REVISIONS TO THE STATE IMPLEMENTATION PLAN FOR THE CONTROL OF OZONE AIR POLLUTION

REQUIREMENTS FOR GASOLINE VOLATILITY AND SULFUR CONTENT IN EAST AND CENTRAL TEXAS

AND

FEDERAL CLEAN AIR ACT §211(c)(4)(C) WAIVER REQUEST

TEXAS NATURAL RESOURCE CONSERVATION COMMISSION
P.O. BOX 13087
AUSTIN, TEXAS 78711-3087

RULE LOG NO. 98058-SIP-AI

DECEMBER 16, 1998

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CLEANER GASOLINE SIP
LIST OF ACRONYMS

AAMA - American Automobile Manufacturers Association
BPA - Beaumont/Port Arthur
CARE - Clean Air Responsibility Enterprise
CO - Carbon Monoxide
COAST - Coastal Oxidant Assessment for Southeast Texas
CRC - Coordinating Research Council
Commission - Texas Natural Resource Conservation Commission
DFW - Dallas/Fort Worth
ELP - El Paso
EPA - Environmental Protection Agency
FCAA - Federal Clean Air Act
FTE - Full Time Employee
HGA - Houston-Galveston
I/M - Inspection and Maintenance
LDT - Light-Duty Trucks
LDV -
LEV - Low Emission Vehicles
MY - Model Year
NAAQS - National Ambient Air Quality Standard
NLEV - National Low Emission Vehicles
NMHC - Non-Methane Hydrocarbon
NO_x - Nitrogen Oxides
ORVR - On-Board Refueling Vapor Recovery
OTAG - Ozone Transportation Assessment Group
PPB - Parts Per Billion
PPM - Parts Per Million
PSIA - Pounds Per Square Inch Absolute
RFG - Reformuated Gasoline
RVP - Reid Vapor Pressure
SIP - State Implementation Plan
TCAS - Texas Clean Air Strategy
TCM - Transportation Control Measures
ULEV - Ultra Low Emission Vehicles
VOC - Volatile Organic Compound

CLEANER GASOLINE SIP
LIST OF APPENDICES

Section VI: CONTROL STRATEGY

B. OZONE CONTROL STRATEGY

1. - 8. (No change.)

9. SIP REVISIONS FOR THE ATTAINMENT DEMONSTRATION (Revised. See attached chapters.)

a. - c. (No change.)

d. Cleaner Gasoline (New.)

10. - 13. (No change.)

14. HEARING REQUIREMENTS (Revised.)

a. - i. (No change.)

j. The state has conducted four public hearings for this SIP and accompanying rule revisions. Locations, dates, and times are as follows:

City	Date/Time	Location
Austin	January 25, 1999 - 11:00 a.m.	TNRCC Complex 12100 N. IH-35, Building F, Room 2210
San Antonio	January 25, 1999 - 7:00 p.m.	City Council Chambers 103 Main Plaza
Lufkin	January 26, 1999 - 2:00 p.m.	City Council Chambers 300 E. Shepherd, Room 102
Tyler	January 26, 1999 - 7:00 p.m.	Tyler Junior College Regional Training and Development Complex 1530 South Southwest Loop 323, Room 104

CHAPTER 1: INTRODUCTION

The State of Texas has four 1-hour ozone nonattainment areas: Houston/Galveston (HGA), Dallas/Fort Worth (DFW), Beaumont/Port Arthur (BPA), and El Paso (ELP). State Implementation Plans (SIPs) for attainment of the 1-hour ozone National Ambient Air Quality Standards (NAAQS) are under development for the HGA and DFW areas. Several other areas around the state have already had exceedances of the new 8-hour NAAQS. Due to the significant air quality concerns under the 1-hour NAAQS, and the new challenges imposed by the 8-hour NAAQS, Texas has developed the Texas Clean Air Strategy (TCAS). (See Figure 1)

Figure 1

The TCAS has five elements. First are the voluntary efforts taken through the Clean Air Responsibility Enterprise (CARE) program. The CARE program will draw older industrial facilities, commonly known as “grandfathered” facilities, into the agency’s permitting program. Second is the proposed reduction in nitrogen oxides (NO_x) and volatile organic compounds (VOC) emissions from larger (greater than 250 tons of NO_x per year or greater than 100 tons of VOC per year) point sources typically industrial-type facilities and power plants. Third is support of the National Low Emission Vehicle (NLEV) program which will bring cleaner cars to Texas by model year (MY) 2001. Fourth, is Stage I vapor recovery for larger gas stations. Stage I equipment recovers gasoline vapors from underground storage tanks as they are refilled by tank trucks. The final element of the TCAS is cleaner gasoline.

The cleaner gasoline proposed in this SIP revision would have a lower reid vapor pressure (RVP) outside DFW and HGA, and a limit on the amount of sulfur in each gallon of gasoline. The RVP required in this SIP revision is 7.8 pounds per square inch absolute (psia) starting May 1, 2000. The RVP limit would be in effect every summer from May 1st through October 31st. A 7.8 psia RVP fuel is expected to reduce evaporative emissions from automobiles, off-highway gasoline powered equipment, and all gasoline storage and transfer operations. Evaporative VOC emissions from automobiles will be reduced by at least 14%. The rules would further provide for counties or large cities to opt into these regulations earlier than proposed here provided certain conditions are met.

The sulfur cap is 150 ppm per gallon of gasoline, starting May 1, 2003. Low sulfur gasoline is expected to reduce NO_x emissions from today’s cars by 8.5% according to the U.S. Environmental Protection Agency’s (EPA) complex model.

Sulfur is a catalyst poison, and all vehicles with catalysts are adversely impacted by sulfur poisoning. Most cars and light trucks manufactured since MY 1975 have had catalysts installed. Sulfur competes for the active sites on the catalyst surface with the ozone precursors the catalyst is attempting to control, VOC and NO_x. Sulfur can also increase emissions of carbon monoxide (CO), a metabolic poison. In addition, sulfur interferes with the oxygen storage capacity on catalytic surfaces further exacerbating the impacts on NO_x emissions. Sulfur poisoning can be reversed on some vehicles under certain conditions. Most advanced technology cars, such as NLEV vehicles, can have their emission controls severely compromised by elevated sulfur levels found in fuel.

