

DEGADIS MODEL ENHANCEMENT – AQ-4

Staff: H. Feldman

Objective: Provide an efficient microcomputer version of the Dense Gas Dispersion (DEGADIS) model with improvements needed to model the accidental release of toxic materials.

Initiated: Phase I -- \$44K, 1986; Phase II -- \$50K, 1988; **Contractor:** Phase I -- JRT Consulting Services; Phase II -- T. O. Spicer, University of Arkansas

Scope: Phase I -- DEGADIS was developed by the University of Arkansas for the U.S. Coast Guard. Thus, it is one of the few toxic models publicly available, although there are a number of proprietary toxic models on the market. However, DEGADIS has not been adapted to the personal computer; therefore, it is not readily usable for operators in the field who must develop emergency response plans. This program would adapt the model to the PC, simplify it, and add features to make it more complete.

Phase II -- Spicer will take the results from Phase I and further enhance the PC model to include modifications included in version 2.1 of DEGADIS and make it compatible with FORTRAN 77. He will also develop a comprehensive test plan for the model.

Status: Phase I -- A final draft model and report are being reviewed; Phase II -- Work began during the first quarter of 1989.

Completion Date: Phase I -- June 1989; Phase II -- December 1989

EFFECTS OF SURFACE ROUGHNESS ON DENSE GAS DISPERSION – AQ-4

Staff: H. Feldman

Objective: Determine the effects of man-made structures, similar to those in refineries, on the dispersion of heavier-than-air gases.

Initiated: Phases I & II -- 1986; Phase III -- 1987; **Phase I --** \$10K; **Phase II --** \$40K; **Phase III --** \$82.5K; **Contractor:** Cermak, Peterka, and Petersen Wind Engineering Consultants

Scope: A three-phase program is planned. Phase I was a literature review of methods for the estimation of the dispersion coefficients pertaining to surface roughness effects. The report is available as API Publication No. 4459. Phases II and III involve wind tunnel experiments to provide subscale data on the dispersion effects of refinery structural configurations.

Status: Final report undergoing OGC review.

Completion Date: June 1989

OCD 1989 MODEL REVIEW AND TEST – AQ-7

Staff: H. Feldman

Objective: Review the most recent version of the Offshore and Coastal Dispersion Model to ensure its acceptability.

Initiated: 1989 (April); \$15K; Contractor: Reese-Chambers Systems Consultants, Inc.

Scope: The Minerals Management Service has revised the OCD air quality dispersion model. This model is used to estimate the impact on air quality of criteria and toxic pollutants from offshore and coastal facilities. In 1988, API sponsored a revision to this model. MMS has requested that API peer review the latest changes before they release the model. (The RFP for MMS' work indicated that their contractor would add area source algorithms to the OCD model.) Our contractor will review the changes made in the model and, by means of test data, will evaluate the effect on concentration calculations.

Status: Draft report received May 1989.

Completion Date: June 1989

SLAB HEAVY GAS DISPERSION MODEL – AQ-7

Staff: H. Feldman

Objective: Provide a microcomputer version of an improved SLAB model.

Initiated: 1987; \$90.1K + \$47.5K (1989); Contractor: Lawrence Livermore National Laboratory

Scope: SLAB is a promising toxic model developed by Lawrence Livermore National Laboratory. In its current state, it lacks a number of necessary features to be used effectively by industry as an emergency response planning tool. For example, it cannot be run on a personal computer. This project will convert the code to run on a PC, incorporate a release submodel and a thermodynamics submodel, as well as develop a User's Manual.

Status: The last phase of this work, to allow for the implementation of a vertical jet source capability, increase the robustness of the code, and provide concentrations as a function of crosswind distances, was initiated in April 1989.

Completion Date: August 1989

ABSORPTION, TISSUE EQUILIBRIA, AND EXCRETION ROUTES OF INHALED HYDROCARBON VAPORS AND THEIR METABOLITES -- PS-56

Staff: E.H. Vernot

Objective: To determine the relationship between exposure to gasoline vapors and the dose to target tissues, and to determine relative rates of absorption, distribution, metabolism, and elimination of n-octane and 2,2,4-trimethylpentane.

