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16. Abstract

This report provides annotations of over 90 publications that were relevant to the objectives of a research study on the development of traffic information for estimation of mobile source emissions for air quality modeling. The abstracts reviewed, while not complete or comprehensive, are representative of the current literature. Emphasis was placed on studies which relate to the pollution problems in Houston, Harris County, Texas, to methods of estimation of mobile source emissions, to mobile source emission models, and to the impact of various vehicle and traffic technologies on mobile source emissions. The literature on the impact of various vehicle and traffic technologies on mobile source emissions is extensive. As the research study progresses, additional literature will be annotated and included in later volumes of this report.

Annotations are categorized and presented in the following areas: Air Quality and Mobile Source Emissions Bibliographies, Emissions and Emission Models, Air Quality Impacts of Transportation System Management Type Actions, Traffic Estimation (VMT, Peak Periods, Vehicle Mix) Methodology, Hot/Cold Starts and Hot Soak Estimation Methodology, and Houston Area Oxidant Studies (HAOS) and Related Oxidant Studies.

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THE DEVELOPMENT OF TRAFFIC INFORMATION FOR ESTIMATION OF MOBILE SOURCE EMISSIONS FOR AIR QUALITY MODELING

VOLUME I - ANNOTATED BIBLIOGRAPHY

by

George B. Dresser

and

Ann M. Horton

Research Report 282-1
Research Study Number 2-8-80-282

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AIR QUALITY AND MOBILE SOURCE EMISSIONS BIBLIOGRAPHIES

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AIR POLLUTION ASSESSMENT METHODOLOGY AND MODELING - BIBLIOGRAPHY OF GREY LITERATURE ON AIR QUALITY MODELING. North Atlantic Treaty Organization, Committee on the Challenges of Modern Society, Brussels, Belgium. Oct. 1978.

From the results of the NATO/CCMS Pilot Study Air Pollution fifteen recommendations have been derived, one of which deals with air quality modeling. Since the publication of this recommendation, a world-wide cooperation in the field of modeling activities has proved the necessity to review the state of the art of air quality modeling and to show international trends in model standardization. Therefore the Modeling Panel decided to prepare a Technical Document of this so-called "Grey Literature" and started questionnaire action. Response was so impressive that the Modeling Panel decided to split this document into two parts: (1) Bibliography of Grey Literature on Applied Air Quality Models (especially Gaussian Plume Models); and (2) Bibliography of Grey Literature on New Modeling Techniques. This volume represents the final version of the part concerning Gaussian plume models.

185 pages

NTIS Abstract

PB 80-806383

AUTOMOBILE AIR POLLUTION: ABATEMENT THROUGH MANAGEMENT AND PLANNING, Volume 2, 1979--February 1980 (Citations from the NTIS Data Base). Diane Cavagnaro. National Technical Information Service. March 1980.

Planning and management studies for the abatement of air pollution from automobiles are covered. This includes reports on maintenance and inspection programs, emission factors, urban planning related to pollution, government policies, and the effects of these strategies on citizens and urban growth. Reports which give background information pertinent to such abatement decisions are also cited. 52 abstracts.

NTIS Abstract

PB 80-805757

AUTOMOBILE AIR POLLUTION ATMOSPHERIC MOTION (Citations from the NTIS Data Base). Brian Corrigan. National Technical Information Service, March 1980.

The modeling, diffusion, and motion of motor vehicle exhaust emissions are presented in these citations. These reports were chosen because of possible interest to those involved with the prediction of pollution from motor vehicles or entire highway systems. 126 abstracts.

NTIS Abstract

PB-289 501

BIBLIOGRAPHY ON GREY LITERATURE ON AIR QUALITY MODELING, PART II: NEW MODELING TECHNIQUES. North Atlantic Treaty Organization, Committee on the Challenges of Modern Society, Brussels, Belgium.

A worldwide cooperation in the field of modeling activities has proved the necessity to review the state of the art of air quality modeling and to show international trends in model standardization. An important point to fulfill the task was the registration and documentation of all those papers and reports which have not yet been published in generally available journals. Therefore, the Modeling Panel decided to prepare a Technical Document of this so-called "Grey Literature" which has been separated into two parts: (1) Bibliography of Grey Literature on Air Quality Modeling (especially Gaussian Plume Models) and (2) Bibliography of Grey Literature on Air Quality Modeling (New Models). In this document the actual version of the part concerning the new models is presented.

123 pages.

NTIS Abstract

PB-282 347

AIR QUALITY IMPACTS OF TRANSIT IMPROVEMENT, PREFERENTIAL LANE, AND CARPOOL PROGRAMS: AN ANNOTATED BIBLIOGRAPHY OF DEMONSTRATION AND ANALYTICAL EXPERIENCE, J.F. DiRenzo, R.B. Rubin. Peat, Marwick, Mitchell and Company for EPA, Department of Transportation. March 1978. 88 pages.

In accordance with the Clean Air Act Amendments of 1977, the EPA is evaluating the use and cost-effectiveness of alternative short-range transit fare and service improvement strategies, carpool and vanpool strategies, and strategies involving the preferential treatment of high occupancy vehicles to improve air quality in urban areas. The evaluation of individual strategies and combinations of the above strategies include their emission and air quality impacts and their related energy, noise, and economic impacts. A comprehensive literature review was also conducted, as part of this evaluation, to identify both observed and projected travel, emission, air quality, energy, noise, and economic impacts of the short-range low-cost strategies of interest.

From Highway Research Information Service Records

PB-300 293

ONLINE LITERATURE SEARCHING AND DATABASES AT THE U.S. ENVIRONMENTAL PROTECTION AGENCY ENVIRONMENTAL RESEARCH CENTER LIBRARY, CINCINNATI, OHIO; Mary L. Calkins. October 1978.

In order to meet the information needs of the U.S. EPA rapidly and efficiently, traditional library services have been integrated with new automated services. One of these automated services is using computer databases for literature searching. The purpose of this publication is to explain the online searching services available to the EPA at the Library of the Environmental Research Center-Cincinnati.

NTIS Abstract

PS-79/0767

URBAN AIR POLLUTION, Volume 2, 1976-1977 (A Bibliography with Abstracts). Diane Cavagnaro. National Technical Information Service. August 1979.

This bibliography contains citations on urban air pollution and its abatement. These research reports are of interest to urban planners which will enable them to become aware of new abatement strategies and techniques. They include various aspects of transportation emission as well as health standards, atmospheric models to aid in planning, law enforcement, abatement policies and the effects of new modes of transportation. 170 abstracts.

NTIS Abstract

AIR QUALITY MODELS

AIR QUALITY ANALYSIS IN TRANSPORTATION PLANNING, Transportation Research Record 670. "Atmospheric and Wind Tunnel Studies of Air Pollution Dispersion Near Highways," Water F. Dabberdt and Howard A Jongdyk. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1978.

Atmospheric and wind tunnel studies of gaseous dispersion near roadways have identified new concepts regarding the influence of roadway traffic and stimulated the development of a versatile yet simple simulation model, ROADMAP. Influences of site geometry and roadway configurations were observed and quantified. Two effects found to be particularly significant to microscale dispersion were (a) thermal turbulence and buoyancy caused by vehicular waste heat and (b) mechanical turbulence from highway traffic, ROADMAP simulates two-dimensional gaseous dispersion patterns for various roadway configurations including grade-level, vertical, and slant-wall cut, fill, and viaduct sections. Development of the model is first detailed for a uniform, grade-level freeway. Dispersion patterns were obtained up to heights of 14 m and to downwind distances of 100 m by a sampling array that measured meteorological conditions and concentrations of carbon monoxide and two artificial tracer gases released in the traffic. Comparison of equivalent field and wind-tunnel tests for grade-level roads shows good agreement except for acute wind-roadway angles. ROADMAP's capability for varied site geometries was evaluated by analyzing field and wind tunnel tests for 20 roadway configurations. Comparisons of ROADMAP to independent carbon monoxide data (i.e., data not used in developing the model) from the grade-level field tests resulted in high values of the linear correlation coefficient: 0.91 for neutral stability, 0.67 for stable atmospheric conditions, and 0.80 for unstable conditions. Values for the cut and elevated-section tests in the wind tunnel ranged from 0.69 to 0.93.

Author's Abstract

PB-299 358

ANALYTICAL DIFFUSION MODEL FOR LONG DISTANCE TRANSPORT OF AIR POLLUTANTS, James A. Fay and Jacob J. Rosenzweig. Fluid Mechanics Laboratory, Dept. of Mechanical Engineering, MIT, Cambridge, MA 02139; for Environmental Sciences Research Laboratory--RTP,NC, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. June 1979.

A steady-state, two-dimensional diffusion model suitable for predicting ambient air pollutant concentrations averaged over a long time period (e.g., month, season or year) and resulting from the transport of pollutants for distances greater than about 100 km from the source is described. Analytical solutions are derived for the primary pollutant emitted from a point source and for the secondary pollutant formed from it. Depletion effects, whether due to wet or dry deposition or chemical conversion to another species, are accounted for in these models as first order processes. Thus, solutions for multiple point sources may be superimposed.

The analytical theory for the dispersion of a primary pollutant is compared with the numerical predictions of a plume trajectory model for the case of steady emission from a point source. Good overall agreement between the two models is achieved whether or not depletion by wet and dry deposition is included.

The theory for the dispersion of a secondary pollutant is compared with measurements of the annual average sulfate concentration in the U.S. Calculations are carried out using SO_2 emissions from electric power plants in the U.S. as a source inventory. Using optimum values of the dispersion parameters, the correlation coefficient of the observed and calculated ambient concentrations for the U.S. is 0.46. However, when the observed data is smoothed to eliminate small scale gradients, the best correlation coefficient achieved is 0.87 for the eastern U.S. and 0.69 for the western region. The optimum dispersion parameters used are comparable to values quoted in the literature.

29 pages

Author's Abstract

COMPUTER ASSISTED AREA SOURCE EMISSIONS (CAASE) GRIDDING PROCEDURE (REVISED IBM 370/OS VERSION USER'S MANUAL), Richard Haws and J.W. Dunn III. U.S. EPA, Research Triangle Park, NC 27711. March 1978.

Atmospheric dispersion modeling programs such as the Climatological Dispersion Model (CDM), Air Quality Display Model (AQDM), and Implementation Planning Program (IPP) are among the most basic tools used for evaluation of air quality and State Implementation Plans. Since emissions data comprise the most important input information for these models, any factor affecting the availability and completeness of the emissions data has a significant impact on the results of the modeling programs. Procedures for formatting emissions from point sources are well defined, however area source emission data present problems. Usually the smallest goegraphic unit for which accurate primary data are available is the county. These data must be disaggregated and appropriately allocated to smaller areas to provide an adequately detailed input.

The CAASE gridding programs with associated subroutines containing automated gridding procedures provide an objective method for allocated county-level data to grid squares selected on the basis of demographic features and sized to give appropriate detail for input to air quality modeling programs.

In addition to maps for the study area the CAASE user needs the following data:

A. U.S. Bureau of Census MED-X (Master Enumeration District Listing extended to include latitude and longitude coordinates) tape.

B. U.S. Bureau of the Census DIME County Outline File (DIMECO), as reformatted by EPA.

C. Conversion tables (used by the GTGR subroutine) to convert, when necessary, Universal Transverse Mercator (UTM) location coordinates from one UTM zone to another.

D. Area Source Data for the counties being processed. The required format is the same as for cards A1 through A5 on NEDS Area Source Input Form - EPA (DUR) 219 3/72.

E. Current stationary source and mobile source emissions factors for area source categories.

F. (Optional) If population and housing data are to be projected (i.e., modified), the user must provide growth factors and location coordinates for new housing development areas. (The CAASE method for using these data is described in detail in Section 2, CAASE1 Program.)

G. (Optional) The user can optionally read in a set of sub-county grid squares developed independently of CAASE or developed during an earlier CAASE computer run. (The procedures for formatting and inputting a user-supplied set of grid squares are described in Section 3, CAASE2 Program.)

H. (Optional) The user can optionally override any of the sub-county apportioning factors calculated by CAASE. These overriding weighting factors are input on cards.

The CAASE5 program performs the functions of calculating the emissions and allocating fuels and emissions to each grid square and source category combination.

CAASE5 reads area source fuels (throughput) data for each county in the study area in the same format as the first five cards (A1 through A5) from the NEDS Area Source Input Form.

Current area source emission factors are input by the user. The factors can be the national emissions factors published by EPA or those developed by state or local agencies. Emission factors for highway motor vehicles are input directly; those for stationary sources and off-highway mobile sources are scaled for input. The scaling of the emission factor takes into account the scaling of the fuels data and units conversion.

CAASE5 uses the fuels (throughput) totals and the emission factors to calculate county-total emissions in the same way as the NEDS program.

The county totals for fuels and emissions are allocated to each grid square and source category combination using the apportioning factors calculated by CAASE4. The apportioning factor file output from the CAASE4 program is used as direct input to CAASE5.

CAASE5 completely processes one county in the study area before proceeding to the next county.

For each county, CAASE5 produces the following output:

A. Tables of allocated fuels for each grid square and source category combination.

B. Tables of emission totals for the county for each pollutant and source category combination.

C. Tables of allocated emissions for each grid square, pollutant, and source category combination.

D. The county total emissions for each pollutant, i.e., the sum of all area source categories.

E. An atmospheric dispersion model area source input card for each grid square. The required units, scaling, and format for one of three models (IPP, AQDM, OR CDM) is selected by the user with an input variable.

F. A formatted tape file containing the above output data elements. (This is not a "print tape"; it is provided as a computer readable data base for those users who may want to process CAASE output in ways other than dispersion modeling. A "print tape" can also be produced easily by changing the definition of the printer in the Job Control Language (JCL) stream.)

From NTIS Abstract and Text

PB-287 089

DEVELOPMENT OF GRIDDED AREA SOURCE EMISSION FOR THE TWIN CITIES, MINNESOTA AIR QUALITY CONTROL REGION, Richard C. Haws and Harry L. Hamilton, Jr. Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709; for Region V, Environmental Protection Agency, 230 South Dearborn, Chicago, IL 60604. August 1976.

The Computer Assisted Area Source Emissions procedure (CAASE) was used to allocate county total emission to subcounty area source grid squares. The grid square system provided a continuous set of squares over the seven counties of the Twin Cities, Minnesota AQCR. Objective apportioning factors based on population, housing units, area of the grid square, or a combination of these characteristics were used for the distribution of most emission source categories. The application of these factors is included in the CAASE computer programs. The remaining emission source categories -- diesel rail locomotive, aircraft operations, and waterborne vessels -- were allocated on the basis of factors especially developed for this AQCR.

Assuming the correctness of the totals of each category of emission furnished to the contractor, the allocated area source emissions should provide a suitable base for air quality modeling.

16 pages

NTIS Abstract

ENVIRONMENTAL AND CONSERVATION CONCERNS IN TRANSPORTATION: ENERGY, NOISE, AND AIR QUALITY, Transportation Research Record 648. "Comparative Analysis of HIWAY, California, and CALINE2 Line Source Dispersion Models," Kenneth E. Noll, Terry L. Miller, and Michael Claggett. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1977.

This paper provides a comparison of three different, idealized line source dispersion models -- HIWAY, California Line Source, and CALINE2 -- that predict carbon monoxide concentrations near highways. All are based on the Gaussian dispersion equations and are compared by means of sensitivity analysis and model validation. The sensitivity analysis analyzes the dependence of normalized pollutant concentration on variations in several independent input parameters such as stability class, wind angle with respect to the highway, and receptor distance from the highway. The models are validated by comparing carbon monoxide concentrations measured near a highway with concentrations predicted by the models.

Author's Abstract

ENVIRONMENTAL AND CONSERVATION CONCERNS IN TRANSPORTATION: ENERGY, NOISE, AND AIR QUALITY, Transportation Research Record 648. "Line Source Emissions Modeling," Lonnie E. Haefner, D.E. Lang, R.W. Meyer, J.L. Hutchins, and Bigan Yarjani. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1977.

The objective of this paper is to describe the development of the line source sorting model NETSEN II and its use in conjunction with the automobile exhaust emissions modal analysis model of the U.S. Environmental Protection Agency (EPA). Speed-profile analogies from the Regional Air Pollution Study of the St. Louis air quality control region, developed for use in the modal emissions model are used.

Author's Abstract

PB-288 783

GUIDELINE ON AIR QUALITY MODELS. U.S. EPA, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711. April 1978.

The purpose of this guide is to recommend air quality modeling techniques that may be applied to air pollution control strategy evaluations and to new source reviews, including prevention of significant deterioration. It is intended for use by EPA Regional Offices in judging the adequacy of modeling analyses performed by EPA, by State and local agencies and by industry and its consultants. It serves to identify for all interested parties those techniques and data bases that EPA considers acceptable.

This guide makes specific recommendations concerning (1) air quality models, (2) data bases and (3) general requirements for concentrations estimates. It should be followed in all evaluations relative to SIPs. However, it may be found that (1) the recommended air quality model is not appropriate for a particular application, (2) the required data base is unavailable, or (3) a better model or analytical procedure is available and applicable. In such cases, alternatives indicated in this guide or other data, models and techniques deemed appropriate by the Regional Administrator may be used. Specific recommendations in this guide should not be considered rigid requirements.

DESCRIPTORS: Air Pollution; Atmospheric Models; Atmospheric Diffusion; Meteorology; Air Pollution Abatement.

138 pages

From Text

PB-280 788

A HIGHWAY MODEL FOR THE ADVECTION, DIFFUSION AND CHEMICAL REACTION OF POLLUTANTS RELEASED BY AUTOMOBILES: PART I - ADVECTION AND DIFFUSION OF SF_6 TRACER GAS, Robert E. Eskridge and Kenneth L. Demerjian. From Preprint Volume, Joint Conference on Applications on Air Pollution Meterology, Salt Lake City, Utah. Boston, American Meterological Society, 1977, pp 337-342.

A two-dimensional, finite-difference model simulating a highway has been developed which is able to handle linear and nonlinear chemical reactions.

Transport of the pollutants is accomplished by use of an upstream-flux-corrected algorithm developed at the Naval Research Laboratories. This algorithm insures positive concentrations and reduces numerical diffusion.

The model develops background eddy diffusion coefficients which are then perturbed by the mechanical turbulence introduced by vehicular motion.

The model calculations are compared to the SF_6 experiments carried out by General Motors in the GM sulfate dispersion experiment. Model predictions are compared to observations at each of the twenty observation points for all the experiments. The observations and predictions are correlated for each half hour period, and scatter diagrams presented. A discussion of the results and additional statistical comparisons are also included.

This paper presents a finite-difference model of a highway which includes surface layer physics and a parameterization of the wake effect of automobiles. This model was shown to produce better results than the EPA highway model. Analysis of the model shows that the accuracy decreases with increase of distance from the highway, that it does not predict as well when the winds are light and that the errors are evenly distributed.

8 pages

From NTIS Abstract and Text

PB-289 377

INTRODUCTION TO AIR QUALITY MODELING - A REPORT OF THE NATO/CCMS PILOT STUDY ON AIR POLLUTION ASSESSMENT METHODOLOGY AND MODELING. North Atlantic Treaty Organization, Committee on the Challenges of Modern Society, Brussels, Belgium. October 1978.

The purpose of this report is not to give a detailed review of the existing air quality models but to review the methods used for modeling, in particular for models to be used in AQMS, in order to give indications where they could preferably be applied, to state their advantages and disadvantages and summarize the problems connected with the application of models.

The goal of Air Quality Modeling is to supply pertinent information for decisions made within the framework of AQM systems, especially in connection with control strategies. The fundamental problem which has to be solved within an AQM is how to calculate air concentrations of one or more species in space and time as related to the independent variables such as the emissions into the atmosphere, the meteorological variables, and such parameters which describe removal and transformation processes.

The text is divided into three types of models: deterministic, statistical and physical. Descriptions of the various models in each division are given.

From NTIS Abstract and Text

A LAGRANGIAN APPROACH TO MODELING AIR POLLUTANT DISPERSION - DEVELOPMENT AND TESTING IN THE VICINITY OF A ROADWAY, R.G. Lamb, H. Hogo, L.E. Reid. Systems Applications, Inc., 950 Northgate Drive, San Rafael, CA 94903; for Environmental Sciences Research Laboratories, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. April 1979.

A microscale roadway dispersion model based on Lagrangian diffusion theory has been developed and demonstrated. The model incorporates similarity expressions for the mean wind and turbulence energy in the atmospheric boundary layer, through which the effects of wind shear and atmospheric stability are taken into account; a parameterization of vehicle wake turbulence; and provisions for predicting the turbulence quantities required to simulate second-order chemical reactions. Through simple modifications, the model can be structured to treat particle settling, deposition, and resuspension, as well as buoyancy of the effluent material. Calm winds, winds parallel to the roadway, flows around depressed or elevated roadways, shallow mixed layers, and transient or spatially variable meteorological conditions can be all explicitly taken into account within the framework of our modeling approach. The model requires minimum computer core storage and fairly small execution times. It is not based on finite difference equations, and therefore, it is free of the truncation errors and computational stability and convergence problems that models based on those methods encounter.

The model was demonstrated by applying it to 52 of the 30-minute experimental periods reported in the GM sulfate study. Of the 1040 predicted values of the mean concentration of an inert material (SF_6), we found half of them to be within ± 30 percent of the measured values. The overall correlation coefficient was 0.91. The monitoring sites treated ranged in distance from 2 to 100 meters from the edge of the roadway. The computer time (but not core storage) required by our model is directly proportional to the distance between the farthest receptor and the road. For the studies reported here, the model required on the average 20 seconds of CPU time on the CDC 7600 to simulate each of the 30-minute GM experiments.

