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USER'S GUIDE TO THE LIRAQ MODEL: AN AIR POLLUTION MODEL FOR THE SAN FRANCISCO BAY AREA

Michael C. MacCracken, Principal Investigator

December 19, 1975

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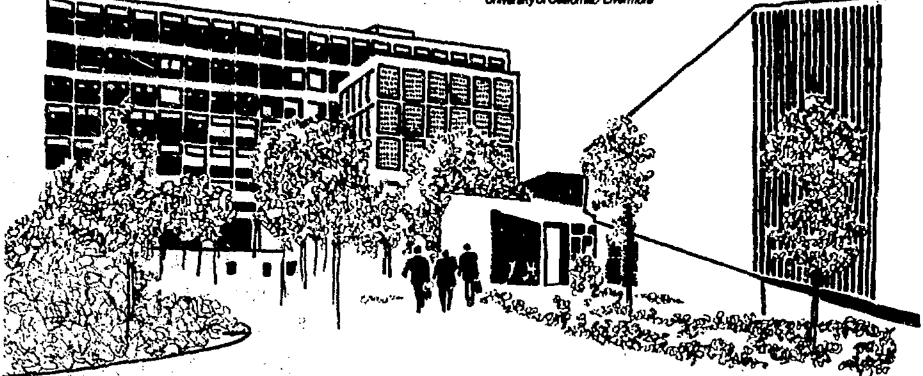
LAWRENCE LIVERMORE LABORATORY
University of California/Livermore



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Michael C. MacCracken

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MS. date: December 19, 1975

Preface

This User's Guide has been written to assist the potential user of the LIRAQ model to conduct numerical simulations at the Lawrence Berkeley Laboratory (LBL) Computer Center. Although the project to develop and validate a numerical model was sponsored by the National Science Foundation as a joint project of the Lawrence Livermore Laboratory (AG-412), the NASA Ames Research Center (AG-411), and the Bay Area Air Pollution Control District (GI-36390), primary responsibility for the numerical modeling rested with LLL. As such, the numerical codes (with the exception of several data-processing codes developed by Mike Kim and Howard Harawitz of the BAAPCD and included here in Appendix J) were developed on the LLL computer system. Those codes essential to LIRAQ model operation at LBL have subsequently been transferred there.

The scope of the modeling aspect of the NSF project (see MacCracken and Sauter, 1975 for a description of the entire project) is itself very broad, ranging from data storage and processing to model development and output presentation. Thus, this task has involved a team of participants at LLL, and the technical outcome of this effort should be viewed as the collective work of the listed participants:

Marvin H. Dickerson
William H. Duewer
Keith E. Grant
Donald M. Hardy
William E. Johnston
Michael C. MacCracken
Theodore W. Stullich
John J. Walton
Donald J. Wuebbles

During the project at LLL, scientific administrative support has been provided by R. Carroll Maninger, as Project Manager for the three-agency effort, and Joseph B. Knox, Division Leader for the Atmospheric and Geophysical Sciences Division. Important comments and feedback on the work undertaken have been provided by David Dorn at LLL and by the Research and Planning Section of BAAPCD.

Although the modeling for this project has focused on simulation of air quality in the Bay Area, the models have been designed so that transfer to other regions depends almost completely on assembling data for that region. Thus, the focus in this report on the Bay Area is only indicative of the particular specific region to which the models have been applied and is not meant to imply that transfer is not possible.

This work has been supported in part by the National Science Foundation and performed under the auspices of the U.S. Energy Research and Development Administration.

Because continuing effort is being devoted to development and application of the model in conjunction with other projects, we recommend that, prior to using the model on the LBL system, contact be made with LLL in order to receive information on any changes that may affect the framework for access to the model.

In addition, we would like to acknowledge the very helpful manuscript preparation of this report by the LLL Technical Information Department, with technical editing by Robert A Condouris.

Michael C. MacCracken
Principal Investigator

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USER'S GUIDE TO THE LIRAQ MODEL: AN AIR POLLUTION MODEL FOR THE SAN FRANCISCO BAY AREA

Abstract

The Livermore Regional Air Quality (LIRAQ) model comprises a set of computer programs that have been integrated into an easily used tool for the air quality planner. To assemble and modify the necessary data files and to direct model execution, a problem formulation program has been developed that makes possible the setup of a wide variety of studies involving perturbation of the emission inventory, changes to the initial and boundary conditions, and different choices of grid size and problem domain. In addition to describing the types of air quality problems for which the LIRAQ model may be used, this User's Guide provides detailed information on how to set up and conduct model simulations. Also included are descriptions of the formats of input data files so that the LIRAQ model may be applied to regions other than the San Francisco Bay Area.

1. Summary

The Livermore Regional Air Quality (LIRAQ) model is a sophisticated regional air quality analysis and planning tool that has been developed to assist air quality planners. A detailed presentation of the physical and chemical basis for the LIRAQ model structure is presented in the final report on this project submitted to the National Science Foundation (NSF) (MacCracken and Sauter, 1975). Before using the model, the Final Report should be reviewed. This User's Guide is intended only to provide guidance for the actual user so that problems of interest can be formulated, run on the CDC computers* at the Lawrence Berkeley Laboratory (LBL) Computer Center, and output for analysis. A few computer codes, needed for automated generation of input data files, are still only functional on the Lawrence Livermore Laboratory (LLL) computer system.

*Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Energy Research & Development Administration to the exclusion of others that may be suitable.

The User's Guide is divided as follows:

- Section 2 provides a brief, descriptive overview of the physical basis of the model, including an introduction to the range of problems for which the model has been designed.
- Section 3 outlines the hierarchy of computer codes which together form the LIRAQ model, including a description of how these codes are structured to provide the user with a quite simple procedure for investigating a variety of complex regional air quality situations. For some other types of problems, resort will have to be made to the descriptions in the appendices and individual problems will have to be run under direct user control.
- Section 4 presents an example, from the view of the air quality planner, of one of the types of regional air quality problems which the model is designed to treat.
- The appendices (A-K) contain detailed documentation of the format of the input needed to run the model and of the numerical codes, which together make up the LIRAQ model.
- The actual code listings are included in microfiche form as an attachment to this User's Guide.

2. Overview

Because of the complex atmospheric and chemical interrelationships that combine to determine air quality on an urban and regional basis, the use of sophisticated planning and analysis tools is necessary for developing the information that can guide in making decisions that will affect air quality. The set of computer codes, which together comprise the Livermore Regional Air Quality (LIRAQ) model, have been developed as an operational tool to assist air quality control agencies in tasks such as assessing the compliance of present air quality with Federal ambient air quality standards, evaluating the impact on regional air quality of various land use alternatives, and predicting the effect on regional air quality of new sources and postulated emission control strategies.

The LIRAQ model has been developed by the Lawrence Livermore Laboratory (LLL) with the support of the National Science Foundation (NSF) and in cooperation with the Bay Area Air Pollution Control District (BAAPCD), which has provided a detailed source inventory and much of the information needed to compare the numerical model predictions with observations, and is the initial user agency; and the NASA Ames Research Center, which has used its instrumented aircraft to gather data for model comparison with observation. The model has been applied to the San Francisco Bay Area because it is a region that evidences photochemical air pollutant concentrations that exceed the federal air quality standards and to which reasonably complex modeling approaches are only beginning to be applied (see, for example, Ludwig and Kealoha, 1974). The examples given in this User's Guide are chosen based on model application to the Bay Area environment. This should not be construed to mean that the model is applicable only to this region, as the intent from the beginning of the project has been to allow ready transfer to other air quality regions. Because of the modular structure of the model and of the data input, this should be relatively straightforward if the appropriate input data are provided.

The LIRAQ model attempts to treat most of the important factors that determine regional air quality as a function of time. The region of initial interest, the San Francisco Bay Area, is characterized by both its complex topography and its changing meteorology. As shown in Fig. 1, the region has quite intricate geographic features, including numerous ridges, hills, valleys, the Pacific Ocean, a central bay, and major inland flats. Meteorological systems formed over the Pacific Ocean are influenced by the complex Bay Area topography to create complicated, temporally and spatially varying wind fields, and inversion base heights.* The model treats both the complex topography and changing meteorology on one of several available grid scales (1 km or greater) from which the user may choose to study a particular air quality problem. The model does not attempt to forecast air quality, because that would require the capability to forecast the regional meteorology, a formidable problem in itself. Instead, in LIRAQ

*In the LIRAQ model, inversion base height is treated as being equivalent to the depth of the layer through which pollutants emitted at the surface become well-mixed.

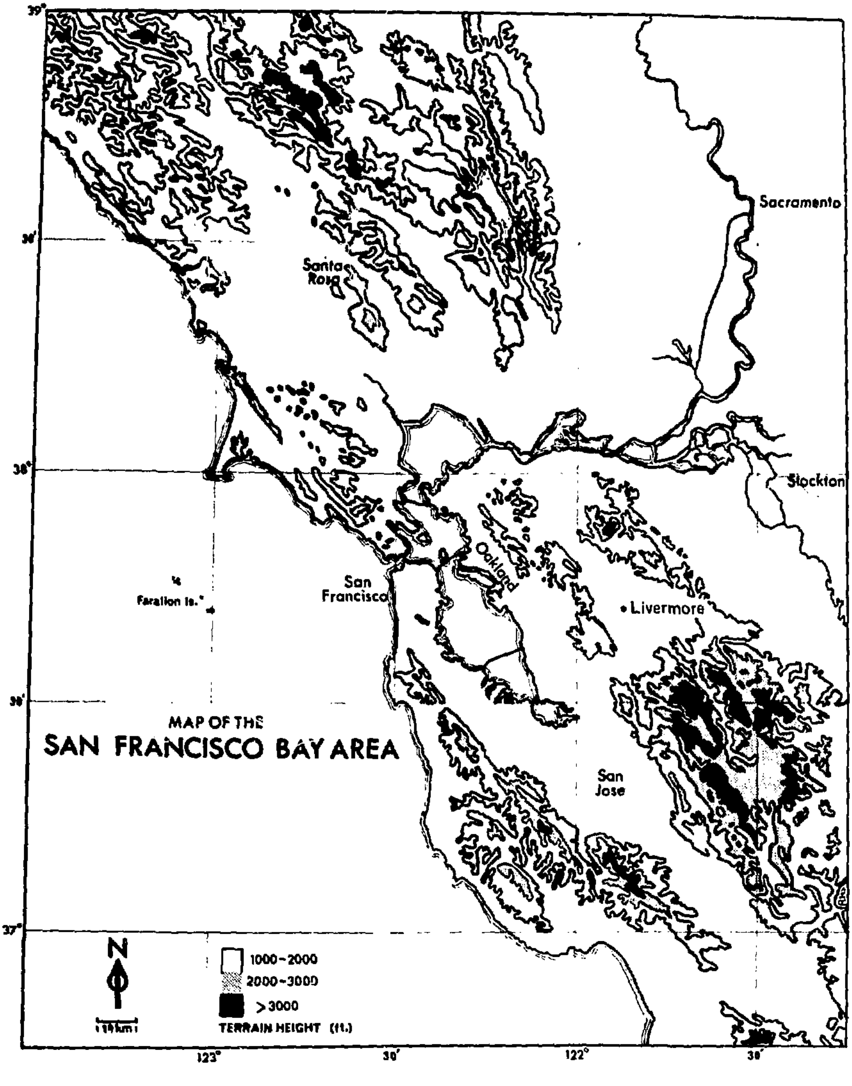

Fig. 1. Topography of the San Francisco Bay Area.

the meteorology (wind speed and direction, atmospheric transmissivity, and mixing depth) must be specified, either at measurement stations or by coordinates. Typically, this involves use of either real or hypothetical meteorological situations (based on sets of previously acquired meteorological observations) that may be expected to be similar to future weather patterns.

The air quality region being studied is based on the boundaries of the Bay Area Air Pollution Control District and encompasses all or parts of nine counties (see Fig. 2).

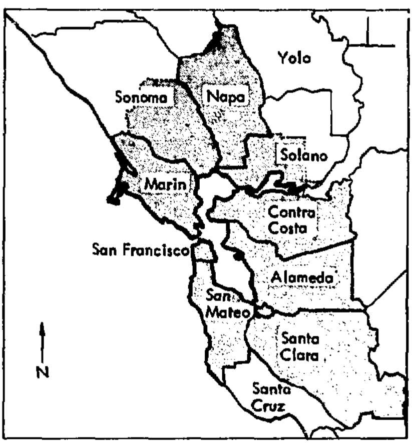

Fig. 2. Boundaries of the Bay Area Air Pollution Control District (BAAPCD).

Within the approximately 14000 km^2 of the BAAPCD, the population, and therefore the emission of pollutants, is spread in a non-uniform pattern over the region of interest. The model deals with four separate types of pollutant sources:

- Mobile (using emissions derived from a traffic model that represents the Bay Area traffic network using about 13 600 highway links and simulates hourly loading).
- Point (based on a compilation of major point sources from the BAAPCD with an hourly emission cycle and differentiating between surface and elevated).
- Airport (treated as limited-area surface sources with estimated hourly air traffic loading).
- Area (based on a distribution of estimated emissions* in proportion to 1970 U.S. census tract population distributions).