Initiated: 1985; \$210K; **Contractor:** A. Dahl, Lovelace Laboratory, Inhalation Toxicology Research Institute

Scope: The inhalation absorption of representative compounds from each major chemical class found in gasoline have been assayed in rats. Pharmacokinetic investigations have been carried out with inhaled n-octane and 2,2,4-trimethylpentane (isooctane) and/or their metabolites. Parameters investigated include the kinetics of absorption, distribution, excretion, and tissue retention.

Status: Vapor uptake experiments have been completed for 10 hydrocarbons covering a wide volatility range including unsaturated and aromatic compounds at concentrations from 1-5000 ppm. Trends observed included: 1) highly volatile hydrocarbons are less well absorbed than less volatile hydrocarbons, 2) unsaturated compounds are better absorbed than saturated ones, and 3) branched hydrocarbons are less well absorbed than unbranched ones. There was little effect of concentration on the fractional uptake.

In comparing the pharmacokinetic profiles of octane (nephrotoxic) and isooctane (nephrotoxic), much more of the isooctane is excreted through the kidney, whereas a significant proportion of the n-octane is metabolized to CO₂ as compared to almost none of the isooctane. The final report, "Studies on the Absorption, Tissue Equilibria, and Excretion Routes of Inhaled Hydrocarbon Vapors and Their Metabolites," is available as a departmental report.

Completion Date: Completed in April 1989.

ESTIMATION OF AMBIENT LEVELS OF GASOLINE OR OTHER HYDROCARBONS --

Staff: W.M. Ollison

Objective: To develop a computer program that can predict ambient concentrations of certain hydrocarbons in the workplace.

Initiated: 1987; \$58K; **Contractor:** Midwest Research Institute

Scope: The computer program would allow a user to predict a range of airborne

concentrations of gasoline components from liquid composition data and measured vapor levels of only a few gasoline components. The program will be validated with existing liquid composition and exposure data. It is expected that this project will be useful in defining occupational exposures in many settings where "ball park" estimates are needed.

Status: A draft user manual and software diskettes have been reviewed by the task force, and final analysis and revisions by the contractor are anticipated to begin in June 1989.

Completion Date: Final report expected December 1989.

GENOTOXICITY OF LIGHT HYDROCARBONS -- PS-61

Staff: E.H. Vernot

Objective: To define relationships between chemical components of unleaded gasoline and observed genotoxic activity.

Initiated: 1986; \$42K; Contractor: Microbiological Associates

Scope: Mutagenic activity was observed when mammalian cells were treated with an evaporative residue of gasoline in the presence of metabolic activation, and with a DMSO extract in the absence of metabolic activation. This project is designed to assess the mutagenicity of gasoline components in the mouse lymphoma assay and to examine the genotoxicity of gasoline, its evaporative residue, and DMSO extract using the in vitro unscheduled DNA synthesis (UDS) assay.

Status: These studies are complete and the reports finalized. All gasoline components tested (2,2,4-trimethylpentane, 2,3-dimethylpentane, n-octane, and the 220- to 280-degree gasoline cut) were negative in the mouse lymphoma assay. The whole unleaded gasoline and the DMSO extract were negative in the UDS test, and the evaporative residue was positive. Final reports are available as departmental reports.

Completion Date: Completed in March 1989.

HISTORICAL PROSPECTIVE MORTALITY STUDY OF EMPLOYEES EXPOSED TO DOWNSTREAM GASOLINE IN THE PETROLEUM INDUSTRY -- OH-38D

Staff: D. Mongillo

Objective: To determine whether distribution and marketing gasoline workers (excluding service station employees) are at increased risk of dying from specific diseases, including kidney cancer and lymphatic/hematopoietic cancers, because of exposure to gasoline.