The finding from the tests of the model is that vehicle wake turbulence is important in dispersing material near the roadway, especially under stable atmospheric conditions. The great improvement in the accuracy of the predicted concentrations achieved by adding just a simple parameterization of the wake indicates that concentration levels close to the road are relatively insensitive to the intensity of ambient turbulence.

Further refinement and testing of this model is planned to improve the wake turbulence parameterization, to evaluate in more detail the accuracy of the method used to simulate ambient turbulence effects under combined light wind and very unstable situations, to incorporate the nonlinear chemical reaction simulation capability, to make the simple modification necessary to simulate fugitive dust dispersion, and to optimize the computer code.

117 pages

Author's Abstract

PB-300 470

A LAGRANGIAN PHOTOCHEMICAL AIR QUALITY SIMULATION MODEL, ADAPTATION TO THE ST. LOUIS - RAPS DATA BASE, VOLUME I. MODEL FORMULATION, Fred Lurmann, Daniel Godden, et al. Environmental Research and Technology, Inc., 2625 Townsgate Road, Westlake Village, CA 91361; for Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. June 1979.

A Lagrangian photochemical air quality simulation model has been adapted to St. Louis Missouri/Illinois metropolitan region and the Regional Air Pollution Study (RAPS) aerometric and emissions data base. This adaptation was performed to provide a means for EPA to independently assess the validity of a state-of-the-art Lagrangian photochemical model.

Chemical kinetic oxidation mechanisms involving hydrocarbons, nitrogen oxides and sulfur oxides and a vertical diffusion formulation developed by Environmental Research and Technology Inc. for modeling reactive pollutants in the troposphere are described. Methods for determining model input parameters are discussed and model results for ozone, nitrogen dioxide, carbon dioxide, sulfur dioxide, and sulfate are presented for three summer days in 1976. In considering so few simulations, no firm conclusions concerning model reliability are possible, although predicted pollutant concentrations are of reasonable levels. Most noteworthy for future users, the results suggest that the model may predict less ozone than is actually generated in St. Louis. Uncertainty in initial conditions of ozone and organic species is likely responsible for this discrepancy between observed and computed values.

152 pages

Author's Abstract

PB-300 471

A LAGRANGIAN PHOTOCHEMICAL AIR QUALITY SIMULATION MODEL, ADAPTATION TO THE ST. LOUIS - RAPS DATA BASE, VOLUME II. USER'S MANUAL, Fred Lurmann, Daniel Godden, et al. Environmental Research and Technology, Inc., 2625 Townsgate Road, Westlake Village, CA 91361; for Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. June 1979.

A set of instructions has been compiled for use of a Lagrangian photochemical air quality simulation model adapted to the St. Louis, Missouri/Illinois metropolitan region and the Regional Air Pollution Study (RAPS) data base. The computer model, developed by Environmental Research and Technology, Inc., consists of a set of computer programs for the simulation of atmospheric transport, turbulent diffusion, and chemical kenetics of photochemical pollutants. The model is used to predict atmospheric concentrations of ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and sulfate within an air column moving at the mean wind speed.

Descriptions of the meteorological, source emissions, and air quality data requirements, as well as sample input and output files, are provided. The computational procedures for using the model and a listing of the computer code are included.

448 pages

Author's Abstract

PB-289 451

A PILOT STUDY ON DISPERSION NEAR ROADWAYS, William B. Petersen. Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. August 1978.

The purpose of this study is to investigate and develop methods for estimating dispersion near roadways. A major objective is to investigate the performance of the EPA HIWAY model using dispersion estimates from the fluctuation statistics of the wind.

The GM Sulfate Dispersion Experiment provides an excellent data base for investigating dispersion near roadways. Not only was this a controlled roadway study, but also three components of the wind were measured and recorded every second at 20 locations across the test track. This high frequency wind data is most valuable in estimating dispersion. The data used in this pilot study represent three half-hour periods during which the winds were nearly parallel with the road. While the analysis of the data from the three periods gives valuable insight into the dispersion during parallel wind conditions, the major function of this paper is to set forth the techniques that will be used to analyze the whole data set. The entire data set consists of about 60 half-hour periods.

The following conclusions can be made as a result of the analysis of the data used in this pilot study: (1) during conditions when the winds are nearly parallel to the test track, concentrations are less sensitive to crosswind dispersion than expected; (2) dispersion parameters determined from the fluctuation statistics of the wind have a shape similar to the PG curves for downwind distances up to 500 m; (3) the fluctuation statistics of the wind indicate that the atmosphere near the ground was more dispersive than the stability class indicated; and (4) the performance of the model was significantly improved using the dispersion parameters determined from wind fluctuations.

33 pages

From Text

SUMMARY REPORT OF THE NCAQ ATMOSPHERIC DISPERSION MODELING PANEL, VOLUME 1, prepared by Dames & Moore, 7101 Wisconsin Avenue, Washington, D.C. 20014; for The National Commission on Air Quality, 499 South Capitol Street, S.W., Second Floor, Washington, D.C. 20003. March 1980.

In November 1979, the National Commission on Air Quality (NCAQ) convened an Atmospheric Dispersion Modeling Review Panel to provide guidance to the Commission on uses and limitation of currently available models for air quality management and appropriate dispersion models and technical approaches to be considered in the Commission's evaluation of the Clean Air Act through a series of comprehensive regional studies. The deliberations of this panel are documented in this report.

The Panel was strongly supportive of air quality modeling as a useful mechanism for achieving effective and equitable air quality management. The Panel stated that models are excellent predictive tools within the confines of the conditions for which they were developed, and noted that air quality models are the only predictive tools available for use in the permit process implementing the prevention of significant deterioration (PSD) provision of the Clean Air Act and for assessing the impact of growth on future air quality. The Panel cautioned that models should not be used as the sole determinant for establishing emissions limitations or for determination of marginal attainment/nonattainment situations because of uncertainties or inaccuracies in the simulation of complex physical and chemical processes, emission inventories, and available meteorological data. The Panel pointed out that use of a model in a situation for which it was not designed or validated could result in inaccuracies. It was also noted that while models should not replace rational and informed decisionmaking, models can usually provide some useful information to the decisionmaker. The Panel recommended that model results be routinely accompanied by estimates of their expected accuracy.

For the Commission's five regional studies, the Panel declined to recommend specific dispersion models, preferring to allow flexibility to contractors and Commission staff who would have access to more detailed information about each of the study regions. The Panel developed technical recommendations on aspects of dispersion modeling for consideration in the regional studies. These recommendations are summarized below.

Meteorological Data Bases: The Panel recommended that currently available meteorological measurement programs be improved considerably. Specifically, it recommended that hourly average values of wind speed, wind direction, turbulence, air temperature, and relative humidity be obtained at the surface and up to a height of 1 kilometer or more. The Panel recommended that neither the CRSTER nor RAM algorithm for mixing heights be used. The Panel recommended that 5 years of data be used for the calculation of short- and long-term impacts.

Complex Terrain: The Panel recommended specific changes to the standard Gaussian model (such as VALLEY and CRSTER) for use in the Four Corners and Ohio River Valley areas.

Stability and Plume Spread: The Panel recommended that more sophisticated techniques than those employed by the current regulatory models be used if the available resources permit their use. It endorsed the recommendations of the American Meteorological Society Workshop on Stability Classification Schemes and Sigma Curves.

Tall Stacks: The Panel suggested that the criteria for stack heights corresponding to "good engineering practice" (GEP) consider terrain effects beyond 800 meters and plume buoyance effects.

Plume Rise: The Panel endorsed Briggs' methodologies to estimate plume rise, and recommended that if data were available on vertical temperature and wind profiles, partial plume penetration into an inversion layer should be incorporated into those methodologies.

Long Range Transport, Transportation, and Removal: The Panel identified specific models that could be used to estimate the impacts of long-range transport and transformation of pollutants. It recommended that models used to estimate local impacts incorporate linear chemical kinetics and deposition.

Building Wake Effects: The Panel suggested that if these effects were of concern, then either the Nuclear Regulatory Commission's approach or Huber's approach be used. Such effects could not be characterized beyond distances equal to 30 building heights.

Averaging Time: To correct the standard dispersion coefficients for longer averaging times, the Panel endorsed the AMS position paper.

Panel Statements on Uses and Limitations of Air Quality Models

The provisions of the Clean Air Act as amended required the establishment of a link between emissions from a source and the resultant impacts at a receptor located some distance away. Atmospheric dispersion models provide the link between source and receptor by simulating the complex physical and chemical processes affecting the pollutant during transport. The Panel strongly supports air quality modeling as the most useful mechanism for achieving effective and equitable air quality management.

Modeling is a developing science which is becoming more accurate as a result of considerable research and development activity. In practical applications, model accuracy is limited by operational constraints. The accuracy of the calculated pollutant concentration of any air quality model is affected by the following factors:

- Uncertainties in the simulation of complex physical and chemical processes.
- Uncertainties or inaccuracies in emission inventory data used as input to the model.
- Uncertainties in the quality or representativeness of the meteorological data used as input to the model.
- Limited applicability of the model to the situations other than the particular one for which it was developed and validated.

Although overall model accuracy can only be discussed in the context of a specific application, certain types of model applications are inherently more accurate than others. For example:

- Relative vs. Absolute Application: Using a model as a predictive tool to project differences between two or more alternatives is inherently more accurate than attempting to calculate an absolute number.
- Magnitude vs. Location: Models generally predict the magnitude of a concentration more accurately than the precise location of that magnitude because of inaccuracies in the meteorological fields used by the models.
- Field vs. Point: The accuracy of predicting an area of all points above a certain concentration (i.e., within a particular concentration isopleth) is better than the accuracy of predicting the concentration at a particular point.
- Long-term vs. Short-term Estimates: The accuracy of calculated annual average concentrations is better than calculated "worst-case" 1-, 3-, or 24-hour concentrations because mean value is more accurately determined than extreme values.

The Panel believes that the most appropriate uses of air quality models for air quality management and regulatory applications are for:

1. Estimation of the impacts of new source growth and as a planning tool to track growth.

2 Comparison of the relative impacts due to various control strategy scenarios.

Models should not be used as a sole means of determination in marginal attainment/nonattainment situations (e.g., in lieu of monitoring).

The Summary Report is an outstanding discussion of the benefits and uncertainties associated with air quality modeling. Although the Panel was not reluctant to identify the many shortcomings present with the existing air quality models, they, nevertheless, concluded that not only are air quality models needed and desirable, but they represent the only predictive tool available for air quality management.

74 pages
From Text

TRANSPORTATION ENVIRONMENTAL REVIEW PROCESS, Transportation Research Record 580. "Evaluation and Comparison of Three Air Pollution Prediction Models," William A. Carpenter and Gerardo G. Clemena. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1976.

This paper presents a brief discussion of the theoretical and mathematical development of a line-source dispersion model AIRPOL-4 designed by the Virginia Highway and Transportation Research Council to eliminate some of the problems encountered with existing models. It also comparatively evaluates the predictive and cost performances of AIRPOL-4 with those of the California Division of Highways and the U.S. EPA models. The predictive performances of these models are evaluated, against measured data, in relation to wind speed, road-wind angle, atmospheric stability class, source height, and receptor location. The results demonstrate that the predictive capability and reliability of AIRPOL-4 are generally superior to those of the other models. Comparison of cost performances for the models is based on operating costs determined for each of the models for air quality analyses involving identical input parameters. The results of this cost comparison demonstrate that AIRPOL-4 is significantly more cost effective than either of the other models.
Author's Abstract

PB-239 944

USER'S GUIDE FOR HIWAY: A HIGHWAY AIR POLLUTION MODEL, John R. Zimmerman and Roger S. Thompson. National Environmental Research Center, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. February 1975.

A computer model called HIWAY that can be used for estimating the concentrations of nonreactive pollutants from highway traffic is described. This steady-state Gaussian model can be applied to determine air pollution concentrations at receptor locations downwind of "at-grade" and "cut-section" highways located at relatively uncomplicated terrain. For an at-grade highway, each lane of traffic is modeled as though it were a finite, uniformly emitting line source of pollution. For the cut section, the top of the cut is considered an area source. The area source is simulated by using ten line sources of equal source strength. The total source strength equals the total emission from the lanes in the cut. The air pollution concentration representative of hourly averaging times at a downwind receptor location is found by a numerical integration along the length of each lane and a summing of the contributions from each lane. With the exception of receptors directly on the highway or within the cut, the model is applicable for any wind direction, highway orientation, and receptor location. The model was developed for situations in which horizontal wind flow occurs. The model cannot consider complex terrain or large obstructions to the flow such as buildings or large trees. An interactive version of the computer model is available on Environmental Protection Agency's Users' Network for Applied Modeling of Air Pollution (UNAMAP).

68 pages

Author's Abstract

USER'S MANUAL FOR THE APRAC-1A URBAN DIFFUSION MODEL COMPUTER PROGRAM, R.L. Mancuso and F.L. Ludwig. Stanford Research Institute, Menlo Park, CA 94025. September 1972.

The APRAC-1A diffusion model has been developed as a versatile and practical model for computing the concentrations of pollutants at any point within a city. It is the result of the studies of Ludwig et al. (1970, 1972) and Johnson et al. (1971) and includes the most recent modeling features of these studies. The model calculates pollutant contributions from diffusion on various scales, including:

1. Extraurban diffusion, mainly from sources in upwind cities.
2. Intraurban diffusion from freeway, arterial, and feeder street sources.
3. Local diffusion of emissions within a street canyon.

Currently, the model treats only carbon monoxide, a relatively inert gas in the atmosphere but an important pollutant in terms of health. Motor vehicles are the major source of this gas.

The computer program can be used to make calculations of the following types:

1. Synoptic model: hourly concentrations as a function of time, for comparison and verification with observed concentrations and for operational applications.
2. Climatological model: the frequency distribution of concentrations, for statistical prediction of the frequency of occurrence of specified high concentrations in connection with planning activities.
3. Grid-point model: concentrations at various locations in a geographical grid, providing detailed horizontal concentration patterns for operational or planning purposes.

120 pages
From Text

PB-292 249

WORKBOOK FOR THE COMPARISON OF AIR QUALITY MODELS, Albert E. Smith, Kenneth L. Brubaker, Richard R. Cirillo, and Donald M. Rote. U.S. Environmental Protection Agency, Office of Air and Waste Management, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711.

This workbook describes a technique for the qualitative comparison of modeling approaches on technical grounds. The methodology is based upon an applications approach. The results of the model comparison depend upon the application for which the model is to be used as well as upon the model characteristics. In each application of the technique, the model of interest (the "study" model) is compared with a "reference" model. Any models may be specified as study or reference models, as long as they are compatible with the application of interest.

The approach taken in this workbook is restricted to models that mathematically simulate the physical phenomena which determine atmospheric pollutant concentrations. Simulation models may require locally measured air quality data in order to fix the initial and boundary conditions or to determine appropriate background pollutant levels. Models excluded from that category are any that make use of locally measured air quality data to optimize or determine adjustable parameters unrelated to the physical processes being simulated. Thus, for example, calibration or averaging time conversion procedures are not considered as part of a simulation model but rather as statistical procedures which are applied to the calculations of a simulation model. Rollback models are also excluded from the category of simulation models. General considerations involved in the comparison of rollback and statistical or empirical models are discussed briefly in Section 7.

It is important to understand that the methodology described in this workbook does not enable the user to evalute the results obtained using a particular air quality model, but to determine only if the model used is as technically adequate as another model for the application of interest.

This workbook contains seven main sections and four appendices. Section 2 contains an overall description of the methodology and general instructions for its implementation. Sections 3-6 contain specific instructions and guidelines for carrying out various steps in the procedure. Section 3 deals with the classification of the user's application. Section 4 is concerned with the general suitability and compatibility of a model with the given application. It also considers the importance of various aspects of atmospheric dispersion in that application. Selected reference models for the various applications are also suggested in Section 4. Section 5 provides guidelines for identifying the treatments of various physical phenomena by a given model. Section 6 contains instructions and guidelines for making the comparative evaluation. Finally, Section 7 contains a discussion of some of the considerations involved in comparing rollback/statistical models.

The appendices contain general reference material useful in implementing the methodology: technical discussions of the physical phenomena that determine atmospheric pollutant concentrations; discussion of the importance of each phenomenon in different types of applications; information on treatments of these phenomena by selected reference models, including the working equations; examples of the use of the methodology in various common applications.

113 pages

From Text

MOBILE SOURCE EMISSIONS AND EMISSION MODELS

AIR QUALITY AND AUTOMOBILE EMISSION CONTROL. A report by the Coordinating Committee on Air Quality Studies, National Academy of Sciences, National Academy of Engineering; prepared for the Committee on Public Works, United States Senate. Volume 1, Summary Report; Volume 2, Health Effects of Air Pollutants; Volume 3, The Relationship of Emissions to Ambient Air Quality; Volume 4, The Costs and Benefits of Automobile Emission Control. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. September 1974.

Excerpts from Volume 1

Automobile Emission Standards

With certain important provisos, the study found that : (a) The federal ambient air quality standards for carbon monoxide could be met by 1990, even with some relaxation of the present statutory emission standards; (b) The federal emission standard of 0.4 grams per mile for NO_x may be somewhat more stringent that is needed to achieve the ambient air quality standard for NO_2; (c) The existing analysis relating NO_x emissions to subsequent oxidant formations are considered inadequate. It is not certain that the ambient air standards for oxidants would be met in all large cities or locations downwind from cities if the NO_x emission standards were relaxed; (d) At least in the Los Angeles area, the federal statutory hydrocarbon emission standard of 0.41 g/mi may not be sufficiently stringent to ensure compliance with national ambient air quality standards for oxidants. However, present analyses are inadequate to justify changes in the federal motor vehicle emission standard for hydrocarbons at this time. These conclusions assume that emissions from heavy vehicles and stationary sources are reduced in the same proportion as emissions from light vehicles and that we remain satisfied with relatively modest safety margins.

Relation of Emissions to Air Quality

Because of uncertainty in estimated emission and measured ambient air quality data, it has been difficult to demonstrate a precise quantitative relationship between emission and air quality trends. However, available information does suggest that since the implementation of emission controls strategies, measured ambient air quality generally reflects changes that have taken place in aggregate nationwide emissions of several pollutants: decreases for carbon monoxide and particulate matter and increases for oxides of nitrogen. Trends in photochemical oxidant concentration are poorly documented except in California. In recent years, oxidant concentrations have been decreasing in the coastal and central portions of the Los Angeles Basin while increasing in downwind inland portions of that Basin. These trends illustrate the important influence of meteorological conditions as well as the concentrations of the oxides of nitrogen and of reactive hydrocarbons on the formation of photochemical oxidant. There is a developing body of evidence that oxidant levels approaching and sometimes exceeding the federal standard occur in some non-urban locations. The high rural levels of oxidant concentration may be related to the dispersion on a regional basis of man-produced precursor pollutants such as hydrocarbons and nitrogen oxides.

A variety of air quality models has been employed relating the emission source to the resulting pollutant concentrations in the atmosphere. To date, only the most rudimentary models have been used in establishing and reviewing automotive emission standards. Analysis of the rollback calculations indicates that the federal ambient air quality standards for carbon monoxide could be met by 1990 even with some relaxation of the present statutory emission standards. This could be done only, however, if emissions from heavy vehicles and stationary sources were reduced in the same proportion as emissions from light vehicles. (The rollback method assumes that when the emissions of a substance are reduced by a certain amount, the concentration of that substance in the ambient air will be reduced proportionately.) On the basis of analyses used in the modified rollback method, it appears that the federal emission standard of 0.4 g/mi for NO_x may be somewhat more stringent than is needed to achieve the ambient air quality standard for NO_2 by itself. (The modified rollback method used in setting the emission standards for NO_x and HC handles interactions between them in producing oxidants by (1) setting the NO_x standard low enough to avoid direct health effects of NO_2; and then (2) setting the hydrocarbon standard low enough so that the interactions of NO_x with HC will not produce oxidants in excess of the ambient air quality standard.) The existing analysis relating NO_x emissions to subsequent oxidant formations are considered inadequate. It is not certain that the ambient air standards for oxidant will be met in all large cities or locations downwind from cities if the NO_x emission standards were relaxed, unless auxiliary local measures were taken. The Committee has also determined that the impact of motor vehicle emissions on ambient air quality varies greatly among different geographical regions.

Excerpts from Volume 3

There is a developing body of evidence that oxidant levels approaching, and sometimes exceeding the federal standard, occur in non-urban locations in the United States. These concentrations may be related to the transport and dispersion of man-produced precursor emissions from distant metropolitan areas. Natural sources of HC and NO_x emissions, downwind transport, and stratospheric ozone or some combination of all these factors may also explain the observed rural oxidant concentrations.

What techniques exist for estimating or predicting the relationship between emissions and air quality? What are the degrees of uncertainty associated with each method?

Two techniques are available to predict the impact of the emission changes of ambient air quality for readily inert primary pollutants such as CO: linear proportional rollback and physico-chemical diffusion models. The rollback method does not account for changes in distribution of emissions over time and space. When emission patterns are significantly altered, complex mathematical physico-chemical diffusion modeling is more applicable than rollback. For pollutants found in the atmosphere, such as oxidant, at least four alternative approaches for predicting the emissions to air quality relationships are available: linear proportional rollback, modified rollback based on smog chamber experiments, modified rollback based on empirical analysis of air monitoring data, and mathematical physico-chemical diffusion models. Linear proportional rollback, when used to describe oxidant formation, depends on the arbitrary assumption that oxidant levels are proportional to reactive hydrocarbon emissions. Modeling and relevant research have established that oxidant levels depend on both HC and NO_x emission levels, that the HC/NO_x ratio must be taken into account and that the relationship of subsequent oxidant formation to precursor emission levels is non-linear. It is difficult to ascertain the comparative degree of uncertainty involved in utilizing the empirical smog chamber and physico-chemical models for oxidants. Disagreement exists over which approach is best.