The pollutant species of interest in studying the regional air quality in the Bay Area can be divided into primary and secondary species. The primary species (meaning those which have identifiable anthropogenic sources) that the LIRAQ

*For the Bay Area, this is computed by estimating total stationary emissions from such data as fuel usage, and subtracting the contributions from specified point and airport sources.

model can treat are carbon monoxide (CO), nitric oxide (NO), and hydrocarbons (HC). Based on the particular reaction set used in this model to treat photochemical air quality, hydrocarbons are divided into three characteristic types based on their reactivity: HC1 (mainly alkenes), HC2 (mainly alkanes, simple aromatics, ethers, alcohols, etc.), and HC4 (mainly aldehydes, some ketones, some aromatics). In addition, secondary species (those created through chemical transformation processes in the atmosphere) including ozone (O_3), nitrogen dioxide (NO_2), and others must be and are treated by the LIRAQ model.

Because of the complex and nonuniform characteristics of the Bay Area (and to some extent of every region) and because a regional pattern is needed instead of a measure of air quality at a specific point, the mathematical approach that has been used is based on the establishment of an Eulerian (fixed) grid in the two horizontal dimensions. Options for a grid size of 1, 2 and 5 km are available over most of the area of interest shown in Fig. 3. All variables and locations are specified in the Universal Transverse Mercator (UTM) grid system. Because the depth of air through which pollutants mix is highly variable in space and time and in addition may intersect topography, the model has had to be limited to treatment of a single layer in the vertical. The height of this layer, however, may vary in space and time.

The LIRAQ model is thus capable of simulating the time- and space-varying concentrations of non-reactive and reactive pollutants on a regional basis using prescribed meteorology and source emissions. The basic types of questions that the model has been designed to deal with can be divided into three categories:

- Assessment of present air quality: By inputting to the model the present regional pattern of source emissions, the air quality on several specific days may be simulated. While observations from various measurement systems do provide an indication of present air quality at a few points (observations with which the model results may be compared), the model also indicates what the air quality is at locations between such observation sites. Such results may thus point to regions where more extreme air pollutant concentrations may prevail than are being measured. Such information

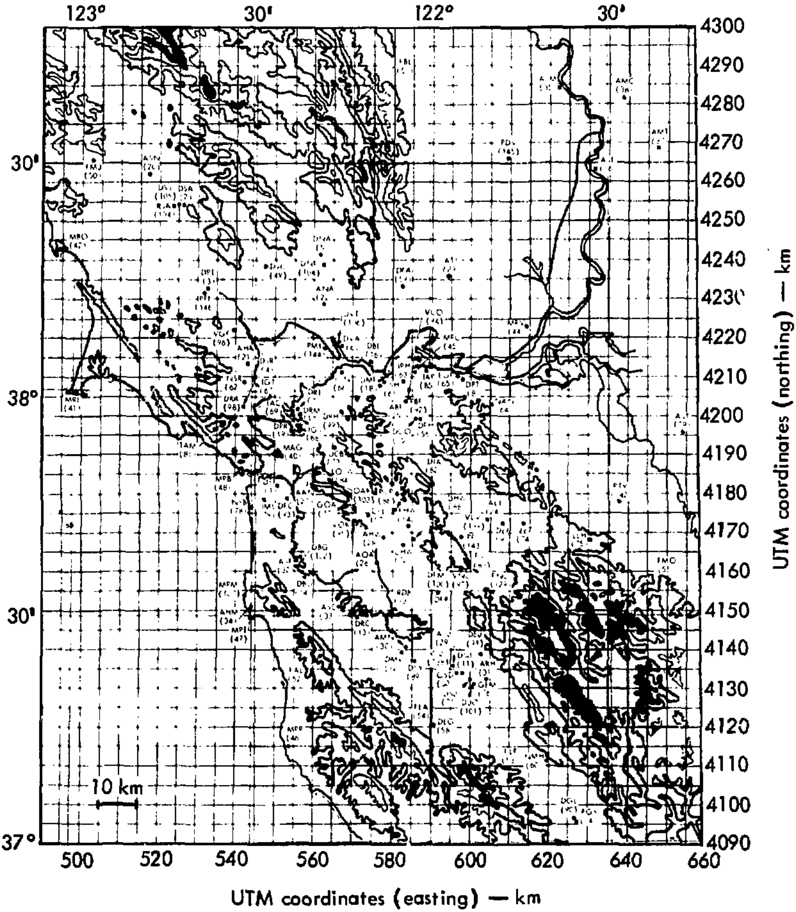

Fig. 3. Outline of the region of interest in the Bay Area that can be studied using LIRAQ.

may then assist in locating monitoring stations or indicate where mobile measurement stations should sample.

- Development of emission control strategies: For regions which do not meet the Federal air quality standards, the development of emission control strategies is an important consideration. A variety of model simulations may prove useful, depending on the time and spatial scale of the problem. A first step might be to identify the contribution made by various source regions to the adverse air quality elsewhere in the region (e.g., the comparison of model results for inland valley oxidant when the emissions in San Francisco are at present levels - both when the inland valley emissions are zero and nonzero - with results from simulations in which the San Francisco emissions have been set to zero). A second step might be to determine the relative role played by various types of sources - mobile, point, airport, and area - in degrading regional air quality. A third subject to investigate might be the relative importance of various species, as for example the importance of hydrocarbons with different reactivities. With such information, short- and long-range control strategies could be proposed and their effect simulated in order to determine the sense and magnitude of the effect. (For example, on episode days reduce traffic and switch to cleaner fuels; or, in the long term, reduce gasoline service station emissions, require retrofit controls, and reduce vehicle miles travelled.)

- Planning for future air quality: Although control of emissions is the primary way to improve present air quality, proper planning of the locations, extent, and mix of future pollutant emissions is believed to be useful in assuring that future air quality meets appropriate standards. One aspect is looking at the general concept of land use (such questions as the relative effects on air quality of growth of pollutant emissions in the North Bay versus the South Bay, or the effect on air quality in various subregions of different population levels and their associated emissions). More specifically, the effect on air quality of a proposed source of subregional significance can be investigated if the pollutant emissions can be hypothesized. In addition to investigating land use, planning aspects of air quality and planning for potential changes in fuel usage can be undertaken; for example the potential effect of substituting methanol for gasoline or fuel oil for natural gas could be simulated, again if emission data can be specified.

The range of problems that are being addressed by air quality planners is very broad. The LIRAQ model, as outlined above, has been designed to treat problems of subregional and regional significance on spatial scales of more than a kilometre and time scales upwards from about an hour. Because of assumptions made in its development, both intentionally and induced by limitations in our knowledge of the physics and chemistry of air quality, there are certain types of problems for which the model is not suitable. These include:

- Air quality problems resulting primarily from and close to (less than several kilometres) from major point sources (which may be more appropriately treated using Gaussian plume or other models).
- Air quality problems close to intense line sources such as highways.
- Air quality problems affected by the presence of major buildings or obstructions (e.g., street canyons).
- Air quality problems resulting from emissions from natural sources, unless they are included in the source emission information.
- Air quality problems affected by species not presently treated in the model (e.g., sulfur oxides, aerosols).
- Air quality problems that depend strongly on distribution of pollutants in the vertical (e.g., effects of varying stack heights).

To use the LIRAQ model, the user must provide input indicating what problem is to be undertaken. As described in the next section, most problems require only interactive teletypewriter contact with a special problem formulation processor code in order to input the relevant information. In this mode the user need only type in straightforward technical responses to questions posed by the problem formulator. Use of this capability for problem formulation is described in Appendix G and sample runs of this type are described in Sec. 4. Once the problem is specified, a few additional instructions are required to initiate problem calculation.

For some problems, however, the set of data files available to the user may not be adequate, and more involved interaction with the various input components may be needed (e.g., a change in the automotive emission indices of various model year cars). For this type of problem, detailed documentation is provided, including: the Final Report, which describes the physical basis for the various codes; internal comment cards within the codes describing what is being done; and this User's Guide, which outlines the structure and operation of each of the codes (see appendixes) to the extent needed to run most problems.

The next section describes the LIRAQ model structure with the aid of schematic diagrams in order to convey a conceptual understanding of how the model addresses the various problems it is capable of treating.

3. The LIRAQ Model

The LIRAQ model is actually an assemblage of numerical models and data processing routines, which have been designed to treat the variety of air quality questions discussed in Sec. 2. This section describes the framework used to interconnect the various parts in a context oriented to the air quality planner. In this general discussion, reference will be made to the appropriate appendixes in this guide that contain further detail.

Figure 4 shows schematically how the model is constructed. The LIRAQ-1 and LIRAQ-2 models are the essence of the LIRAQ model. The primary capability of the LIRAQ-1 model is treating non-reacting chemical species. The LIRAQ-2 model, on the other hand, treats the photochemically reacting species. To the typical user (1 in Fig. 4), however, the LIRAQ model will appear as a simple, problem formulation program, called LIRPRB, which, in the interactive

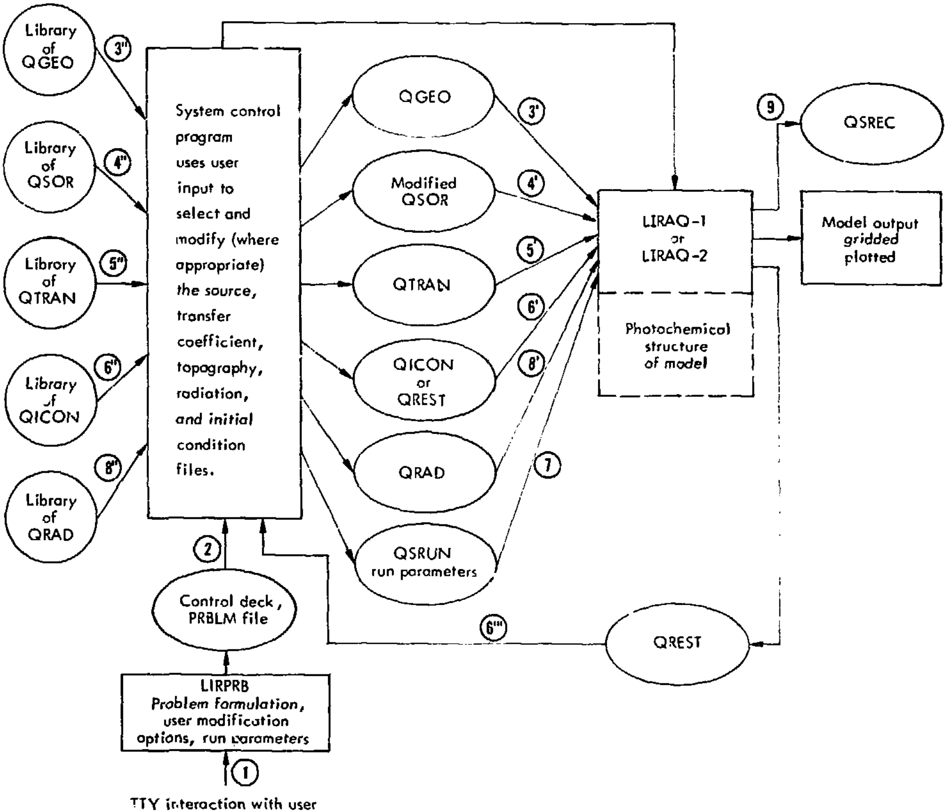

Fig. 4. Steps that occur in running the LIRAQ model

mode, will ask questions about the type of problem to be run (in order to select it from a wide range of typical air quality problems) and solicit all information necessary to run the problem. This includes input on grid size, pollutants of interest, subregion to be studied, output mode, meteorological pattern to be used, and source inventory to be used, including desired modifications. Examples of input are shown in Sec. 4 and detailed instructions are given in Appendix G.

The typical user, upon completion of input to LIRPRB and subsequent initiation of the created control deck, does not see any of the other model operations until tabular and graphical presentations of the data are output. Choice of model and assemblage of needed files from the data base are handled automatically. But it is important for the user to understand the chain of operations leading to the model output.

The files created by LIRPRB consist of the system control deck (2 in Fig. 4) and the PRBLM file, which contains the information required to modify the data files and to set up the run parameter file (QSRUN). Appendix G explains the problem formulation, and Appendix H describes the program which handles data file modification and QSRUN construction.

To then run the specified problem, the appropriate data must be assembled. A wide variety of types of data are needed to simulate regional air quality including source, meteorology, topographic-geographic, initial concentration, radiation, and photochemical rate data. For all but the last type of data, which are presently treated as being internal to the LIRAQ-2 code, libraries of appropriate prepared data sets have been assembled that will allow the user to address a variety of (but not all) questions. The various libraries in the data base are indicated in Fig. 4. Each will be discussed in turn, as will the possible file modifications. For problems for which data are not included in the data libraries, the user may specify a tape containing alternative data files.