Initiated: 1985; **Epidemiology** \$2,805K + \$423K (1989); **Exposure Assessment** \$302K;
Contractor: Epidemiology -- ENSR Health Sciences (formerly EHA); **Exposure Assessment** --
University of Massachusetts (Tom Smith)

Scope: The study, involving approximately 38,000 distribution and marketing employees in both marine and inland operations, is designed to provide information on the possible human health risks associated with gasoline exposure. These employees are thought to have had relatively high exposure to gasoline vapors. The work includes the integration of two segments: 1) an epidemiology study ascertaining the work histories and mortality, and 2) an exposure assessment study characterizing exposures.

Status: Epidemiology -- the contractor has coded the employment histories of approximately 80 percent of the employees estimated to be members of the final cohort. The contractor is also performing estimations of error rates in the coding process. The task force and contractor are investigating various means of providing independent estimates of cohort verification.

Exposure Assessment -- Industrial hygiene (IH) surveys at older distribution and marketing facilities have been completed. An exposure assessment plan has been submitted in draft form. A method to integrate the IH data with the epidemiology data base is being developed.

Completion Date: April 1990

LIGHT HYDROCARBON-INDUCED NEPHROTOXICITY -- PS-67

Staff: E.H. Vernot

Objective: To elucidate the mechanisms of light hydrocarbon-induced nephrotoxicity and carcinogenicity.

Initiated: 1983; **\$1,750K;** **Contractor:** Chemical Industry Institute of Toxicology (CIIT)

Scope: With the identification of the compound types responsible for male rat nephropathy, mechanistic studies were undertaken to determine the pathogenesis of male rat kidney lesions. These included binding studies with a nephrotoxic metabolite and a male rat specific serum protein (alpha-2u-globulin), cell proliferation in the kidneys of exposed male rats, initiation/promotion experiments, and a search for human serum proteins related to alpha-2u-globulin.

Status: Studies have indicated that a cascade of events must occur for the kidney tumors to occur: strong binding between the chemical and the protein, accumulation of the protein in lysosomes to the point where the lysosomes rupture leading to cell toxicity and death, and increased cellular proliferation that acts as a promoter to increase the rate of background tumors. More recent studies are focusing on the characteristics of human

proteins related to alpha-2u-globulin. Exposure of male rats to European high test gasoline did not produce the nephrotoxic effects associated with PS-6 gasoline. The European product contains only small amounts of the isoparaffins believed responsible for the kidney toxicity and carcinogenicity. CIIT has published many papers on this work in the scientific literature. CIIT will bring this project to conclusion using in-house funding.

Completion Date: Completed in

MECHANISMS OF CARCINOGENESIS OF FEMALE MOUSE LIVER TUMORS INDUCED BY UNLEADED GASOLINE -- PS-67

Staff: E.H. Vernot

Objective: To elucidate the mechanism of nongenotoxic carcinogenesis of female mouse liver induced by unleaded gasoline and to determine if this mechanism is available in humans at normal levels of exposure.

Initiated: 1989 (May); \$250K; **Contractor:** Chemical Industry Institute of Toxicology

Scope: To determine the relationships among dose and exposure time and unleaded gasoline-induced cell proliferation and oncogene expression, to determine the active fraction of gasoline, to develop culture systems for comparison of effects on test animals and humans, and to characterize lesion development and relate it to tumor induction.

Status: Preliminary experiments have indicated that exposure of mice to vapor concentrations of unleaded gasoline that cause female mouse liver tumors lead to greater cell proliferation in the livers of female mice than in those of male mice.

Completion Date: 1993

REFINERY WORKER KIDNEY CANCER CASE-CONTROL STUDY -- OH-38A

Staff: D. Mongillo

Objective: To determine whether exposure to hydrocarbons is associated with the development of kidney cancer among refinery workers, and to estimate the strength of the association in relation to other possible etiologic factors.

Initiated: 1985; \$547K; **Contractor:** Epidemiology Resources, Inc.

Scope: This case control study is an investigation of whether individuals who died as a result of kidney cancer are more likely to have been exposed to hydrocarbons compared to persons dying of other causes. The combined cohort (approximately 94,000 employees) was

derived from mortality studies by five collaborating member companies. A comparison between exposure scores of the cases and controls will enable estimates of the effects, if any, of various categories of hydrocarbons on the occurrence of kidney cancer.