What is the recommended technique for relating emissions to ambient air quality for each of the motor vehicle pollutants?

The linear proportional rollback model generally is adequate for calculating the emissions to air quality relationships for non-reactive pollutants such as carbon monoxide. Assuming that changes in the distribution of emissions over time and space are small, greater confidence in the results derived from linear rollback estimates can be attained by applying existing mathematical diffusion models as a cross-check. The rollback technique is more dependable when utilized in evaluating emission control strategies that have been uniformly applied to all emission sources. However, rollback is less helpful for characterizing the effect of an emission from specific sources, such as highway configurations, chemical production facilities, or power plants. Diffusion modeling methods are more appropriate in such situations.

Three alternatives are recommended for predicting emissions to air quality relationships for oxidant: modified rollback based on empirical analysis of air monitoring data, modified rollback based on smog chamber experiments, and mathematical physico-chemical diffusion modeling. Because of the complexities involved in the formation of oxidant, simple rollback methods are indirectly limited in effectiveness for evaluating alternative control strategies. Physico-chemical diffusion models explicitly account for meteorological factors, emission distributions and atmospheric chemistry. These more sophisticated mathematical models are presently not fully operational.

The usefulness of all model approaches for predicting the relationship of emission to air quality is critically dependent on the quality and detail of the input data. Comprehensive studies to better define and improve such information have the greatest potential for reducing the current uncertainty in relating emissions to air quality in the near future. In the long term, physico-chemistry models currently under development offer the best potential for reducing this uncertainty. However, at present, the relative usefulness of the simple rollback and the more sophisticated physico-chemical models is unclear.

Are the present federal motor vehicle emission standards for CO, HC, and NO_x and oxidant too stringent?

Available rollback calculations suggest that the present federal motor vehicle emission standard for CO of 3.4 g/mi is more stringent than necessary to achieve the ambient CO standard of 9ppm by 1990. However, for any given metropolitan area, this conclusion is uncertain unless the influence of emissions from other stationary and transportation sources and their variation in time and space is considered.

The present statutory hydrocarbon emission standard of 0.41 g/mi may not be sufficiently stringent to ensure compliance with the national ambient air standard for oxidant of 0.08ppm, at least in the Los Angeles area.

It appears that the current statutory NO_x emission standard of 0.4 g/mi may be more stringent than needed for Los Angeles to meet the national NO_2 air quality standard of 0.05ppm annual average. However, the existing analyses relating NO_x emissions to subsequent oxidant formation are considered inadequate. It is not certain, on the basis of these findings, that the federal ambient air quality standard for oxidant would be met in all large cities or locations downwind from cities if the established NO_x automobile emission standard were relaxed. The determination of optimal level of NO_x emission necessary to most effectively inhibit oxidant formation is a complicated problem that requires further research.

Volume 1 - 130 pages
Volume 2 - 511 pages
Volume 3 - 137 pages
Volume 4 - 470 pages

From Text

AIR QUALITY ANALYSIS IN TRANSPORTATION PLANNING, Transportation Research Record 670. "Development of a Method to Relate 8-Hour Trip Generation to Emissions Characteristics," Lonnie E. Haefner, J. Lee Hutchins, Donald E. Lang, Robert W. Meyer, and Bigan Yarjani. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1978.

The objective of this paper is to demonstrate the development and integration of an efficient method for computing 8-h periods of trip generation and their resulting carbon monoxide, nitrogen oxide, and hydrocarbon emissions, by employing current emissions-dispersion models in conjunction with a direct assignment algorithm and appropriate regression analysis. After appropriate determination of land use stimuli and functional highway class, volumes are forecast using the direct assignment approach and input into the emissions model computations. Subsequently, calibration of a regression-of-emissions versus trip-generation input yields the capability to forecast a series of emissions consequences versus land use.

Author's Abstract

AIR QUALITY AND ENVIRONMENTAL FACTORS, Transportation Research Record 492. "Analysis of Urban Area Automobile Emissions According to Trip Type," Joel L. Horowitz and Lloyd M. Pernela. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1974.

Travel data from the Pittsburgh transportation survey and emissions data developed by the Environmental Protection Agency have been used to estimate Allegheny County (Pittsburgh), Pennsylvania, automobile emissions according to trip purpose, length, origin, and destination. The results include estimates of diurnal evaporative emissions, cold-start and hot-soak emissions, and actual running emissions. Home-based work trips and trips to and from the central area of the county each produce one-third to one-half of Allegheny County automobile emissions and are the dominant causes of automobile emissions in the county. Cold starts and evaporations produce approximately half of the hydrocarbons and a quarter of the carbon monoxide. Trips shorter than five miles and trips longer than five miles produce roughly equal quantities of carbon monoxide and hydrocarbons. However, long trips produce greater quantities of nitrogen oxides. These findings suggest that improved peak-period and radial transit may be effective in improving air quality through reducing automobile travel if such transit reaches peripheral areas of the county. However, cold-start and evaporative emissions may significantly impair the effectiveness of transit approaches that rely on the automobile for residential collection and distribution.

Author's Abstract

AIR QUALITY AND ENVIRONMENTAL FACTORS, Transportation Research Record 492. "A Simple Model for Estimating Regional Automotive Emissions," Frank J. Cessario. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1974.

A simple model for estimating regional automotive emissions of carbon monoxide, hydrocarbons, and nitrogen oxides is developed. The model is designed for use when rough, low-cost pollution estimates are desired. Traffic volumes are assumed to be available. Given the characteristics of the regional highway network, the model calculates the vehicle-miles of travel over different road types in each specified subarea of the region and the vehicle speeds at which travel takes place. Then by use of emission functions that relate the output of pollutants to vehicle speeds, emission estimates are calculated for the given travel pattern. An application to the Watertown, New York, region is discussed.

Author's Abstract

ASSESSING TRANSPORTATION-RELATED AIR QUALITY IMPACTS, Special Report 167. "Mobile Source Emission Factors: State of the Art and Future Programs," Marcia E. Williams. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1976.

Various approaches to air quality modeling have been used to relate changes in emission rates to changes in ambient air quality. The commonly used roll-back model assumes that a change in the amount of pollutant emitted from one or more source categories will result in a directly proportional change in ambient air quality. The model does not consider the localized effects of meteorological and topographical conditions nor does it allow for changes in background pollutant concentration and emission distribution in space and time over the projection period. Moreover, point source indicators of air quality may not be representative of air quality over an entire region of modeling interest. The use of the second highest concentration value as a base predictor may compound this problem since limited data analyses indicate that it may not be the best predictor of average mean ambient concentration or number of times the standard is exceeded annually either at a single sampling point or in a region.

Diffusion models, although considerably more data intensive than the simple proportional model, can be expected to improve predictive ability since they recognize the importance of meteorological and topographical variables. However, all models are limited by the accuracy of the input data. Before a model can be applied, an estimate of the amount of pollutant emitted must be computed for the base year and the future years of interest. The amount of pollutant emitted for future years is a function of both the emission factors, defined as the rate at which a pollutant is released to the atmosphere as a result of some activity, and the growth rate of the activity. In addition, accurate estimates of base-year ambient concentration, and in the case of diffusion models, meteorological and topographical variables are needed. This paper will address the sources and accuracy of the emission factor inputs necessary to perform air quality modeling of carbon monoxide.

Carbon monoxide is largely a localized problem although a second-order areawide problem may exist as a result of workday buildup of CO. Moving a monitor a few feet will usually result in a large change in measured concentration, and locating monitors in different places within a central business district will show large concentration differences. High CO concentrations are normally found at busy intersection, street-side, and other locations of high traffic density. As a result of the hot-spot nature of CO, motor vehicles tend to dominate the modeling situation and stationary sources have little impact.

Estimates contained in the National Emissions Data Systems (NEDS) indicate that during 1973 more than 93 million tons (84.4 TG) of CO were emitted in the U.S. by man-made sources. Seventy-eight percent of these are attributed to mobile sources, and the automobile alone accounts for nearly 50 percent. Most urban monitoring sites at which ambient CO concentrations are high are located in areas of high traffic density and are rarely influenced by stationary sources of CO. Urban violations of the national ambient air quality standard for CO are almost exclusively due to vehicular traffic, and the importance of stationary sources is even less than indicated by the nationwide emissions.

Estimates for 1971-1974 calendar year stationary source contributions to hot-spot problems are on the order of three percent. Although further control of mobile source CO can be expected to increase the importance of an accurate determination for stationary source emission factors and growth rates, the overriding concern at present is in the area of mobile source emission factors. Any comparison of the effectiveness of alternative control strategies for achieving ambient air quality improvement or the need to evaluate the implications of new or existing indirect sources is dependent on the ability to estimate the CO emission factor under various conditions.

Author's Abstract

ASSESSING TRANSPORTATION-RELATED AIR QUALITY IMPACTS, Special Report 167. "SAPOLLUT: Estimating the Air Quality Impact of Vehicular Emissions Resulting from a Traffic Assignment", Thomas P. Kozlowski. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1976.

Special area pollution (SAPOLLUT) is the noise and air quality analysis portion of special area analysis (SAA) developed by the U.S. Department of Transportation. SAA is an attempt to encourage the consideration of social and environmental factors in the planning of transportation systems for urban areas by providing the analytical tools to address some of the social and environmental issues. SAA was initially included as a mandatory item of the 1974 National Transportation Study for all urban areas greater than 500,000 population. Participation in the SAA portion of the study was later made voluntary.

The purpose of the air quality analysis section of SAA is to present a methodology to quantitatively estimate the daily atmospheric loading of the highway-related pollutants (carbon monoxide, hydrocarbons, and nitrogen oxides) resulting from the daily travel on an urban street and highway system. This analysis is pertinent due to the requirements of the Clean Air Act Amendments of 1970 and the Federal-Aid Highway Act of 1970. Consequently, SAPOLLUT is being used in many areas for transportation system alternatives evaluation and transportation and air quality consistency determinations.

Approximately 50 copies of the program software have been distributed by the Urban Planning Division of the Federal Highway Administration to state transportation and highway departments, local urban transportation planning agencies, air quality planning agencies, consultants, and universities. SAPOLLUT was initially distributed in late 1973. Many comments on the program were received, and, as a result, a new version of the program was developed. Major changes to the program have been made that improve its operating efficiency, add flexibility to the input requirements, and increase the output options.

Author's Abstract

ASSESSING TRANSPORTATION-RELATED AIR QUALITY IMPACTS, Special Report 167. "Air Quality Modeling at Signalized Intersections", Robert M. Patterson. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1976.

A good deal of effort has been focused in recent years on the problem of estimating the carbon monoxide ambient air quality impact of roadways. This effort has centered around the characterization of motor vehicle pollutant emissions and the dispersion of pollutants in the atmosphere. Emissions have been characterized as coming from vehicles traveling at an average route speed, and hence an average emission strength has been calculated as a function of average speed and VMT on traffic links. This is the approach presented in EPA Publication AP-42, the FHWA program of model SAPOLLUT, and the user's manual for model APRAC-1A. The subsequent atmospheric dispersion of pollutants has been estimated by numerical integration along the roadway line source of a Gaussian point source plume, the method used in the EPA HIWAY model, or by application of the line source formulation of the Gaussian plume assumption, the technique used in a modified form in the FHWA line source model and in model APRAC-1A.

Increasing attention is now being paid, however, to the localized, microscale problem of hot spots of motor vehicle-related pollutants and, particularly, of carbon monoxide. Hot spots generally occur near locations where traffic congestion, slow speeds and driving mode changes cause high emission densities and high concentrations. One such location is the signalized intersection. The average route speed assumption is inadequate to characterize either traffic movements or the concomitant emissions at signalized intersections.

This paper presents a validated method for handling the intersection problem. The analytical procedure considers both traffic flow parameters and the effects of driving mode changes on emissions, and it has been used to estimate emissions of carbon monoxide from observed traffic at a signalized intersection. The emission estimates have been applied as inputs to the HIWAY model, and the calculated concentrations show good mean agreement with those observed near the intersection.

Author's Abstract

PB-284 948

AUTOMOBILE EXHAUST EMISSION MODAL ANALYSIS MODEL EXTENSION AND REFINEMENT, H.T. McAdams. Calspan Corporation, Buffalo, NY for U.S. Environmental Protection Agency, Office of Air and Waste Management, Ann Arbor, MI 48105. 10/74.

This report on modal analysis of automobile emissions constitutes a refinement and extension of a modal analysis exhaust emission model originally developed under EPA contract and released as "Automobile Exhaust Emission Modal Analysis Model." The modal analysis exhaust emission model makes it possible to calculate the amounts of emission products emitted by individual vehicles or groups of vehicles over an arbitrary driving sequence. Refinements to the model permit an improvement in computational efficiency and a reduction in input data requirements. Extensions of the model include a scheme for computation of fuel usage in terms of CO_2, CO and HC output by means of a carbon-balance approach and a procedure for more definitive assessment of the precision of the model in predicting group emissions.

The required traffic parameters can be estimated in a straightforward way. Traffic in the vicinity can be monitored and classified according to vehicle make, model, age, and other factors known to influence emissions. Moreover, speeds and accelerations prevailing along the trafficway in question can be measured and tabluated. Unless emissions can be expressed as functions of the applicable traffic parameters, however, it is not possible to assess vehicular contributions to air pollution.

The report discusses the following: investigating means to increase the computational efficiency of the model; determining whether modal testing requirements can be reduced without appreciable loss of information; defining the accuracy and precision with which group emission predictions can be made from modal data; and using the modal analysis approach to predict fuel economy over arbitrary driving sequences.

98 pages

Author's Abstract and Text

PB-233 580/AS

CHARACTERISTICS OF URBAN TRANSPORTATION SYSTEMS -- A HANDBOOK FOR TRANSPORTATATION PLANNERS, D.B. Sanders and T.A. Reynen, DeLeuw, Cather and Company; for U.S. Department of Transportation, Urban Mass Transportation Administration, 400 Seventh Street, S.W., Washington, D.C. 20590. June 1979.

This report consists of a handbook to be used by transportation planners and urban specialists for estimating system parameters for conventional transportation technology. Three modes are evaluated: rail transit, local bus and bus rapid transit, and highway systems. Each model contains an assessment of the following seven selected supply parameters: speed, capacity, operating cost, energy consumption, pollutant emissions, capital costs, and accident frequency. These parameters are organized as proxy variables in describing the characteristics of each transport mode. Each mode has an analogous appendix section whereby these parameters are evaluated in further detail and for particular geographic areas. Two additional appendix sections contain all references used in the tables/figures and a general bibliography for further information.

The report provides data on bus pollutant emission factors in GR/MI for CO, HC and NOX for diesel and gasoline fuels for residential, line haul and CBD trips.

Composite pollutant emission factors for autos and trucks on freeways and surface arterials are also provided. Factors are provided based solely on VMT or based on four trip components:

- Hot operation emissions per VMT
- Vehicle start emissions per trip
- Hot soak emissions per trip
- Diurnal emissions per vehicle

PB-260 877

A COMPUTER SIMULATION MODEL FOR ANALYZING MOBILE SOURCE AIR POLLUTION CONTROL STRATEGIES. MATHTECH, Inc., Princeton, NJ 08540. Corvallis Environmental Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Corvallis, Oregon 97330. September 1976.

The MATHAIR model enables the user to perform experiments evaluating the impact of air pollution control strategies in different geographic regions. For each strategy devised, MATHAIR calculates both the effect on air quality and the dollar benefits and costs associated with that strategy for a user-specified geographic region. These calculations are made relative to a baseline, or zero-control, strategy.

The effect of a pollution control strategy on air quality is calculated by first projecting the emission sources in a region and the level of emissions associated with each source. The impact of the control strategy on the level of emissions from each source is then calculated. Finally, an air quality model relates the changes in emission levels to changes in ambient air quality. Attention is focused on controlling emissions of CO, HC and NO_X. The principal emission source considered is automobiles; control measures considered affect air quality both by reducing emissions holding automobile use constant, and by reducing automobile use.

As regards the calculation of benefits and costs, the total cost for a strategy is taken to be the additional cost over that associated with the baseline strategy. Thus, costs do not, for example, include the purchase price of automobiles but do include the extra capital and operating costs of pollution control devices.

In addition to direct costs, also calculated were the implied cost to travelers of reduced (or enhanced) mobility, the idea being that certain strategies may reduce the number of automobile trips, and an imputed value of these foregone trips should count as a strategy cost.

To calculate the benefits of improved air quality resulting from air pollution control strategies, the damage due to air pollution is quantified in monetary terms for each control strategy. The benefit of a strategy is then calculated by subtracting those damages from the damages associated with the baseline, zero-control, strategy.

In order to demonstrate the use of MATHAIR, four large urban regions were selected for the simulation experiments reported here: Los Angeles, New York, Washington, D.C., and Chicago. These regions provide a spectrum of the air quality problems found in large urban areas.

The simulation strategies analyzed include (1) measures requiring the installation of pollution control devices directly on the source of pollution and (2) inducements to change patterns of transportation behavior. Examples of the first type include mandated installation of catalytic convertors on automobiles built after 1975 and required carbon adsorbers for hydrocarbons on all dry-cleaning plants. Examples of the second type include increasing the cost per mile of automobile travel by imposing a tax on gasoline and decreasing bus waiting times by operating additional buses.

The impacts of the strategies on ambient pollution concentrations are mixed and thus difficult to summarize. Even modest controls affect significant air quality improvements. However, Federal standards for some pollutants cannot be met even with the most stringent strategies. A moderate level of control proved optimal, in the sense of maximizing net benefits, in Los Angeles and Chicago. Very modest controls were best in New York, while no controls was the optimal choice in Washington.

Based on the numerical results of the experiments conducted with MATHAIR, some conclusions can be drawn:

1. Different regions have different composition of total emissions, different meteorological carrying capacities, and different transportation systems; and a flexible national policy that encourages exploitation of these differences could yield substantial economic benefits. It is economically inefficient to impose the same program of controls in different regions.

2. Costs associated with changes to less preferred modes of transportation and reduction in trip frequency can be substantial and should not be omitted from a cost calculation. There may be social benefits associated with these changes -- reduced congestion, less noise pollution, fewer accidents, and conservation of scarce fossil fuels -- as well as the air pollution reduction benefits. Results indicated, however, that these other benefits may have to be large to offset the marginal costs of adding transportation controls to an existing program of moderate controls.

3. MATHAIR air quality predictions show that oxidant standards cannot be met by 1985 in any study region even with the most stringent strategy. The strictest measures, including transportation controls, are needed to meet the carbon monoxide standards.

4. Inspection and maintenance of automobiles appears to be beneficial in all regions.

5. Strategies requiring hardware control devices for automobiles are most successful in regions where the average automobile is driven intensively.

6. Transportation controls discouraging use of the automobile are most successful, in conjunction with other measures, in regions with the greatest existing availability of common transportation.

7. A program consisting of transportation controls ONLY appears to be beneficial, though of limited impact.

From Text

ENVIRONMENTAL AND CONSERVATION CONCERNS IN TRANSPORTATION: ENERGY, NOISE, AND AIR QUALITY, Transportation Research Record 648. "Use of Traffic Simulation in Analysis of Carbon Monoxide Pollution," Stephen L. Cohen. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1977.

One of the serious problems facing traffic engineers, from an operations and planning standpoint, is the requirement that certain standards for carbon monoxide concentrations be met. The problem of predicting traffic-generated CO concentrations near streets and highways is particularly important for meeting these standards. From the planning viewpoint, the question is what the effect will be on air quality if land use near a traffic facility is changed in such a way as to increase the traffic burden on the facility. From the operations viewpoint, the question is what the effect will be on air quality if changes are made in a traffic facility (e.g., more lanes or a computer-controlled signal system).

The standard approach is to consider the traffic facility, in the case of an arterial or a freeway, as a line source of pollution or, in the case of urban networks, as a set of line sources. A dispersion model is then applied to predict CO concentrations at various distances downwind from the line source. An example of such a model is the HIWAY model of the U.S. EPA, which is based on the principle of Gaussian dispersion. But the HIWAY model has a serious shortcoming: It assumes that the strength of the emissions from the line source is constant along its length. This assumption means that the line source has a constant emission profile. Although this is a fairly good assumption for uninterrupted flow conditions, it is totally inadequate in interrupted flow conditions such as those caused by traffic signalization.

In a number of papers, R.M. Patterson has investigated the use of traffic queuing models at signalized intersections in an attempt to estimate the non-constant emission profiles caused by stop-and-go traffic at the stop line. Although subject to the limitations described below, Patterson's work indicates that the queuing process is a copious source of CO near the stop line. As the author points out, the reason is not that CO emissions are high during low speed and idling -- they are in fact about the same as during higher speed operations -- but that the amount of time spent near the stop line is much greater than the amount of time spent near mid-block. Thus, most CO will be emitted near the stop line while automobiles are stopped for a red light, and the result is that the emissions profile will be sharply peaked at the stop line and fall off rapidly toward mid-block, leading, under most wind conditions, to a similar nonuniformity in pollution levels between stop line and mid-block.

There are, however, some limitations in Patterson's approach. The queuing models considered assume either constant or uniformly distributed arrivals to and departures from the queue. These assumptions are often violated in the field. Examples include right turn on red, unprotected left turns, pedestrian blockages of left- or right-turning traffic, buses dwelling at nearside stops, and platooned arrivals. The inclusion of such effects requires a much more comprehensive model.

Author's Abstract

HIGHWAY SKETCH PLANNING: CAPM, THE COMMUNITY AGGREGATE PLANNING MODEL (CAPM) USERS' GUIDE. James M. Ryan. Urban Planning Division, FHWA, April 1979.