Section 211(c)(4)(A) of the FCAA prohibits states from prescribing or attempting to enforce any "control or prohibition" of a "characteristic or component of a fuel or fuel additive" if EPA has promulgated a control or prohibition applicable to such characteristic or component under §211(c)(1). Section 211(c)(4)(C) provides an exception to this prohibition for a nonidentical state standard contained in a SIP where the standard is "necessary to achieve" the primary or secondary NAAQS that the SIP implements. EPA can approve a SIP provision as necessary if the Administrator finds that "no other measures that would bring about timely attainment exist," or that "other measures exist and are technically possible to implement, but are unreasonable or impracticable." Therefore, Texas is proposing this revision to the SIP as adequate justification and is requesting a waiver from §211(c)(4)(A) of the FCAA.

CHAPTER 2: BACKGROUND

At the time the 1990 FCAA Amendments were enacted, the focus on controlling ozone pollution was centered on local controls. However, for many years an increasing number of air quality professionals have asserted that ozone is a regional problem requiring regional strategies in addition to local control programs. As nonattainment areas across the United States prepared attainment demonstration SIP revisions in response to the 1990 FCAA Amendments, several areas found that modeling attainment was made much more difficult, if not impossible, because of high ozone and ozone precursor levels entering from the boundaries of their respective modeling domains (e.g. high background levels of ozone).

The Texas Natural Resource Conservation Commission (commission) conducted air quality modeling and upper air monitoring that found regional air pollution should be considered when addressing air quality in Texas' ozone nonattainment areas. This work is supported by research conducted by the Ozone Transport Assessment Group (OTAG), the most comprehensive attempt ever undertaken to understand and quantify the transport of ozone. Both the commission and OTAG study results point to the need to take a regional approach, such as that proposed in the TCAS, to controlling air pollutants.

As part of the Coastal Oxidant Assessment of Southeast Texas (COAST) project, the commission and its contractor (Environ, Inc.), conducted regional-scale modeling to develop future year boundary conditions for the COAST modeling domain. The emissions inventory used in this modeling was based on the OTAG emission inventory. The modeling was conducted for a domain covering most of Texas as well as several southern states.

During the OTAG process, the commission modeling staff ran several sensitivity analyses using this regional modeling setup to assess the impact of potential OTAG reductions on Texas. Applying the OTAG 5c reductions across the domain (60% reduction of point source NO_x, 30% reduction of low-level NO_x, 30% reduction of VOC), compared to the case of no reductions, indicates that modeled reductions would significantly reduce ozone throughout most of the eastern half of Texas. Overall, the modeling indicates that a regional reduction strategy would be beneficial across a wide area of the state.

During modeling for the HGA attainment demonstration SIP revision, the commission modeling staff conducted sensitivity analyses to determine the benefits regional reductions might have on HGA, when applied simultaneously with local reductions. Unlike the commission regional modeling exercises discussed above, these model runs offer an opportunity to assess separately the benefits of reductions made within and outside a region, since model runs with and without the regional reductions scenarios in HGA were run. Modeling runs were completed to evaluate the 8-hour average ozone concentrations in the COAST modeling domain for September 8, 1993 with 2007 projected emissions and assuming a reduction of 70% NO_x and 15% VOC in the 8-county HGA area. Even with the large reductions in HGA, much of the upper Texas Coast is projected to be well above the 8-hour standard. Also, Austin, Victoria, and Corpus Christi showed modeled 8-hour average concentrations above 80 parts per billion (ppb). The benefit of applying OTAG 5c reductions outside the HGA 8-county area clearly showed that the reductions are beneficial to HGA and provided additional ozone benefits of between 5 and 10 ppb in HGA. This modeling provides part of the evidence of the benefit of regional reductions on Texas' nonattainment areas.

Conclusions from the commission's work are supported by OTAG studies that also illustrate the importance of implementing a regional air quality control strategy. Overall, the conclusions and recommendations of OTAG are very consistent with the TCAS, leading to the determination that regional control strategies are needed to achieve the NAAQS for ozone.

CHAPTER 3: TECHNICAL FUEL INFORMATION

3.1 OVERVIEW

The commission has evaluated a cleaner gasoline for the eastern and central parts of Texas. After much research, industry consultation, and communication with local, state and federal agencies, the commission has proposed a fuel it believes will move Texas much closer to achieving its overall air quality goals. The fuel the agency has proposed is a low RVP gasoline with a sulfur cap. Results of the commission's evaluation efforts to date are summarized below along with more detail on the proposed fuel.

The commission has completed modeling runs incorporating the overall regional strategy. The first run was modeled with NLEV, cleaner gasoline, Stage I, and 50% point source NO_x reductions and showed upwards of a 12 ppb decrease in ozone. A modeling run was also made using only the mobile source controls (the NLEV program, cleaner gasoline, and Stage I vapor recovery). This second modeling run showed an overall ozone reduction of about 4 ppb. Based on the available monitoring data, these levels of reduction may be enough to keep the near-nonattainment areas in attainment with the 8-hour NAAQS. Reductions in the regional levels of ozone and ozone precursors will help to reduce the maximum ozone concentration and the duration of ozone events in the nonattainment areas. With the mobile nature and commuter lifestyle of larger urban areas, a cleaner gasoline over a broader area is much more reasonable and practicable than other types of controls.

Texas and other states have used low RVP fuels for a number of years as an effective program for reducing ozone levels. While EPA is not looking at RVP, it is considering lowering the sulfur content of all U.S. gasoline concurrent with its evaluation of new motor vehicles standards (Tier II). The Tier

II regulations should be finalized in late 1999 with a new fuel starting in 2004. By this SIP amendment and concurrent rulemaking, Texas would get cleaner gasoline sooner than what may be required federally. Texas has watched and has been a part of the national debate on cleaner gasoline. Texas will continue these efforts and if the national situation continues in a timely and positive direction, Texas may not need to proceed on its own with the lower sulfur aspect of cleaner gasoline. However, if reductions in sulfur at the national level are not consistent with where Texas needs be in relation to mobile source controls and do not occur in a timely manner, then Texas will proceed with sulfur controls on gasoline.

