factors cause cost effectiveness to vary between projects and by where they are located.

The projects listed above represent a reasonable cross-section of projects found in the Dallas-Fort Worth area. Though similar in type, they vary in extent and location thus having different levels of estimated users based on the demographic characteristics of a particular area. For the trail projects, some are in relatively dense areas connecting to regional transit centers thereby generating higher estimated users, while others are in less populated areas and do not have the same impact. The same can be said for the on-street route projects. Some projects are large in scale and are located in areas where people are more prone to bicycle, while others may be less extensive and located in areas where cycling rates are less.

To generate a cost per ton of NOx estimate, the seven listed projects were summed and used as a representative sample providing for an average cost per ton measurement of bicycle and pedestrian projects. The design life of bike/pedestrian facilities is 12 years.

Cost (\$/ton $NO_x$) = \$10,723,854 / (25.5 tons/year * 12 years) = \$35,045.00/ ton NOx

**COMMENTS**

**Technical Implementation Feasibility and Ranking**
Implementation of additional bicycle and pedestrian facilities is highly likely based on the amount of investment already made and the growing momentum to expand existing facilities. To date there are over 300 miles of existing on-street routes, with over 400 more programmed miles to be implemented. There are approximately 113 miles of Regional Veloweb in place with another 35 miles programmed or under construction.

**Likely Ozone Directional Effect**
Reduce ozone through NOx reduction from the replacement of vehicle trips with cycling and walking trips.

**Responsible Agency for Implementation**
NCTCOG and local government agencies

**Political/Social/ Public Acceptance**
Political and social acceptance of implementing additional bicycle and pedestrian infrastructure is high. NCTCOG studies have shown large amounts of users on regional trail facilities and willingness to walk or bicycle if the proper infrastructure and amenities are put in place. Additional investments in bicycle and pedestrian infrastructure will lead to increased usage and replacement of some vehicle trips with cycling or walking trips. Acceptance from the business community could be a challenge in some cases since they will be asked to carry some of the expense in providing end of trip facilities. This can be overcome through partnership programs that provide funding to offset the additional costs the employer must incur, therefore creating an incentive for participation.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 2, 3, 4, 8, 13, 31, 39, 40, 41, 42, 43, 44, 46, 47, 48, 7, 16, 23, 24, 25, 26, 27, 32, 33, 34, 35, 1, 18, 19, 20, 21, 22 | Bicycle and Pedestrian Programs | Implementation of bicycle and pedestrian projects with supporting programs. | Onroad | 91.71 tpd | 0.08 | 0.07 | $35,045.00 |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 2, 3, 4, 8, 13, 31, 39, 40, 41, 42, 43, 44, 46, 47, 48, 7, 16, 23, 24, 25, 26, 27, 32, 33, 34, 35, 1, 18, 19, 20, 21, 22 | Bicycle and Pedestrian Programs | Implementation of bicycle and pedestrian projects with supporting programs. | Onroad | 93.02 tpd | 0.04 | 0.04 | Cost effectiveness is based upon NOx reductions. |

**REFERENCES**

North Central Texas Council of Governments, ‘Mobility 2025 2005 Amendment’ approved on April 14, 2005.

North Central Texas Council of Governments, Transportation Department, 2002 Bicycle and Pedestrian Traffic counts.

The Texas Guide to Accepted Mobile Source Emission Reduction Strategies, El Paso MPO, August 2003.

# DRAFT

**Control Measure:** AirCheck Texas Repair and Replacement Assistance Program, Measures #173, 179, 182, 619
**Category:** Onroad
**Author:** Shannon Stevenson, North Central Texas Council of Governments

## DESCRIPTION

Offer financial assistance to low-income vehicle owners whose vehicles fail the emissions inspection test. The program is designed to help vehicle owners comply with vehicle emissions standards to reduce ozone-forming pollutants created by on-road motor vehicles. The program targets the highest polluting vehicles and provides an incentive for citizens to contribute to the regional air quality solution. Qualified participants may receive a voucher worth up to $600 for emissions repairs, or $1,000 towards the cost of a replacement vehicle that meets emissions standards if they retire their old vehicle.