The Community Aggregate Planning Model (CAPM) is a computerized sketch planning program available through UTPS. CAPM is useful in a number of sketch planning applications, including the analysis of urban development patterns, alternative system investments, air quality, and energy consumption. This guide is an introduction to the model and its potential uses. Included are discussions of input requirements and output reports. Also presented is a description of the assumptions and algorithms upon which the model is based.

Program outputs include the automobile and truck:

Daily KGMS CO (000)
Carbon Monoxide GM/VMT
Daily KGMS HC (000)
Hydrocarbons GM/VMT
Daily KGMS NOX (000)
Nitrogen Oxides GM/VMT

The air pollutant emission factors used were derived from MOBILE 1. In this derivation, the age distribution of vehicles was assumed to be that presented in MOBILE 1. Additionally, the vehicle mix (auto, heavy duty, etc.) was obtained from "Characteristics of Urban Transportation Systems," (CUTS) for both 1975 and 1995 for the BASE and ALTERNATIVE factors, respectively. Standard EPA test conditions were assumed for the remaining parameters: ALTERNATIVE factors were derived assuming that all legislated vehicle emission standards would be enforced by 1995.

From NTIS and Text

HOW DO DIESEL AND GASOLINE ENGINE EMISSIONS COMPARE? From Automotive Engineering, Vol. 85, No. 11, November 1977, pp 50-55.

Southwest Research Institute has undertaken a head-to-head comparison of diesel- and gasoline-fueled passenger cars. The results corroborate recognized trade-offs of dieselization: some 30-60% better fuel economy, moderate losses in acceleration, a bit more noise, and levels of regulated emissions comparable to those of converter-equipped gasoline cars. Unregulated emissions, however, may require new techniques for adequate quantification and control. In particular, the study pinpoints particulates, polynuclear aromatics, smoke, and odor as matters of potential concern with an expanding diesel passenger car fleet.

From Highway Research Information Service Records

HYBRID COMPUTER SIMULATES FTP. From Automotive Engineering, Vol. 86, No. 5, May 1978, pp 49-53.

This article describes a method devised by General Motors engineers to simulate a complete Federal Test Procedure test for automobile exhaust emission and fuel economy in 8 minutes. The GM computer model exploits hybrid programming: an analog computer handles continuous simulation chores at four times normal speed, while a digital device takes care of computational work, storage, and control. The system gives an efficient simulation of emissions and fuel economy testing sufficiently robust to study effects of varying test procedures, vehicle calibrations, and product mix. It is a simulation of vehicle/driver/dynamometer interactions in a macroscopic sense, with enough details incorporated to allow reasonable confidence in the model's predictions of absolute values and trends. Comparison of computer simulations and vehicle tests gave an indication of the model's robustness. Vehicle tests, of course, involved the same engine/emission-control configuration used to generate the model's performance maps.

From Highway Research Information Service Records

IMPACT OF AIR QUALITY CONTROL MEASURES, Transportation Research Record 714. "Exhaust Emissions, Fuel Consumption and Traffic: Relations Derived from Urban Driving Schedule Data," Leonard Evans. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1979.

Traffic variables were calculated from the defined speed-time history of the LA-4 driving schedule for each of the 18 stop-to-stop cycles that constitute this schedule, in a manner similar to that previously applied to field data. The ability of these traffic variables to explain emissions and fuel consumption was examined by using data from 12 automobiles run on federal test procedure dynamometer tests. It was found that hydrocarbon emissions can be expressed as a linear function of average trip times per unit distance for urban driving at low speeds. Relations of variables that are more difficult to measure for actual traffic are required for carbon monoxide and oxides of nitrogen. Data collected from a single test can yield a relation from which a vehicle's fuel consumption at any urban speed can be estimated.

Author's Abstract

IMPACT OF AIR QUALITY CONTROL MEASURES, Transportation Research Record 714. "Travel and Emissions Impacts of Transportation," John F. DiRenzo. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1979.

The Clean Air Act Amendments of 1977 and the Transportation-Air Quality Planning Guidelines jointly developed by the U.S. Environmental Protection Agency and the U.S. Department of Transportation require the states and metropolitan planning organizations to prepare revised state implementation plans and conduct air quality alternatives analyses to meet national ambient air quality standards. This paper summarizes basic information developed from a synthesis of literature to assist metropolitan planning organizations and other agencies in meeting the requirements of the planning guidelines. Specifically, the paper (a) identifies transportation control measures for reducing emissions, (b) summarizes the effects on travel and emissions of individual measures and packages of measures, and (c) suggests approaches and issues to be addressed in air quality planning.

Author's Abstract

PB-295 672

MOBILE SOURCE EMISSION FACTORS. Environmental Protection Agency, Washington, D.C. March 1978.

To answer the question of how well vehicles perform in actual use, EPA has administered a series of exhaust emission surveillance programs. Test fleets of consumer-owned vehicles within various major cities are selected by model year, make, engine size, transmission, and carburetor in such proportion as to be representative of both the normal production of each model year and the contribution of that model year to total vehicles miles traveled. In the case of heavy-duty vehicles, fuel type and gross vehicle weight were also key items in the stratification scheme.

The data collected in these programs are analyzed to provide mean emissions by model-year vehicle in each calendar year, change in emissions with the accumulation of mileage, change in emissions with the accumulation of age, percentage of vehicles complying with standards, and effect on emissions of vehicle parameters (engine displacement, vehicle weight, etc.). These surveillance data, along with prototype vehicle test data, assembly line test data, and technical judgment, form the basis for the existing and projected mobile source emission factors presented in this document.

The EPA has developed a series of correction factors to expand upon the LDV and HDV test procedures and to predict emissions from a large number of user-specific scenarios. Data required to develop these correction factors have been generated using carefully designed statistical studies which test consumer-owned vehicles.

Emission factors for the following vehicle categories are provided: light-duty, gasoline-powered vehicles (automobiles); light-duty, gasoline-powered trucks; heavy-duty, gasoline-powered vehicles (trucks and buses); heavy-duty, diesel-powered vehicles (trucks and buses); and motorcycles. Information is provided for use in all areas except California and high altitudes (this information is provided in separate parts of the document).

A computer program for using these emission factors can be obtained from the Office of Transportation and Land Use Policy, Washington, D.C. (Address: AW-445, EPA, 401 M Street S.W., 20460).

Also discussed: Pollutant emission factors for light-duty vehicles; travel weighting factor; speed-temperature-hot/cold correction factor; applicability of correction factors; comparisons with Supplement 5 Factors ambient temperature-hot/cold correction factors for pre-1975 and 1975 model year cars; LDV correction factor for air conditioning; vehicle loading correction factor; trailer towing correction factor; humidity correction factor; idle emission factors for LDVs; crankcase and evaporative emission factors.

381 pages

From Text

PB-296 272

MOBILE SOURCE EMISSION FACTORS FOR LOW-ALTITUTE AREAS ONLY. Office of Transportation and Land Use Policy, U.S. EPA, 401 M Street, S.W., Washington, D.C. 20460. March 1978.

This document officially revises previous mobile source emission factors which were presented in Supplement No. 5 to AP-42, Compilation of Air Pollutant Emission Factors (Dec. 1975).

This document does not revise all information in Supplement No. 5. In particular, updated factors are not included for light-duty diesel automobiles, light-duty diesel trucks, off-road sources, or aircraft; nor is any information included on particulates.

To answer the question of how well vehicles perform in actual use, EPA has administered a series of exhaust emission surveillance programs. Test fleets of consumer-owned vehicles within various major cities are selected by model year, make, engine size, transmission, and carburetor in such proportion as to be representative of both the normal production of each model year and the contribution of that model year to total vehicle miles traveled. In the case of heavy-duty vehicles, fuel type and gross vehicle weight were also key items in the stratification scheme.

The data collected in these programs are analyzed to provide mean emissions by model-year vehicle in each calendar year, change in emissions with the accumulation of mileage, change in emissions with the accumulation of age, percentage of vehicles complying with standards, and effect on emissions of vehicle parameters (engine displacement, vehicle weight, etc.). These surveillance data, along with prototype vehicle test data, assembly line test data, and technical judgment, form the basis for the existing and project mobile source emission factors presented in this document.

For localized pollutants such as CO, the ability of the test procedure to predict changes in emissions depends on the similarity of the localized driving pattern and associated operating conditions to those in the test procedure. The EPA, therefore, has developed a series of correction factors to expand upon the LDV and HDV test procedures and to predict emissions from a large number of user-specified scenarios. Data required to develop these correction factors have been generated using carefully designed statistical studies which test consumer-owned vehicles.

200 pages

From Text

MONITORING CARBON MONOXIDE CONCENTRATIONS IN URBAN AREAS. National Cooperative Highway Research Program, Report 200. Transportation Research Board, National Research Council, Washington, D.C. April 1979.

The estimation of the existing worst case levels (background levels) of carbon monoxide is one requirement for an environmental impact report on a new highway. At present, there is no widely accepted justification for less than one full year of CO monitoring to measure background; such extensive monitoring is expensive and can cause significant delays in highway construction. The major objective of this study was to determine a method of estimating the two critical annual statistics of the carbon monoxide levels at a proposed highway site, the annual second maximum 8-hour average and the annual second maximum one-hour average, using considerably less than one full year of data. Specifically the possibility of sampling for one month was to be investigated along with other sampling plans. In the extrapolation from this small data set, three separate possibilities were to be considered: having auxiliary CO data available (in the form of existing monitoring stations), having auxiliary meteorological data available, and having no auxiliary data available.

The main result of this study was the following. As long as it is possible to monitor during a part of the CO season (October to January, possibly February), the two statistics mentioned can be accurately estimated from one month of sampling. The restriction of monitoring to the CO season represents a change from some current practices. The most accurate of the methods tested was the simplest -- use the highest 8-hour average observed during the period of monitoring at the highway site as the estimate of the annual second maximum. It must be verified that the monitoring period contained enough meteorologically adverse days to make the estimate valid. Such adverse days must be determined using an existing monitoring station nearby which has been operating for at least a year, by a meteorological index, or, less persuasively, by typical rates of occurrence of adverse days for the months encompassed by the monitoring period.

An approach based on using an estimated statistical distribution to estimate the annual statistics from limited measurements was less accurate than the observed-maximum approach.

Simple methods for obtaining annual average CO levels were recommended; however, this statistic seems to be more sensitive to meteorology than to emissions, and does not appear to be a useful statistic to estimate.

The degree to which the error in the estimation process creates uncertainty in the estimate was quantified. Means for assessing confidence intervals were recommended.

From the results of this investigation, the following conclusions are drawn:

1. Sampling should be limited to the four most adverse months of October, November, December and January, with the possible inclusion of February. There is insufficient occurrence of adverse days in the other months for either of the methods evaluated to be reliable.

2. From the observed-maximum method, very little accuracy is gained by going from a one-month sampling period to a two-month sampling period. For the distribution method, there is a substantial improvement.

3. Although adverse CO concentrations are encountered less often on weekends than on weekdays (less than in a ratio of 2 to 7), they do occur on weekends fairly often. Thus, sampling on weekends is not irrelevant.

4. The observed-maximum method is clearly better than the distribution method for sampling within a one-month period. For a two-month sampling period, the methods are closely comparable in accuracy. Combining the two basic methods did not result in a method better than either of the two basic methods alone.

5. The accuracy obtained by either method (and by the observed-maximum method in particular) is excellent. Further methodological refinements are not necessary or justified in the context of the application addressed in this study.

6. For the observed-maximum method, the occurrence of at least six adverse days in one-month sampling and ten in two-month sampling should be verified.

7. Beyond the minimum, accuracy did not improve systematically as the number of adverse days in the sampling period increased (for either method).

8. The annual maximum one-hour-average CO concentration can be estimated from the estimated 8-hour second maximum. Since the one-hour CO standard is seldom exceeded, this procedure provides more than enough accuracy.

9. The annual average is dominated by meteorology rather than emissions and does not vary greatly from locale to locale. For this reason, discussion of estimation of the annual average was limited to the most straightforward approach.

Author's Abstract

PB-292 703

PREDICTIONS OF HIGHWAY EMISSIONS BY A SECOND ORDER CLOSURE MODEL, M.E. Teske and W.S. Lewellen. Aeronautical Research Associates of Princeton, 50 Washington Road, Princeton, NJ 08540; for Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. February 1979.

The dispersion of sulfur hexafloride tracer and sulfate from automobile emissions in the immediate vicinity of a highway were estimated for conditions similar to those existing during the General Motors sulfate dispersion experiment conducted at a GM test track. A second-order closure model of turbulent transport in the planetary boundary layer was used to predict the steady-state dispersion under two conditions: with the mean wind and velocity component variances specified by the data or predicted with the aid of an automobile wake model. The GM measured wind data apparently suffered from low vertical velocity variance readings at the 1.5 meter height, and led to an overprediction of the SF_6 levels by an average factor of 1.77 for the 18 tower collection points during the 15 test days. The correlation fell to 0.96 of the measured levels when the model also predicted the wind fields. The results indicate that close to the highway, buoyancy effects were small even in the critical case when the wind is light and aligned with the roadway.

95 pages

Author's Abstract

PROGRAM MANUAL GRIDSUM 2, State of Alabama Highway Department Bureau of Urban Planning. September 1974.

GRIDSUM 2 integrates traffic emissions of CO, HC and NO_x by grid squares for a grid system superimposed on a major street network. The traffic emission part of the program uses speed corrected factors taken from EPA Manual AP-42. Three run options are available. Option 1 is a mobile emission inventory, Options 2 and 3 process data for isolating areas of roadway capacity deficiency but are different in their approach to this kind of analysis. The program allows a choice of three types of grids: square grids whose size may be varied with different runs, variable rectangular balanced grids, and variable rectangular unbalanced grids. The program outputs network miles, vehicle miles and the emission of CO, HC and NO_x.

37 pages

PB-274 560

STUDY OF EXHAUST EMISSIONS FROM 1965 THROUGH 1975 MODEL YEAR LIGHT-DUTY VEHICLES IN HOUSTON, CHICAGO AND PHOENIX, Douglas R. Liljedahl, and Jerry L. Terry. Automotive Testing Laboratory, Inc., Aurora, CO.; for U.S. EPA, Emission Control Technology Division, Ann Arbor, MI. April 1976.

Emission tests were performed on a sample of light-duty vehicles operating in the Chicago, Houston and Phoenix metropolitan areas. In each site, the sample included ten 1975 model year light-duty trucks. All vehicles were tested in the as-received condition by the current Federal Test Procedure. The majority of vehicles were tested in connection with the development emission factors. Many of these were also tested using the Surveillance Driving Sequence and Steady State Procedures for emission factors development. Fifteen vehicles were additionally tested using these modal procedures to establish emission factors for loaded vehicles and vehicles towing trailers.

639 pages

Author's Abstract

PB-280 725

STUDY OF EXHAUST EMISSIONS FROM 1966 THROUGH 1976 MODEL-YEAR LIGHT-DUTY VEHICLES IN DENVER, CHICAGO, HOUSTON AND PHOENIX, Douglas R. Liljedahl and Jerry L. Terry. Automotive Testing Laboratory, Inc., Aurora, CO 80011; for U.S. EPA, Office of Air and Waste Management, Office of Mobile Source Air pollution Control, Emission Control Technology Division, Ann Arbor, MI 48105. August 1977.

Emission tests were performed on a sample of light-duty vehicles operating in the Chicago, Houston, Phoenix and Denver metropolitan areas. These tests were performed for the determination of light-duty vehicle emission factors. All vehicles were tested in the as-received condition by the Federal Test Procedure. Other tests included the Highway Fuel Economy Test, Modal Emission Tests, the Federal Short Cycle Test, a composite of the New Jersey ACID Test and the New York Short Test, the Clayton Keymode Test, the Two Speed Idle Test and the Federal Three Mode Test. A Revised Federal Three Mode Test and the Sulfate Emission Test were also performed. The Phoenix sample included twenty diesel-powered vehicles which were tested by the diesel version of the Federal Test Procedure, the Highway Fuel Economy Test and Modal Emission Tests. Evaporative Emission Tests by the SHED procedure were also conducted on twenty vehicles in Denver.

803 pages

NTIS Abstract

TRANSPORTATION ENVIRONMENTAL REVIEW PROCESS, Transportation Research Record 580. "Comparison of Automobile Emissions Based on Trip Type in Two Metropolitan Areas," Joel L. Horowitz and Lloyd M. Pernela. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1976.

Estimates of the distribution of automobile emissions among various trip types in the Washington, D.C., area are developed and compared with analogous estimates previously reported for Allegheny County, Pennsylvania. Work trips produce approximately equal proportions of emissions in both regions. However, trips to and from the central area and short trips are of considerably lesser importance in Washington than in Allegheny County. In addition, cold starts and evaporations produce a smaller proportion of emissions in the Washington area than in Allegheny County. These results suggest several ways in which measures that are effective in reducing automobile emissions in Washington are likely to differ from measures that are effective in achieving the same objective in Allegheny County. For example, improved suburban transit service and disincentives to suburban automobile travel are likely to be of greater importance in the Washington area than in Allegheny County. Jitney service or other measures oriented toward short trips may be of greater value in Allegheny County. In both regions, however, control of emissions from trips with one or both ends in the suburbs is necessary to achieve substantial reduction in regional automobile emissions.

Author's Abstract

USE OF TRAFFIC SIMULATION IN ANALYSIS OF CARBON MONOXIDE POLLUTION (ABRIDGMENT), S.L. Cohen, Federal Highway Administration. From Transportation Research Record, No. 648, 1977, pp 74-76.

Simulation models, such as the HIWAY model, which endeavor to predict changes in CO concentration caused by changes in a traffic facility such as a freeway, assume that the line source has a constant emission profile. This assumption is inadequate in interrupted flow conditions such as those caused by traffic signalization. This situation can be rectified by integration of the HIWAY model with the UTCS-1 model, a microscopic traffic simulation model which can provide a profile of the emissions of individual vehicles at given speeds and accelerations along various points of a network. A simulation using both models of a section of Wisconsin Avenue in Washington, D.C. shows that emissions fall off rapidly at mid-block, (thus confirming the effects of idling on emissions) and that pollution levels at a given distance from the street will vary in a manner similar to the emissions. This work demonstrates that the emission profile is necessary for the prediction of pollution levels in urban areas that the UTCS-1 model is a useful tool for generating such profiles under a wide variety of conditions.

Author's Abstract

USER'S GUIDE TO MOBILE 1: MOBILE SOURCE EMISSIONS MODEL. EPA, Office of Air, Noise, and Radiation, EPA-400/9/78-007. August 1978.

MOBILE 1 is a computer program that calculates composite emission factors for HC, CO, and NO_x from motor-vehicles using the methodology and factors presented in Mobile Source Emission Factors, Final Documents EPA-400/9-78-005 published in March 1978. MOBILE 1 is the most commonly used mobile source emission program and is widely used for a variety of purposes throughout the country.

Composite emission factors are provided for:

low altitude regions
California
high altitude regions

Composite emission factors are provided for:

light duty vehicles
light duty gasoline powered trucks, 0-6,000 lbs GVW
light duty gasoline powered trucks, 6,000-8,500 lbs GVW
heavy duty gasoline powered vehicles
heavy duty diesel powered vehicles
motorcycles

The three pollutants for which MOBILE 1 computes composite emission factors are:

hydrocarbons (HC)
carbon monoxide (CO)
oxides of nitrogen (NO_x)

The emission factors for light duty vehicles and light duty trucks are derived from analyses of FTP results. These factors can be corrected for speed, temperature, and operating mode conditions which vary from the assumptions of the FTP. Credits for inspection/maintenance programs are available within the program or may be supplied by the user.

Four additional correction factors for light duty vehicles and light duty trucks are available on an optional basis to the user. These are:

air conditioning correction factor
extra loading correction factor
trailer towing correction factor
humidity correction factor

One additional correction factor for heavy duty gasoline and diesel powered vehicles may be used to take into account the weight/power rates of these vehicles in calculating their emissions.

In addition to composite emission factors for the three primary pollutants MOBILE 1 will also provide composite idle emission factors in units of gm/minute. Composite crankcase and evaporative HC emissions for each vehicle type as well as total HC emission factors may be computed. Either total or non-methane hydrocarbon composite emission factors may be computed.

From Text

VEHICLE EMISSIONS CONTROLS AND AMBIENT AIR QUALITY, E.N. Cantwell, J.M. Pierrard and R.L. Willis (DuPont de Nemours and Company, Inc.). From Society of Automotive Engineers (Australasia), Vol. 38, No. 1, January 1978, pp 2-19.

This paper was presented at the Society of Automotive Engineers Jubilee Conference, Melbourne, May 1977 as paper 26. A methodology has been described which relates vehicle CO emissions rates, traffic activity, ambient CO concentrations. The use of this methodology has indicated that an average vehicle CO emission rate of 16 g/km would be adequate for attainment of the U.S. CO air quality standard, even in the most heavily travelled portions of urban areas. A DuPont modeling technique was employed to calculate future vehicle use and hydrogen projections. The hydrocarbon projections showed that continued replacement of older vehicles by new ones meeting the current U.S. exhaust hydrocarbon emission standard of 0.93/km for light duty vehicles will extend the existing downtrend of total man-made hydrocarbon emissions into the 1980's, even in the absence of further controls on stationary sources.

From Highway Research Information Service Records

AIR QUALITY IMPACTS OF TRANSPORTATION
SYSTEM MANAGEMENT TYPE ACTIONS

AIR QUALITY ANALYSIS IN TRANSPORTATION PLANNING, Transportation Research Record 670. "Integrated Planning and Management of Transportation and Air Quality," Joel Horowitz. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1978.