Through the NLEV program, automobile manufacturers have made a commitment to introduce cleaner cars to the nation earlier than what would have been required by the FCAA. The reductions from this action, although significant, will not be enough to get Texas where it needs to be in relation to overall air quality. Improvements in gasoline quality alone also may not be enough. An improvement in gasoline quality, combined with the advanced vehicle technology, will move Texas closer to achieving its overall air quality goals than either step alone could possibly achieve.

Texas refineries supply gasoline not only to the Texas market but also to markets outside of Texas. One state which will be relying on Texas and other Gulf Coast refineries for its supply of low RVP/low sulfur gasoline is Georgia. Gasoline that is proposed for the Atlanta area is very similar to the fuel being proposed by Texas, thereby creating a greater demand for this type of fuel. Also at the national level, sulfur reductions are likely to be the means most refiners will use to meet the Phase II RFG requirement for NO_x reductions. Phase II RFG will have sulfur levels very close to what is proposed for the Texas market. Based on these factors, EPA's evaluation of fuel sulfur limits, Phase II RFG with reductions in fuel sulfur, and other states' consideration of sulfur limits, the commission believes the fuel proposed here is consistent with national trends regarding improvements in fuel quality.

Starting in late 1997, the commission began to evaluate different types of cleaner burning fuels (gasoline, diesel, etc.) as part of an overall regional strategy. The commission eventually settled its focus on a cleaner gasoline. Of the cleaner gasolines under consideration, four were evaluated thoroughly: 1) federal reformulated gasoline (RFG); 2) a gasoline with equal emissions performance to federal Phase II RFG; 3) a formula-based fuel with low RVP, low sulfur fuel; and 4) California reformulated gasoline.

After further discussions the commission completed its analysis on the top two fuels of choice, a performance-based fuel with emissions limits equal to federal phase II RFG, and the formula-based fuel with controls on RVP and sulfur. The low RVP/low sulfur fuel was settled upon for the following reasons: 1) emissions performance; 2) effect on advanced technology cars; 3) impacts on off-road emissions; and 4) low production costs.

3.2. EMISSIONS PERFORMANCE

Several of the state's areas are in need of significant NO_x reductions along with some level of VOC reductions. Photochemical grid modeling shows that NO_x reductions are necessary for the HGA, DFW, and BPA nonattainment areas to demonstrate attainment of the 1-hour ozone standard and are very beneficial for the state’s near-nonattainment areas to comply with the 8-hour ozone standard. Therefore, one of the first objectives of a cleaner gasoline was that it achieve NO_x reductions.

Additional state and federal modeling has shown that reductions in VOCs, specifically in the urbanized areas, continue to contribute to reductions in ozone. Lower RVP gasoline will reduce evaporative emissions of VOCs from not only motor vehicles but from refueling operations, gasoline terminals, off-road equipment, and refineries. The reduction of sulfur will help today's cars maintain their certified emissions levels and tomorrow's more advanced cars reach and maintain their low tail pipe emission limits.

Radian completed specific modeling for the commission in September 1997 ("Evaluating the Impact of Reformulated Gasoline in the DFW Area") evaluating low RVP and RFG. EPA's complex model indicates VOC emission reductions of 14.3% with 7.8 psia RVP fuel and a 150 ppm cap on sulfur. NO_x reductions of 8.5% are also seen with the low RVP/low sulfur fuel proposed here.

Some national studies conducted by a variety of groups regarding the impact of fuel sulfur on current and advanced technology vehicles have been completed. Some of these groups include: private industry (such as the American Automobile Manufacturers Association (AAMA)), the automotive and refining industries (The Auto/Oil Air Quality Research (Auto/Oil) program), the federal government (EPA), state government (California, Georgia, Arizona), and other groups, such as the Coordinating Research Council (CRC) and OTAG.

Estimates by EPA in their "Staff Paper on Gasoline Sulfur Issues" indicate that in-use vehicles, such as vehicles certified to the Tier 0 standard which have been available through MY 1993 and vehicles certified to the Tier I standard which have been available since MY 1994, show reductions in emissions associated with a reduction in gasoline sulfur levels.

Decrease in Emissions with Fuel Sulfur Decreasing from Average In-Use Level (330 ppm) for Tier 0 and Tier I Vehicles (Source EPA)						
	NMHC		CO		NO_x	
Sulfur	150 ppm	40 ppm	150 ppm	40 ppm	150 ppm	40 ppm
Tier 0	4.6 %	13.0 %	4.4 %	12.6 %	5.0 %	11.1 %
Tier I	not tested but assumed to be equivalent to Tier 0	16.3%	not tested but assumed to be equivalent to Tier 0	16.4%	not tested but assumed to be equivalent to Tier 0	11.0 %

Using EPA's Complex Model, Georgia estimated the benefits of their low RVP/low sulfur gasoline. The Complex Model shows the following emission reductions from conventional fuel (modeled with 8.7 psia RVP, 330 ppm sulfur, benzene at 1.53 volume percent, olefins at 9.2 volume percent, and aromatics at 32 volume percent) for the second phase of Georgia's program (modeled with RVP at 7.0 psia, 40 ppm sulfur, olefins 4 volume percent, and aromatics 22 volume percent):

Emission Reductions: Georgia Evaluation of Their Phase II Formula-Based Gasoline Using EPA's Complex Model			
VOC	CO	NO_x	Air Toxics
23.9%	NA	14.71%	20.59%

It should be noted that the Complex Model assumes a 1990 (Tier 0) technology vehicle. It does not take into consideration Tier I or advanced technology cars (LEVs, ULEVs), nor does it consider the effects on heavier light-duty trucks (LDT 3's and 4's).