TOPOGRAPHIC-GEOGRAPHIC DATA

The first type of information needed by the model is topographic and geographic data, which are conveyed to the model (3' in Fig. 4) as a data file called QGEO.* A

*The names of data files described in this report are given as their equivalenced names. That is done because these names generally indicate the function of the file. The numerical designation used within the codes can be determined from the PROGRAM card for each code.

single QGEO file has been created covering the region shown in Fig. 3 with a 1-km grid resolution. The LIRAQ model then selects data from this file based on the resolution specified by the user. From the QGEO file, inputs of several types are provided:

- The height of terrain. Data are specified on a 1-km grid and then selected from these data for either the 2- or 5-km grid. These data have been developed for the Bay Area from data supplied by the USGS.
- A series of data points outlining the land-water interface. These are used to provide a reference map in the graphical output.
- UTM locations of all stations of interest within the region and the symbol to be used in representing them on graphical output.

The system control routine transfers the QGEO file from its storage location and identifies it as input to the LIRAQ model. Appendix E details information on the structure of the QGEO file.

SOURCE EMISSION DATA

Source emission data are central to the analysis of air quality problems. Substantial effort must be made to ensure accurate input with a temporal and spatial resolution commensurate with the problem to be studied. For the Bay Area, this effort is detailed in Chapter 6 of the Final Report. The LIRAQ model typically requires data on a 1-, 2-, or 5-km grid (depending on choice of grid size) on an hourly basis and divided into surface and elevated emissions. Here elevated emissions are taken to mean those emissions which do not substantially affect the surface pollutant concentrations in the grid square in which they are emitted. These data must be provided to the LIRAQ model (4' in Fig. 4) in a data file called QSOR. Because of the different grid sizes, different years for which source data may be needed, and the different domains over which the LIRAQ model may be run, a set of QSOR files has had to be constructed. The domains that have been selected are described in conjunction with the meteorological data description. As shown in Fig. 4, the particular QSOR file that is to be used by LIRAQ is based on a file selected from the library of available QSOR files (4"). This file is then modified by the MODFILE routine, which is initiated when the system control deck is run. The modification is based on the instructions given by the user during problem formulation and made available to LIRAQ as part of the PRBLM file.

Each of the files in the library of QSOR files is constructed through a sequence of operations described in more detail in Appendix D and shown schematically in Fig. 5. For the Bay Area, in addition to a variety of source emission data from the BAAPCD, additional information on mobile emissions has been prepared by J. Fennessey* in cooperation with the Metropolitan Transportation Commission (MTC), and on population-distributed area emissions by the Association of Bay Area Governments (ABAG). Appendix J describes the codes to handle the mobile and population distributed emission information that have been developed by the BAAPCD. Basically, processed emission information is provided on a 1-km UTM grid for mobile, population distributed, point, and airport sources for five pollutants: carbon monoxide, nitric oxide, hydrocarbons, sulfur oxides, and particulates.† Where available, hourly and seasonal data are provided. Otherwise, estimates of fractional emission per hour for a daily or annual cycle can be imposed, if desired. It is planned that these data will later be developed by the BAAPCD for various years other than the base year 1973, which has been developed as part of this project.**

In developing the sets of files in the QSOR library, preprocessing routines assemble the 1-km data into data files appropriate for various 1-, 2-, and 5-km domains, with hourly resolution and provision for elevated and surface sources. As explained in Chapter 9 of the NSF Final Report, the hydrocarbons are divided into three characteristic types, referred to as HC1, HC2, and HC4, based on their general reactivities. Each QSOR file thus contains hourly information on seven pollutants for each grid square.

The QSOR library is the collection of various QSOR files, and contains current and forecast emissions for what might be called control case simulations on a variety of preselected domains. The problem formulation/control system link allows choice of year and season from the library of QSOR files.

Based on instructions provided from the user, the control system runs a MODFILE program, which can modify the selected QSOR emission files in any of several ways. These options include:

- Setting the reference source emissions in a grid element

*J. Fennessey is an employee of Deleuw, Cather and Company.

†The LIRAQ model presently treats neither sulfur oxides nor particulates.

**A 1980 inventory for mobile emissions was prepared and is available from the BAAPCD.

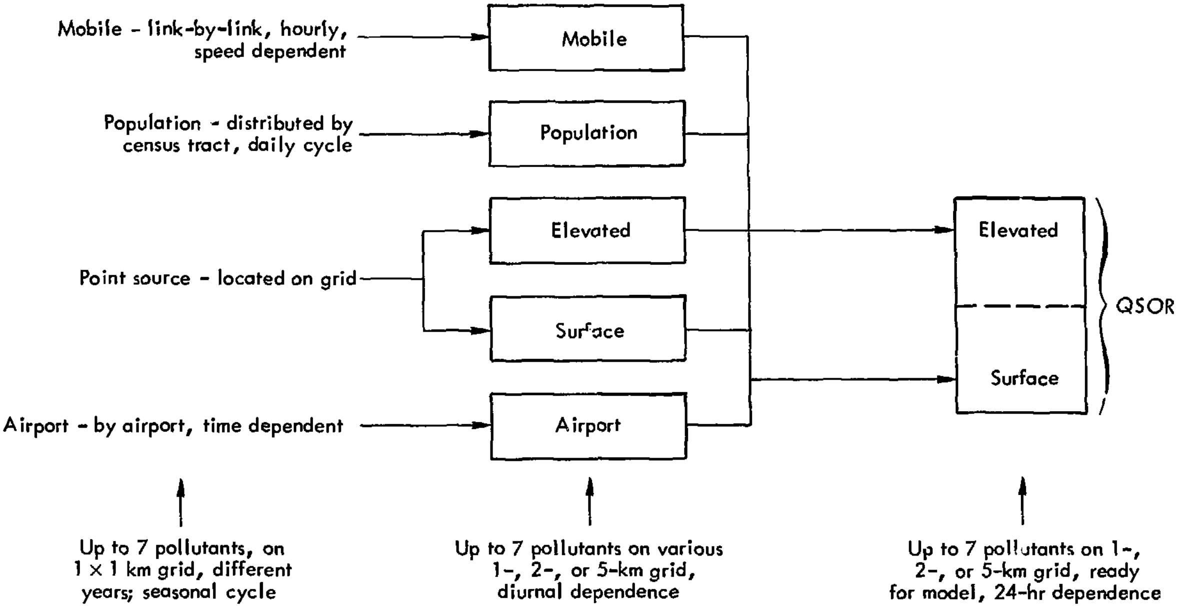

Fig. 5. Steps involved in developing a source emission file for use by the LIRAQ model.

or over a region to some fixed value, including zero.

- Multiplying the reference source emissions in a grid element or over a region by some fixed value including zero.
- Augmenting or decrementing the reference source emissions at a point or over a region by some fixed value.
- Any consistent combination of the above.

The possibilities allow investigation of many air quality problems, although clearly some very interesting options are not readily available. For such things as changing emission indices, altering the highway network demand pattern (for example because of extensive mass transit), or switching all homes to electric power, it is much more straightforward to go back to the basic input data that are used to make up the QSOR files than to patch in each of these changes. Such an undertaking is relatively simple if the instructions given in Appendixes D and J are followed.

One additional option provided for is the designation of whether the source emissions are based on standard or daylight saving time. The feature can also be used to study the effects on air quality of shifting emissions by this time interval.

METEOROLOGICAL DATA

Although the source emission information determines the mass and type of pollutants emitted, the characteristics of the atmosphere determine the extent of the dispersal and thus the pollutant concentrations and air quality that will result. Ideally, numerical prediction of the meteorological elements would be possible, and such data could be used to forecast tomorrow's or explain today's air quality. Unfortunately, numerical simulation of the temporal and spatial evolution of the atmospheric boundary layer is still a research goal whose accomplishment seems several years off. Thus the meteorological data used in the LIRAQ model for air quality analysis are either data sets representing past days on which extensive effort was made to collect needed information (see, for example, Chapters 7 and 8 of the Final Report and Appendix I) or are sets constructed for hypothetical days to represent weather patterns of interest.* The user then investigates aspects of future air quality by seeing what change in concentrations a modified source emissions inventory would induce in contrast to the present source inventory for a known or hypothetical day.

*This latter option, while feasible, has not yet been exercised.

The QTRAN library contains processed meteorological data files ordered by date (for observed data) or pattern (for hypothetical days) and by grid size and domain. The data consist of horizontal transfer coefficients describing advection and turbulent eddy transport, vertical (through the inversion) transport coefficients, mixing layer depths, surface vertical eddy diffusion coefficients, and solar transmissivity coefficients, all ordered by grid location on a UTM grid and available on a three hourly basis (according to present convention). Within the limits and options given in the user's guide for problem formulation (Appendix G), the control system will select the appropriate meteorological data file for use by LIRAQ, as indicated by 5" in Fig. 4, and make it available to LIRAQ, as indicated by 5'.

Figure 6 shows the method of generating the various QTRAN data files from the raw meteorological data. Based on techniques and a program described in Chapter 8 of the Final Report, data for selected observation days accumulated from a variety of measurement systems are entered in the LIRAQ data bank. Appendix I describes the structure of the data base and an overview of the data that are available for the Bay Area.

Processing routines have been developed that select, for example, wind and mixing layer depth data from the data bank and present them in a form suitable for transfer to the model. Experience has dictated, however, that for a region as topographically and meteorologically complex as the Bay Area, evaluation by a seasoned meteorologist has proven helpful in the selection of the data actually given to the model as QMET and QCLD data files. This evaluation is necessary primarily because the array of wind and inversion base height data for QMET and pyranometer data for QCLD are usually not as complete, nor sometimes as representative, as are needed to actually define the atmospheric conditions in adequate detail for model use. Because subjective processing of this input is not an option directly available to the normal user, details on the structure and variables needed to develop QMET and QCLD files for hypothetical or other observation days have been limited to a discussion in Appendix C. Development of QMET and QCLD files for days not already processed requires both accumulation of appropriate data and, for QMET, an iterative interaction with the MASCON model. This process is discussed more fully in Appendixes 8-1 through 8-3 of the Final Report.

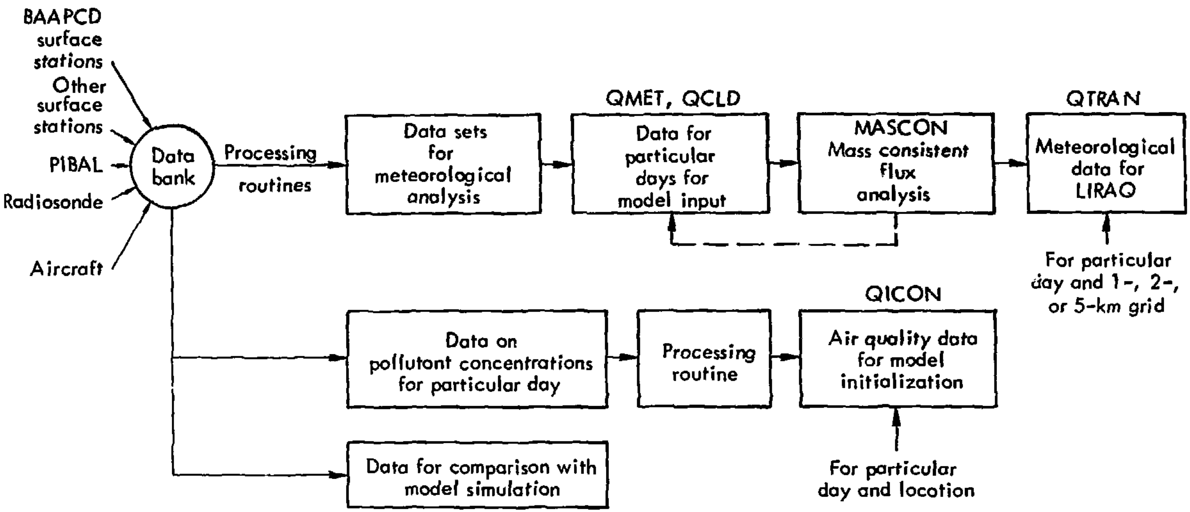

Fig. 6. Steps to develop QTRAN and QICON files.

To develop QTRAN files from the evaluated meteorological data in the input data files, an objective analysis is performed using MASCON in order to achieve mass consistency in the regional flow patterns. As shown in Figs. 7, 8, and 9, however, a regional, self-consistent flow pattern can be developed from a rather sparse array of wind observations. It should be noted that observed winds are at 3-hr intervals, and the advective flux* field is centered at a time midway between observation times. The processed patterns take account of the topography on the grid scale of interest (either 1-, 2-, or 5-km grid) as well as the meteorological evolution in time and space.

Because of computer limitations, the maximum field of grid elements that MASCON can treat is limited to 65 by 65. This has meant that the whole Bay Area can only be treated with a 5-km grid, and that for smaller grid elements, the region must be subdivided into a number of subregions. As shown in Fig. 10, the area can be well covered by three 2-km subgrids, and a QTRAN file has been developed for each. For the 1-km grid, QTRAN files are developed for the seven subgrids shown in Fig. 11. This will allow treatment of essentially all land area in the Bay region on this scale. The actual coordinates and designation for each of these domains are given in Table 1. The control system selects the appropriate QTRAN file for the user based on the specification during problem formulation.

*Flux is the vertical integral of wind speed from the surface to the base of the inversion.