Efforts to implement the transportation control provisions of the Clean Air Act Amendments of 1970 have generated much discussion but little implementation of transportation measures to improve air quality. Reasons for this include conflicts over transportation priorities, inadequate institutional arrangements for combined transportation and air quality planning, and insufficient information concerning the relation between transportation and air quality. The Clean Air Act Amendments of 1977 provide a framework for handling these problems. However, important questions remain to be answered concerning organizational roles in transportation and air quality planning, the structure of the planning process and the responsibilities of transportation and air quality decision makers.

Author's Abstract

AIR QUALITY ANALYSIS IN TRANSPORTATION PLANNING, Transportation Research Record 670. "Air Quality Considerations in Transportation Planning," Elizabeth A. Deakin. Transportation Research Board, National Academy of Sciences, Washington, D.C. 1978.

For the past five years, transportation control plans and related air quality analyses of transportation projects have been the major focus of air quality considerations in transportation planning in metropolitan areas. Experience with control plans has been mixed: In many areas, tight deadlines, weak intergovernmental coordination, limited analysis of the costs and effectiveness of measures, and lack of public support for the plans combined to limit implementation of control measures. The Clean Air Act Amendments of 1977 include provisions to correct these problems. The amendments call for the development and implementation of plans to attain the national ambient air quality standards by 1987 under procedures that emphasize metropolitan,

state and local participation, consultation with elected officials and the public, and incremental progress in implementing transportation measures that improve air quality. The amendments authorize $75 million for planning grants to nonattainment areas and forbid federal agencies to approve or fund any activity that does not conform to the plan approved by the U.S. EPA. Federal agencies also must give priority to plan implementation. The amendments point to a process in which air quality considerations are an integral and continuing part of transportation planning. Wherever possible, the metropolitan planning organization would coordinate transportation air quality activities as part of the continuing, cooperative, comprehensive transportation planning process for the area. The unified work program, the long-range and transportation systems management elements of the transportation plan, and the improvement program would document the actions being planned or programmed to improve air quality. Periodic review of procedures being followed and progress in implementation would serve as the basis for determinations of conformity and for funding decisions. A major unresolved question is whether the transportation planning process can be shifted away fron consideration of air quality to the implementation of air quality improvement measures. This implies that the role of the metropolitan planning organization may have to evolve from coordinating and summarizing planning activities to orchestrating and catalyzing action. Next is the question of whether the incentive of planning funds and the threat of possible loss of federal assistance will be sufficient to induce agencies to experiment with those measures that often are perceived as visiting very clear inconveniences or costs on the public to reduce diffusely perceived threats to health and welfare. Finally, there are great uncertainties about whether and how a combined transportation and air quality planning process would be evaluated and whether pressures for responsiveness could be brought to bear effectively.

Author's Abstract

AIR QUALITY IMPACT OF SIGNALING DECISIONS, Richard G. Griffin. Colorado Department of Highways, Division of Transportation Planning, 4201 East Arkansas Ave., Denver, Colorado. September 1979.

Denver has been identified as having serious air pollution problems which are related to vehicular traffic. The 1977 Clean Air Act Amendments require Denver to improve its air to meet federal standards by 1982. Vehicles emit substantially more air pollution stopping and starting as compared to operating at a constant speed. Therefore, a significant reduction in air pollution could be realized if traffic controls could be optimized to reduce stops and idle time. Unfortunately, appropriate tools for determining air quality impacts of signaling decisions are not readily available to city, county, and state personnel designing traffic controls.

In Colorado, the only model available for estimating changes in air pollution emissions due to changes in traffic signals is the UTCS-1 (Urban Traffic Control System) Network Simulation Model. The basic drawback to this model is its large size and extensive input data requirements. It requires 240,000 words of central memory on a large computer. Because of this, this model cannot be used by most cities and counties and therefore, air quality is not considered in traffic signaling decisions.

The object of this study is to prepare a manual for estimating the impact of traffic signaling decisions on air quality. The manual will contain a methodology to estimate air pollution emissions in the area of a small group of signals given: geometry of roadway, signal timing and demand responsiveness, traffic volumes and turning movements, truck mix. It will also contain Nonographs for estimating emissions based on a few basic parameters for standard intersection configurations, traffic control techniques/alternatives for reducing emissions, and general criteria for determining signal type, green time, etc. for minimum air pollution. Many of these procedures could be expanded to determine vehicle energy consumption.

The first step in this research project was to determine automotive emission rates based on the mode of operation (acceleration, deceleration, idle, and steady state cruise).

Field monitoring of intersection behavior was performed in order to better determine the parameters used in the models and to determine how well the models depict reality.

Three models have been chosen to be investigated for incorporation into the manual. The first model is NETSIM. This model, earlier known as UTSC-1, is a large, very sophisticated model developed for the Federal Highway Administration. In later years of development, air pollution emissions and fuel consumption were incorporated into the model. The second model is program MICRO which is the intersection submodel for APRAC-2. APRAC-2 is a regional air quality model developed for Stanford Research Institute. MICRO is based on standard traffic engineering formulas for delay and queue length. The third model is program SIGNAL which was being developed. It is a simulation model for smaller systems and with less capabilities than NETSIM.

In addition to the models which estimate emissions for a given situation, a theoretical analysis was undertaken to determine signal timing for minimum emissions.

From Text

PB-282 346

AIR QUALITY IMPACTS OF TRANSIT IMPROVEMENT, PREFERENTIAL LANE, AND CARPOOL/ VANPOOL PROGRAMS, J.F. DiRenzo, R.B. Rubin. Peat, Marwick, Mitchell and Company for EPA, Dept. of Transportation. March 1978. 125 pages.

The report has been prepared in accordance with Section 108(f) of the Clean Air Act, as amended, August 1977. It is intended to assist urban areas in developing State Implementation Plans and integrating their transportation system management and air quality planning programs as required by FHWA, UMTA, and EPA. The report analyzes the air quality, travel, energy consumption, economic, and cost impacts of three types of transportation programs: priority treatment for high occupancy vehicles on freeways and arterials; areawide carpool and vanpool programs; and transit fare reductions and service improvements. Important factors (e.g., meteorological conditions, traffic volumes and speeds and changes in modal choice) likely to influence air quality and emissions for the above programs are also analyzed.

From Highway Research Information Service Records

PB-259 949

PARKING MANAGEMENT STRATEGIES FOR REDUCING AUTOMOBILE EMISSIONS, J. Dern, J. Cole, et al. Energy & Environmental Analysis, Inc., Arlington, VA 22209, for Office of Research and Development, U.S. EPA, Washington, D.C. 20460. Sept. 1976.

This study defines the concept of parking management and explores how parking management can be used to improve air quality, support mass transit, reduce energy consumption and improve the amenities of life in urban areas. Specific goals of the study are: (1) to develop a prototype parking management plan for the Washington, D.C., metropolitan area illustrating types of measures which can be used for parking management; (2) to evaluate the socioeconomic impacts of the parking measures in the plan and their effectiveness in reducing vehicle miles traveled (VMT) and improving air quality; (3) to develop a parking management planning process which integrates local and regionwide planning through the use of regional guidelines.

Four target areas in the D.C. region were studied in detail. A regional plan was then developed from information gathered in the target area studies, including an analysis of regionwide parking related goals and problems.

196 pages

Author's Abstract

PB-299 515

PARKING POLICY AS A TRANSPORTATION SYSTEM MANAGEMENT MEASURE, V.R. Vuchic and M.S. Hessami, University of Pennsylvania, Department of Civil and Urban Engineering, Philadelphia, PA 19104; for U.S. Dept. of Transporation, Urban Mass Transportation Administration, Washington, D.C. 20590. January 1979.

In many cities, parking is considered as an independent component of the transportation system, and often without public control. The main purposes of this study are: (1) to show that parking policy represents a potentially effective tool for regulation of urban transportation under the Transportation System Management (TSM) program; (2) to define the relationship between the parking policy with other complementary or alternative TSM measures; (3) to present and evaluate various aspects of a parking policy and illustrating these by various applications in different cities; and (4) to recommend the potential parking policies which cities can apply as a part of their TSM measures.

This study presents different types of parking restraints in the forms of regulatory measures, limits on parking supply, and pricing. Applicability and effectiveness of each measure is discussed. Groups affected, whether positvely or negatively, by various parking measures are defined. Experiments undertaken in several cities with different types of parking regulations and pricing are described. The report recommends that parking be included in analyses and planning of urban transportation systems and used as a very effective tool of traffic regulation, modal split change, and improvements of both urban travel conditions and urban environment in general.

75 pages

From Text

THE SANTA MONICA FREEWAY DIAMOND LANES: EVALUATION OVERVIEW, J.N. Billheimer. Transportation Research Record, No. 663, 1978, pp 8-16.

The Santa Monica Freeway Diamond Lanes, a pair of concurrent-flow preferential lanes for buses and carpools linking the City of Santa Monica, California with the Los Angeles Central Business District, opened on March 16, 1976 and operated amid much controversy for 21 weeks until the U.S. District Court halted the project. The Diamond Lane project marked the first time preferential lanes had been created by taking busy freeway lanes out of exsiting service and dedicating them to the exclusive use of high-occupancy vehicles. Although the Diamond Lanes entailed no major physical modifications or construction on the freeway itself, they caused significant physical and emotional dislocation among freeway drivers, public officials and other residents of Los Angeles, and generated considerable controversy regarding the reported and actual impacts of the project. This paper summarizes the findings of the official, objective, independent evaluation of the project sponsored by the U.S. Department of Transportation as part of the UMTA Service and Methods Demonstration Program. The paper addresses a broad range of project impacts in the following major areas: traffic speeds and travel times; traffic volumes and carpool formation; bus operations and ridership; safety and enforcement; energy and air quality; and public attitudes and response. Analysis shows that the project succeeded in increasing carpool ridership by 65% and the increased bus service accompanying the Diamond Lanes caused bus ridership to more than triple. Nonetheless, energy savings and air quality improvements were insignificant, freeway accidents increased significantly, non-carpoolers lost far more time than carpoolers gained, and a heated public outcry developed which has delayed the implementation of other preferential treatment projects in Southern California and given planners and public officials in other areas ample cause for reflection before attempting to implement similar projects.

From Highway Research Information Service Records

PB-299 984

SIMPLIFIED AIDS FOR TRANSPORTATION ANALYSIS: ESTIMATING PARKING ACCUMULATION, Peat, Marwick, Mitchell & Co., Washington, D.C.; for U.S. Department of Transportation, Urban Mass Transportation Administration, Washington, D.C.

This report describes simplified aids to improve transportation decisions without resorting to computers or extensive data collection. The analytical aid described in this report provides a method for estimating the accumulation of parked vehicles within a study area over the course of a typical weekday. Parking accumulation and utilization of parking facilities may be estimated for all parkers, long-term parkers, and/or short-term parkers, based on an estimate of daily automobile trip destinations, an inventory of available parking supply, and a set of parking "accumulation factors" which may be derived from a parking survey within the study area or from default values provided in this report.

The primary use of the parking accumulation estimation method is to analyze the adequacy of available parking supply in relation to expected parking demand. The method may also be used to monitor and suggest revisions to automobile travel impedance values used in transportation planning models.

This report is one in a series of six reports. Other reports are:

1. Annotated Bibliography (UMTA-IT-06-9020-79-1)
2. Forecasting Auto Availability and Travel (UMTA-IT-06-9020-79-2)
3. Estimating Ridership and Cost (UMTA-IT-06-9020-79-3)
4. Transit Route Evaluation (UMTA-IT-06-9030-79-4)
5. Estimating Parking Accumulation (UMTA-IT-06-9020-79-5)
6. Fringe Parking Site Requirements (UMTA-IT-06-9020-79-6)

From NTIS Abstract

PB-297 523

TRANSPORTATION CONTROL PLAN. Volume 1: Summary; Volume 2: Transportation Control Planning in the Baltimore Region; Volume 3: Technical Documentation; Volume 4: Evidence of Commitments; Emery Hines, Jack Anderson, Ganie DeHart. Regional Planning Council, 2225 North Charles Street, Baltimore, MD 21216; for U.S. Department of Transportation, 400 Seventh Street, SW, Washington, D.C. 20590. September 1978.

The Transportation Control Plan for the Baltimore metropolitan area sets forth the actions that will be taken by the region between now and 1987 to reduce the amount of air pollution caused by motor vehicles. The development and implementation of this plan is required by the Environmental Protection Agency as a result of the 1977 Clean Air Act Amendments.

The plan contains measures both for implementation and for study. Thirteen control measures and a public education campaign are to be implemented by 1982. At least twelve more control measures will be studied by the end of 1980 for possible inclusion in a more detailed and comprehensive transportation control plan to be completed in 1982.

Even after all measures now specified for implementation are fully applied, the region will still not achieve EPA's air quality standards by 1987. Ways of further reducing air pollution in the region will have to be found.

MEASURES FOR IMPLEMENTATION - The following measures are to be implemented by 1982:

Incentives for High Occupancy Vehicles

1. Park-and-ride lots
2. Improved rail transit
3. Carpooling
4. Vanpooling
5. Preferential parking for ridesharing vehicles
6. Bus service improvements

Measures for Cleaner Vehicles - Inspection and maintenance of motor vehicles

Measures to Reduce Congestion-Related Emissions

1. Traffic flow improvements
2. On-street parking restrictions
3. Reduction of extended idling
4. Encouragement of bicycling

Measures to Reduce Automobile Use - Residential permit parking

Other Measures

1. Land use management
2. Public education campaign

MEASURES FOR STUDY - The following measures are to be studied before the end of 1980:

Incentives for High Occupancy Vehicles

1. Exclusive lanes for buses and ridesharing vehicles
2. Reduced transit fares

Measures for Cleaner Vehicles

1. Cleaner fleet vehicles
2. Retrofit of emission control devices
3. Cold start emission reduction programs

Measures to Reduce Congestion-Related Emissions

1. Staggered or flexible work hours
2. Encouragement of moped use

Measures to Reduce Automobile Use

1. Increased parking fees
2. Increased fuel taxes
3. Auto-free zones
4. Road tolls

Other Measures - Episodic vehicle controls

17 pages

From Introduction by Author

TSM: TINKERING SUPERFICIALLY AT THE MARGINS?, D.W. Jones (California University, Berkeley) and E.C. Sullivan. ASCE Journal of Transportation Engineering, Volume 104, Number 6, November 1978, pp 817-834, 14 references.

This paper summarizes the findings of a two-year evaluation of the Transportation System Management (TSM) program of the U.S. Department of Transportation. The study assessed both the technical options commonly associated with TSM--such as car pool matching, flexible work hours, exclusive lanes for buses and car pools, and discriminating pricing--and the planning philosophy implicit in the federal regulations. The analysis suggests that a package of TSM measures combining preferential freeway entry, car pool matching, paratransit, and flexible working hours, which emphasize exploiting underutilized capacity, are technically and politically superior to the more drastic penalty-centered alternatives, such as dedicating freeway and arterial lanes to high-occupancy vehicles, removing parking in congested areas, and heavy auto-disincentive surcharges (in excess of marginal cost pricing). It appears that most TSM measures--even relatively stringent disincentives--will have air quality and energy conservation impacts that are marginal at best. Air quality and fuel conservation planners would be advised to focus on vehicle technology improvements and vehicle inspection programs for more telling results. The research concludes that time-management strategies, such as variable work hours, are the least exploited of the promising measures available, and thus deserve increased attention.

Author's Abstract

TRAFFIC ESTIMATION (VMT, PEAK PERIOD, VEHICLE MIX) METHODOLOGY

AN ANALYSIS OF URBAN AREA TRAVEL BY TIME OF DAY, Lawrence H. Tittemore, Michael R. Birdsall, et al. (Peat, Marwick, Mitchell & Co.). For U.S. Department of Transportation, Federal Highway Administration, Office of Planning, Washington, D.C. 20591. January 1972.

This research project is a thorough analysis of the temporal distribution of vehicular travel in eight U.S. urban areas (Boston, Massachusetts; St. Louis, Missouri; Louisville, Kentucky; Seattle, Washington; Oklahoma City, Oklahoma; Stockton, California; Fall River, Massachusetts; Colorado Springs, Colorado) with populations ranging from 100,000 to 3,500,000. Graphical models were developed for the analysis and explanatory factors of the temporal distribution are delineated.

Travel in an example urban area, St. Louis, and the other cities, is summarized and displayed in both graphical and tabular form. Approximately 80 percent of an urban area's vehicular traffic is by autos or other similar four-wheel vehicles. Trucks (six wheels or more) account for the remaining 20 percent of the vehicular traffic. Home-based non-work person trips predominate and account for approximately 55 percent of internal person travel in an urban area. Work trips account for 29 percent of the internal person travel, with the remaining 16 percent non-home based travel. Average trip travel time by auto is approximately 4/10 hour, in comparison to 3/4 hour by transit.

Extensive computer plots of person trips in motion, distributed by time of day, and vehicle miles of travel, distributed by time of day, were prepared and displayed in this report for nine purposes of personal travel, for taxi trips, and for truck trips. These distributions show that the highest VMT are obtained between 4 and 5 p.m. Work travel peaks between 7 and 8 a.m. and non-work travel peaks between 7 and 8 p.m. Graphical relationships and models were developed to explain these temporal distributions and to exhibit the effects of various socio-economic characteristics and traffic congestion factors.

The research work for this study was conducted in two phases. In Phase A, five submodels were used to aggregate hourly travel into similar time groups, i.e., wee hours, morning, mid-day, afternoon, evening. In Phase B, areawide traffic count data were used to determine total vehicle miles of travel occurring on various classes of highway, and at varying distances and orientations from the central core city, on directional and non-directional bases.

From Text

CHARACTERISTICS OF URBAN TRANSPORTATION DEMAND - A HANDBOOK FOR TRANSPORTATION PLANNERS, Herbert S. Levinson, Wilbur Smith and Associates and DeLeuw Cather & Company. UMTA, April 1978.

This report is a handbook which can be used by urban transportation planners in estimating the various components of urban transportation demand. It contains characteristics of urban bus, rail, and highway systems, and urban trip-making. A part of the Urban Transportation Planning System (UTPS) of UMTA and FHWA, it provides basic inputs to the urban transportation planning process as well as ways of checking the results for reasonableness and relevance.

An appendix to the CUTD handbook offers detailed data on individual cities, roads, routes, stations, etc. These are not in a form that is comparable from place-to-place, but may be of interest from an historical perspective for the urban areas concerned. The appendix is available only from NTIS as Project No. UMTA IT-06-0049-78-2.

From Text

CHARACTERIZATION OF VEHICLE USE IN FIVE AIR QUALITY CONTROL REGIONS, John A. Eldon and Donald B. Hunsaker. Technology Service Corp. for U.S. Environmental Protection Agency, Emission Control Technology Division, Ann Arbor, MI 48105. 3/78.

Under contract to the Emission Control Technology Division of the Environmental Protection Agency, Technology Service Corporation (TSC) has compiled data, estimates and projections of vehicle population and use by vehicle age and type for the following Air Quality Control Regions: Chicago, Denver, Los Angeles, Houston and Phoenix. Each of these regions is one in which ambient standards for one or more automotive pollutants are exceeded significantly.

Meteorological data for the five AQCRs were also compiled. To test the hypothesis that motor vehicle use or climate within a central urban core may differ from that of the region containing it, we also collected data for the metropolitan centers of four of the AQCRs, omitting Phoenix because of its uniformly low population density and near-absence of a traditional urban core.

Eight sets of data were compiled on vehicle use, vehicle population and climate. These data sets and assumptions and procedures used in their development are the subjects of Chapters 2 through 9.

Presented are:

1. projections of the ratio of urban to nonurban travel for the years 1975 through 1990.
2. estimates of average individual vehicle use (miles driven per year) as a function of age and type.
3. lists for each AQCR, distribution of vehicle registration by vehicle age, separated by vehicle type.
4. distribution of total VMT in each AQCR by vehicle age and type. Given the vehicle emission factors as a function of age, and the total traffic load of a given roadway, the results can be used to compute the corresponding total emissions.
5. future trends in total vehicle miles traveled for each AQCR.
6. vehicle sales projections for each AQCR based on national popu-

lation and vehicle sales projections and an analysis of historical sales trends.

7. temperature and absolute humidity data for each AQCR. Monthly mean and average monthly range of temperature were compiled, as well as monthly mean absolute humidity. Data were computed from ten-year averages of data for each calendar month.

This data was severely limited by the availability of data -- in many cases, the desired data were nonexistent and had to be estimated from other information.

94 pages

From Text

A METHODOLOGY FOR FORECASTING PEAK AND OFF-PEAK TRAVEL VOLUMES, Martin Wohl (The Urban Institute). From Highway Research Record 322, 1970. Washington D.C.

No information can be more important to transport planners, designers, and analysts than reliable forecasts of the peak and off-peak travel volumes on transportation networks. Yet, no reasonably complete and valid methodology has been proposed -- much less developed and verified -- that will permit the transport planner and analyst to properly differentiate travel by time of day; to determine realistically the duration and level of peaking and recognize its dependence on the transport system design and performance; and to account for shifts in trip-making from one hour to another, from one mode to another, and from car pooling to driving alone in response to changes in transport system design, in service, or in price. Further, the usual travel forecasting process treats trip generation as though trip-making were independent of transport system changes, and it treats the trip distribution, modal-split, and the route assignment phases as though trip-making choices -- whether to travel, final destination, mode, and route -- are made sequentially and apart from the circumstances attendant with the other phases. Accordingly, the purpose of this paper is to formulate a model structure such that these phases can be treated simultaneously, that the total amount of trip-making (as well as the destination, modal, and routes choices) can be varied with the transport system and its performance and price characteristics (among other factors), that shifts from car pooling to driving alone can be represented, that shifts from one hour of travel to another can be characterized, and that the amount of travel during peak and off-peak hours (i.e., the absolute buildup or decrease in peak or off-peak flow) can be determined.