OTAG also evaluated a low sulfur fuel in typical attainment areas (no I/M, etc.) and found that with a 150 ppm sulfur level the following emission reductions were obtainable:

Emission Reductions: OTAG Evaluation of Low Sulfur (150 ppm) Gasoline			
VOC	CO	NO_x	Air Toxics
2.5 - 5.3%	3.3 - 8.0%	4.4%	NA

3.3. EFFECT ON ADVANCED TECHNOLOGY CARS

For advanced technology cars (LDV) and light trucks (LDT) covered by the NLEV program (LEVs/ULEVs), EPA estimated emission increases with fuel sulfur above 40 ppm. These numbers are not comparable to the earlier table on Tier 0 and Tier I emissions improvements with low sulfur fuel. It was assumed that a low sulfur fuel would be used to certify advanced technology vehicles; therefore, the emissions impacts of fuel sulfur levels are indicated as percent increases over 40 ppm sulfur certification fuel.

Increase in Emissions with Fuel Sulfur Increases from Baseline (40 ppm) for LEVs and ULEVs (LDVs and LDTs) (Source EPA)						
Pollutant	NMHC		CO		NO_x	
Sulfur, ppm	150 ppm	330 ppm	150 ppm	330 ppm	150 ppm	330 ppm
All LDV/LDT1	26.7 %	43.0 %	58 %	75.8 %	65.7 %	136 %
All LDT2/LDT3	23.0 %	26.4 %	12.5 %	31.2 %	33.7 %	65.5 %

3.4 IMPACTS ON OFF-ROAD EMISSIONS

For non-road engines, there will be evaporative VOC benefits associated with the low RVP/low sulfur fuel. There may also be some exhaust benefits for VOC. However, NO_x benefits may be very minor, mainly because sulfur effects are associated with catalyst-equipped vehicles and engines, and non-road engines typically are not catalyst-equipped. VOC emission reductions of upwards of 3% may be seen in off-road sources.

3.5 STATE LEGAL AUTHORITY TO IMPLEMENT CLEANER GASOLINE

State authority for the commission to implement Cleaner Gasoline is contained in the following statutes:

- Texas Health and Safety Code §382.011 (general power and duties),
- Texas Health and Safety Code §382.012 (authority for SIPs),
- Texas Health and Safety Code §382.017 (authority to promulgate rules),
- Texas Health and Safety Code §382.019 (authority to control mobile sources),
- Texas Health and Safety Code §382.037(g) (confirms no specific authority needed for fuel standards if the standards are 1) federal standards, 2) necessary to achieve attainment, or 3) made in consultation with the Texas Department of Health and it is determined that a fuel standard is needed to protect public health),
- Texas Water Code Chapter §7.002 (commission can enforce its rules).

3.6 PRODUCTION COSTS OF LOW RVP/LOW SULFUR GASOLINE

Low RVP gasolines are used as VOC control strategies and do not have significant additional production costs. Average summertime RVP is about 8.5 - 9.0 psia. Other states have found that it generally costs from 0.3 to 0.5 cents more per gallon to produce low RVP (7.0 psia) gasoline. According to EPA's Regulatory Impact Analysis for RFG, RVP controls cost about 0.2 cents per psia of RVP reduced. For example going from 8.8 psia to 7.8 psia would cost about 0.2 cents per gallon. Therefore, the RVP reduction proposed here would cost less than 0.3 cents per gallon.

The American Petroleum Institute contracted with MathPro to estimate sulfur reduction costs. The estimated costs are as follows:

Estimated Cost of Reducing Gasoline Sulfur (MathPro for API)			
Average Sulfur Control Level (ppm)	150	100	40
Cost (cents/gallon)	2.7	3.4	5.1

EPA also estimated costs of reducing sulfur and determined the following:

Preliminary Estimates of Sulfur Reduction Costs (Volume-Weighted Average for PADDs 1 and 3, 8% return on investment)			
Average Sulfur Control Level (ppm)	150	100	40
Cost (cents/gallon)	1.1 - 1.8	1.9 - 3.0	5.1 - 8.0

However, EPA said they were aware of emerging technologies that could reduce sulfur reduction costs down to 1-2 cents per gallon when going from 330 ppm to 40 ppm sulfur. The costs for a 150 ppm fuel would logically be lower.

3.7 AGENCY IMPACTS

A low RVP/low sulfur fuel would be easier to enforce in the long run than a performance-based fuel. The commission will enforce the program at the refinery gate and at the bulk terminal. Enforcement at the retail level will also be accomplished as necessary through scheduled and unscheduled retail level sampling. With only two parameters to check initially (RVP and sulfur), fuel testing would be simplified over a performance-based fuel like federal RFG.

Georgia has decided to enforce their program mainly at the refinery level. Each refiner is required to take two samples of each batch of fuel and have it tested. This same sample will be sent to a state contracted lab for verification. They also plan on using their Stage II inspectors to pull follow up samples as the inspector is doing the regular Stage II inspection.

The Arizona Weights and Measures Department is responsible for enforcing the Arizona Clean Burning Gasoline (CBG) program. They have 6 inspectors for the whole state, 1 dedicated to Maricopa County. Arizona has tested for gasoline quality since the early 90's, and the parameters tested include: sulfur, octane (research, motor, and index), distillation temperatures (10%, 50%, 90%, end point (EP), and residue), oxygen (type and quantity), aromatics (including benzene), olefins, and saturates. Arizona had its own lab until about 1997, and now has a contract to complete this testing. The one inspector dedicated to Maricopa County collects approximately 80 random samples a month. According to Arizona, each station eventually gets inspected. The Arizona Legislature appropriated 1 FTE for the Arizona Weights and Measures Department to organize the program and register the refiners, and $150,000 for the Arizona CBG program in Maricopa County. Arizona has such low costs due to the fact that they already have a gasoline inspection program in place.

The area proposed to be covered by the Cleaner Gasoline program is larger and impacts more gas stations and people than Arizona's program. The Texas program will cover 110 counties and about 80% of the state's population and gas stations.