Actually, because of storage limitations and to promote ease of handling, each QTRAN file is actually a family of files QTRANn where n is an integer starting with 0 and running to a maximum of 9. Each of the QTRANn files contain meteorological data for a 6-hr period, the n running sequentially from the beginning to end of the period of interest. The control system and the LIRAQ model automatically take care of the family of files.

INITIAL POLLUTANT CONCENTRATIONS

Regional air quality is determined not only by emissions at the time of measurement, but also, and often more importantly, by both emissions at earlier times and pollutants that have been transported into the region. Thus, in simulating a typical or hypothetical day's air quality it is important to specify the initial and boundary conditions.

Initial concentration information is conveyed to the model (as indicated by 6' in Fig. 4) by the control deck

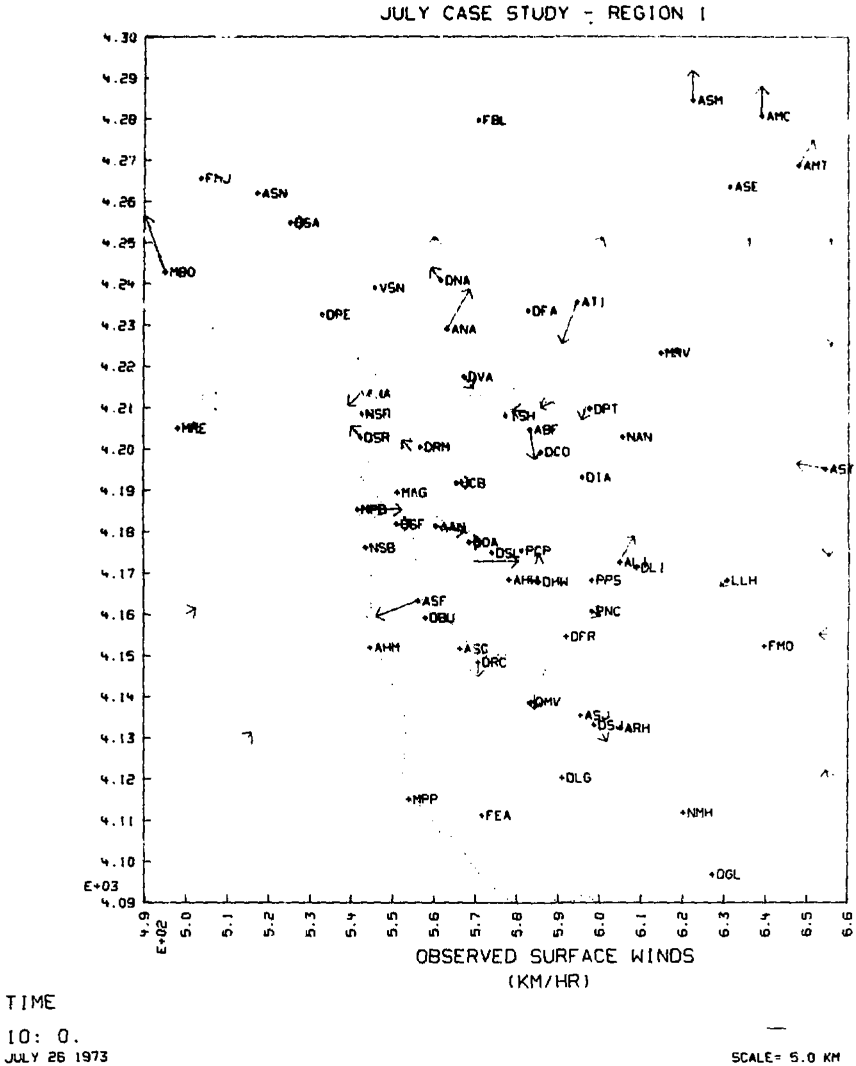

Fig. 7. Observed station winds for July 26, 1973.

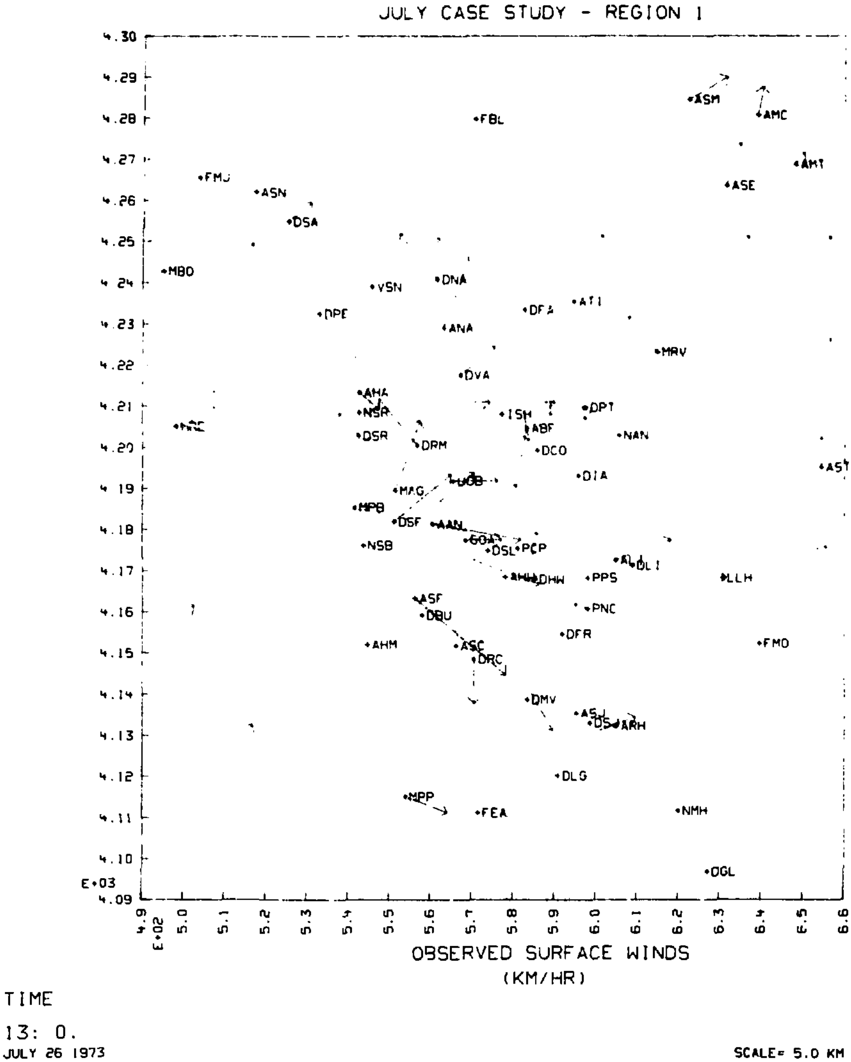

Fig. 8. Observed station winds for 1300 July 26, 1973.

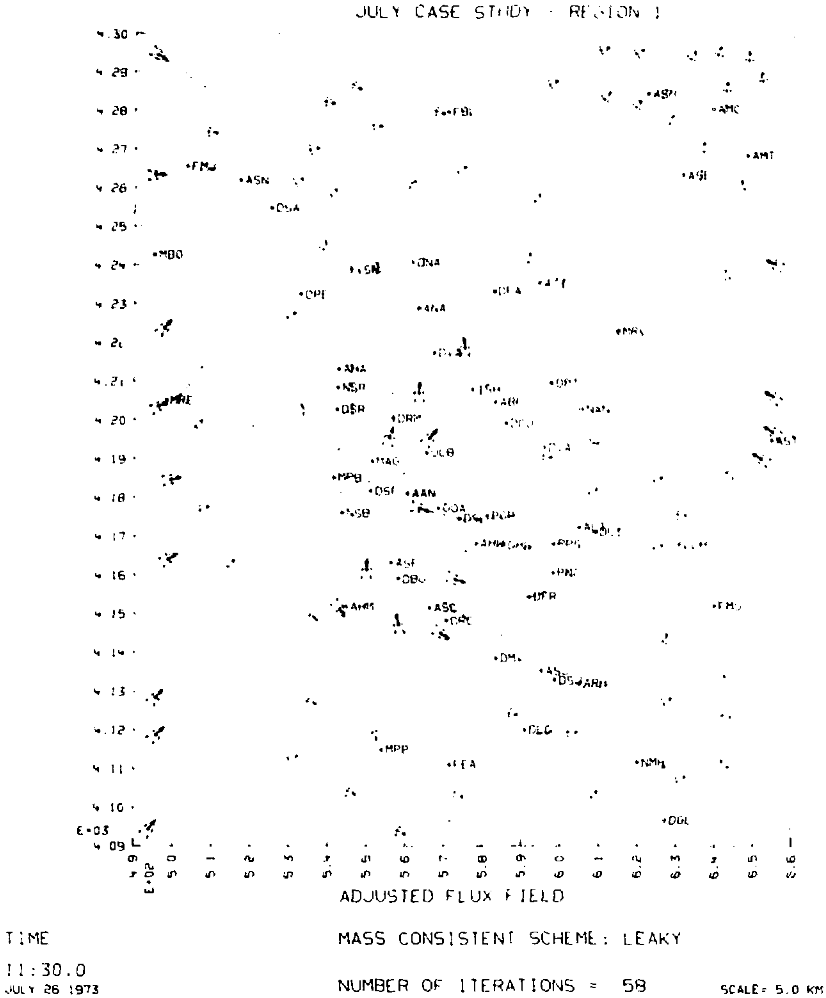

Fig. 9. Adjusted mass-consistent streamlines for 1130 July 26, 1973 to cover period from 1000 to 1300.

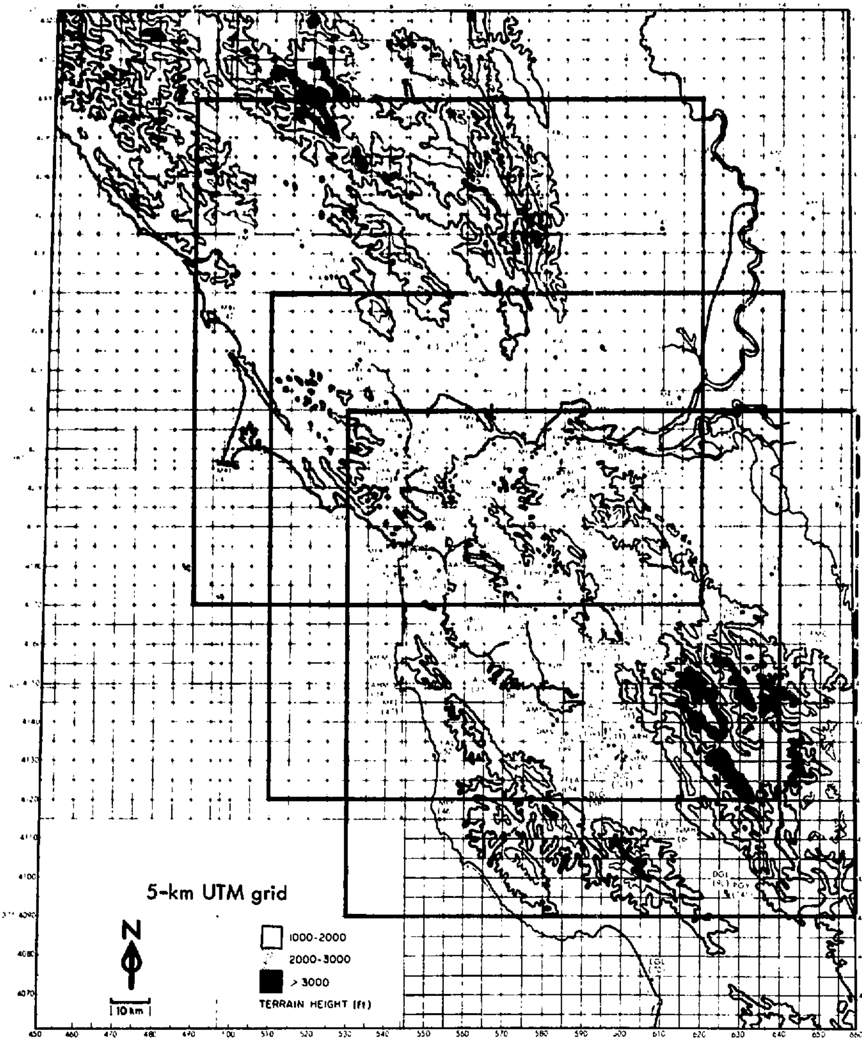

Fig. 10. Map of Bay Area s owing the three subregions within which 2-km grid resolution is available in LIRAQ.