36 pages

Author's Abstract

PREDICTING PEAK-HOUR TRAFFIC, Louis A. Y. Shallal and Ata M. Khan. From Traffic Quarterly, Vol. 34, No. 1, January 1980, pp 75-90.

In spite of recent advances made in the refinement and application of the urban transportation planning methodology, the process of converting urban daily travel demand to peak-hour volumes is highly deficient. Existing approaches to peak-hour ratio estimation and application are reviewed in this article and their deficiencies are described. New approaches that are generally behavioral based, namely, trip end, trip interchange, concentrated work trip, and the disaggregated approaches, are identified and offer potential for improved estimation of peak-hour travel patterns.

For development of the improved approaches, the following suggestions are offered:

1. To establish the level of reliability of various approaches for peak-hour ratios estimation and application, it is suggested that a comparative analysis be performed at two levels, namely, at the link level and for the entire network level. At the link level, comparative analysis will indicate, when model volumes are compared to actual counts, which approach is the most reliable. The transport network assignment of matrices produced through various applications of the different peak-hour ratios approaches, on the other hand, can establish the range of possible variation in resultant peak-hour volumes.

2. In the disaggregate household and individual level analysis, it is suggested that the "maximum likelihood technique" be employed to investigate the variation of peak-hour ratios as a function of individual or household attributes. The investigation should take a behavioral form similar to that of the logit model in modal-split analysis. The dependent variable would be the probability of making a peak-hour trip given certain individual attributes in much the same way as the logit model establishes the probability of choosing a particular transportation mode by various users.

3. Further research into the variation of peak-hour ratios and directional-split factors by facility type and various geographic areas is suggested.

4. It is suggested also that research into 24-hour, PM peak hour, and AM peak hour based models be supported, where feasible, since the cost of simulation is a small portion of the cost of the overall process. Benefits of individual link design should undoubtedly offset the cost of simulation.

5. Finally, it is recommended that further research be carried out to take into account the seasonal variation of travel. The definition of the model output should be reconciled with the time basis of traffic counts used to validate results.

From Text

VEHICLE OPERATING COSTS, FUEL CONSUMPTION AND PAVEMENT TYPE AND CONDITION FACTORS, J.P. Zaniewski, B.C. Butler, et al. Prepared for Federal Highway Administration, Office of Research and Development, Washington, D.C. 20590; by Texas Research and Development Foundation, 2602 Dellana Lane, Austin, Tx. April 1980. Report No. FHWA-RD-80.

This is the first interim report on a FHWA sponsored research project on "Vehicle Operatings Costs, Fuel Consumption and Pavement Type and Condition Relationships". The relationship between vehicle operating costs and roadway characteristics has not been studied in the United States for over 10 years. Since that time, all of the cost factors associated with owning and operating an automobile have increased. The cost of fuel has shown the greatest increase.

More recent research has been conducted in foreign countries, but the transferability of these findings across international boundaries has yet to be established. If it can be shown that the effects of highway characteristics on vehicle operating costs can be transferred to the United States, then the research effort to update vehicle operating costs in the United States may be reduced.

The purpose of this report is to present a synthesis of the vehicle operating costs literature. Over 600 articles and reports were reviewed in preparation for this report. Major emphasis was placed on fuel consumption, and the other components of vehicle operating costs. Vehicle classification, running speeds, accidents, and emissions are also addressed. Recommendations for further research are presented.

The results and conclusions presented in this report are limited to the information currently available in the scientific literature. Areas of insufficient or obsolete information are identified for further research.

The first issue addressed is vehicle classification. Historical data were reviewed and three automobile and five truck classes were selected to represent the vehicle population as described in Chapter 2. Fuel consumption receives major emphasis in this report. Relationships between fuel consumption and highway characteristics are described in Chapter 3 along with an experimental program for updating fuel consumption tables. The other components of vehicle operating costs are addressed in Chapter 4. Vehicle speeds, accidents, and emissions are described in Chapters 5, 6, and 7. Further research needs and the work plan are described in Chapter 8.

From Text

HOT/COLD STARTS AND HOT SOAK ESTIMATION METHODOLOGY

PB-293 842

ANALYSIS OF HOT/COLD CYCLE REQUIREMENTS FOR HEAVY-DUTY VEHICLES, Chester J. France. U.S. EPA, Office of Air and Waste Management, Office of Mobile Source Air Pollution Control, Emission Control Technology Division, 2565 Plymouth Road, Ann Arbor, MI 48105. July 1978. 76 pages.

EPA has been involved recently in the development of transient engine and chassis cycles from the CAPE-21 survey data. The CAPE-21 survey data was gathered from 88 in-use trucks; 44 in New York City and 44 in Los Angeles. Vehicle speed, engine rpm, engine power, engine temperature, and various traffic and road describers were recorded on tape at approximately one second intervals. Prior to the actual generation of the cycles, the need for a unique cold start cycle (engine and/or chassis) was investigated.

OBJECTIVE

The purpose of this report is to determine if there is a need for a unique cold start cycle for heavy-duty transient emission testing.

RESULTS

The temperature analysis was done on CAPE-21 truck data by Olson Laboratories. The summary statistics were obtained from a representative cross-section of trucks surveyed during CAPE-21 for which reliable second-by-second temperature data were available. A complete copy of the summary statistics provided by Olson is presented in this report.

The results from the analysis indicate that there does not appear to be a significant difference in hot versus cold truck operation from a practical viewpoint. Cold operation constitutes 2.3% of the total operation. The only definite trend identified during the analysis was a longer than normal initial idle following a cold start.

CONCLUSIONS

There does not appear to be a substantial difference in vehicle/engine operation following a cold, warm, normal or hot start. The only exception to this is that a cold start is typically followed by a slightly longer than normal idle period. Consequently, the sole requirement for a cold start portion of an emission test cycle is an idle period of approximately twenty seconds immediately following engine start-up.

From Text

PB-288 860

DETERMINATION OF PERCENTAGES OF VEHICLES OPERATING IN THE COLD START MODE, Theodore P. Midurski, et al. GCA Corp., Bedford, MA, GCA Technology Div. August 1977. 112 pages.

The report provides detailed information on a number of aspects of (1) the cold start mode in general; (2) the techniques used in the analysis; (3) the data base used; and (4) the results of the entire study. Section 1 provides a general introduction including discussion regarding the background and purpose of the study.

The technical aspects of cold mode operation are discussed in Section 2. Included are discussions concerning the primary relationships between cold operation and emission rates, and the factors that are instrumental in determining the impact of operating in the cold mode. Discussion is also provided regarding the definition of cold operation.

Section 3 provides a discussion of the general techniques used in the study. Included are descriptions of the mechanics of the procedure as well as the data and data sources used. A more technical discussion of the study methodology is provided in Section 4.

The results of the study are presented in Section 5. This section includes discussions of the results of analyzing the 60 study links both separately and in groups. Separate discussions are provided for Pittsburgh and Providence (cities where the studies were conducted). The results of the sensitivity analysis are also discussed in this section. Section 6 discusses the conclusions of the entire analysis and offers several recommendations for further study.

Three technical appendices are provided describing the Federal Test Procedure, the comprehensive planning process, and an example computation of the percent of vehicles operating in the cold mode on a study link, respectively.

A glossary defining a number of technical terms used throughout the report is also provided.

From Text

THE DETERMINATION OF VEHICULAR COLD AND HOT START OPERATING FRACTIONS FOR ESTIMATING HIGHWAY EMISSIONS. George W. Ellis; State of Alabama Highway Department; prepared for FHWA Office of Environmental Policy. Washington, D.C. September 1978.

Part I describes the research and a detailed procedure by which cold and hot fractions can be calculated for any time of day for any set of urban traffic conditions. Part II is a stand-alone workbook which can be used to calculate three cold/hot parameters required for the emission factor computation that is an essential part of air quality analysis: the fraction of travel in the cold-transient mode, non-catalytic; the fraction of travel in the cold-transient mode, catalytic. Three procedures of increasing refinement are developed. The Simplified Method requires a user supplied average trip length for all internal auto driver trips. A series of curves furnished in the workbook are used to estimate percent of travel by hour of the day for each of the three cold/hot parameters. The Abbreviated Method requires a user supplied average trip length for all internal auto driver trips for each trip purpose and either the fraction of travel represented by each purpose or the number of trips for each purpose. A series of worksheets, figures, and tables are then used to estimate percent of travel by hour of day for each of the three cold/hot parameters.

The Complete Procedure requires the user to furnish:

(1) From O-D survey data or other source, the cold-start fraction (non-catalytic and catalytic equipment) and hot-start fraction (catalytic equipment) for each purpose for the hour of interest.

(2) From O-D survey data or other source, the fraction of travel represented by each purpose for the hour of interest.

(3) Using trip distribution data with terminal times included, the transient mode by purpose for each purpose contributing to travel. The cold/hot parameters of interest are then computed using procedures described in the handbook. The complete procedure is not normally recommended due to the data and computational requirements.

The basis for this study was O-D survey data for six urban transportation study areas in Alabama and the Eastern Massachusetts Regional Planning Project for the years 1965 and 1966 for Alabama and 1963 for Massachusetts. The raw data required that each vehicle be uniquely identified, the beginning and end times of each trip and the purpose of each trip must be available. The data from these six urban areas are assumed to be similar to other urban areas of comparable size.

103 pages

From Text

PG-270 689

HOT SOAK TIME CONSTRAINTS (In-House Test Program Report No. 6), Thomas Rarick and Gary Wilson, Standards Development and Support Branch, Emission Control Technology Division, EPA, Ann Arbor, MI 48105. July 1976.

The objective of the in-house evaporative emission enclosure (SHED) test program is to develop a concise, accurate, and practical evaporative emission test procedure. One of the tasks identified for the test program was to establish a recommended time from the end of the dynamometer test cycle to the start of the hot soak evaporative emission test. The report discusses the data which were gathered to fulfill this task. The objective of the report is to use the collected data to establish the effect of the time between the exhaust emissions and hot soak emissions test phases on the measured evaporative emission levels during the hot soak and to recommend a time tolerance based on this information and practical considerations.

SUMMARY AND CONCLUSIONS:

The time tolerances of two operations prior to the hot soak evaporative emissions test were evaluated. They were:

a) The time from the end of the exhaust test cycle to engine shutdown (idle time); and

b) The time from engine shutdown to the start of the hot soak test.

FIRST EVALUATION:

Procedure

1. vehicle allowed to idle 2, 4, 6, or 8 minutes.
2. measure carburetor bowl and hydrocarbon losses during the one hour hot soak following engine shutdown

Results

1. initial bowl temperatures for longer idle time were higher
2. peak bowl temperatures were the same
3. no trend of increasing emissions with increasing idle times

Recommendation

That time be specified at a four minute maximum time tolerance. Experience obtained during testing program indicates that this will not be a difficult time tolerance to achieve in production.

SECOND EVALUATION

Procedure

1. measured hot soak emissions on six test vehicles on time delay from engine shutdown to start of hot soak test.

2. error resulting from time delay of one minute was estimated using hydrocarbon loss data from first and last minute of 60 minute hot soak test.

Results

1. errors as large as 2% can result from one minute time delay.

2. longer delays may cause even larger errors, depending on relative rates of hydrocarbon evolution at the start and end of hot soak test.

3. time tolerance of less than one minute is not practical.

Recommendation

Time tolerance of 1.0 minute should be established for the key-off to the start of the hot soak test operation.

HOUSTON AREA OXIDANT STUDIES (HAOS)

AND RELATED OXIDANT STUDIES

PB-299 647, 648, 649

AEROMETRIC DATA ANALYSIS FOR THE HOUSTON AREA OXIDANT STUDY, VOLUME 1, Executive Study; Volume 2; Volume 3, Data Summaries; F.L. Ludwig and J. Raul Martinez. SRI International, 333 Ravenswood, Menlo Park, CA 94025; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. July 1979.

This report presents the results of a study to use data collected during the Houston Area Oxidant Study and other available data to:

1. Describe the air quality and meteorological conditions in the Houston area.
2. Describe emissions (both anthropogenic and natural) in the Houston area.
3. Examine linkages that relate air quality in the Houston area to meteorological and emissions conditions.
4. Examine some of those conditions that seem to be unique to the Houston area.

The findings of this study are described in Volume 2 of the report. The major findings are:

1. From the standpoint of climate, the HAOS study period (summer and early fall of 1977) was generally typical of recent years. The important climatological factors (e.g., temperature, cloudiness, winds) were close to their long-term averages and oxidant concentrations were well within their ranges observed during recent years.
2. Hourly average PAN levels in the Houston area measured during the study period ranged from 0 to 15 ppb. Detectable concentrations were found only about 30 percent of the time with the highest concentrations occurring at Aldine and Fuqua. In general, PAN levels increased from June to October, which suggests a seasonal factor affected PAN production.
3. The majority of the 0600-0900 (CDT) $NMHC/NO_x$ ratios observed within the urban envelope ranged from 2 to 50 with a median ratio of 12. Outside the urban area the median ratio was 29, substantially higher than the urban ratios. This spatial variability of $NMHC/NO_x$ ratios must be considered when formulating ozone control strategies.
4. Only a limited analysis of detailed hydrocarbon data was performed because the data became available too late. Selected hydrocarbons measured at Aldine, Clinton, Crawford and Fuqua during the period 0600-0900 were examined. Evidence of motor vehicle influence was found at all the sites, with Crawford and Aldine showing the strongest mobile source effect. Clinton and Fuqua showed evidence of widespread influence from sources other than motor vehicles. Ethane and propane were ubiquitous in the Houston area with Fuqua exhibiting a higher proportion of these compounds than the other sites. The hydrocarbon mixture at the Crawford site in downtown Houston was found to be similar to that in downtown Los Angeles because of the predominance of mobile sources. Substantial differences exist between the mixtures of the other three sites (Hoboken, NJ, St. Louis, MO and Houston) and that for Los Angeles.

5. The medians of special visibility observations taken during morning and early afternoon hours have a spatial pattern that is similar to that of the average ozone concentrations during late morning hours. In general, the highest average ozone concentrations were found to the north northeast of central Houston during these hours; the poorest visibilities are nearby, but somewhat further to the east. Average morning ozone concentrations decrease toward the west and toward the east, while median morning visibilities increase in these directions. Comparisons of visibility and ozone could not be made for periods of peak photochemical activity, because the special visibility observations were not made during the mid- and late afternoon hours.

6. Based on observed concentrations of beryllium-7 (an indicator of the presence of stratospheric air), there were some incursions of stratospheric air into the Houston area during the fall of 1977. The indications are that the stratospheric ozone contributions, averaged over 24 hours, probably amounted to a few tens of ppb. The stratospheric contributions may have had important variations about the 24-hour average; hence, there may have been some individual hours with higher contributions. The possibility also exists that this ozone may have enhanced the local formation of ozone, as has been suggested in the literature.

7. Statistical correlation analysis between hour-averaged ozone concentrations and concurrent measurements of meteorological factors and precursor concentrations show that the closest statistical relationships are with temperature and wind speed. Ozone concentrations in excess of 120 ppb are virtually nonexistent when temperatures are less than $75^{o}F$ or wind speeds are outside the range from 1 to 4 m/s (approximately 2 to 8 mph). The lack of a strong correlation between ozone and precursor concentrations probably reflects, in part, the fact that the formation of ozone tends to be removed in space and time from its precursor origins.

8. Although it was not possible to quanitfy natural emissions in the emissions inventories that were prepared, observations of hydrocarbon emissions from pine forests elsewhere in the United States suggest that the natural source associated with the forest to the northeast of Houston may produce significant amounts of hydrocarbons.

9. The three-dimensional distribution of ozone in the Houston area is a complex product of offsetting processes: destruction, formation and transport. Ozone is frequently isolated in layers aloft at night and mixed downward to ground level during the day. The ozone aloft may also hasten the nighttime conversion of NO to NO_2.

10. The Empirical-Kinetic Modeling Approach (EKMA), developed by the U.S. EPA generally predicts ozone concentration higher than those observed in Houston. However the EKMA does provide reasonable estimates of the upper limits of ozone production and hence the maximum concentration that is likely to occur for a given morning mixture of NMHC and NO_x.

Volume 1 - 56 pages
Volume 2 - 333 pages
Volume 3 - 271 pages

From Text

PB-299 643

AIRBORNE AEROALLERGEN MEASUREMENTS IN HOUSTON, TEXAS, J.T. Ivy. Southwest Research Institute, 3600 Yoakum Blvd., Houston, Texas 77006; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, Texas 77002. March 1979.

Three principal objectives were established for the aeroallergen study, including sampling of Houston air for aeroallergens on a daily schedule for a period of four months beginning in July 1977, using a documented, reliable, reproducible method; identifying and documenting major aeroallergens which might contribute to allergic responses in humans; and determining and documenting the accuracy and precision of the qualitative and quantitative determinations required above.

The sampling program provided adequate data for the support of the analysis of the health effects data. Daily variations and seasonal trends of aeroallergens were observed which were comparable with expectations for the Houston area. For application to analysis of allergic response, aeroallergens present in the Houston area may be categorized in three major groups: ragweed pollen, grass pollens, and total mold spores. This conclusion is based on the daily and seasonal variations observed in this study, consultations with area allergists, and review of the available literature.

115 pages

From Text

PB-299 642

AIRBORNE OZONE STUDY, VOL. 1, THE EXPERIMENT AND FINDINGS, VOL. 2, THE INDIVIDUAL FLIGHT DATA, Maxwell E. Shauck and W. Merle Alexander. Baylor University, Institute of Environmental Studies, Waco, Texas; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, Texas 77002. May 1978.

From September 1976 through November 1977 an Aerial Air Quality Monitoring Program was conducted as part of the Houston Area Oxidants Study. Measurements were made utilizing an instrumented aircraft as an instrument platform. The program was designed to maximize the three-dimensional capability of the aircraft and its value to the HAOS. The aircraft was capable of providing measurements above and below the mixing depth and upwind and downwind of the Houston area. Flight patterns were designed to take into account the prevailing meteorology and to collect data in both the upwind and downwind areas of Houston.

The measurement program included continuous ozone, nitrogen oxide, nitrogen dioxide, scattering coefficient and temperature measurements. Air samples were collected in cannisters at various times for analysis.

Although the ozone concentration upwind of the Houston-Galveston area frequently exceeded 100 ppb, passage of air over the ship channel resulted in an elevation of the ozone levels. This effect was observed to be most pronounced during periods of weak pressure gradient, high solar insolation and high temperatures. It was not unusual for the ozone concentration to double and sometimes more than double. Observations lead to the conclusion that the urban plume emanating from Houston may be considered as originating at the Houston end of the ship channel.

Trajectory analysis of data collected on three separate flights imply the existence of transport of ozone exceeding the 80 ppb level into Houston. In one instance, the ozone seems to have been transported into Houston from a region of the Gulf of Mexico which makes it very unlikely that the ozone is anthropogenic in origin. In another, the ozone circulates from Houston or its vicinity out into the Gulf and then back into the opposite side of Houston. The third trajectory indicates transport of ozone exceeding 80 ppb into the Houston area from the Gulf after having just passed over the coast near Mobile, Alabama.

While the nature of this airborne study by itself precludes assigning any percentage of contributions to anthropogenic as opposed to non-anthropogenic sources of ozone in the Houston area, the data indicates that the urban area in all probability can generate levels of ozone over 100% in excess of present NAAQS levels by itself, but that Houston does receive, from transport, air containing levels of ozone already exceeding the 80 ppb level.

The frequency with which ozone concentrations of greater than 100 ppb were recorded in rural areas under conditions which seemed to preclude an urban source indicates that the standard for ozone should at least be greater than 100 ppb. The various circumstances under which high levels of ozone were transported into Houston and the variety of sources indicated implies a very complex structure in the formation and transport of ozone. An expanded research effort in the area of formation and transport of ozone, particularly in the Gulf coast region was recommended.

175 pages

From Text

PB-285 549

AMBIENT OZONE, OXIDANTS, AND NITROGEN OXIDES MEASUREMENTS IN THE HOUSTON AREA, Robert T. Jorgen, Rockwell International Corporation, Atomics International Division, Air Monitoring Center; for Radian Corporation, P.O. Box 9948, Austin, TX 78766. May 1978.

Rockwell International performed ambient air analyses in Houston, Texas, during the period June 15, 1977 through October 31, 1977. Total oxidant was monitored at each of three designated sites in Houston; ozone and oxides of nitrogen were monitored at a rural site northwest of Houston; and ozone was monitored at an offshore platform southeast of Houston in the Gulf of Mexico.

A rigorous quality assurance program was maintained during the course of the study. The program consisted of frequent instrument calibration, inter al quality assurance audits and a second independent quality assurance audit program was conducted by HAOS during the course of the study.

Data retrieval rates were generally good throughout the study. Overall data capture after validation was 91% of possible hours with individual site rates of 96%, 89%, 94%, 89%, and 92%.

The highest hourly average oxidant level observed in Houston was 194 ppb occurring on September 21, 1977. The highest hourly average ozone level observed at the offshore site in the Gulf of Mexico was 156 ppb occuring on September 5, 1977. The highest hourly average ozone concentration observed at a rural site northwest of Houston was 186 ppb occuring on October 5, 1977. The highest oxides of nitrogen and nitric oxide hourly averages observed at the rural site were 55 ppb and 28 ppb respectively, both occurring on October 12, 1977.