CHAPTER 4: EVALUATION OF OTHER CONTROLS

In the HGA and DFW areas there are significant mobile source control measures in place. Some of these include inspection and maintenance (I/M), Stage I vapor recovery, Stage II vapor recovery, RFG, and transportation control measures (TCMs). Additional mobile source controls will be put in place through federal regulations such as NLEV, heavy-duty on-highway diesel controls, small gas engines, locomotives controls etc.

Outside the HGA and DFW area, Stage I vapor recovery and cleaner gasoline are proposed in addition to the federal mobile source controls will be put in place. Additionally, Stage I vapor recovery and cleaner gasoline are proposed. State law (Texas Health and Safety Code, §382.037(c)) prohibits the Texas Motorist Choice (I/M) program from expanding to additional counties unless the mayor of the largest city and the county judge request expansion of the program. At this time, there is no significant interest in expanding the Texas Motorist Choice program to attainment areas, making extension of I/M impracticable as a control measure.

Stage II vapor recovery is prohibited by state law from expansion into attainment areas (Texas Health and Safety Code, §382.019(c)). In addition, Stage II vapor recovery is being replaced by on-board refueling vapor recovery (ORVR). ORVR will capture the majority of vehicle refueling vapors within the next 12 to 18 years. The state prohibition combined with the federal implementation of ORVR makes Stage II impracticable for use as an additional control measure.

Although additional mobile source emissions reductions are being phased in at the federal level, these controls will not be in place soon enough for many of Texas' near-nonattainment areas to avoid nonattainment designation under the 8-hour standard.

With significant VOC point source controls already in place in the HGA and DFW areas, additional VOC point source controls for these areas do not appear to be reasonable at this time. Significant point source controls for NO_x will be put in place in the HGA and DFW areas. The magnitude of the reductions necessary indicates that point source controls alone are not able to reduce ozone levels enough to demonstrate attainment; therefore, additional NO_x controls must come from the mobile source area. Cleaner gasoline will contribute to NO_x reductions from commuters coming in from outlying areas and through the cap on sulfur in gasoline in the HGA and DFW area.

The commission is also evaluating the implementation of point source NO_x and VOC controls outside the HGA and DFW areas. The commission believes that the combination of mobile source controls (such as cleaner gasoline, NLEV, and Stage I vapor recovery), and point source NO_x controls outside the HGA and DFW areas will be sufficient to significantly reduce the ozone levels in the state's nonattainment areas.

Modeling has previously been submitted to EPA regarding the amount of emission reduction necessary to achieve the NAAQS in the HGA and DFW areas to achieve attainment (see Tables 1, 2, 3, and 4). The NO_x and VOC reductions necessary to achieve the NAAQS are significant (see Tables 5, 6, 7, and, 8).

Several other areas of the state have already had exceedances of the new 8-hour NAAQS. The emissions inventory in several of these areas are largely composed of mobile sources. Without the cleaner gasoline, these areas cannot reasonably and practicably achieve attainment of the NAAQS.

Table 1. Attainment Target Calculations for 2007 NO_x Emissions in the HGA Area

	Episode Day			
	9/8	9/9	9/10	9/11
Required reduction from 2007 base EI				
Worst-case	83%	78%	85%	80%
Best-case	62%	53%	67%	61%
2007 Projected NO_x emissions (tons/day)				
Worst-Case (Base 2007 EI)	1467	1457	1531	1376
Best-Case (Alt. EI I)	986	978	1035	930
2007 Attainment target (tons/day)				
Worst-case	249	321	230	275
Best-case	375	460	342	363
1990 baseline NO_x emissions (tons/day)	1330			
Adjusted for Alt. EI I Assumptions	908			
Required reduction relative to 1990 baseline				
Worst-case	82%	77%	83%	80%
Best-case	59%	49%	62%	60%
Required Reduction in tons/day				
Worst-case	1081	1009	1100	1055
Best-case	533	448	566	545
Reductions by 1999 from 9% SIP	(104)	(104)	(104)	(104)
Remaining required reductions				
Worst-case	977	905	996	951
Best-case	429	344	462	441

Table 2. Attainment Target Calculations for 2007 VOC Emissions in the HGA Area

	Episode Day			
	9/8	9/9	9/10	9/11
Required reduction from 2007 base EI	15%			
2007 Projected VOC emissions (tons/day)	831	838	849	847
2007 Attainment target (tons/day)	706	712	722	720
1990 baseline VOC emissions (tons/day)	1064			
Required reduction relative to 1990 baseline	34%	33%	32%	32%
Required reductions in tons/day	358	352	342	344
Reductions by 1999 from 15% & 9% SIPs	(305)	(305)	(305)	(305)
Remaining required reductions in tons/day	53	47	37	39

Table 3. Attainment Target Modeling: Reduction Levels and Predicted Design Values

	Reduction		Predicted Design Value
Model Run #	NO_x	VOC	(ppb)
1 (1999 Base)	0%	0%	139
2	30%	25%	128
3	40%	25%	124
4	50%	25%	121
5	60%	25%	116
6	70%	25%	109
7	80%	25%	100

Table 4. Attainment Target Modeling: Reduction Levels and Peak Modeled Ozone

	Reduction		Peak Modeled Ozone (ppb)		
Model Run #	NO_x	VOC	6/21/95	6/22/95	7/3/96
1 (1999 Base)	0%	0%	140	145	168
2	30%	25%	130	135	154
3	40%	25%	126	129	149
4	50%	25%	122	124	142
5	60%	25%	116	118	134
6	70%	25%	109	110	127
7	80%	25%	100	99	120