The education and outreach component of the program will promote AirCheck Texas Repair and Replacement Assistance Program participation through increased education, outreach, and advertising efforts, which experiences a considerable increase in participation each time an advertising campaign is launched. Other outreach strategies for the program areas include posters, danglers, brochures, flyers, mailers and inserts to targeted zip codes, billboards, and various media campaigns. Other outreach strategies will utilize inspection and maintenance failure data to target areas with high emission failure rates to provide vehicles owners with information about assistance available or how they can bring their vehicles into compliance.

The establishment of a Regional Smoking Vehicle Program for North Central Texas will also support an enhanced AirCheck Texas Repair and Replacement Assistance Program. The integration of the Smoking Vehicle Program into the AirCheck Texas Repair and Replacement Assistance Program will create one seamless high emitting vehicle program yielding a more efficient process by which the local agency would provide solutions on how to bring high emitting vehicles into compliance. By utilizing the existing infrastructure for the AirCheck Texas Repair and Replacement Assistance Program, the incorporation of the Smoking Vehicle Program will encourage greater participation by providing local solutions to vehicle owners.

The expansion of the pilot constable enforcement program in Dallas County to a region-wide program for inspecting, diagnosing and possibly repairing high emitting vehicles that remain unclaimed after being removed from the roadways due to fictitious or counterfeit state inspection and/or registration stickers will also support various components of the current and enhanced AirCheck Texas Repair and Replacement Assistance Programs.

Develop and implement new and different strategies for the use of remote sensing in order to expand current use of technology.

# DRAFT

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty gasoline emissions (91.22 tpd $NO_x$, 92.76 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

Ninety-five percent of the vehicles repaired under the AirCheck Texas Repair and Replacement Assistance Program are vehicles that are model years 1995 or older, or vehicles tested utilizing the Acceleration Simulation Mode (ASM). The program repairs an average of 270 vehicles per month, or 3,240 vehicles per year.

ASM vehicles repaired under the program experience, on average, a 70 percent reduction in nitrogen oxide (NOx) emissions. This reduction can be found by calculating the difference in NOx concentrations from the failing and passing inspections. The passing inspection reflects emissions repairs being performed on the vehicle prior to that inspection.

Emissions reductions were estimated using a sample data set of vehicles repaired under the AirCheck Texas Repair and Replacement Assistance Program. An estimate of the average NOx and hydrocarbon (HC) reductions in tons per day can be calculated using the following parameters:

- Pre and post-repairs emissions readings; and
- Horsepower used at the time of the inspection; and
- Average exhaust conditions provided by an on-board vehicle emissions study by the University of Texas at Arlington; and were used in converting the concentrations of parts per million into grams/cubic meters
- Based on the dynamometer set horsepower and the methodology used by the National Center For Vehicle Emissions Control And Safety at Colorado State University to calculate the exhaust flow rate.

$$Tons / year = \frac{A*B*C}{453.6*2000}$$

$$A = \frac{P}{RT}*\frac{M.W}{10^6}*C_{ppm}$$ ---------------------------------------→ Grams/cubic meter

$$B = HP\,(1.1)*1.75*0.0283*\frac{60}{S}$$ --------------------------------→ Cubic meter/mile

$$C = \frac{Miles}{Year}$$

P = Exhaust Pressure in Pascal

# DRAFT

T = Temperature in Kelvin
R = Universal gas constant
M.W = Molecular weight
Cppm = Concentration of pollutant in parts per million
HP = Dyno set horse power measured at the time of testing
1.1 = correction factor recommended by Colorado National Labs
1.75 = Constant conversion factor (cubic feet/HP-min)
S = Vehicle testing speed (miles/hour)
C = Miles/year calculated for each vehicle (odometer reading/(Testing year-Model year))

$$\text{NOx Reduction} = \frac{0.2249 \text{ tons}}{\text{day}} \text{ or } \frac{82.07 \text{ tons}}{\text{year}}$$

$$\text{HC Reduction} = \frac{0.0125 \text{ tons}}{\text{day}} \text{ or } \frac{4.56 \text{ tons}}{\text{year}}$$

**Cost Effectiveness**

Cost
NOx:

$$\frac{\$987{,}714}{\text{year}} \times \frac{1 \text{ year}}{82.07 \text{ tons}} = \frac{\$12{,}035}{\text{ton}}$$