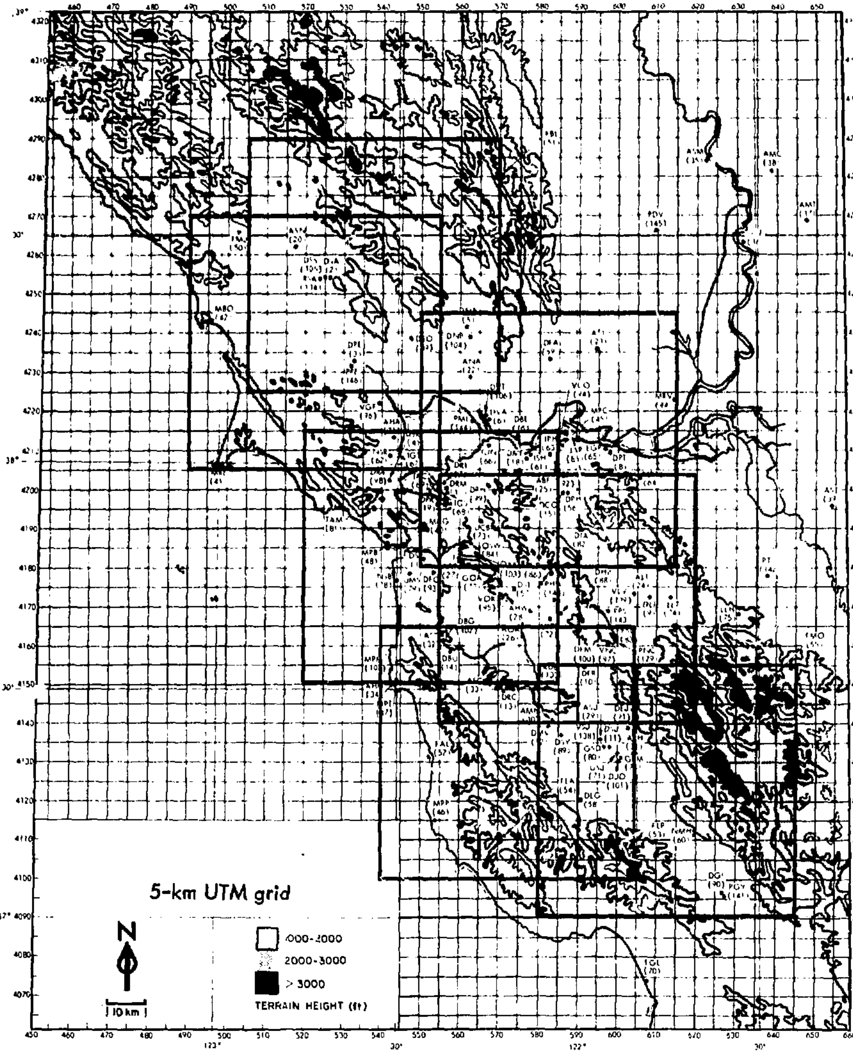

Fig. 11. Map of Bay Area showing the seven subregions within which 1-km grid resolution is available in LIRAQ.

Table 1. Domains of regions considered by the MASCON model.

Region	Name	Grid size (km)	UTME[a] (min)	UTME (max)	UTMN[b] (min)	UTMN (max)	E-W zones	N-S zones
1	Greater Bay Area	5	490	- 660	4090	- 4300	34	42
2	South Bay Area	2	530	- 660	4090	- 4220	65	65
3	Central Bay Area	2	510	- 640	4120	- 4250	65	65
4	North Bay Area	2	490	- 620	4170	- 4300	65	65
5	Santa Clara	1	580	- 645	4090	- 4155	65	65
6	San Mateo	1	540	- 605	4100	- 4165	65	65
7	East Bay	1	555	- 620	4140	- 4205	65	65
8	Golden Gate	1	520	- 585	4150	- 4215	65	65
9	Carquinez	1	550	- 615	4180	- 4245	65	65
10	Marin	1	490	- 555	4205	- 4270	65	65
11	Napa-Sonoma	1	505	- 570	4225	- 4290	65	65

[a]UTM easting.

[b]UTM northing.

based on input either from the library of QICON files (6") or from a hypothetical QICON file constructed by the user and given to the LIRAQ model by the user's instructions during problem formulation. In LIRAQ-2, an alternative form of concentration initialization can be carried out through instruction to LIRPRB; namely, a problem may be restarted from a previous run through use of a restart file called QREST (6"'). This file contains concentrations for all species in all zones, written at each edit time. Appendix B contains further details on QREST and restart procedures.

Data files of pollutant concentration information corresponding to the observation days that are available in the QTRAN library are stored in the QICON library. Data to initialize the model are based on measured concentrations from either surface stations or aircraft, as shown in Fig. 6. For reactive species that are not measured, the LIRAQ model sets initial concentrations to preselected values. Under most circumstances the concentrations of these species rapidly adjust to values consistent with the concentration of the specified species. Concentration data are available at regular intervals throughout the observation period, so that the model simulation may be initiated at any hour during the period. For "days" for which the meteorological pattern input is hypothetical, initial data must also be based on hypothetical surface measurements. Such initial concentration values must be specified by the user through designation of a file of data to substitute for the available data, as explained in Appendix G.

Unlike the other input data files, QICON does not usually input initial concentrations at each regular grid point used by LIRAQ. Rather, the model, after reading the QICON file, interpolates the vertical average concentrations (derived from the observed surface concentrations using the vertical pollutant profile assumption as explained in Chapter 4 of the Final Report) to the regular LIRAQ grid.

Appendix F presents the details of the structure and content of the QICON file.

BOUNDARY CONDITIONS

Boundary condition information is provided to the LIRAQ model in the QSRUN file. The choice of boundary conditions is necessarily coupled to the choice of the region of interest. The optimal situation is when the region's boundaries can be so situated that pollutants transported in through the boundaries have a negligible effect. In that case, background concentrations typical of the region could be specified for the major pollutants; namely CO, NO, NO_2, ozone, and hydrocarbons.

Because computer limitations force a tradeoff between resolution and overall size of the region which can be treated, however, it is sometimes necessary to situate boundaries such that an important fraction of the pollutants affecting a sub-region may be advected into the sub-region from nearby source regions. This situation may result not just from horizontal boundaries, but from substantial change in the depth of the mixing layer during the run, since entrainment of air initially above the inversion is one way in which the mass consistency of the horizontal wind transport fields may be achieved. Great caution must be exercised in such situations, because the only way to represent the effects of external sources in the LIRAQ model is indirectly by specification of boundary pollutant concentrations. At present the options available for specification in LIRAQ-1 are rather inflexible;

namely, a pollutant concentration for each of CO, NO, HC1, and HC2 must be specified on each of the four horizontal boundaries and above the inversion. This concentration is presently assumed uniform in time during the run.

For the LIRAQ-2 model the options are slightly more flexible. This model uses a boundary condition of the form $C_B = (C_O^2 + (\rho C_A)^2)^{1/2}$, where C_B is the boundary concentration, C_O is a floor value separately specified at each of the boundaries for each pollutant, C_A is the concentration in the grid square adjacent to the boundary, and ρ is a parameter that can be between 0 and 1. In the present formulation of the model, ρ is taken as 0.95 for the horizontal boundaries and is separately fixed for each species in the vertical. The user does not have control over the choice of ρ during problem formulation, but can alter the values by recompilation of one subroutine.

Details of the QSRUN file, which also provides the models with a number of other parameters, are presented in Appendix A for LIRAQ-1 and in Appendix B for LIRAQ-2.

CHEMICAL TRANSFORMATION

The LIRAQ model has been developed with the capability to simulate both non-reacting and reacting pollutants. Extensive testing has been undertaken in order to ensure that the photochemical mechanisms for reactive species realistically represent what has been observed to happen both in the atmosphere and in smog chambers. Thus a system involving 19 species has been developed, as explained in Chapter 9 of the Final Report. Photodissociation rates are read from a file QRAD (8' in Fig. 4), control of which is transferred to the LIRAQ model during the system control phase, when the file is fetched from a library of QRAD files (8").*

Where possible, the reaction rates for inorganic reactions have been taken from the most up-to-date evaluated rate data, and otherwise from the best available data. Because of the variety of hydrocarbons present in the atmosphere and the number of chemical reactions that could be involved, the hydrocarbons have been lumped into three basic categories (essentially alkenes, alkanes, and

*Although the QRAD library provided to the BAAPCD contains only one file based on average atmospheric conditions, the data contained therein are actually a function of atmospheric composition to the top of the atmosphere above the region and thus should properly be altitude dependent (i.e., Denver would be different than San Francisco) and perhaps seasonally dependent (daily variations in stratospheric ozone, etc. would then be ignored, however).

aldehydes) based on relative reactivity. Reaction rates for reactions involving lumped organic species have been calibrated against available experiments, but always within the bounds of reaction rates for individual components of the class of organic species.

Because of the delicate balance achieved in developing the reaction set, including provision for the effects of diurnally varying solar radiation (i.e., sunrise and sunset), changing the chemistry or the reaction rates is not an option made available to the user during problem formulation. Such changes require recompilation of the LIRAQ-2 code. Great care should be exercised if any such change is undertaken. Refer to the discussion of the LIRAQ-2 model in Appendix B for detailed information.

As described more fully in a later subsection below, two models, LIRAQ-1 and LIRAQ-2, are provided to solve regional air quality problems. The transformation mechanisms in LIRAQ-1 are limited to provision for simple decay and surface deposition, and thus that model should be used primarily for studies involving CO, total hydrocarbons (under special circumstances), and possibly total nitrogen oxides. (Other inert tracers or simple species would also be suitable.) Although not provided for at present, extension to include a simple form of the sulfur cycle and perhaps simple photochemistry should be feasible.

The LIRAQ-2 model, on the other hand, includes provision for 15 active species and 4 species that are held in equilibrium with the active species, as listed in Table 2. The reaction set involves 48 reactions, as given in Table 3. Some of the equations are not stoichiometrically balanced; the rates are given for the rate-controlling reaction with the products determined by subsequent rapid reactions

Table 2. Species treated in LIRAQ-2.

Active	Equilibrium
HC1	$O(^3P)$
HC2	NO_3
HC4	HO
HNO_2	RO
HNO_3	
H_2O_2	
NO	
NO_2	
N_2O_5	
O_3	
RNO_2	
RCO_3	
RO_2	
HO_2	
CO	

Table 3. Reaction set used in LIRAQ-2.

Reactions[a]	Reaction number Q as used in LIRAQ-2	Arrhenius A factor[b]	Parameter C in Arrhenius expression[b]
1. $NO_2 + h\nu = NO + O$	QJ1		
2. $O + O_2 + ZM = O_3 + ZM$	1	1.07 E-34	-510.
3. $O_3 + NO = NO_2 + O_2$	2	9.0 E-13	1200.
4. $O + NO + ZM = NO_2 + ZM$	3	4.0 E-33	-940.
5. $O + NO_2 = NO + O_2$	4	9.1 E-12	
6. $O + NO_2 + ZM = NO_3 + ZM$	5	3.5 E-32	-300.
7. $O_3 + NO_2 = NO_3 + O_2$	6	1.10 E-13	2450.
8. $NO_3 + NO_2 = N_2O_5$	7	3.80 E-12	
9. $N_2O_5 = NO_3 + NO_2$	8	5.7 E+14	10600.
10. $NO_3 + NO = 2NO_2$	9	8.7 E-12	
11. $N_2O_5 + H_2O = 2HNO_3$	10	3.0 E-16	3300.
12. $HNO_2 + h\nu = HO + NO$	QJ2		
13. $HO + NO_2 = HNO_3$	11	5.0 E-12	
14. $HO + NO = HNO_2$	12	5.0 E-12	
15. $HO + CO = CO_2 + HO_2$	13	1.40 E-13	
16. $HO_2 + NO = HO + NO_2$	14	3.0 E-12	700.
17. $H_2O_2 + h\nu = 2HO$	QJ3		
18. $HC1 + O = RO_2 + \alpha RCO_3 + (1-\alpha)HO_2$[c]	15	1.0 E-11	360.
19. $HC1 + O_3 = HO_2 + RO + HC4$	16	7.0 E-15	1900.
20. $HC1 + HO = RO_2 + HC4$	17	5.0 E-11	350.
21. $HC2 + O = RO_2 + HO$	18	4.1 E-11	2000.
22. $HC2 + HO = RO_2 + H_2O$	19	4.0 E-11	900.
23. $HC4 + h\nu = RO_2 + HO_2$	QJ4		
24. $HC4 + HO = RCO_3 + H_2O$	20	3.0 E-11	350.
25. $RO_2 + NO = RO + NO_2$	21	3.3 E-12	300.
26. $RCO_3 + NO = RO_2 + NO_2 + CO_2$	22	6.5 E-12	600.
27. $RCO_3 + NO_2 = PAN$	23	2.95 E-14	
28. $RO + O_2 = HO_2 + HC4$	24	1.6 E-13	3300.