A general trend of increasing oxidant concentration was apparent from south to north across the city. Air entering the area from the southeast contains a 25 - 30 ppb background level of ozone as evidenced by the measurements made at the offshore site where mean ozone concentration persisted at this level day or night with a relatively small ($\sim$15 ppb) arithmetic standard deviation. Any method for the control of photochemical oxidant precursors would most certainly require the evaluation of this significant level of background (or transported) ozone.

From Text

PB-299 633

AN ANALYSIS OF ATMOSPHERIC VISIBILITY DATA IN THE HOUSTON AREA, John M. Lansinger and Deborah A. Miller. Physical Dynamics, Inc., Northwest Office, P.O. Box 3027, Bellevue, WA 98009; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. May 1979.

This report describes the analysis of data related to atmospheric visibility obtained during the HAOS, and the measurements of visibility and visual range.

Three methods of measuring visibility or visual range were employed during the project: human observation and instrumental measurements using a telephotometer and nephelometers. The combined measurements provided not only a means of confirming the results but also comparison of the techniques. All three methods were used from mid-June to mid-October 1977. Trained human observers made estimates of the visibility at five locations in or near Houston.

Histograms were prepared to show the day-to-day and hourly variations in visual range. An analysis of the entire available data set showed that both instruments and human measurements indicated a general clearing trend during the progression of the day between 0600 and 1300 CST.

Cross-correlations were performed on all possible pairs of data. Telephotometer and human measurements yielded correlation coefficients ranging up to 0.96. This higher correlation showed up during periods of stagnation. Highest correlations between human observations and nephelometer measurements, for separated stations, was 0.88, which occurred during periods of stagnation.

A general clearing trend during the progression of the day between 0600 and 1300 CST is indicated based on both instrument and human measurements. Measurements terminated before 1400 CST. Using all available data corresponding to the study period, visual range varied from 16 to 26 miles over the progression of the day, as determined from the telephotometer data at the downtown site. Co-located human measurements of prevailing visibility showed a corresponding variation of 10 to 16 miles. Human observation of prevailing visibility were typically 75 percent of the values of telephotometer-derived daylight visual range for visual ranges less than 10 miles. The higher correlation observed for stagnant conditions are attributed to lower instrument errors for conditions of lower visibility.

115 pages

From Text

ANALYSIS OF OZONE MONITORING DATA - HOUSTON, TEXAS, Herbert C. McKee, Assistant Health Director for Environmental Control. City of Houston Health Department, 1115 N. MacGregor Street, Houston, TX 77030. December 1979.

This report was prepared to present an analysis of ozone monitoring data obtained by the Air Quality Control Program of the City of Houston over the past few years. Ozone measurements were made continuously at six stations throughout the city. Measurements were also made of sulfur dioxide, oxides of nitrogen, hydrocarbons, and carbon monoxide.

Major conclusions resulting from this review of the monitoring data include the following:

1. General Nature of Problem. This type of air pollution problem results from atmospheric reactions involving hydrocarbons and oxides of nitrogen, two classes of contaminants that occur in the atmosphere of any modern city. Reacting in sunlight, this system produces a complex mixture of contaminants that can adversely affect human health and welfare. Ozone is measured as an indicator of the entire mixture. However, many of the adverse effects attributed to the mixture are caused by constituents other than ozone. Available evidence indicated that some of the chemical reaction characteristics of this problem in Houston are significantly different from the patterns that have been studied extensively in Southern California and other localities.
2. Natural Ozone. Ozone occurs as a natural constituent of the atmosphere at low levels. Measurements in Houston have confirmed the occurence of levels as high as 0.06 part per million (ppm) under conditions which appeared to eliminate any reasonable possibility of man-made influences, thus confirming natural levels documented elsewhere. Occasional measurements up to 0.11 to 0.12 ppm or higher have been obtained when man-made influences seemed unlikely, thus raising questions about the possibility of naturally occurring levels at or above the present federal standard of 0.12 ppm.
3. Historical Development of Oxidant Problems in Houston. A comprehensive air pollution survey in 1956-58 found only low ozone levels that were attributed to natural causes, indicating no significant photochemical oxidant formation. A followup survey in 1964-66 found somewhat higher

levels of ozone, indicating a measurable degree of oxidant formation. In recent years, occasional ozone levels higher than any measured in the 1964-66 survey give an indication of a greater degree of oxidant formation. This change over the past two decades has likely been due to the growth of the city, with accompanying increases in hydrocarbon and nitrogen oxide emissions that are responsible for this type of air pollution.

4. High Ozone Levels in Houston. In contrast to the low ozone levels that can be attributed to natural causes, levels in excess of 0.08 ppm occur more than 100 days each year in Houston and most of these are undoubtedly influenced by man-made sources of air pollution. Levels of 0.20 ppm and above have occurred in at least some portion of the city between 10 and 25 days per year, based on data for 1975-78. The highest single readings obtained during this period have been slightly above 0.30 ppm.

5. Variability of Ozone Episodes. The occurrence of high ozone levels in Houston is a highly variable phenomenon, which may occur on some days in only one section of the city, but which may on other days occur over a large area including most or all of the city. This makes it necessary to obtain measurements at several locations in order to understand the process of ozone formation, to identify the source or sources responsible and to adequately inform the public about air quality problems. Use of the Pollutant Standard Index system will be required by federal law to inform the public, but a public information program that does not identify differences in different areas of the city would be very misleading for a substantial portion of the population.

6. Recent Control Efforts. State regulations were responsible for significant decreases in hydrocarbon emissions from industrial sources during the period from 1973 to 1975 and some additional reductions have occurred since 1975. Federal regulations were responsible for significant reductions in total hydrocarbon emissions from vehicles over the period from 1968 to the present, in spite of an increase in the number of vehicles. While long-term ozone data are available, the information that is available indicates that no significant reduction in ozone occurrence has resulted from these control efforts. This raises important questions with regard to future control efforts; i.e., should such efforts depend on additional hydrocarbon reductions, or would some other approach be more appropriate?

In developing future control programs, serious study and consideration should be given to the role of oxides of nitrogen in ozone formation.

7. Importance of Distant Sources. On some ozone episode days, air coming into the Houston area is substantially free of contaminants and the high ozone levels that occur are due to air contaminants originating in the Houston area. On other episode days, air coming into the Houston area contains significant amounts of ozone that has formed from contaminants that originate 50 miles away or farther. With a southeast wind, sources in the Texas City-Galveston area sometimes appear to be responsible for a significant portion of the ozone in the Houston area. With a wind from the east, some contribution may be made by sources in the Beaumont-Port Arthur area approximately 90 miles to the east, although this is less well established. It is obvious that ozone formation is often a regional problem, which cannot be solved by controlling pollution sources in the Houston area alone.

8. Role of Vehicle Emissions. In many cities, vehicle emissions are the major source of hydrocarbons and oxides of nitrogen involved in ozone formation. As a result, national control requirements place a major emphasis on vehicle emission control. In Houston, vehicle exhaust appears to be a much less dominant factor in ozone formation than industrial or other sources based on the following:

   a. Air mass trajectories across the city indicate that ozone formation occurs predominantly in air masses that have passed over industrial pollution sources, but only to a minor extent in air masses that have passed over areas where the major vehicle traffic levels occur.

   b. Industrial emissions show very little variation between days of the week, whereas vehicle traffic is much lighter on Sundays than on weekdays. During the period 1975-78, ozone episodes occurred on Sundays with essentially the same frequency as on any other day of the week. These results indicated that ozone episodes would not be reduced by any measurable amount if vehicle traffic were reduced in the Houston area, even if traffic levels could be reduced as much as 35 to 50 percent from the present levels.

From Text

PB-299 632

BERYLLIUM-7 PROGRAM OF THE HOUSTON AREA OXIDANTS STUDY, Harry M. Walker. Monsanto Co., P.O. Box 711, Alvin, TX 77511; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. July 1979.

This report summarizes the work done by the Houston Area Oxidants Study and its contractors in measuring levels of Beryllium-7 in the ambient air of Houston during its 1977 monitoring program. Beryllium-7 is taken to be a valid parameter measuring the presence of stratospheric air and consequently the presence of stratospheric ozone during the study period. These data are related to a variety of other monitoring and meteorological data taken during the HAOS program. Some conclusions are reached regarding the possible role stratospheric air plays in the initiation of photochemical ozone episodes.

The most important findings from this portion of the HAOS program are summarized as:

1. Three wide-spread ozone episodes were identified during the study period. ^{7}Be levels were elevated during all three (8/3-4, 9/21-22, 10/14).

Frontal passage occurred within 72 hours prior to each identified episode. During two of these episodes, atmospheric stagnation was evident; during one it was not (8/3-4).

2. Four non-episodes were identified having stagnation conditions and other factors which on the basis of presently accepted theories should have led to high ozone but did not (7/21, 7/26, 8/9, 8/16).

Neither elevated ^{7}Be nor prior frontal passage was associated with any of these non-episodes.

3. Two localized episode days (8/12, 8/17) were identified where high ozone concentration was found only in very limited areas.

These days possessed stagnation conditions and other factors favorable to ozone generation but no associated elevated ^{7}Be or prior frontal passage.

4. Wind vector analysis associated high ozone levels in one of the episodes analyzed with obvious urban/vehicular pollutant sources (8/17); in another with mixed urban/vehicular and industrial sources (9/21), and in the third with purely rural non-sources (10/14).

High ozone levels were found associated with two rural non-source wind vectors (8/4, 10/14).

5. Three vectors associated with pollutant source areas and other factors favorable to ozone generation did not result in high ozone (7/21, 8/9, 8/16).

6. Correlation of Houston daily maximum ozone levels with rural average maximum ozone at widely dispersed sites was better than expected ($R^2 = .425$; $p < .01$.)

7. Ozone at rural sites on different sides of Houston showed similar variance.

8. Maximum ozone at rural Hempstead was found to correlate somewhat with NO_x at the same site and hour. ($R^2 = .296$; $p < .01$.)

9. An ozone value of .123 ppm was observed at one rural southwest site with a 40-hour wind vector entirely derived from rural agricultural areas further to the southwest.

The above findings carry implications as to the fundamental mechanisms controlling the formation and occurrence of ozone. From consideration of these findings with respect to possible mechanisms, the following conclusions are offered:

1. The classical parameters of precursor concentration, temperature and solar radiation do not adequately explain all episodes of high ambient ozone nor are they always consistent with observations of low to moderate ambient ozone.

2. The missing parameter historically referred to as the "meteorological factor" is associated with prior frontal passage and evidence of the injection of stratospheric ozone.

3. This parameter at times dominates the precursor concentration factor.

4. It is suggested that this parameter may involve a free-radical initiation process beginning with stratospheric ozone as a fundamental input.

82 pages

From Text

PB-292 242

COST AND ECONOMIC IMPACT ASSESSMENT FOR ALTERNATIVE LEVELS OF THE NATIONAL AMBIENT AIR QUALITY STANDARD FOR OZONE, Kenneth H. Lloyd. Economic Analysis Branch, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711.

In accordance with the provisions of Sections 108 and 109 of the Clean Air Act as amended, the EPA has conducted a review of the criteria upon which the existing primary and secondary photochemical oxidant standards are based. The Act specifically requires that National Ambient Air Quality Standards be based solely on scientific criteria relating to the level that should be attained to adequately protect public health and welfare. Based on the wording of the Act and its legislative history, EPA interprets the Act as excluding any consideration of the costs of achieving those standards or the existence of technology to bring about the needed reductions in emissions. EPA has prepared an assesssment of the potential cost and economic impacts associated with efforts to attain the promulgated standard as well as alternative levels of the standard.

This report presents the results of an analysis of the potential impact of feasible changes in the national ambient air quality standard for ozone on national costs of control and attainment status for various areas of the country. An assessment is made for 90 AQCRs of the control requirements for alternative levels of the standard. For each AQCR this analysis estimates the potential emissions in 1987 and the allowable emissions for attainment of the standard levels. Next, the analysis estimates the potential emission reduction achievable with the Federal Mobile Vehicle Control Program, new and modified source control, application of reasonably available control technology on existing stationary sources and further motor vehicle controls through inspection/maintenance programs and transportation control plans. Based on the projected emission reductions, control costs are estimated for applying technology in an attempt to attain alternative standard levels. While the analysis considers each AQCR separately, the results are presented in aggregate form for all 90 AQCRs instead of each individual AQCR.

The analysis does not include a rigorous economic impact assessment on the numerous affected industries or the impact of growth restrictions on the economies of affected urbanized areas. A summary of the impact on several industries for which EPA has conducted economic impact studies is presented. These industries include petroleum refining, retail gasoline service station, gasoline bulk plants, automobile assembly plants, metal furniture industry.

143 pages

From Text

HAOS QUALITY ASSURANCE FINAL REPORT: CRITERIA POLLUTANTS, VOL. 1. Radian Corporation, 8500 Shoal Creek Blvd., Austin, Texas 78766; for Houston Chamber of Commerce; 1100 Milam Building, 25th Floor, Houston, TX 77002. Dec. 1978.

A comprehensive quality assurance program for criteria pollutants was undertaken as part of the Houston Area Oxidants Study. Audits were conducted from June 15 to October 31, 1977 on the following parameters: ozone, oxides of nitrogen, sulphur dioxide, total hydrocarbons and methane, carbon monoxide, total suspended particulates.

The following local agencies and private contractors were involved in the collection of criteria pollutant data for the study: Texas Air Control Board, City of Houston Public Health Department, Houston Lighting and Power, Celanese Chemical Company, Gulf Chemical Company, Shell Development Company, General Motors Corporation, Monsanto Company, Rockwell International Corporation, Radian Corporation, Engineering Sciences, Inc.

The results of the audits were generally good and demonstrated the validity and comparability of the data taken by the diverse monitoring groups. Although the SO_2 and CO audit data were generally low and variable, good agreement was obtained for ozone, oxides of nitrogen, THC, CH_4 and TSP. Problems uncovered during the audits were reported to the responsible agency or contractor for their consideration and appropriate corrective action.

The results of the quality assurance study were generally encouraging. Although discrepancies and problems were encountered, audits usually indicated the acquisition of valid data. Particularly good agreement was achieved for ozone, oxides of nitrogen, hydrocarbons, and total suspended particulates. Ninety-one percent of the ozone audit cases showed relative errors within ± 15 percent. The oxides of nitrogen audit results revealed that 96.1 percent of the NO, 97.4 percent of the NO_x and 92.3 percent of the NO_2 audit data were within the ± 20 percent error limits. Ninety-three percent of the methane and 85 percent of the THC data were within ± 20 percent of the reference input value. Of the 18 audit cases for TSP, 89 percent were within the ± 15 percent relative error limit. The sulphur dioxide and carbon monoxide audit data were generally low and variable, which indicated a possible high threshold of detectability.

RECOMMENDATIONS

The results of the quality assurance program should be used to assist in analyzing criteria pollutant data collected during the HAOS monitoring period. The results should help to evaluate the relative importance and validity of the monitoring data. Data which does not fall within accepted limits should be identified and used only to predict trends.

In the case of the ozone data, where different calibration procedures were used at several monitoring sites (e.g., gas phase titration and UV photometry), the data should be so identified in the HAOS data base.

If SO_2 and CO data are to be taken on a continuing basis at state and local monitoring sites in the Houston area, a study should be made to determine the cause of the unusually high threshold of minimum detectability. Because the state-of-the-art detection of SO_2 and CO has improved considerably in recent years, the use of newer EPA approved reference of equivalent monitors might significantly improve the quality of data collected.

119 pages

From Text

PB-299 640

HAOS QUALITY ASSURANCE FINAL REPORT: NON-CRITERIA POLLUTANTS, VOL. 2. Radian Corporation, 8500 Shoal Creek Blvd., Austin, TX 78766; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. March 1979.

Audits and review of the non-criteria pollutant sampling programs to assess the quality of the data collected were conducted. The project also served to identify and resolve problems that were associated with instrument calibration or routine operation and maintenance.

Independent sensor audits or audit observations were conducted on the following parameters: detailed hydrocarbons, peroxyacetyl nitrate (PAN), total oxidants, human visibility, light scattering, visibility using telephotometry, respirable particle sampling and analysis, aeroallergens, ultraviolet radiation, upper air meteorological measurements, aldehydes. There were no known standards for aeroallergens, UV radiation and pibal measurements. Therefore, observations of actual ambient data from one or more laboratories or monitoring groups were made to determine relative differences.

A description of the results of each of the parameters is given.

132 pages

From Text

PB-299 629

HOUSTON AREA OXIDANT STUDY DETAILED HYDROCARBON ANALYSIS, R.B. Denyszyn, E. Pellizzari, et al. Research Triangle Institute, RTP, NC 27709; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. April 1979.

One of the primary objectives of the Houston Area Oxidant Study was to identify and quantitate the volatile organic species present in the Houston ambient air. Analyses for organic species on samples collected between June 22, 1977 and October 31, 1977 were performed. The analysis program involved the use of the following gas chromatographic techniques: gas chromatography with flame ionization detector; gas chromatography with electron capture detector; gas chromatography with mass spectrometry, computer system. Samples for analysis by GC/FID and GC/ED were collected in treated stainless steel containers. These samples were analyzed for 49 organic species ranging from C_1 to C_{10} molecules. Samples for analysis by GC/MS were collected on Tenax GC cartridges. GC/MS analyses were to provide absolute identification of the volatile organic species present in the Houston ambient air.

Samples for hydrocarbon analysis were collected at three primary sites: Aldine-Mail, Clinton Drive and Fuqua. Field samples were collected between 6/22/77 and 10/31/77. Areawide sampling, upwind-downwind sample pairs and special grab samples were conducted at various times throughout the program. Diurnal studies were performed on 9/12/77, 7/21/77, and 10/26/77.

283 pages

From Text

PB-299 638

HOUSTON AREA OXIDANTS STUDY. Program Summary. Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. July 1979

This report gives a detailed description of the Houston Area Oxidants Study (HAOS), a comprehensive, regional research program organized by the Houston Chamber of Commerce in 1976 to investigate the extent, causes, and impacts of airborne oxidants and haze in the Houston area. The overall purpose of HAOS is to provide the public with current and reliable information for the development of effective, responsible air quality standards and control programs. Over twenty separate interrelated technical projects in four study areas (airborne oxidants, regional haze, community health, and socioeconomics) comprise this $1.4 million study, funded wholly by private contributions. Most of the HAOS field data was collected June through October 1977. Preliminary measurements of ozone concentrations were made in late 1976. Some measurements were also made in 1978. Extensive analysis and interpretation of the HAOS and other available data on local air quality, meteorology, emissions, public health, and socioeconomics provide new insights and an improved understanding of the region's air quality and the potential impacts of proposed emission control strategies.

SUMMARY OF CONCLUSIONS

1. Air quality in the Houston area was better than the National Ambient Air Quality Standard for ozone over 99 percent of the time in 1977.
2. Reducing emissions of hydrocarbons alone may not significantly reduce ambient ozone concentrations in the Houston area.
3. Ozone formed outside of the Houston area contributes heavily to ozone levels in metropolitan Houston.
4. Meteorology is a major factor influencing ambient ozone concentrations in the Houston area.
5. Houston air quality differs markedly from that of Los Angeles; thus, control strategies developed for Los Angeles may not be effective in Houston.
6. Little evidence was found for any association between ozone levels prevalent in Houston's air and various health responses of sensitive individuals.
7. Currently available methods for measuring atmospheric visibility are inadequate for the Houston area.

8. Proposed air quality control strategies will seriously reduce projected growth and employment in Houston's chemical, machinery manufacturing, and primary metals industries and thereby will have an impact on the area's overall projected growth.
9. Proposed transportation-related control strategies will reduce, but not eliminate, the large increase in traffic congestion predicted for 1995.

TENTATIVE CONCLUSIONS

(In addition to the broadly substantiated conclusions, there is directed but limited evidence from HAOS to support some tentative conclusions. In some cases, the conclusions are more suggested than substantiated; more research is needed for substantiation.)

1. Automobile emissions seem to have a larger impact on ambient ozone concentrations in the Houston area than point source emissions, even though point sources account for about half of the total hydrocarbon and nitrogen oxide emissions.
2. Ozone transported into the Houston area may initiate the formation of high local ozone concentrations.
3. Haze in Houston area seems to be caused by scattering of sunlight by airborne fine particles which are mostly sulfates and organic compounds.

391 pages

From NTIS Abstract and Text

PB-293 226

HYDROCARBONS IN HOUSTON AIR, William A. Lonneman, George Namie, and Joseph F. Bufalini. Environmental Sciences Research Laboratory, Office of Research and Development; U.S. EPA, Research Triangle Park, NC 27711. Feb. 1979.

Ambient air samples were collected in Houston downtown and industrial areas to determine hydrocarbon composition and concentrations. Twenty-one samples were collected on three days of sampling: September 1, 1973, January 30, 1974, and April 2, 1974. The results of the detailed hydrocarbon analyses of these samples are presented and suggest that both vehicular and industrial sources of hydrocarbons are important. Some of these samples were collected during periods of extremely stagnated meteorological conditions. It was observed that although the total nonmethane hydrocarbons were high, they did not exceed 10 ppmC. Measurements of nitrogen oxides were made for some of these samples. These samples suggested that the NMHC/NO_x ratio in the Houston area was not atypical, usually ranging from 10/1 to 20/1.

44 pages

Author's Abstract

PB-293 227

NON-URBAN HYDROCARBON CONCENTRATIONS IN AMBIENT AIR NORTH OF HOUSTON, TEXAS, R.L. Seila. Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. February 1979.