HC:

$$\frac{\$486{,}486}{\text{year}} \times \frac{1 \text{ year}}{4.56 \text{ tons}} = \frac{\$106{,}686}{\text{ton}}$$

The average repair cost for a vehicle repaired under the AirCheck Texas Repair and Replacement Assistance Program is $455. Therefore, the average annual cost for repairing 3,240 vehicles is $1,474,200. Sixty-seven percent of the funds are spent repairing NOx emissions failures and 33 percent of the funds are spent repairing HC failures. Therefore, $987,714 is directed towards repairing NOx emissions failures and $486,486 is directed towards repairing HC emissions failures.

**COMMENTS**

A sample set of vehicles was reviewed to determine the failure rates for vehicles failing NOx, HC, or both pollutants. The analysis is based on the benefit received each year for the vehicles repaired in that year. However, 98 percent of the vehicles repaired remain compliant in successive years and benefits are still being achieved. Therefore, with each progressive year, the benefits from the vehicles repaired in that year plus the previous years' benefits may be claimed, though the previous years' benefits would diminish over time as the vehicle ages and emissions slowly increase. Some type of rate needs to be established that incorporates the accumulation rate the benefits achieved versus the deterioration rate of the vehicle's repair effectiveness.

The AirCheck Texas Repair and Replacement Assistance Program was designed to target NOx emissions reductions and the analysis reveals that the majority of vehicles, 67 percent, failed NOx. Another important fact is that vehicles emit up to ten times more NOx emissions than HC emissions in general, so the NOx reduction will inherently be at least ten times more than the HC reduction. Also, since NOx emissions are inversely proportionate to HC emissions, the NOx reduction is achieved at the expense of an increase in HC emissions.

Future work includes the following investigations:

The analysis only considers benefits achieved from repairing vehicles under the AirCheck Texas Repair and Replacement Assistance Program. However, additional NOx reductions can be expected from vehicles that are retired and replaced. Further analyses are needed to quantify the benefits received from the vehicle replacement component of the program.

Evaluation of a larger sample size of vehicles: sample an even number of vehicles that fail on NOx emissions with an even number of vehicles that fail on HC emissions and an even number of vehicles that fail on both, NOx and HC emissions to gain a better average emission reduction per pollutant.

Investigate how much credit is accounted for in the model, State Implementation Plan, and emissions inventory for the AirCheck Texas Repair and Replacement Assistance Program to determine whether additional credit can be received.

**Technical Implementation Feasibility and Ranking**
The program is currently operational.

**Responsible Agency for Implementation**
The Texas Commission on Environmental Quality, participating counties, North Central Texas Council of Governments

**Political/Social/Public Acceptance**
High because the program is already in effect, therefore no additional cost is expected.

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 173, 179, 182, 619 | AirCheck Texas Repair and Replacement Assistance Program | Financial assistance program to for out of compliance vehicles. | Onroad | 91.22 tpd | 0.47 | 0.25 | $12,035 |

# DRAFT

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| 173, 179, 182, 619 | AirCheck Texas Repair and Replacement Assistance Program | Financial assistance program to for out of compliance vehicles. | Onroad | 92.76 tpd | 1.98 | 0.01 | $106,686 |

**REFERENCES**

E-mails and telephone calls with Mr. Mike Cole and Mr. Joe Beebe (Emissions Lab) with the National Center For Vehicle Emissions Control And Safety at Colorado State University, August – October 2005.

The Aftermarket Technology and Fuel Additive Research Program being conducted by Dr. Melanie Sattler of the University of Texas at Arlington's Department of Civil & Environmental Engineering, September 2005, provided on-road data.