Status: In the draft report, the preliminary results suggest a small increase in the incidence of kidney cancer associated with long term (> 5 years) exposure to gasoline distillates, as indicated by a relative risk of 1.3. This magnitude of increase is not statistically significant. When exposure to aromatics was controlled, however, the association with gasoline distillates rose to a relative risk of 2.3. The data also suggest an inverse relation between kidney cancer and aromatics exposure. Currently, the investigator has described these findings as "an unexplained anomaly." The investigator has been given additional funds to allow an examination of the consistency of the assigned exposure scores and additional analyses to better understand the implications of the findings. These additional data are currently being reviewed by the task force.

Completion Date: October 1989

FUEL SPILLAGE DURING VEHICLE REFUELING --

Staff: D. Lax

Objective: Determine the frequency and amount of gasoline spilled during refueling with Stage II and conventional nozzles.

Initiated: 1988; \$52K; **Contractor:** EA-Mueller

Scope: Trained observers will judge spillage at twenty matched service stations in Washington, DC (Stage II) and Baltimore (conventional). The stations are matched in terms of throughput and location (city center/suburbs). The total amount of fuel spilled will be determined from the frequency and quantity of each spill. The results will be used to assess the actual in-use efficiency of Stage II.

Status: A second draft report received in February 1989 was unacceptable. The contractor performed additional statistical analyses; a revised final report is under review.

Completion Date: July 1989

FUEL TANK WEATHERING --

Staff: D. Lax

Objective: Determine if gasoline at the low RVPs proposed in EPA's volatility regulations weathers in the fuel tank to the point that the vapor enters the explosive range.

Initiated: 1988; \$60K; **Contractor:** Southwest Research Institute

Scope: During higher temperature days (above 85 degrees), five cars will be driven repeatedly over a road route to ensure typical hot day weathering of gasoline in the tank. Three fuels will be tested with RVPs of 11, 9, and 7 psi. Volatility of each fuel will be measured frequently to determine how it is weathering. RVP of the weathered fuel will then be compared to flammability limits based upon temperature and mole percent vapor in the fuel tank.

Status: A draft report was received in April 1989 and was returned to the contractor with extensive comments. A second draft was received in June and is currently under API review.

Completion Date: July 1989

RUNNING LOSS EMISSIONS TEST PROGRAM – AQ-13

Staff: D. Lax

Objective: Conduct an exploratory program to determine what vehicle and fuel factors lead to running loss emissions, and how test conditions effect the generation of these emissions.

Initiated: 1989 (May); \$168K; **Contractor:** Automotive Testing Laboratories (ATL)

Scope: This program will examine vehicle and fuel factors thought to contribute to high running losses. These factors include: tank temperature rise profile, ambient temperature, RVP, ethanol blending, and fuel weathering. The relative effects of these factors will be determined through running loss measurements performed on four vehicles.

Status: The program is in the preliminary stage of initiation. Details of the experimental design, measurement procedures, and fuels to be used in the study have been approved by API and discussed with the contractor.

Completion Date: April 1990

IMPROVED VEHICLE STATE I&M PROGRAMS --

Staff: D. Lax

Objective: To identify and evaluate the costs and benefits of improving existing vehicle state I&M programs in order to reduce ozone levels and avert the mandating of new control measures such as oxygenated fuels.

Initiated: 1988; \$60K; **Contractor:** EA-Mueller

Scope: Deficiencies in current I&M programs will be determined by reviewing existing programs in key states and by evaluating available studies of the effectiveness of I&M. Realistic options for improving the I&M programs will be identified and their implementation costs estimated. Such options include improving vehicle test procedures and mechanics' training and tightening the exemption criteria and checks for tampering.

Status: The final task of the study -- quantification of emissions benefits and costs of recommended improvement strategies -- was delayed pending the release of MOBILE4 by EPA. This task has now been completed and a draft final report is being reviewed by the task force.