Table 5. Potential VOC Control Strategies

Federal Control Strategies

Control Measure	Estimated 2007 Emissions Reduction (tpd)
Small Gasoline Engines *(began phase-in 1995--phase in complete by 2005)*	50.80
Heavy Duty Diesel Non-Road *(began phase-in 1995--phase-in complete by 2008)*	1.74
Locomotives *(final rule--begin phase-in 1999--complete by 2005)*	0.00
Reformulated Gasoline, FMVCP Tier I, I/M *(RFG Phase II begins in 2000--other programs in place)*	29.06
Recreational Marine Engines *(began phase -in 1995--complete by 1998)*	5.42
Commercial Aircraft *(rule took effect in 1994)*	1.17
RFG Non-Road Mobile Sources *(RFG Phase II begins in 2000)*	3.48
MACT Standards--Core Counties *(*Please see note below)*	16.5
MACT Standards--Perimeter Counties out to 100km	3.5

State Control Strategies

National Low Emissions Vehicle Program--Core Counties *(currently under negotiation--could begin phase-in MY2001)*	4.66
National LEV Program--perimeter counties--100km	0.95
Reformulated Gasoline out to 100km	16.33
VOC RACT out to 100km	7.90
Stage I out to 100km	23.91
Excess VOC Reduction Carryover from 9% SIP	0.69
Voluntary Industry Reductions	Amount not available at time of proposal

Local Options Control Strategies

Reductions Available from Local Option (See Appendix 9c-J for more details)	60.91

*Historically, most MACT standards have been promulgated 1-2 years after their required promulgation date. There are approximately 30 MACT standards that were slated to be promulgated by 1997. Most appear to be running 1-2 years late for their predicted promulgation date. There are approximately 60 standards in the 2000 bin. Current EPA information is that most are on track for promulgation by 2000. Compliance dates for MACT standards are typically three years after promulgation. Therefore, even if the historical pattern of delay occurs for the 1997 bin standards, it's reasonable to assume that sources will be in compliance by 2002, and that the 2000 bin standards will be promulgated and generating emission reductions by 2005.

Table 6. Potential NO_x Control Strategies

Federal Control Strategies

Control Measure	Estimated 2007 Emissions Reduction (tpd)
On-Road Heavy Duty Diesel Standards *(proposed in 1997--effective date 2004)*	6.98
Heavy Duty Diesel Non-Road *(began phase-in 1995--phase-in complete by 2008)*	32.61
Locomotives *(final rule--begin phase in 1999--complete by 2005)*	6.49
Reformulated Gasoline, FMVCP Tier I, I/M *(RFG effective in 2000--other programs in place currently)*	39.93

State Control Strategies

National Low Emissions Vehicle Program--Core Counties *(currently under negotiation--could begin phase-in MY2001)*	12.15
National LEV Program--perimeter counties--200km	7.44
Reformulated Gasoline--perimeter counties--200km	12.38
NO_x RACT applied to perimeter counties--200km	80.00
Excess Reductions from 9% SIP--Carryover	4.25
Voluntary Industry Reductions	Amount not available at time of proposal
Point Source Combustion Modification--Tier I--Core Counties	241.00
Point Source Flue Gas Controls--Tier II--Core Counties	584.00
Point Source Tier I +Tier II=Tier III--Core Counties	620.00
Point Source Tier I--Perimeter Counties	333.00
Point Source Tier II--Perimeter Counties	811.00
Point Source Tier III--Perimeter Counties	864.00
Reformulated Gasoline for Non-Road Sources	Amount not available at time of proposal

Local Options Control Strategies

Reductions Available from Local Option (See Appendix 9c-J for more details)	72.74

Table 7

Table 8

CHAPTER 5: DISCUSSION OF TEXAS' 8-HOUR NEAR-NONATTAINMENT AREAS

Texas has very significant challenges ahead regarding its potential 8-hour nonattainment areas. Based on the emissions inventory and the 8-hour levels these areas are currently monitoring, a mobile source control program, such as cleaner gasoline, is the quickest and most effective mobile source control strategy the state could implement.

The mobile source emissions inventory from each near nonattainment area (especially Austin and San Antonio) makes up a sizable portion of the overall emissions. Therefore, any ozone control strategy must include some type of mobile source control. A fuel control strategy is the most logical way to get immediate emission reductions from on-road, off-road, and area sources. The VOC emissions from bulk loading of gasoline storage vessels will be reduced through less evaporative emissions from the lowered RVP of cleaner gasoline. Sulfur reductions will improve the NO_x performance of today's cars while helping advanced technology cars maintain their certified emissions levels.

VOC Emissions Inventory as a Percentage of the Total Inventory

	Austin	**San Antonio**	**Longview/Tyler**	**Corpus Christi**
On-Road	44	33	25	19
Off-Road	24	32	18	23
Point Sources	1	1.9	21	36
Area Sources	31	33	36	22

NO_x Emissions Inventory as a Percentage of the Total Inventory

	Austin	San Antonio	Longview/Tyler	Corpus Christi
On-Road	56	46	18	25
Off-Road	27	24	7	15
Point Sources	14	27	74	59
Area Sources	3	3	1	1

The 8-hour ozone levels are shown below. As is shown, several areas, if evaluated today, would be in violation of the 8-hour ozone NAAQS. A cleaner gasoline in the 2000-2003 time frame would contribute greatly to improving these monitored numbers. Without the cleaner gasoline, these areas cannot reasonably and practicably achieve attainment of the NAAQS.

Current 8-Hour Ozone Averages

	Fourth High 8-hour Ozone Averages in parts per billion				
Area	'95	'96	'97	'98	3-year 4th high average '96 -'98 where available
Beaumont Port Arthur	100	84	93	96	91
Dallas/Fort Worth	111	97	104	101	101
El Paso	87	79	75	92	82
Houston/Galveston	116	123	110	117	117
Longview	102	82	91	104	92
Austin	N/A	N/A	87	81	84
Corpus Christi	89	83	77	82	81
Laredo	N/A	57	63	67	62
Lower Rio Grande Valley	69	65	65	71	67
Midlothian	N/A	83	83	97	88
San Antonio	95	82	84	90	85
Tyler	95	86	87	90	88
Victoria	87	71	78	78	76

CHAPTER 6: MODELED JUSTIFICATION

6.1 OVERVIEW OF REGIONAL SCALE MODELING

The commission has conducted extensive ozone modeling to develop a scientific basis for the SIP revisions for the HGA and DFW areas. Three different ozone episodes have been modeled and have met EPA modeling performance criteria. These episodes have been used in the SIP revisions which have been submitted to the EPA for review. This chapter describes the results of the regional evaluations of the effectiveness of cleaner gasoline based on those three episodes and concludes that:

- Regional emissions controls are an effective complement to urban controls for reducing ozone in both rural and urban areas of Texas.