# DRAFT

**Measure Title:** I/M exemption for 1974 and Older Model Year Vehicles, Measure #TCEQ
**Category:** Onroad
**Author**: Madhusudhan Venugopal, North Central Texas Council of Governments

## DESCRIPTION

Dallas-Fort Worth (DFW) nonattainment counties implemented inspection and maintenance (I/M) program to reduce the mobile source emissions. Traditionally I/M exemption is applied to gasoline vehicles outside a 24-year-model rolling window. Changing the exemption to a set 1975 model year will help with keeping the gross emitters off the street. However, vehicles registered as antiques will be excluded from the requirement.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty gasoline emissions (91.22 tpd $NO_x$, 92.76 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

EPA's MOBILE6.2 Mobile Source Emission Factor Model was used to develop emission factors for this analysis based on regional fleet characterization and emission controls in place by 2009. Only light duty gasoline vehicles were analyzed in this strategy as I/M test is currently conducted for light duty gasoline vehicles in the region. Vehicle counts were collected for model years 1975 through 1980 as shown in Exhibit A. Average miles per day were estimated by odometer readings estimated from a local sample size.

Emission benefits were calculated by multiplying emission factors with average miles/day and the difference in emission factors developed with and without I/M and anti-tampering program. Estimated emission benefits by requiring 1975 through 1980 model year vehicles go through I/M program is 1.71 tons/day for VOC and 0.43 tons/day for NOx as shown in the Exhibit A.

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## EXHIBIT A

### AREAWIDE 1975 THROUGH 1980 VEHICLE COUNTS AND ASSOCIATED EMISSION BENEFITS

| Model Year | Count | | | Average Miles/Day | Emission Benefits (Tpd) | |
|---|---|---|---|---|---|---|
| | LDGV | LDGV12 | LDGV34 | | VOC | NOx |
| **1975** | 1792 | 1112 | 239 | 20.5 | 0.11 | 0.03 |
| **1976** | 2927 | 2323 | 367 | 15.1 | 0.15 | 0.04 |
| **1977** | 3833 | 3429 | 433 | 33.8 | 0.48 | 0.11 |
| **1978** | 4769 | 4371 | 474 | 18.6 | 0.32 | 0.07 |
| **1979** | 5655 | 4217 | 619 | 20.4 | 0.36 | 0.09 |
| **1980** | 3649 | 2607 | 330 | 34.1 | 0.29 | 0.10 |
| Total Emissions (tpd) | | | | | **1.71** | **0.43** |

*LDGV = Light Duty Gasoline Vehicles
*LDGT12 = Light Duty Gasoline Trucks1&2
*LDGT34 = Light Duty Gasoline Trucks3&4

**Cost Effectiveness**

An Inspection and Maintenance program has operated in the DFW nine nonattainment counties for many years, so there is no cost involved to set up the program. Instead the estimated revenue received by selling inspection stickers as shown in Exhibit B in relation to the emission as shown in Exhibit A.

## EXHIBIT B

| COST ANALYSIS (Expanding Vehicle Model Year Requirement of the I/M Program) | | | |
|---|---|---|---|
| **Description** | **Revenue** | **Number** | **9 County Total** |
| **Program Cost** | N/A | N/A | N/A |
| **Revenue earned by state per inspection sticker** | $8 | 43,146 vehicles | $345,168 |
| **Total Revenue of the Program** | | | **$345,168** |

Annual NOx Emission Reduction = 0.43 tpd * 365 day/year = 157 tpy

Annual Cost-Effectiveness = -$345,168 / 157 tpy = -$2199/ton NOx → Revenue of $2,199 / ton NOx / year

**COMMENTS**

**Likely Ozone Directional Effect**
Reduce ozone through VOC and NOx reduction

**Responsible Agency for Implementation**
Texas Commission on Environmental Quality

**SUMMARY OF RESULTS: $NO_x$**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| TCEQ | I/M exemption for 1974 and Older Model Year Vehicles | Expand I/M Program to include additional vehicles | Onroad | 91.22 tpd | 0.47 | 0.43 | $2,199/ ton per year |

**SUMMARY OF RESULTS: VOC**

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| TCEQ | I/M exemption for 1974 and Older Model Year Vehicles | Expand I/M Program to include additional vehicles | Onroad | 92.76 tpd | 1.84 | 1.71 | Cost effectiveness is based upon NOx reductions. |

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## REFERENCES

None

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**Control Measure:** Transit Off-Peak Pass, Measures #TCEQ
**Category:** Transit
**Author:** Chad Edwards, North Central Texas Council of Governments

## DESCRIPTION

Provide an off-peak unlimited-ride pass. This practice would encourage use of transit for midday, evening, and weekend trips by those who do not commute by transit. Incremental cost to provide service would be negligible due to unused midday transit capacity. May encourage reduction in peak load.