Completion Date: August 1989

UNREGULATED EMISSIONS FROM VEHICLES USING OXYGENATED FUELS --

Staff: D. Lax

Objective: Measure individual hydrocarbons, alcohols, aldehydes, and MTBE in exhaust emissions from oxygenate blends for use in assessing potential health implications and impact on ozone formation.

Initiated: 1988; \$40K; **Contractor:** National Institute for Petroleum and Energy Research

Scope: The study is an "add-on" to the Denver vehicle emissions CRC project. It funds the collection and analysis of samples of unregulated pollutants from six of the twelve vehicles tested as part of the CRC study. The CRC study measured only regulated emissions (CO, NOx, HC).

Status: Testing has been completed and data compilation is underway. A preliminary review indicates considerable data variability on some samples, which needs to be investigated prior to data analysis. API proposes that a combined final report be published that would contain all of the CRC, EPA, and API data.

Completion Date: Third quarter 1989

VEHICLE EVAPORATIVE AND EXHAUST EMISSIONS –

Staff: D. Lax

Objective: To determine the effects of temperature, RVP, and oxygenate blends on vehicle exhaust and evaporative emissions.

Initiated: 1988; \$540K + \$296K (1989); Contractor: Automotive Testing Laboratories

Scope: A two-phase program has been designed. Ten cars (1981-1988 model years) will be tested on five fuels. The fuels and corresponding RVPs are (1) gasoline (13, 10, 8.5, & 7 psi); (2) 10% splash-blended ethanol (13 & 8.5 psi); (3) 7.5% MTBE blend (13 & 8.5 psi); (4) 15% MTBE blend (13 & 8.5 psi); and (5) 17.2% ETBE blend (8.5 psi).

Phase I will be conducted at 55 and 80 degrees F. (ETBE will be tested only at 80 degrees.) In Phase II, exhaust emissions will be measured at 35 degrees using the same cars and fuels as in Phase I (except that the ETBE blend, 7.5% MTBE blend, and 7-psi fuels will not be tested).

Total HC, CO, and NOx exhaust emissions will be determined at all temperatures. Total HC evaporative emissions data will be collected only at 55 and 80 degrees F. Individual HCs, alcohols, and aldehydes will be determined in the evaporative component at 55 and 80 degrees and in the exhaust at 35 and 80 degrees. (For individual exhaust components, data will be collected only on the 8.5-psi RVP fuels set.)

Status: Phase I testing was delayed pending the receipt of test fuels that met the proper specifications. This has now been accomplished and Phase I testing commenced the end of May 1989. This phase should be completed by the end of November 1989.

Funding for Phase II was approved in March 1989. This phase is expected to commence in November 1989 and be completed by February 1990.

Completion Date: First quarter 1990

**IMPACT ON URBAN OZONE FROM CHANGES IN FUEL VOLATILITY AND USE OF
ETHANOL BLENDS --**

Staff: H. Feldman

**Objective: Assess the ozone impact that changes in fuel volatility and ethanol blends
would cause in order to respond to studies done by the Renewable Fuels Foundation and EPA.**

Initiated: 1988; \$40K + \$10K (1989); Contractor: Systems Applications Inc.

**Scope: The EKMA model is being used for seven cities to determine the impact that
changes in RVP and/or use of ethanol and MTBE blends would have on ambient ozone levels.
The estimates are for 1985, 1990, and 1995. Various sensitivities to running losses,
background CO, and NOx are also being examined.**

**Status: Draft report has been received. The results indicate that any benefits seen
for ethanol in 1985 diminish with time due to fleet turnover. By 1990, the direction of
ethanol's ozone impact will vary among the seven cities. However, MTBE always results in
less ozone formation than ethanol and base gasoline. SAI is being asked to perform a few
more model runs and make some text modifications.**

Completion Date: July 1989

**CHEMICAL FATE AND TRANSPORT OF OXYGENATES IN GROUNDWATER --
GW-16**

Staff: B. Bauman

Objective: To evaluate the impact of oxygenates in gasoline on the fate and transport of BTEX (benzene, toluene, ethylbenzene, and xylene) in groundwater.