Table 3. (Continued)

Reactions[a]	Reaction number Q as used in LIRAQ-2	Arrhenius[b] A factor	Parameter C in Arrhenius expression[b]
29. $RO + NO_2 = RNO_3$	25	5.0 E-14	
30. $RO + NO = RNO_2$	26	5.0 E-14	
31. $HO_2 + HO_2 = H_2O_2 + O_2$	27	3.0 E-11	500.
32. $RO_2 + HO_2 = RO + HO + O_2$[d]	28	6.7 E-14	
33. $RO_2 + RO_2 = 2RO + O_2$	29	6.7 E-14	
34. $HC4 + O = HO + HO_2 + CO$	30	4.0 E-12	900.
35. $RNO_2 + h\nu = RO + NO$	QJ5		
36. $HC4 + h\nu = 2HO_2 + CO$	QJ6		
37. $NO_3 + h\nu = NO_2 + O$	QJ7		
38. $HO_2 + HC4 = H_2O_2 + RCO_3$	31	8.0 E-13	3700.
39. $RO_2 + HC4 = ROOH + RCO_3$	32	8.0 E-13	3750.
40. $O_3 + h\nu = O + O_2$	QJ8		
41. $O_3 + h\nu \overset{H_2O}{=} O_2 + 2HO$	QJ9		
42. $HO_2 + NO_2 = HNO_2 + O_2$	34	1.0 E-12	1200.
43. $NO_3 + HC4 = RCO_3 + HNO_3$	35	3.0 E-15	900.
44. $HO + HO_2 = H_2O + O_2$	36	2.0 E-10	
45. $HC4 + HO = CO + HO_2 + H_2O$	37	3.0 E-11	350.
46. $NO_3 + HC4 = CO + HNO_3 + HO_2$	38	3.0 E-15	650.
47. $HC1 + HO = RO_2 + H_2O$	39	3.0 E-11	350.
48. $HO + HNO_3 = H_2O + NO_3$	40	9.0 E-14	

[a]The following symbols and conventions are used:

- HC1 (alkene-like compounds)
- HC2 (alkane-like compounds)
- HC4 (aldehyde-like compounds)
- RO_2 (alkylperoxyl radicals)
- RCO_3 (acylperoxyl radicals)
- RO (alkoxyl radicals)
- ROOH (organic hydroperoxides)
- RNO_2 (alkyl nitrites)
- RNO_3 (alkyl nitrates)
- PAN (peroxyacyl nitrates)
- ZM (total number density of all molecules)
- H_2O (assumed constant)
- O_2 (assumed constant).

Table 3. (Continued)

[b]The Arrhenius expression used was: $k = Ae^{-C/T}$, where T is temperature in Kelvin.

[c]The stoichiometric factor α is set equal to 0.5.

[d]The reaction rate for reaction 32 was accidentally set equal to zero in the LIRAQ-2 simulation runs reported in Chapters 12 and 13 of the Final Report. A subsequent experiment has indicated that this omission had less than 0.1% effect on the concentrations of any of the observed species.

given as if they were direct products. The column Q indicates the reaction number used in the model, where the symbols QJ_n (n=1,...,11) indicate photochemical reactions. The calculated photochemical reaction rates are dependent on latitude, time of day, and time of year. Thus a diurnal solar cycle and its related nighttime chemistry are included.* Provision is also made for reduction of photodissociation rates due to the presence of clouds and aerosols by multiplying the photodissociation rates by the transmission coefficient derived from pyranometer data. In addition to these reactions, surface deposition has been introduced for some of the reactive species. Deposition velocities are given in Table 4.

*While this allows multi-day simulations, special numerical considerations tend to make such computations quite demanding of computer time.

Table 4. Pollutant deposition velocity.

Pollutant No.	Pollutant	Deposition velocity (cm/s)
1	HC1	0
2	HC2	0
3	HC4	1.
4	HNO_2	3.
5	HNO_3	3.
6	H_2O_2	1.
7	NO	0
8	NO_2	0
9	N_2O_5	0
10	O_3	0.66
11	RNO_2	0
12	RCO_3	0
13	RO_2	0
14	HO_2	0
15	CO	0.1

THE LIRAQ-1 AND LIRAQ-2 MODELS

Because the regional air quality problem is extremely complex, treatment of as large a region and as complex a reaction set as might be desired are not simultaneously feasible with present computer capabilities. As a result, two models have been developed.

The LIRAQ-1 model is for use with pollutants subject only to simply represented decay or deposition mechanisms. The model can treat four species over regions as large as 45 by 50 grid squares,* where the grid interval may be 1, 2, or 5 km. The transport algorithm is accurate to better than second order since the flux-corrected transport representation has been used. This means that LIRAQ-1 will better represent limited area sources than will LIRAQ-2. In addition, because it does not have to calculate photochemical reactions, the time step is less restricted and the model is usually faster running. Thus LIRAQ-1 model should be chosen when dealing with species for which reactions need not be treated but for which a quite accurate transport algorithm is needed (e.g., for example, for carbon monoxide in a valley or city).

LIRAQ-2, on the other hand, treats the regional photochemical problem. Its treatment of species and reactions is as complete as present scientific capabilities permit. The mathematical solution technique required, however, limits the accuracy of the transport algorithm to first order and the array of grid squares to 20 by 20. The first limitation appears to be acceptable, because photochemical pollution levels seem to be less tightly tied to local sources than are those of the longer-lasting nonreactive pollutants. It does mean, however, that calculations close to strong point sources will be less accurate than the transport calculated by LIRAQ-1. The second restriction means that only with a 5-km grid will a substantial fraction of the Bay Area be covered with a single model run. With a 2-km grid, only limited subregions may be treated. For a 1-km grid, boundary conditions, which are difficult to properly specify, may play too important a role to allow useful results. Another aspect of the use of LIRAQ-2 is the computation time required. When used on regional problems, a 24-hr simulation using a 5-km grid requires on the order of three quarters of an hour of CDC 7600 computer time.

Thus, choice of which model to use must be undertaken with due consideration, and problems should be thought through carefully to ensure that they are properly posed.

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*A larger maximum grid would be possible if only one species were treated at a time.

RUN PARAMETERS

In addition to the topographic-geographic, source, meteorological, initial and boundary condition, radiation, and photochemical data to be input to the appropriate LIRAQ model, certain other information is asked for in the problem formulation stage. These data are inputted to LIRAQ-1 or LIRAQ-2 as a QSRUN file (indicated by 7 in Fig. 4). In addition to boundary condition and pollutant type information described earlier, data related to the length of the calculation, the grid size, the domain of study, and the output options are also input using QSRUN.

The LIRAQ model is set up so that it can run from any starting hour to any ending hour, within the limits of the meteorological data available in the QTRAN file that is selected. In choosing the starting time, the user should allow sufficient time for the model initial conditions to settle down before he begins to interpret the model results as being representative of the problem posed. To reduce computer time, the model should not be run beyond the length of time for which data are desired.

A variety of output options are available including regional patterns at regular time intervals for various species, time histories at particular specified stations or locations (which are output as a QSREC file as indicated by 9 in Fig. 4), and graphical output. These options are explained in the problem formulation stage (see Appendix G).

SUMMARY

The LIRAQ model is structured so that the typical user does not have to deal with the several models and data-handling routines that are essential to simulation of regional air quality. This section has attempted to provide an introduction to the essential elements internal to the model in order both to increase the understanding and capability of the air quality planner and to serve as a basis for deeper understanding for the researcher interested in pursuing the details of the model functions.

The next section provides examples of typical LIRAQ model use in order to introduce the air quality planner to realistic applications of the model.

4. A Sample Simulation with LIRAQ

SETTING UP AND RUNNING THE PROBLEM

The only way to appreciate the capabilities of LIRAQ is to test it on a sample problem, or "scenario." Thus, this section highlights the sequence of actions that might be followed in studying a particular problem, emphasizing the considerations that led to the particular formulation of a problem.

As described in Chapter 13 of the Final Report, there has been great interest in the relative importance of local vs imported contributions to the air quality in some of the inland valleys. One scenario carried out with the model to gain insight into this problem was to compare a simulation that set to zero all of the surface pollutant emissions in the Livermore Valley with a control (or base) case simulation. As described in Chapter 13, with the sea breeze meteorology of July 26, 1973, local emissions in the valley appeared to have only a minor (less than 2%) effect on the oxidant concentrations.

A logical follow-up question is to ask what would happen if there were zero emissions everywhere in the region except the Livermore Valley, with present levels of emissions maintained in the Valley. Before just setting up and running this problem (which would be straightforward), some thought should be given to what results might be anticipated and to any complications that might arise.

One early consideration is the question of treatment of background concentrations, which would prevail over much of the region if there were zero emissions. The model is not particularly well-suited for treatment of the global background because, for example, natural concentrations of some species are not well defined, and emissions from natural causes in the region are not treated at all. Thus, to maintain some dominance of the atmospheric chemistry by regional sources, a 90% reduction of emissions outside the Livermore Valley seems a more reasonable case to study.

A second consideration is the choice of initial concentrations when starting the simulation. Some types of models, in particular Lagrangian (trajectory) models, are very sensitive to the initial concentrations specified in the model run. This is because rather than sweep air through the grid square, such models tend to follow an air parcel, and initial concentrations will be important until source emissions along the trajectory have accumulated to amounts that will dominate the initial pollutant charge. Although Eulerian models, such as LIRAQ, are less sensitive to initial conditions because the pollutants are swept through the grid cell and eventually out of the domain, such models are, however, more sensitive to boundary conditions than Lagrangian models. Because of this, it is probably best to start with the same initial conditions as for the control case so as to remove this factor as a potential cause for any difference between model results. Doing this, however, means that initial conditions over much of the region cannot be sustained by the reduced emissions, and so there will be a general lowering of concentrations during the run. Because the initial charge of pollutants is higher than would be the case in reality, the results at early times should not be construed to be those that would really occur if emissions actually had been reduced by 90%.

Given that initial conditions would be as for the control run for July 26, 1973, described in Chapter 12 of the Final Report, the actual times of simulation must be considered. Although the earlier run started at 0400 July 26, for reasons of economy this run was started after sunrise at 0600. This may cause some differences at early times, but should not affect afternoon oxidant concentrations significantly.

Figure 12 is a reproduction of the actual teletypewriter listing (including mistypes) setting up the run for an 0600 to 0700 1-hr test to check that everything is ready for a follow-on run (starting from the QREST file) from 0700 to 1800. The sequence of operations is started by logging into the system (LOGIN,...) loading the program from the IBM Data Cell (↑LOAD,...) and initiating problem execution (↑RUN).

Once the LIRPRB program has been initiated all responses by the user follow prompts indicated by the asterisk symbol (*) in the first column. Before input to set up the actual problem is sought, two responses are sought on how the user desires to do this. First, a question is asked about whether full or brief instructions are wanted, and second whether the input will be provided interactively or from a specified data file. In this case the answers were #FULL# and #YES#, respectively. The exclamation symbol (!) indicates transmittal of the input line to the computer.

With these choices, answers to 12 questions are sought; the options are described fully in Appendix G.

```
>LOG,PRB,16,200.679656,MACCRACKEN!
LOGIN  CP-21  TTY-077  13.59.46.••BKY61K•B•11/25/75.
PRB0001 LOGGED IN.  SESAME 2.3
OK - SESAME
^LOAD,PRBCNTL,LIRQLIB!
Ŧ\7
LOAD COMPLETE, ENTERING ^EDIT
OK - ^EDIT
^RUN!
 THIS IS THE •L•I•R•A•Q• PROBLEM FORMULATOR.
 DO YOU WANT FULL HELP PACKAGE OR BRIEF PROMPTS
RESPOND      #FULL#      OR        #BRIEF#

•#FULL#!
 THIS PROBLEM FORMULATOR SETS UP SEVERAL FILES WHICH MAYBE
  SUBSEQUENTLY USED TO RUN ONE OF THE •LIRAQ• MODELS.
  THESE FILES ARE
       1) •CNTL• - THE LBL SYSTEM CONTROL DECK FOR THE  MODEL
                 RUN DEFINED BY THIS PROBLEM FORMULATION.
       2) •STAGE• - DIRECTIVES TO EXTRACT THE REQUIRED DATA
                 FROM THE •LIRAQ• DATA LIBRARY.
       3) •PRBLM• - THE FORMAL DESCRIPTION OF THE PROBLEM,
                 WHICH IS READ BY THE •MODFILE• PROGRAM IN
                 ORDER TO SET UP THE •QSRUN• AND MODIFIED
                 •QSOR• FILES.



 YOUR DATA INPUT IS BEING HANDLED BY THE FREE FORM INPUT
 ROUTINE .FFINP. ,THE BASIC RULES ARE AS FOLLOWS -
 1) THE DATA (NUMBER OR TEXT) EXPECTED, AND ITS ORDER,
     IS DETERMINED BY THE CALLING PROGRAM, SO MAY NOT VARY.

  2) THE INPUT DATA MUST BE BLANK DELIMITED, BOTH SIDES.

   3) WHEN TEXT IS EXPECTED AS DATA, IT SHOULD BE
    DELIMITED, BOTH SIDES, WITH THE FOLLOWING SYMBOL    #
    ALL OTHER TEXT (EXCEPT THE SPECIAL SYMBOLS EXPLAINED IN
    THE DOCUMENTATION) IS IGNORED.


  IS INTERACTIVE INPUT DESIRED   ( YES  OR  NO )

•#YES#!
 DETAILED INSTRUCTIONS WILL BE GIVEN.

 THIS IS THE FIRST OF TWELVE SUB-SECTIONS (A-L) OF INPUT.
 TYPE IN PROBLEM •NAME•  (40 CHAR MAXIMUM - TEXT)
A.
•#NON-LIVERMORE RED\D}]C
#NON-LIVERMORE REDUCED BY 10#!
```