## ANALYSIS

### Emissions Affected

This measure would affect on-road light-duty emissions (91.71 tpd $NO_x$, 93.02 tpd VOC) in the nine-county ozone nonattainment area.

### Emissions Benefit

No real data is available to evaluate this strategy directly. This strategy would primarily shift trips from the peak to the off-peak period; it would seem to have negligible impact on total transit ridership. A suggested impact of somewhere between 0.1-1 percent decrease in VMT as a result of this strategy would be anticipated. Professional opinion would put the decrease closer to the 0.1 percent which would be approximately 125,000 VMT per day.

For the counties of Collin, Dallas, Denton, Rockwall, and Tarrant, VMT and speeds were estimated using a link-based methodology for each time period and episode day for the year 2009. For the Counties of Ellis, Johnson, Kaufman, and Parker VMT and speeds were estimated using Texas Department of Transportation (TxDOT) highway performance monitoring system (HPMS) data and population forecast for each of the counties in a top down approach. EPA's MOBILE6.2 Mobile Source Emission Factor Model is used to develop 2009 vehicle emission factors for this analysis.

An estimated of 125,000 vehicle miles traveled was decreased due to the free off-peak passes strategy introduced in the ozone season. Emission factors were calculated using total emissions by each vehicle classes and dividing by the total vehicle activity by respective vehicle class. A total of 0.067 tons/day of NOx and VOC was reduced as shown below in Exhibit A.

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**Exhibit A**

| TRANSIT OFF-PEAK PASS EMISSION QUANTIFICATION | | | | | | |
|---|---|---|---|---|---|---|
| EPA VEHICLE TYPE | EMISSION FACTOR (grams/mile) | | VMT FRACTION | VMT* (miles) | EMISSION (tons/day) | |
| | NOx | VOC | | | NOx | VOC |
| **LDGV** | 0.4281 | 0.4727 | 69.9% | 87,405 | 0.041 | 0.046 |
| **LDGT1** | 0.4699 | 0.5674 | 5.1% | 6,402 | 0.003 | 0.004 |
| **LDGT2** | 0.6876 | 0.5985 | 17.1% | 21,313 | 0.016 | 0.014 |
| **LDGT3** | 0.5019 | 0.3351 | 5.0% | 6,258 | 0.003 | 0.002 |
| **LDGT4** | 0.7336 | 0.3692 | 2.3% | 2,878 | 0.002 | 0.001 |
| **LDDV** | 0.4266 | 0.2043 | 0.1% | 80 | 0.000 | 0.000 |
| **LDDT12** | 2.5482 | 2.5955 | 0.0% | - | 0.000 | 0.000 |
| **LDDT34** | 0.4364 | 0.2295 | 0.5% | 664 | 0.000 | 0.000 |
| **TOTAL** | | | 100.0% | 125,000 | **0.067** | **0.067** |

* 125,000 VMT per day was decreased
[1] EPA default diesel fraction used

**Cost Effectiveness**

**COMMENTS**

**Likely Ozone Directional Effect**
Ozone reduction would be minimal.

**Responsible Agency for Implementation**
Transit Agencies

**Political/Social/ Public Acceptance**
Support for the free off peak travel passes would be a hard sell to the transit agencies whose budgets are already very tight.

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### SUMMARY OF RESULTS: $NO_x$

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| TCEQ | Transit Off-Peak Pass | Transit Incentive | Onroad | 91.71 tpd | 0.08 | 0.07 | |

### SUMMARY OF RESULTS: VOC

| Measure ID | Name | Description | Affected Source | Affected Emissions | Expected Emission Reduction | | Cost Effectiveness ($/ton) |
|---|---|---|---|---|---|---|---|
| | | | | | % | Tpd | |
| TCEQ | Transit Off-Peak Pass | Transit Incentive | Onroad | 93.02 tpd | 0.08 | 0.07 | Cost effectiveness is based upon NOx reductions. |

### RESOURCES


Dallas Area Rapid Transit (DART). www.dart.org

Fort Worth Transit Authority (The-T). www.the-t.org

North Central Texas Council of Governments. Dallas Fort Worth Region Travel Model, 2009 Network.