Initiated: 1988; \$100K + \$137K (1989); Contractor: J. Barker, R. Gillham, University of Waterloo

Scope: Blends of gasoline and varying amounts of MTBE, methanol and ethanol will be evaluated in the laboratory to determine oxygenate effects on the solubility, sorptive retardation, and biodegradation of BTEX. A field study will compare the fate and transport of contaminated groundwater plumes using gasoline, a methanol-gasoline mixture (85% methanol, 15% gasoline), and a 15% MTBE fuel.

Status: Initial laboratory experiments for cosolubility effects and biodegradation have been completed; supplementary studies are in progress. Evaluation of results is continuing. BTEX retardation experiments are complete and data are being evaluated. Biodegradation microcosms have been set up for both oxygen-limited and oxygen-unlimited conditions. The oxygen-limited microcosms are still being sampled; others are complete. A report on the laboratory studies will be provided in July 1989. Analysis of 1988 field study data has allowed design of the 1989 field-sampling grid. Additional data evaluation is continuing. Three samplings will occur in 1989 (May, July, and October).

Completion Date: May 1990

METHANOL DOSAGES FROM DERMAL EXPOSURE – PS-32

Staff: R. Rhoden

Objective: To determine the amount of methanol absorbed by the body from dermal exposure to methanol.

Initiated: 1988; \$69K; Contractor: Thomas J. Franz, M.D., University of Arkansas for Medical Sciences

Scope: This project will determine the percutaneous absorption of methanol from methanol-containing fuels using in vitro and in vivo systems. In vitro absorption will be evaluated using pure methanol and four gasoline/methanol mixtures applied to four different animal skins plus human cadaver skin. In vivo tests will be carried out on monkeys and human volunteers. The doses applied to humans will be established with a large safety factor to insure that no acute toxicity occurs.

Status: In vitro experiments began in March and will be completed in June. A University committee is reviewing the protocols for the in vivo experiments. Barring any problems, the work should be completed by October. In vitro experiments with human skin have been completed. They indicate that methanol is absorbed two to three times faster from M85 than from pure methanol. In 50% and 25% methanol/gasoline mixtures, methanol is absorbed seven to eight times faster than from the pure substance.

Completion Date: December 1989

HETEROGENEOUS CHEMISTRY OF METHANOL –

Staff: H. Feldman

Objective: Perform an experimental investigation of the heterogeneous atmospheric chemistry of methanol, particularly whether methanol emissions could lead to the formation of dimethyl sulfate in the atmosphere.

Initiated: 1989 (June); \$51K; Contractor: California Institute of Technology

Scope: It has been postulated that methanol emissions may lead to dimethyl sulfate in the atmosphere, and dimethyl sulfate is an extremely hazardous substance. The contractor will investigate the aqueous phase chemistry of the monomethyl and dimethyl sulfuric acid esters. He will conduct laboratory kinetic studies of several reactions in water and in solutions of sulfuric acid and water. The information from this study will be used in a smog chamber study to be conducted by CRC-APRAC or API in 1990.

Status: Project beginning June 1989.

Completion Date: April 1990

FORMALDEHYDE HOT SPOT MODELING --

Staff: H. Feldman

Objective: To determine whether the build-up of formaldehyde concentrations from methanol vehicle emissions in limited ventilation areas (garages, tunnels, etc.) presents a potential health problem.

Initiated: 1988; \$30K; **Contractor:** TRC

Scope: Using emission factors for methanol and formaldehyde obtained from the literature, models will estimate the concentrations of formaldehyde that could be expected under various scenarios/geographic areas. Carbon monoxide concentrations will also be estimated.

Status: Draft report has been received. Contractor is making revisions and final draft is expected in June.

Completion Date: July 1989

ENERGY EXPENDITURE-VENTILATION REQUIREMENTS IN OUTDOOR OCCUPATIONS -- AQ-9

Staff: W.M. Ollison

Objective: To determine whether ventilation levels (e.g., 42 l/min continuously for 6.6 hrs) chosen in recent EPA ozone-effect studies are realistic estimates of current outdoor work practices in urban environments.