- VOC controls, especially those applied to gasoline and mobile sources provide a significant and necessary contribution to ozone reductions in both rural and urban areas.

6.2 EFFECTIVENESS OF REGIONAL SCALE VOC AND NO_x CONTROLS.

Regional scale modeling performed by the Ozone Transport Assessment Group has shown that NO_x and VOC controls applied regionally help reduce the background concentrations of ozone. Reducing background concentrations of ozone has two positive aspects: it reduces the amount of ozone being transported into the urban nonattainment and near-nonattainment areas; and it assists rural areas in staying below the new 8-hour NAAQS.

Regional scale modeling applied to three different Texas episodes has shown that NO_x controls are more effective than VOC controls in reducing ozone in both urban and rural areas. Nevertheless, there are positive ozone benefits from reducing VOC emissions in Texas, and a combined NO_x and VOC strategy is more effective than either strategy taken alone. Cleaner gasoline is an essential element in this combined NO_x and VOC strategy. Cleaner gasoline helps to reduce both VOC and NO_x emissions for the following reasons:

- Texas is proposing a low RVP (lower than the federal standard) for gasoline to compensate for the higher summer temperatures common in Texas. The lower RVP reduces evaporative emissions at every stage of the gasoline delivery process, starting at the gasoline terminal, including transport and delivery to gas stations and continuing when the gas is pumped into cars and trucks.

- Texas is also proposing a low sulfur content for gasoline. The lower sulfur content improves catalytic converter performance even in older vehicles. Thus, low sulfur/low RVP gasoline not only reduces evaporative emissions, but also reduces motor vehicle combustion emissions of both NO_x and VOC.

- Finally, cleaner gasoline with lower sulfur content is essential to obtaining the benefits of the NLEV program. Without cleaner gasoline, the NLEV fleet will not be able to function as planned, and the emissions reductions promised in the NLEV program will not be realized.

Three different Texas ozone episodes have been successfully modeled and have satisfied EPA modeling performance criteria. These episodes (two for DFW and one for HGA) have used a fine grid in the nonattainment areas supported by a coarser grid over a large regional scale modeling domain. The primary purpose of the coarse grid in SIP modeling is to provide information on boundary conditions affecting the urban nonattainment areas. However, the coarse grid results and sensitivity tests can also be used to test the impact of regional controls on other cities and areas that may be impacted by the new, more restrictive 8-hour ozone standard.

6.3 HOUSTON/GALVESTON OZONE MODELING RESULTS

The Houston/Galveston modeling for the September 6-11, 1993 episode clearly demonstrated that NO_x controls are more effective than VOC controls, both in the urban and rural areas of the domain. However, VOC controls applied over the entire modeling domain also reduced background levels of ozone in addition to reducing ozone in urban nonattainment levels of ozone. Further, a combined NO_x and VOC strategy was more effective than either strategy applied individually. Those results are presented for the future case inventory in the HGA SIP revision, and validated for a range of emissions inventory uncertainties. Figures 2-4 illustrate the incremental advantages of a combined NO_x and VOC strategy in the urban areas.

figure 2

figure 3

figure 4

Additional work on the September 6-11, 1993 episode was done to evaluate the ozone reductions in rural areas and near-nonattainment urban areas occurring as a result of VOC and NO_x controls applied to the regional modeling domain. These follow-on studies explicitly evaluated the benefits of a mobile source control package, point source NO_x controls and a combination of the two strategies. The mobile source control package included cleaner gasoline, NLEV, and Stage I vapor recovery. The results clearly show the benefits of cleaner gasoline as an essential element of the cleaner gasoline/mobile source control package.

The modeling with cleaner gasoline as part of the mobile source package shows that there is a measurable incremental benefit to mobile source controls. Figures A1-A3 of Appendix A show the results of modeling a future case inventory combined with a mobile source control package. The figures show a broad band of reduced ozone concentrations ranging from 1 to 3 ppb, stretching across Texas. The band also shows even greater benefits in the San Antonio and Austin areas. However, very little ozone reduction occurred in either Dallas or Houston during this episode since the winds from the northwest and the southeast during the episode formed a convergence zone in central Texas, resulting in a band of ozone reductions. Other episodes with lighter winds illustrate the statewide benefits of the cleaner gasoline program. The specific results of the mobile source package are explained in more detail in Appendix A.

Figures 5 and 6 show the results of the cleaner gasoline/mobile source control package when combined with the NO_x control package. The 3-dimensional figures show the ozone concentrations that would be expected in the future (2007) with and without a combined VOC/NO_x control package. The yellow portions of the clouds indicate ozone concentrations above 85 ppb, and the red portions indicate concentrations above 125 ppb (the 1-hour standard). Figure 5 shows large areas of Texas covered with yellow clouds indicating those areas are at risk of violating the new 8-hour ozone standard. The red areas indicate violations of the 1-hour standard, mostly occurring in urban areas.

Figure 6 shows what is expected to occur under the same meteorological conditions, if cleaner gasoline controls are combined with NO_x controls. Clearly, the area of yellow clouds exceeding the 8-hour standard has been reduced by this package of controls. Further, the size of the red areas indicating 1-hour exceedances have been significantly reduced, most dramatically in the Tyler/Longview area.

Figure 5

Figure 6

6.4 DALLAS/FORT WORTH MODELING RESULTS

DFW SIP revision modeling was completed for two episodes that had resulted in monitored exceedances of the 1-hour ozone standard in both the DFW and HGA areas, as well as significant monitored 8-hour impacts in several near-nonattainment areas. Analysis of the results indicated again that although NO_x controls are more effective than VOC controls, a combined VOC and NO_x strategy is more effective than either strategy employed alone.