In January 1978, a study was undertaken at Jones State Forest, 38 miles north of Houston, Texas, to determine the concentrations of non-methane hydrocarbons, methane, and carbon monoxide; to detail the composition of hydrocarbons (especially of the vegetation); and to discover the sources of non-methane hydrocarbons. Thirteen 3-hour integrated Tedlar bag samples and five grab samples using stainless steel cans were collected over a 39-hour period. The samples were returned to the Research Triangle Park laboratory for analysis, where the can samples showed lower non-methane hydrocarbon concentration values than did the bag samples. Sources of paraffins (72% of the non-methane hydrocarbons) and the other hydrocarbons were found to be: vehicular exhaust (35%), the forest's vegetation (2%), the city of Houston (22%), and the region between Houston and the forest (32%). Isoprene and alpha-pinene were the vegetative hydrocarbons noted, with the latter showing a distinctive 24-hour cycle of concentration variation.

38 pages

Author's Abstract

PB-293 269

OXIDANT FORMATION IN THE GENERATION OF OZONE, Bruce W. Gay, Jr., George R. Namie, Joseph J. Bufalini. Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. February 1979.

Researchers at the Texas Air Control Board used a modified ferrous ammonium sulfate-thiocyanate method containing 3-cyclohexene-1, 1-dimethanol to measure ozone generated by UV photolysis or silent electric discharge of air. This method combined two different techniques for measuring oxidants, the olefin-singlet oxygen reaction in which a peroxide is formed and the ferrous ammonium sulfate-thiocyanate technique. The TACB investigators found high values of oxidant when the cyclohexene-dimethanol-ferrous ammonium sulfate-thiocyanate method (CHD) was compared to the neutral bufferred potassium iodide (NBKI) method for measuring ozone/oxidants generated by UV photolysis or silent electric discharge. The conclusion reached by the TACB investigators was that singlet oxygen and/or other oxidants are formed in the generation of ozone samples. Also, TACB claimed that the additional oxidant, tentatively identified as electronically excited singlet oxygen, was not measured by other standard methods such as NBKI. They speculated that singlet oxygen may be responsible for the effects observed in clinical health effects studies. The primary national ambient air quality standard for ozone is based on the evidence collected during these health studies. The TACB contends that the evidence may be invalid since other oxidants besides ozone were present during the health studies.

The objective of the experiments described in this report was to determine if any other oxidants are formed in the generation of ozone samples.

The results of the study indicate:

1. The generation of ozone standards produces insignificant concentrations of singlet oxygen and no other oxidant species can be detected by a variety of measurements techniques.

2. Good agreement in ozone measurements was observed between UV photometric, gas phase titration, and NBKI methods. The NBKI method is biased in a positive direction as observed by other investigators.

3. Measurements of ozone in oxygen or air by the CHD method were always substantially (approximately 100%) higher than the NBKI method. In the absence of oxygen, ozone concentrations determined by the CHD method were lower than values determined by UV or NBKI methods.

4. The CHD method did not detect other oxidants.

5. The results of this work disagrees with the TACB position that the CHD method is detecting other oxidants in air "ozonized" by UV irradiation or silent electric discharge. Rather they indicate the CHD method is not applicable to analysis of ozone and/or other oxidants in air because of a variable stoichiometry of the reagent-ozone reaction in the presence of oxygen.

25 pages

From Text

PB-299 644

OZONE EPISODE DOCUMENTATION REPORT, F.L. Worley, Jr., A.A. Siddiqi and L.R. La Motte. University of Houston for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. April 1977.

Manual and computer aided analysis of the Texas Air Control Board (TACB) continuous monitoring station data (1975) plus selected City of Houston data has been carried out. This report describes data handling procedures, statistical methods employed and presents observations and correlations developed using the data. Problems related to completeness of data sets and inadequate meteorological data are discussed.

The more significant findings center around the apparent major role played by non-stationary sources in determining the maximum daily ozone concentration. This effect was observed time and again and gives strong emphasis to the impact of vehicular sources in the state. Analysis of episode periods does not provide any verification that frontal passage has a major role. The dominant meteorological variable appears to be local wind speed, i.e. extended periods of low wind speed are necessary for high ozone levels. A secondary observation involves subsidence of stratospheric air and appears to precede episodes.

204 pages

Author's Summary

OZONE/ULTRAVIOLET RADIATION MONITORING. Radian Corporation, 8500 Shoal Creek Blvd., Austin, TX 78766; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. June 1978.

As part of the Houston Area Oxidants Study, Radian Corporation monitored ambient levels of ozone and ultraviolet radiation at a site northwest of Houston. The monitoring was performed from June 15, 1977 to October 31, 1977.

This report presents the data accumulated during this study. A total of 3,248 hours of ozone data and 2,891 hours of ultraviolet radiation data were collected. The highest hourly ozone average was 307 ppb and was observed on July 13 from 1700 to 1800. The second highest hourly average was 255 ppb and was observed for hours 1600 to 1700 and 1800 to 1900 on July 13. A one-hour average of 80 ppb ozone was attained or exceeded for at least one hour in each of 44 days. The peak ultraviolet radiation levels observed were four langleys.

29 pages

Author's Introduction

PB-295 912

PLAN FOR AIR POLLUTION RESEARCH IN THE TEXAS GULF COAST AREA, VOL. I. PLAN FOR AIR QUALITY STUDIES, G. Tannahill, B. Lambeth, et al. Radian Corporation, 8500 Shoal Creek Blvd., Austin, TX 78758; for Environmental Sciences Research Laboratory; Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. April 1979.

The purpose of this study was to develop a plan for air pollution research in the Texas Gulf Coast Area (TGCA). The plan will be used to support a U.S. EPA study of air pollution problems in the TGCA.

Key issues associated with air pollution in the TGCA were identified. From these issues, a number of of hypotheses were developed and prioritized. Six program options for air pollution research were recommended which would provide the most comprehensive and cost-effective means of data collection and analysis.

The programs recommended were:

Support Program for Comprehensive Health Effects Study
Program for Ambient Air Sampling and Model Development/Validation
Program to Identify the Occurrence and Distribution of Hazardous Pollutants
Program for a Detailed Study of Airborne Aerosols
Program for a Detailed Study of Ambient Oxidants and Hydrocarbons
Program for a Combined Aerosol-Oxidant-Hydrocarbon Study

Detailed program plans are provided for each study, as are cost and duration estimates.

96 pages

Author's Abstract

PB-295 913

PLAN FOR AIR POLLUTION RESEARCH IN THE TEXAS GULF COAST AREA, VOLUME II: PLAN FOR HEALTH EFFECTS STUDIES, D. Johnson and R. Prevost. Southwest Research Institute, 3600 Yoakum Blvd., Houston, TX 77003; for Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. April 1979.

In the study reported here, a plan for air pollution research was developed for the Texas Gulf Coast Area. This report is Volume II of a five part series of reports documenting that plan and is specifically directed at presenting a plan for health effects studies.

A panel of three epidemiologists aided by other support staff developed the health effects study plans presented. Available aerometric, health effects, demographic, and meteorologic data as well as other inputs resulting from public meetings were reviewed and considered in development of the plan. Documentation begins with a general assessment of area populations, air quality, and relevant health effects. Questions are addressed which must be answered in accomplishing a plan for health effects studies.

The plan begins with detailed discussion of the general research needs of the area regarding health effects and presents a set of hypotheses which needs to be addressed with specific studies. The plan culminates with the description of twelve types of studies considered to be most useful in providing definitive answers. Relative priorities, time sequencing, and rough cost estimates are provided with the study descriptions.

61 pages

Author's Abstract

PB-295 914

PLAN FOR AIR POLLUTION RESEARCH IN THE TEXAS GULF COAST AREA, VOL. III. SUMMARY OF PREVIOUS AIR QUALITY STUDY AND DATA, B. Lambeth, B. Maxey and W. Stadig. Radian Corporation, 8500 Shoal Creek Blvd., Austin, TX 78758; for Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. April 1979.

In response to Congressional mandates, the U.S. Environmental Protection Agency will conduct an extensive study of air pollution related problems in the Texas Gulf Coast Area. As an initial effort, EPA awarded a contract to review the existing technical information and record the local viewpoint on air pollution problems in the area, define research needs and design experimental studies addressed to these needs. Results are presented in five volumes. Volume III summarizes previous air quality studies and presents technical data.

Several reports and studies are described including:

1. Respirable Particulate Monitoring with Remote Sensors, Public Health Ecology: Air Pollution; July 1, 1971 - October 31, 1973.
2. Particulate Attainment Analysis; 1971-1975.
3. Urban and Industrial Air Pollution in Houston, Texas - I. Hydrocarbons; July 1973 and July-August 1974.
4. Hydrocarbon Analysis of Houston Air; September 1, 1973, January 30, 1974, and April 2, 1974.
5. Light Hydrocarbon Measurements at Houston; October 8-19, 1973.
6. Houston Urban Plume Study - 1974. Description and Summary of Results. July 15-24, 1974.
7. Photochemical Oxidant Attainment Analysis. Summary and Analysis of Ozone Data. 1974-1976.
8. Study of the Formation and Transport of Ambient Oxidants in the Western Gulf Coast and North Central and Northeast Regions of the United States; July 1-October 1, 1975.
9. Measurement of Light Hydrocarbons and Studies of Oxidant Transport Beyond Urban Areas, Houston Study - 1976; July 1, 1976.
10. Houston Area Oxidant Study (HAOS); 1975-1977.
11. Houston Air Pollution Study (HAPS).

A bibliography with abstracts is included. The bibliography is divided into four sections: emissions, monitoring, meteorology and control. Each category is arranged alphabetically by title.

303 pages

NTIS Abstract and Text

PB-295 915

PLANS FOR AIR POLLUTION RESEARCH IN THE TEXAS GULF COAST AREA, VOLUME V: LOCAL VIEWPOINTS ON RESEARCH NEEDS, Bryan Lambeth, Gary Tannahill. Radian Corporation, P.O. Box 9948, Austin, TX 78758; for Environmental Sciences Research Laboratory, Office of Research and Development, U.S. EPA, Research Triangle Park, NC 27711. April 1979.

A public meeting was held in Houston to solicit information and viewpoints on air pollution problems in the Houston area and related research needs. This volume presents the testimonies given by local technical experts, representatives of industrial organizations, educational institutions, citizens groups, and private individuals. Testimonies given at Congressional hearing pursuant to Section 403(d) of the 1977 Clean Air Act are also presented as an appendix.

284 pages

Author's Abstract

SOCIO-ECONOMIC IMPACT ANALYSIS OF SELECTED AIR POLLUTION CONTROLS IN THE HOUSTON-GALVESTON REGION. Rice Center, Houston, Texas; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, Texas 77002. March 1979.

The purposes of this study were (1) to develop a methodology appropriate for identifying and assessing the social and economic impacts of air pollution control programs and (2) to apply the methodology to the Houston region in order to assess the likely effects of control programs on air quality and the social and economic costs, or benefits, that would accrue to the region.

The scope of the study was limited to a geographic area of eight counties in and around the Houston metropolitan area. The time horizon for the study was 1995, as it was felt that the confidence that could be placed in projections beyond that date would decline dramatically.

The basic framework for methodological development and analysis was formed by several network diagrams, or "trees of impact" that trace the distribution of the socio-economic effects of various control measures.

The types of controls initially considered by the study as being applicable to stationary sources are: 1. complete curtailment of industrial growth; 2. emissions tradeoff (offsets) at existing site of company; 3. emissions tradeoff within the Air Quality Control Region at a level of 3:1; 4. application of Reasonably Available Control Technology to existing sources and of Lowest Achievable Emission Rates to new sources; 5. control of ship and barge loading emissions; 6. control of gas marketing emissions (Stage I); 7. control of gas marketing emissions (Stage II); 8. requirement of Lowest Achievable Emission Rates on existing facilities. Potential controls applicable to mobile sources are: 1. gasoline rationing; 2. limiting parking lot construction; 3. application of parking price adjustments; 4. application of gasoline price adjustments; 5. provision of vehicle-free zones; 6. provision of mass transit incentives; 7. vehicle emission controls, a) inspection and maintenance of vehicle emission control systems, b) retrofit of pre-1968 light duty vehicles.

A selection was made from these potential controls in order to formulate the two case control programs used in the analysis.

The following socio-economic indicators were used to measure the effects of the control programs: 1. regional economic growth (measured as output by industrial sector); 2. regional employment and population; 3. average household income; 4. household consumption expenditures (expressed as a distribution among various types of household expenditure); 5. personal mobility (measured for six different types of trip); 6. housing or neighborhood satisfaction (measured by the surrogate variable of housing density); and 7. emissions of hydrocarbons.

The composition of the first case control program was confined to controls likely to be used to reduce hydrocarbon emissions. The second case extended the controls to limit SO_2 emissions under the assumption that the region which is currently in attainment with the SO_2 ambient air quality standard will fall under Prevention of Significant Deterioration regulations.

The results of the analysis of the probable effects of air pollution programs considered in the study on the future economy and population of the region indicate continued overall growth at slightly reduced rates, although the reduction in economic growth rate within some industrial sectors is likely to be significant.

Under the application of controls considered in the first case, the most significant reduction in projected growth rates was in the Chemical Products sector. Petroleum Refining also is expected to experience significant decline. All other reductions in growth rates were very small or insignificant. Examination of interdependencies between industrial sectors and of the current trend toward diversification of economic activity can, in large measure, account for these differential effects and their small effects on total regional output, employment and population.

Even more significant reductions in growth rates were projected for several industries in the other case, although again, the overall effects on population and overall economic growth remained relatively slight. The Chemical Production sector again showed the largest projected decline in rate of growth below the 1995 baseline, followed by Machinery and Primary Metals. Petroleum Refining again showed a slight reduction in growth rate, although in the baseline forecast, this sector was not projected to grow at an appreciable rate.

CONCLUSIONS

1. The controls considered by the study would result in a substantial reduction of hydrocarbons close to the levels prescribed by TACB and the U.S. EPA for attaining the 0.08 ppm oxidant standard.
2. Capital and operating costs to some industries required by the application of air pollution control devices would be substantial, although the apparent small effects of these costs on product prices remains inconclusive.
3. The product effects of the controls considered by the study on the future economy and population of the region will result in continued overall growth at slightly reduced rates.
4. The effects of the more stringent Case 2 controls on overall economic and population growth rates will be more pronounced than from the Case 1 control programs.
5. The reduction in economic growth rate in certain basic industrial sectors under both control programs is likely to be significant, although the effects of these reductions on overall output will be far less significant.
6. The shares of economic development in the region are shifting from basic industries to secondary and service sectors even without the Case 1 and Case 2 control programs.
7. The socio-economic or population-related effects of the control programs are likely to be small to marginal, with some benefits accruing in the areas of personal mobility, public health, and aesthetics.

148 pages

From Text

PB-299 634

STATISTICAL ANALYSIS OF THE SOURCE-RECEPTOR RELATIONSHIPS FOR OZONE AND HAZE IN THE HOUSTON AREA, Peter H. Guldberg and Harvey E. Jeffries. Walden, Div. of Abcor, Inc., 850 Main Street, Wilmington, MA 01887; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. May 1979.

The objective of this study was to hypothesize and test a causal model of photochemical ozone and haze in the Houston area. Key conclusions of the study are:

1. In Houston O_3 and haze are primarily controlled by availability of nitrogen oxides and not hydrocarbons. HC reductions might have to be very large before they would affect O_3 formation. This is consistent with the findings that ratios of ambient HC to NO_x levels in Houston are significantly higher than ratios that occur in other large U.S. cities outside of Texas. Thus, control strategies different from those used in other cities may be more effective in the Houston area.

2. Long-range transport overland of NO_x and HC from sources within 300 km is a significant cause of O_3 in Houston, but is secondary in importance to the effect of local sources of these pollutants.

3. Very limited data lead to the observation that some of the occurrences of high O_3 levels in Houston may be due, in large part, to long range transport of O_3 in air arriving from the Gulf of Mexico. Sources of this O_3 are unknown, and a comprehensive study of the situation is recommended.

4. Limited data suggest that transport from the stratosphere may contribute from 15 to 53 ppb O_3 to ground-level concentrations in the Houston area. The peak contribution of 53 ppb constitutes 44% of the National Ambient Air Quality Standard of 120 ppb and is thought to occur in April.

200 pages

Author's Abstract

PB-283 230

SUMMARY OF LOW LEVEL SOUNDINGS COLLECTED FOR THE HOUSTON AREA OXIDANTS STUDY, Phil Stickel. Aeromet, Inc., Tulsa, OK 74145; for Houston Chamber of Commerce, 1100 Milam Building, 25th Floor, Houston, TX 77002. April 1978.

The purpose of the final report for low level temperature and wind data collected in Houston from June 15 to October 23 is to validate the collected data, explain the collection and analysis process, explain in summary the scope of the study, reach some superficial conclusions found in the data analysis and recommend changes to similar programs if developed. The data collected covered a wide spectrum of conditions.

Two pilot balloon launch sites were established. The site located in eastern Houston was to be affected by the sea breeze off Galveston Bay, while the western site was to be dominated by land features.

The purpose of collecting the meteorological data was to supply a data base for determining any localized dispersion anomalies of the atmosphere on days of high pollution concentrations. It has been understood for quite some time that the conditions that lead to air stagnation problems are a synoptic scale phenomena, however, the subsynoptic and mesoscale phenomena have not been thoroughly understood or sampled. The outset of the meteorological portion of the investigation leaned more to the conclusions that light wind speeds with an easterly component were the main contributors to the localized air stagnation problem.

Air stagnation advisories were issued for only two 48-hour periods from June 15 to October 23. Although more air stagnation occurrences would have been helpful, the tentative conclusions derived from the initial investigation of the meteorological data yield some very useful and new findings.

1. The measurement of wind data above 2000m by theodolite in the Houston area is quite difficult due to the restricted visibility caused by haze and low level cumulus.

2. The west launch site served little purpose other than verifying questionable data. Comparison of changes at a site throughout the day are believed to be more important that intersite comparisons.

3. A fine grid network of pibal release sites throughout the Houston area would be the only means to adequately measure air parcel trajectory

pattern. It would only be with this type of sampling along with concurrent pollutant measurements that a plume could be followed from its source to its demise.

4. Temperatures are typically altered in the complete 5 km layer throughout the day. The reason for this is primarily associated with afternoon showers.

5. The seabreeze effect is very hard to define as far inland as Channelview. The sea breeze does influence shower activity which helps lessen the pollution buildup.

6. Temperature inversions appear to have a greater influence than winds on air stagnation development, however, treatment independent of wind considerations is not recommended. The stagnation problem is felt to be a synoptic scale phenomena with variation in local severity.

7. Localized air stagnation problems can develop from the marginal stage to the critical state in less than 12 hours. This is believed to be in conjunction with the large variability in the temperature profile in the lower 5 km.

8. Air stagnation problems appear to develop within 2 days of frontal passage.

9. At the completion of all the data processing it was discovered that the 7°E magnetic variation factor was not applied to the data. Thus all wind directions are with respect to magnetic north.

54 pages

From Text

WEEKEND/WEEKDAY DIFFERENCES IN OXIDANTS AND THEIR PRECURSORS, Yuji Horie, Joseph Cassmassi, et al. Technology Service Corporation, 2811 Wilshire Blvd., Santa Monica, CA 90403; for Air Management Technology Branch, Monitoring and Data Analysis Division, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park, NC 27711. March 1979.

The objectives of this study are:

1. To determine if there are significant differences between WE and WD concentrations of precursors and oxidants;
2. To determine the extent to which these differences may be functions of meteorological variations;
3. To examine differences between WE/WD spatial and temporal patterns;
4. To assess whether further study is indicated to quantify the effectiveness of reducing oxidant levels by reducing precursor levels; and
5. To gain greater insight into control strategies that are likely to be the most effective for reducing oxidant levels.

To accomplish the objectives, a large data base of air quality and meteorological data, including ambient pollutant concentrations at 22 sites, surface meteorological observations at 12 sites, and upper-air meteorological measurements at three sites were compiled. The data analysis focuses on the five summer months, May through September, during the years 1973 through 1976.

The 22 study locations represent a wide variety of site characteristics. The study sites were selected from stations upwind of, downwind of, and within the metropolitan area. However, no true rural sites are included in the analysis because of inadequate oxidant data at those sites. The five metropolitan areas studied are: Washington, D.C., Baltimore, Philadelphia, New York-Newark, and Boston.

The percentage decrease in daily maximum oxidant levels on weekends is generally higher at sites downwind of the large metropolitan areas and is lower at sites within or upwind of the metropolitan areas.

The stations with a consistently lower weekend level among four out five cases are found in the periphery of or outside the large metropolitan areas; the stations with a consistently higher weekend level are found within the metropolitan areas; and the stations without a consistent WE/WD difference among the five cases are found in the transitional zones.

WE/WD differences in 6-9 a.m. average concentrations of NO, NO_2, and (NO_2/NO_x) are examined for eight stations reporting on adequate amounts of NO and NO_2 data for the analysis. The eight stations are Bethesda, Silver Spring, Suitland, and Baltimore in Maryland; Camden and Newark in New Jersey; Welfare Island and Mamaroneck in New York.

The average oxidant improvement on weekends is 9% when Sundays are compared with Tuesday through Friday (Sunday WE/WD), and 5% when Saturdays and Sundays are compared with Monday through Friday (normal WE/WD).

A greater oxidant improvement (11% to 12%) is observed in areas downwind of the large metropolitan areas than in the source-intensive urban core areas.

The oxidant improvement (5% to 12%) on weekends is small compared with the 40% to 50% reductions in 6-9 a.m. urban NO_x and NMHC levels on weekends. However, the weekend reductions in daytime and 24-hr precursor levels appear to be considerably smaller than those in 6-9 a.m. precursor levels.

The small oxidant improvement on weekends, brought about by simultaneous control of NO_x and NMHC, may be an indication that the simultaneous control of NO_x and NMHC is less effective for controlling urban oxidants than are hydrocarbon controls.

From Text