Fig. 12. Listing of teletypewriter exchange when setting up LIRAQ calculations.

```
 ENTER CHOICE OF ◆MODEL◆.
B.
◆2!
 INDICATE POLLUTANTS OF INTEREST ◆POLNUMS◆
 MAKE 1 TO 15 ENTRIES, TERMINATE THE LIST WITH A $
C.
◆1 2 3 7 8 10 15 $!
 SPECIFY THE ◆REGION◆ OF INTEREST.
D.
◆1!
 CHOOSE A SUB-AREA IN THIS REGION OF INTEREST
 WITHIN WHICH MODEL CALCULATIONS ARE TO BE MADE, BY SPECIFYING
 ◆EMIN◆, ◆EMAX◆, ◆NMIN◆, AND ◆NMAX◆, IN THAT ORDER.

◆530 630 4120 4220!
 CHOOSE A BASIC SOURCE ◆EMISS◆ PATTERN (BY YEAR),
 THE ◆SEASON◆ OF YEAR, AND ◆TIME◆ FLAG.
E.
◆1973 3 1!
 DO YOU WISH TO CHANGE OR AUGMENT THE BASIC SOURCE
 PATTERN FOR ELEVATED SOURCES  (YES/NO)
F.
◆"NO"!
 DO YOU WISH TO CHANGE OR AUGMENT THE BASIC SOURCE
  PATTERN FOR SURFACE SOURCES   ( YES  OR  NO )

◆"YES"!
 INPUT A SEQUENCE OF CHANGES IN SURFACE SOURCES,
 GIVING ◆POL◆, ◆POLVAL◆, AND ◆CHGOPT◆ ON THE FIRST PROMPT,
 ◆UTME1◆, ◆UTME2◆, ◆UTMN1◆, AND ◆UTMN2◆ ON THE SECOND PROMPT,
 AND ◆START◆ AND ◆STOP◆ ON THE THIRD PROMPT.
 SET ◆POL◆ EQUAL TO 0 TO TERMINATE THESE CHANGES.
◆1 .1 4!
◆530 630 4120 4220!
◆0 24!
◆2 / /!
◆/ / / /!
◆/ /!
◆3 / /!
◆/ / / /!
◆/ /!
◆7 / /!
◆/ / / /!
◆N\V
/ /!
◆15 / /!
◆/ / / /!
◆/ /!
◆1 10 4!
◆590 620 4165 4185!
◆/ /!
```

Fig. 12 (Continued)

```
*2 ' '!
*' ' ' '!
*' '!
*3 ' '!
* ' '!
*' '!
*7 ' '!
*' ' ' '!
*' '!
*15 ' '!
*' ' ' '!
*' '!
*0 $!
 SPECIFY METEOROLOGICAL DATA SET *METEOR* TO BE USED.
G.
* 1!
 ENTER HOUR AT WHICH RUN IS TO START, *RUNSTAR*, AND
 THE NUMBER OF HOURS YOU WISH TO RUN, *NUMHRS*.
H.
*6 1!
 DO YOU WISH TO SPECIFY INITIAL CONCENTRATIONS   (YES/NO/OREST)
I.
*#NO#!
 DO YOU WISH TO IMPOSE POLLUTANT BOUNDARY CONDITIONS
 OTHER THAN THE STANDARD SET  (YES/NO)
J.
*#NO#!
 MODEL OUTPUT WILL CONTAIN PLOTS OF POLLUTANT CONCENTRATION
 BY TIME AND STATION FOR A STANDARD SET OF LOCATIONS,
 PROVIDED THEY ARE WITHIN THE REGION OF INTEREST SELECTED.
 IF YOU WISH TO AUGMENT THIS SET, ENTER *STATION* NUMBERS NOW
 (LIMIT IS 10).  SET *STATION* EQUAL TO 0, IF NO ADDITIONS.
K.
*74 143 139 103 56 6 129 140 24 $!
 IF YOU WANT SPECIFIC UTM LOCATIONS MONITORED FOR
 POLLUTANT CONCENTRATIONS BY TIME, GIVE *UTME* AND *UTMN* FOR
 EACH SUCH LOCATION (LIMIT IS 5).  SET *UTME* EQUAL TO 0., IF
 NO ENTRIES.
*590 4180 59\9\5!
*590 4165!
*615 4165!
*615 4180!
*0 $!
```

Fig. 12 (Continued)

```
 PLEASE ENTER THE LBL TAPE LIBRARY NUMBER FOR THE TAPE
  THAT WILL BE USED TO SAVE A COPY OF THE OUTPUT FORM THE
  MODEL RUN. IN THE CASE OF ◆LIRAQ2◆, THE RESTART FILE
  (◆QREST◆) WILL BE WRITTEN BETWEEN THE THIRD END-OF-FILE
  AND THE END-OF-INFORMATION MARKS ON THE TAPE.


 QSREC/QREST TAPE

◆10509!
 ENTER ◆CODE◆ FOR DESIRED FORM OF MODEL OUTPUT.

◆3!
 THIS IS THE FINAL SECTION OF USER INPUT.
 ENTER THE NUMBER OF COMPUTE UNIT SECONDS ◆CUS◆ ESTIMATED FOR THIS RUN.
L.
◆2000!
 SPECIFY THE PRIORITY ◆PRIOR◆ FOR THIS JOB.
◆3!
 GIVE THE ACCOUNT ◆ACCNT◆ TO BE CHARGED.
◆679656!
%ΔΔS^\^^\^W\W
 ENTER YOUR NAME ◆UNAM◆ (TEXT - MAX 10 CHARS).
◆#MACCRACKEN#!
 GIVE ROUTING INSTRUCTIONS ◆ROUT◆ FOR OUTPUT
 (TEXT - MAX 50 CHARS)
◆#NONE#!

 PLEASE GIVE THE PSS(DATA CELL) LIBRARY SUBSET NAMES THAT
 WILL CONTAIN EACH OF THE THREE FILES (◆PRBLM◆ , ◆CNTL◆ ,
 AND ◆STAGE◆) ,RESULTING FROM THIS PROBLEM FORMULATION. WHEN
 THIS PROGRAM IS COMPLETE, THOSE THREE FILES MUST BE WRITTEN
TO THE DATA CELL USING THE NAMES THAT YOU ARE ABOUT TO SPECIFY.
 (SEE THE USERS GUIDE)
   THE NAMES SHOULD BE ENTERED AS DELIMITED TEXT, NOT LONGER
 THAN 7 CHARACTERS AND THE NAMES SHOULD BE FAIRLY UNIQUE.
   GIVE EACH NAME AS IT IS REQUESTED.

SUBSET NAME FOR ◆PRBLM◆

◆#PL2MT2#!
SUBSET NAME FOR ◆CNTL◆

◆#CL2MT2#!
SUBSET NAME FOR ◆STAGE◆

◆#SL2MT2#!
 SUB-SECTION INPUT IS COMPLETE.  DO YOU WISH TO
 DISPLAY THE PROBLEM FILE  (YES/NO)

◆#YES#!
```

Fig. 12 (Continued)

A.
NON-LIVERMORE REDUCED BY 10
B.
MODEL TO BE USED IS LIRAQ-2
C.
NUMBER OF POLLUTANTS FOR THIS PROBLEM = 7
POLLUTANTS SELECTED =
1. HC1 2. HC2 3. HC4 7. NO 8. NO2 10. O3 15. CO
D.
REGION OF INTEREST = (1) GREATER BAY AREA
GRID SIZE = 5

LOWER LEFT CORNER UTM COORDINATES ARE 490.0 4090.0
NUMBER OF EAST-WEST ZONES = 34
NUMBER OF NORTH-SOUTH ZONES = 42
MODEL CALCULATIONS WILL BE MADE BEGINNING FROM THE
SOUTHWEST COORDINATES 530.0 4120.0
WITH 20 ZONES IN THE EAST DIRECTION
AND 20 ZONES IN THE NORTH DIRECTION.
E.
BASIC SOURCE EMISSION PATTERN YEAR TO BE USED = 1973
SEASON OF YEAR CODE = 3
PST/PDT CODE = 1
F.
CHANGES IN ELEVATED SOURCES

POL	VALUE	CHANGE/OPTION	UTME	UTMN	FROM	TO
0						

CHANGES IN SURFACE SOURCES

POL	VALUE	CHANGE/OPTION	UTME1	UTME2	UTMN1	UTMN2	FROM	TO
1	.100E+00	4	530.0	630.0	4120.0	4220.0	0	24
2	.100E+00	4	530.0	630.0	4120.0	4220.0	0	24
3	.100E+00	4	530.0	630.0	4120.0	4220.0	0	24
7	.100E+00	4	530.0	630.0	4120.0	4220.0	0	24
15	.100E+00	4	530.0	630.0	4120.0	4220.0	0	24
1	.100E+02	4	590.0	620.0	4165.0	4185.0	0	24
2	.100E+02	4	590.0	620.0	4165.0	4185.0	0	24
3	.100E+02	4	590.0	620.0	4165.0	4185.0	0	24
7	.100E+02	4	590.0	620.0	4165.0	4185.0	0	24
15	.100E+02	4	590.0	620.0	4165.0	4185.0	0	24
0								

G.
METEOROLOGICAL SCENARIO = (1) JULY 26-27, 1973.
H.
PROBLEM IS TO BEGIN AT 6 HOURS PST, AND
RUN FOR 1 HOURS.
I.
INITIAL CONCENTRATIONS WILL BE TAKEN FROM A
STANDARD QICON FILE,RESIDING ON TAPENUMBER X
J.
POLLUTANT BOUNDARY CONDITIONS ARE MODIFIED AS

POLNUM	WEST	SOUTH	EAST	NORTH	ABOVE
0					

Fig. 12 (Continued)

```
K.
 THE FOLLOWING STATIONS WILL BE SPECIFICALLY INCLUDED
 IN MODEL GRAPHICAL OUTPUT OF POLLUTANT CONCENTRATION BY TIME
   74  143  139  103   56    6  129  140   24
 THE FOLLOWING UTM LOCATIONS WILL BE MONITORED FOR
 POLLUTANT CONCENTRATIONS WITH TIME
      590.0      4180.0
      590.0      4165.0
      615.0      4165.0
      615.0      4180.0
         0.          0.
 FORM OF MODEL OUTPUT WILL BE
 (3)  TABULAR OUTPUT- MF AND LP /GRAPH OUTPUT-MICROFICHE
L.
 THE MAXIMUM ALLOWED COMPUTER USAGE IS  2000 CUS.
 THE JOB PRIORITY IS  3 - DEFERRED.
 ACCOUNT TO BE CHARGED IS 679656
 USERS NAME -  MACCRACKEN
 ROUTING INSTRUCTIONS ARE - NONE
 DO YOU WISH TO DISPLAY THE CONTROL CARD DECK (YES/NO)

◆#YES#!


LIRQ2, 3, 2000.679656,MACCRACKEN.
(NONE
◆PSS
DISKHOG, 20000.
SCP,A=  1800.
LIBCOPY,LIRQLIB   ,STAGE     ,SL2MT2    .
83\
TAPE,DUMMY,X,NT,R, 14100,I=STAGE.
TAPE,DUMMY,X,NT,R, 14360,I=STAGE.
TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
CXIT.
EXIT.
END.
FIN.
LIBCOPY,LIRQLIB   ,MODFILE   ,MODFILE   .
LIBCOPY,LIRQLIB   ,PRBLM     ,PL2MT2    .
LINK,F=MODFILE,LO=BERX,X.
RETURN,QSOR.
RENAME,QSOR=QSORM.
COPY,QSOR       /RR,MODQSOR    /RR.
DISPOSE,MODQSOR    =MF,T=[LIRAQ      /MODQSOR    ].
EXIT.
FIN.
LIBCOPY,LIRQLIB   ,BINARY    ,LIRQ2BN   .
REWIND,BINARY    .
```

Fig. 12 (Continued)

```
CXIT.
END.
FIN.
GET,BINARY,MAIN.REL/LIRAQ2
REWIND,BINARY      .
REWIND,MAIN        .
WRITEF,TAPE3       .
WRITEF,TAPE12      .
WRITEF,QSTEP       .
REWIND,TAPE3       .
REWIND,TAPE12      .
REWIND,QSTEP       .
FBSIZE,QSRUN=4,PRAD=4,QICON=34.
RFL,     141000,     667000.
TIM.
LINK,F=MAIN,F BINARY,LO=BERX,X.
SCP,A=0.
EXIT.
DUMP,170000.
SCP,A=0.
TIM.
FIN.
RENAME,TSTAGE=STAGE.
COPY,TAPE3       /RR,0FXF,NULL,1F,TAPEQ       .
COPY,QSTEP       /RR,0FXF,NULL,1F,TAPEQ       .
COPY,TAPE12      /RR,0FXF,NULL,1F,TAPEQ       .
COPY,QREST       /RR,TAPEQ      .
STAGE,TAPEQ       , 10509,NT,W.
RENAME,STAGE=TSTAGE.
COPY,TAPE3       /RR,TAPE3A     /RR.
DISPOSE,TAPE3       =LP,T=[LIRAQ2     /TAPE3      ].
DISPOSE,TAPE3A      =MF,T=[LIRAQ2     /TAPE3A     ].
COPY,QSTEP       /RR,QSTEPA     /RR.
DISPOSE,QSTEP       =LP,T=[LIRAQ2     /QSTEP      ].
DISPOSE,QSTEPA      =MF,T=[LIRAQ2     /QSTEPA     ].
COPY,TAPE12      /RR,TAPE12A    /RR.
DISPOSE,TAPE12      =LP,T=[LIRAQ2     /TAPE12     ].
DISPOSE,TAPE12A     =MF,T=[LIRAQ2     /TAPE12A    ].
EXIT.
CXIT.
FIN.
REWIND,STAGE       .
REWIND,INPUT       .
COPYSBF,INPUT,OUTPUT.
COPYSBF,STAGE,OUTPUT.
*REWIND
*FILE,QSOR
*READ,1
*REWIND
*FILE,QTRAN0
*READ,1
```