Once the SIP revision was completed, additional analysis was performed to evaluate the impact of VOC and NO_x controls against the new 8-hour ozone standard. This additional analysis employed the most recent draft EPA guidance and was performed for each near-nonattainment area based upon the coarse grid modeling results. Time and resource considerations permitted testing generic NO_x and VOC control strategies but unfortunately did not allow testing of a specific cleaner gasoline package. Although these results tend to confirm the results of the previous tests, they do not explicitly validate the benefits of a cleaner gasoline control package.

Figures 7-11 show again that NO_x reductions are more effective than VOC reductions, but that a combined VOC/NO_x strategy is more effective than either strategy employed alone. The figures also show that VOC controls alone (and in combination with NO_x controls) deliver significant ozone reduction benefits to San Antonio, Austin and Corpus Christi.

figure 7a

figure 7b

figure 8a

figure 8b

figure 9a

figure 9b

figure 10a

figure 10b

figure 11a

Appendix A

Results of Preliminary Regional Modeling for Texas

Results of Preliminary Regional Modeling for Texas

Summary of Modeling Results

The commission modeling staff have completed a preliminary modeling assessment of potential benefits from two components of the TCAS. The conclusions of this preliminary modeling are:

- Modeling of regional **mobile source** reductions (cleaner gasoline, NLEVs, and Stage I vapor recovery) indicates potential peak 8-hour average ozone reductions of **between 1 and 4 ppb in much of east and southeast Texas**, with the **greatest reductions in the Austin-San Antonio areas** (see Figures 1-3).

- Modeling of regional **point source** reductions (assuming a reduction of 50%) indicates widespread reductions in the peak 8-hour average ozone, with **benefits of more than 12 ppb in some areas**. **Benefits of 3 to 6 ppb can be seen along a broad band stretching from Corpus Christi to Tyler and Longview** (see Figures 4-6).

- Modeling of the **combined point and mobile source** strategies shows a **larger area of reductions** in peak 8-hour average ozone above 3 ppb than either of the strategies modeled individually (see Figures 7-9).

Model Formulation

- Preliminary modeling was conducted to evaluate the potential benefit of regional mobile and point source emission reductions to ozone levels in Texas:
  - ♦ Emissions were projected to the future year 2007, assuming current[1] controls only.
  - ♦ National diesel regulations were assumed region-wide.

- The commission modeled a mobile source strategy consisting of the following elements:
  - ♦ NLEV[2].
  - ♦ Cleaner gasoline.
  - ♦ Stage I vapor recovery.

- The commission also modeled a 50% regional point source NO_x reduction scenario as a reasonable estimate of the level of reduction for the TCAS controls.

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[1]Current as of the 1993 base year upon which the modeling was based.

[2]Modeling assumed a “mature” NLEV program in which the entire fleet of light-duty vehicles was NLEVs. In 2007, it is expected that about 40% of vehicles will be NLEVs.

- The commission then modeled reductions in the appropriate geographic regions for the combined point source/mobile source scenario.
    - ♦ Point source reductions were modeled in the TCAS proposed Regional NO_x Zone .
    - ♦ NLEVs were modeled statewide.
    - ♦ Stage I refueling was modeled in the TCAS proposed Regional VOC Zone.
    - ♦ Cleaner gasoline was modeled in the area proposed for cleaner gasoline.

Important Points to Remember About the Preliminary Regional Modeling:

- An "off-the-shelf" model formulation was used, which was developed for a different purpose.
    - ♦ Emissions were based on an early version of the OTAG inventory.
    - ♦ Future projections to 2007 were based on OTAG statewide growth assumptions.
    - ♦ Nonattainment area-specific controls beyond 1993 were not included in the future inventory.
    - ♦ The 1993 base case model performance evaluation was based on a limited set of rural monitors.
- Only one time period (September 8-11, 1993) was analyzed.
    - ♦ Ozone levels across eastern Texas were generally high during the time period modeled.
    - ♦ Other time periods may show more or less benefit from components of the TCAS.
- The reductions modeled were based on rather general assumptions since specific TCAS emission reductions have not been defined, and may differ significantly from the reductions actually achieved through the TCAS.
- The modeling reported here is preliminary. The commission plans to conduct much more in-depth modeling, after completion of the DFW SIP revision modeling.
    - ♦ The commission plans to model additional episodes to ensure that a wide range of meteorological conditions are represented.
    - ♦ The commission plans to use much improved emissions data, including data collected locally by the near-nonattainment area MPOs.
    - ♦ The commission will explicitly model the TCAS reductions once they have been specifically defined, including reductions associated with the CARE program.

Table of Modeled Reductions

TCAS Component	Applicable Region	Inventory Component	NO_x Reduction	VOC Reduction
NLEVs	Statewide	On-Road Mobile Sources	10%/12.5%[1]	10%/12.5%[1]
		Area/Nonroad Mobile Sources		
		Point Sources		
Stage I Vapor Recovery	TCAS Proposed Regional VOC Zone	On-Road Mobile Sources		
		Area/Nonroad Mobile Sources		3%
		Point Sources		
Cleaner Gasoline	Area Proposed for Cleaner Gasoline	On-Road Mobile Sources	5%	12%/25%[2]
		Area/Nonroad Mobile Sources		10%
		Point Sources		
Point Source NO_x Controls	TCAS Proposed Regional NO_x Zone	On-Road Mobile Sources		
		Area/Nonroad Mobile Sources		
		Point Sources	50%	

[1]NLEV reductions assume 100% of light-duty fleet. Reductions of 10% (VOC and NO_x) were assumed within area proposed for cleaner gasoline, while reductions of 12.5% were assumed elsewhere in Texas.

[2]In areas which already have phase I RFG (HGA and DFW nonattainment areas), cleaner gasoline was assumed to reduce VOC by 12%. The reduction in the remainder of the proposed cleaner gasoline area was assumed to be 25%.

Figure A1

Figure A2

Figure A3

Figure A4

Figure A5

Figure A6

Figure A7

Figure A8

Figure A9