Initiated: 1988; \$7.6K; **Contractor:** W.C. Adams, U. C. Davis

Scope: The project will address the plausibility of chosen exercise-effect levels by completing four tasks: (1) a literature review and analysis of reported energy expenditure-ventilation levels for specific job tasks and job classifications, (2) pilot work in the form of limited time-work observations of individuals performing tasks in active outdoor occupations, (3) a retrospective study of the reproducibility of pulmonary function/symptom responses in clinical subjects participating in sequential high-exercise, ozone-exposure studies at U. C. Davis, and (4) a retrospective review of U. C. Davis exercise physiology research to document the effect of age, gender, size, fitness, and heat stress on heart rate-ventilation correlation.

Status: Task 1 draft report received December 3, 1988; an upper limit of 30 l/min is suggested as a realistic maximum ventilation rate sustainable throughout a workday, with lower levels more likely.

Task 2 will be postponed pending results of Task 4. Should the results of Task 4 warrant the field tests envisaged in Task 2, additional funds will be provided to implement this study. Task 4 draft anticipated in August 1989.

Task 3 report received on March 15, 1989. Pulmonary function, subjective symptoms, and respiration rate appear to be highly reproducible ($r > 0.8$) at ozone concentrations greater than 0.3 ppm with effective doses greater than 800 ppm-l; however, at concentrations less than 0.2 ppm and effective doses below 800 ppm-l, reproducibility was poor ($r < 0.6$).

Completion Date: October 1989

ASSESSING HUMAN EXPOSURE AND DOSE TO OZONE --

Staff: H.L. Spitzer

Objective: To understand the relationship between ozone measured at a fixed-location ambient monitor and actual human exposure; improve exposure models and provide design criteria for additional exposure assessment; advance the concepts of ozone dose assessment to better interpret clinical and epidemiologic studies.

Initiated: 1989 (February); \$75K; Contractor: John D. Spengler, Harvard University

Scope: The project will be divided into three tasks. The first is to review and analyze time/activity data to develop generalizations about human habits -- patterns of activity. The second task is to demonstrate how the data can be used to model ozone exposure for representative populations (Los Angeles; Boston; and Steubenville, Ohio). The third task is to evaluate the data and quantitatively compare it to a previous analysis done by the EPA in Cincinnati.

Status: Draft report expected September 1989.

Completion Date: October 1989

DEVELOPMENT OF IMPROVED METHODS TO MEASURE EFFECTIVE DOSES OF OZONE -- AQ-9

Staff: W.M. Ollison

Objective: To develop personal ozone exposure and ventilation monitors useful on free-living subjects to estimate inspired ozone dose.

Initiated: 1989 (February); \$61.5K; Contractor: Jack D. Hackney, Rancho Los Amigos Medical Center (Anticipate joint funding with MVMA)

Scope: Continuation of 1988 joint API-MVMA pilot project (with Dr. Linn at the same center). Task 1 -- Fabricate active ozone monitors for use in field estimates of personal ozone exposure; continue research on possible passive monitor designs. Task 2 -- Refine heart rate measurement and subjective estimation protocols developed to estimate personal ventilation in the 1988 pilot study, and assess the range of usefulness of each approach under field test conditions. Task 3 -- Monitor heart rates and microenvironmental locations (diary records) 24 hours a day for 3 days in 20 subjects to quantitate ventilation rates that were subjectively estimated in EPRI Cincinnati diary activity database used in the revised NEM exposure model.

Status: A progress report was received on May 24, 1989. Prototype pumped active monitors are light-tight to photodiode tests. Preliminary tests indicate 80% ozone capture on initial filter paper reagent disk; additional capture occurs on subsequent disks. One-hour exposures to 0.1-ppm O₃ at sampling rates of 2.5 lpm give absorbance values five times greater than the blank level.

Completion Date: December 1989

**EVALUATION OF NEW TECHNIQUES FOR ESTIMATION OF PERSONAL OZONE DOSE
IN AMBIENT POLLUTION EXPOSURES -- AQ-9**

Staff: W.M. Ollison

Objective: To develop (1) personal ozone exposure monitors; (2) methods of measuring/estimating ventilation rates in free-living subjects; (3) diary methods to assess hourly activity level, symptomatology, and perceived exposure to air pollutants; and (4) comparisons of three fixed site monitoring methodologies.

Initiated: 1988; \$10.5K (jointly with MVMA); Contractor: Wm. S. Linn, Rancho Los Amigos Medical Center

Scope: Passive ozone monitors were developed, evaluated, and field tested. Comparisons of ventilation rate estimates (direct measurement, estimates from measured heart rates, and subjective estimates from individuals trained on laboratory egometers) were used to develop protocols for reliable ventilation estimations. Diaries were developed to record hourly location, activity, symptoms, medication, and perceived exposure for field testing. Finally, concurrent monitoring data using three independent monitoring technologies were compared to assess accuracy and potential interferences in these methods.

Status: Draft final report received December 22, 1988. Although field tests of the passive monitors were initially unsuccessful due to sunlight interferences, the prototype device can be modified to serve as an active sampler. Research to eliminate the sunlight effect in the passive mode continues. Heart rate estimates of ventilation correlated well to measured values on an individual basis; subjective ventilation estimates from trained subjects, although reasonably accurate at low exercise levels, were less reliable at higher activities. Compact diaries were used successfully with eight subjects at home for 1 week; however, training during the initial days seems necessary. Ozone readings were significantly different among the three instruments, with the ultraviolet method giving the highest long-term values, the gas phase chemiluminescent federal reference method giving intermediate levels, and the liquid phase chemiluminescent instrument giving the lowest concentrations.

Completion Date: December 1989

**RETROSPECTIVE EVALUATION OF REPRESENTATIVE OZONE STATE
IMPLEMENTATION PLANS –**

Staff: H. Feldman

Objective: Identify the reasons for failure of SIPs to achieve attainment, determine if modern analytical techniques would be more successful in producing a SIP that will achieve attainment, and develop recommendations for improvements to the SIP process.

Initiated: 1988; \$50K + \$135K (1989); **Contractor:** PES/SAI

Scope: Seven nonattainment areas will be chosen for an in-depth study. Selection will primarily be based on emissions sources, ozone formation potential (meteorology), ozone exceedances, and ozone transport. Once the study areas have been selected, the SIP for each area will be analyzed. The following steps will be taken during this phase: gather data, analyze model input, evaluate strategy effectiveness, analyze modeling, and develop recommendations. A report aimed at a nontechnical audience will be prepared and will include results of all the analyses and the recommendations. Technical material will be included in appendices.

Status: The seven cities for in depth study have been identified by the contractor and workgroup: Boston; Philadelphia; Washington, DC; Chicago; Cincinnati; Houston; and San Francisco. SIP analyses are underway. Draft report expected July 30, 1989.

Completion Date: September 1989

NEM ACTIVITY – VENTILATION DATA COMPARISON – AQ-9

Staff: W.M. Ollison

Objective: To facilitate conversion of the current EPA deterministic/intuitive NAAQS Exposure Model (NEM) to a probabilistic/empirical model by generation of representative distributions of activity-ventilation patterns from experimental data.

Initiated: 1989 (January); \$11.9K + \$24.7K (1989); Contractor: PEI Associates

Scope: The project addresses the need for realistic estimates of population exposure to ambient ozone. Deficiencies identified in the current EPA NEM are mitigated by use of actual data in place of plausible but intuitive behavioral patterns. PEI will consult with Dr. Jack Hackney on Task 3 of the 1989 API-MVMA Rancho Los Amigos ozone dose measurement project.

Status: Draft reports received March 28, 1989, concerning assessment of ventilation parameters derived from the EPRI Cincinnati database, and April 11, 1989, concerning statistical comparisons of activity patterns among subjects living in Washington, D.C., Denver, and Cincinnati are under review by the Ozone Health Workgroup.

Completion Date: October 1989