Fig. 12 (Continued)

```
*FILE,QTRAN1
*READ,1
*FILE,QTRAN2
*READ,1
*FILE,QTRAN3
*READ,1
*REWIND
*FILE,QICON
*READ,1
*REWIND
*SKIPF,1
*SKIPF,1
*SKIPF,1
*FILE,QRAD
*READ,1
*REWIND
*SKIPF,1
*SKIPF,1
*SKIPF,1
*SKIPF,1
*FILE,QGEO
*READ,1
 THE PROBLEM DECK IS NOW COMPLETE.
 IF YOU REQUIRE FURTHER MODIFICATIONS IN THE PROBLEM SPECIFICATION,
 USE A TEXT EDITOR TO ALTER THE PROBLEM FILE ON THE DATA CELL.
 IT IS ESSENTIAL, HOWEVER, THAT FILE FORMAT BE PRESERVED.
 YOU MUST NOW WRITE THE *PRBLM* , *CNTL* ,AND *STAGE* FILES
 TO THE DATA CELL. THIS IS DONE BY ENTERING THE FOLLOWING
 COMMANDS WHEN THE PROBLEM FORMULATOR TERMINATES. -
          ^CC,SESAME.
          LIBRITE,LIRQLIB,PRBLM,PL2MT2     ,239,W=BAAPCD.
          LIBRITE,LIRQLIB,CNTL ,CL2MT2     ,239,W=BAAPCD.
          LIBRITE,LIRQLIB,STAGE,SL2MT2     ,239,W=BAAPCD.

OK - ^EDIT
^CC,SESAME!
ILLEGAL SESAME COMMAND - RETRY
^CC,SESAME.!
OK - SESAME
LIBRITE,LIRQLIB,PRBLM,PL2MT2    ,239,W=BAAPCD.!
OK - SESAME
LIBRITE,LIRQLIB,CNTL,CL2MT2    ,239,W=BAAPCD.!
OK - SESAME
LIBRITE,LIRQLIB,STAGE,SL2MT2    ,239,W=BAAPCD.!
OK - SESAME
\GG\C,
^CC,DISPOSE,CNTL=IN.!
OK - SESAME
```

Fig. 12 (Continued)

The following considerations apply to the choices made here:

Section A - The initial attempt to enter the name led to some mistypes; the second try was successful;

Section B - The LIRAQ-2 model is chosen. Note that one could have entered "MODEL=2", but just "2" is sufficient.

Section C - In choosing the pollutants, only those pollutants whose concentrations can be compared with observations are selected in order to reduce less important output. Note that a "$" is needed to terminate a sequence of input variables if the number of variables input is not equal to the maximum number of variables that may be listed (in this case 15).

Section D - Region 1 is chosen as the overall region of interest (for source and meteorological data) since that is the region treated previously. The second set of input indicates the subarea of that region to which the LIRAQ-2 model will be applied. Note that for LIRAQ-2, the domain must be 20 by 20 grid squares (by selecting region 1, each grid square is 5 km on a side). Input may be integer or floating point and the order of variables input is important.

Section E - The source inventory chosen is as for the control, the summer (season = 3) of 1973 with a time shift to account for daylight savings time.

Section F - Because elevated sources are relatively unimportant and must be changed individually, no change is going to be made for this category (entry is #NO#). Surface sources are to be reduced by 90% however, so a #YES# is entered to the second prompt. For ease in making the change, rather than reduce the emissions in four rectangular areas surrounding the Livermore Valley, we choose to reduce emissions everywhere by multiplying by .1 and then multiplying those sources in the Livermore Valley by 10. This cuts the amount of input to be done in half. The response to the next prompt (1 .1 4) indicates emissions for pollutant 1 are to be multiplied (since CHGOPT = 4) by .1; the next line indicates this is to be done over the entire region; and the next line that this is to be done for the whole 24-hr period. The choice of time could have been from 5 to 7 and had the same effect on a run from 0600 to 0700; choosing 6 to 7 however, would not have been the same because of the interpolation of source emissions between hours causing some emissions from hour 5 (0500 to 0600) to actually be emitted up to 0615. The fourth line (2 ' ') indicates that the change applies to pollutant 2 with the other variables (POLVAL and CHGOPT) unchanged. Using the apostrophe to permit continuance of an existing specification saves retyping. The second sequence of changes begins with the line (1 10 4), which multiplies the pollutant emissions by 10 in the region specified by the UTM coordinates (590 620 4165 4185). Again the apostrophe indicates continuation of a previous variable specification. The input "0 $" ends the input of source changes.

Section G - Input of a "1" indicates the meteorology of July 26, 1973.

Section H - Input of "6 1" indicates a start time of 0600 and run for 1 hr. For the longer run to 1800, input would be "7 11".

Section I - To use the same initial conditions as in the control, the standard set is chosen by inputting #NO#. For the longer run to 1800, the input would be #QREST# in order to continue from the end of the previous run.

Section J - To use the same boundary conditions as in the control, the standard set is chosen by inputting #NO#.

Section K - The first change in model output that can be made is to augment the stations at which concentration time histories are kept. Because there is a particular subarea we are studying in detail, this has been done. The second part of this section allows up to five locations to be specified by UTM coordinates at which time histories of pollutant concentrations will be kept. The final two parts of this section ask for a tape number on which to store the model results and the code for the form (hardcopy or microfiche) of output desired.

Section L - This section solicits information governing model operation. First is the number of compute unit seconds (CUS) to be allowed. Enough should be allowed for the model to complete its calculation since LBL does not provide restart or recovery options. But the number should not be so long that if a problem arises, an excessive amount of computer time would be sacrificed. The next four requests are for job priority, account number, name, and special handling instructions for the output (#NONE# indicates user will pick up the output). The final request is for subset names of files created by this program for the storage in the IBM Data Cell. It is advisable to establish some system that uniquely identifies the files so that successive model runs are not confused.

Once interactive input has been completed, the user is asked if the problem file that has been created should be displayed. Responding #YES# allows one to review the input to assure that all variables are specified as desired. An option is also provided to output a listing of the control and stage decks that have been created. The final output of LIRPRB is a set of instructions to be followed to write the files which have been created to the IBM Data Cell in the proper way.

Once all of this has been done the problem may be initiated by typing in

↑CC,DISPOSE,CNTL=IN.

The next interaction with the user should then be appearance of the output per the instructions input to LIRPRB. Sample output from the LIRAQ model is shown in Appendixes A and B for the LIRAQ-1 and LIRAQ-2 models, respectively.

ANALYZING MODEL RESULTS

Once the model run has been made, the results must be analyzed. Without attempting to completely analyze the particular problem that was run (including the follow-on from 0700 to 1800), a number of insights can be gained by a brief analysis.

July 26, 1973, was a high oxidant day, and the day on which the 1973 Bay Area oxidant high was measured at 1600 in Livermore (22 pphm prior to correction for calibration error, 17.6 pphm after correction). The meteorology indicated light west winds in the morning with the onset of a stronger sea breeze in the afternoon, presumably carrying pollutants emitted in the central Bay Area into the inland valleys in the afternoon. The LIRAQ-2 model had accurately calculated oxidant in Livermore and over the region as a whole on that day (see the Final Report).

Previous to the simulation that reduced non-Livermore surface source emissions, a numerical experiment had been carried out to determine the effects of locally generated pollutants on Livermore-Amador Valley oxidant for the July 26, 1973 meteorology. In that experiment (more fully described in Chapter 13 of the Final Report), all emissions in the Livermore Valley had been set to zero, leaving all initial and boundary conditions the same as in the control case. There was no significant change in calculated concentrations of any pollutant except in the Livermore Valley and points downwind (east). In the Livermore Valley, all primary pollutants were reduced in concentration and calculated oxidant concentrations in the morning were reduced by 1-2 pphm. However, in the afternoon and at the peak of the calculated oxidant, concentrations were actually increased by 0.3 to 1 pphm. Thus, the calculated oxidant maximum in the Livermore Valley was increased slightly (about 2%). The calculated integrated oxidant dose, however, was decreased by about 1% with local emissions set to zero. The increase in oxidant calculated in the afternoon resulted because in the base case locally generated NO destroys oxidant to a greater extent than late afternoon emissions in the Valley generate it.

Because oxidant formation is highly nonlinear, it was still possible, however, that local sources might generate significant oxidant if there were no external sources. Thus, in the experiment described earlier in this section, all surface emissions outside the Livermore Valley were reduced by 90% while leaving the Valley sources at their standard values. Based on input to LIRPRB, the boundary conditions and initial conditions differed only slightly from the earlier experiments, the earlier simulation experiments having started at 0400, whereas for reasons of economy, this simulation had started at 0600. This resulted in slightly higher initial pollutant concentrations than in the other experiments. Because of the initial conditions, the boundary conditions were also such as to lead to slightly higher concentrations of ozone, NO_2, and primary pollutants than in the earlier simulations. Finally, emissions from elevated point sources outside the Livermore Valley were not reduced in this simulation.

In spite of these differences, all of which would be expected to cause the model to estimate slightly higher oxidant levels than would a model starting at 0400, the simulation from 0700 to 1800 predicted very low oxidant concentrations throughout the Bay Area (the calculated high of 4.5 pphm was in Livermore at 1300). Figure 13 contrasts the results for the control simulation, the zero emissions in the Livermore Valley case, and the 90% reduction outside the Livermore Valley case for several stations.

These results indicate the following:

- The model does respond to a major emissions reduction with a major reduction in predicted concentrations of both primary and secondary pollutants.
- Local sources in the Livermore Valley do not in themselves cause calculated oxidant to exceed the 8 pphm standard for the meteorology of July 26, 1973.
- The model predicts that the oxidant measured in Livermore must be primarily a result of up-wind sources in the Bay Area for meteorology like that of July 26, 1973.

However, note the following caveat in addition to the normal cautions about use of any model. Only

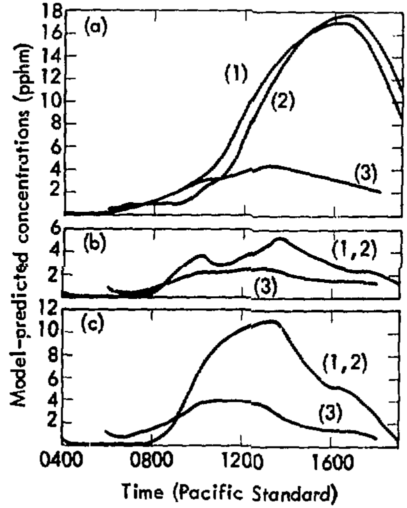

Fig. 13. Time history of concentration of oxidant at the (a) Livermore, (b) San Francisco, and (c) San Jose BAAPCD monitoring stations for (1) the control case, (2) no emissions in the Livermore-Amador Valley, and (3) a 90% reduction in surface emissions outside the Livermore-Amador Valley.

one set of meteorological conditions has been fully investigated. Conclusions valid for the meteorology of July 26, 1973, may not be valid for other wind patterns.

SUMMARY

The sample model calculation described in this section is one of many types of studies that might be performed. With this description, the information provided in the appendixes, some thought in preparing possible scenarios, and some experience, the LIRAQ model should be useful in addressing a wide variety of questions that pertain to regional air quality.

5. Conclusion

The LIRAQ set of models is a "tool" with which many complex questions concerning the causes of poor air quality may be studied. The LIRAQ model uses specific meteorological and emissions information to simulate air quality. It will respond to real-time changes in the input information in carrying out various scenarios. With judicious choices of model parameters, LIRAQ can provide relevant responses to a wide variety of problems; if care is not exercised in setting up a model run, however, results may be unsatisfactory. Thus, although LIRAQ has been made easy to apply to complex problems, such sophistication cannot replace the proper exercising of care in formulating problems and in interpreting results that air quality planning has required in the past. The model is only a tool; the successful application of which requires care and discretion.

Appendix A
The LIRAQ-1 Model

M. C. MacCracken

K. E. Grant

W. E. Johnston

INTRODUCTION

As described in the main sections of this User's Guide and in the Final Report, the LIRAQ-1 model simulates the evolution of regional air quality as a result of the effects of transport and simple source-sink processes. The model uses as input information on topography, meteorology, initial pollutant concentrations, and source emissions that have been gathered and processed prior to being input to the LIRAQ model. The output provided is the regional pattern of air quality including its spatial and temporal variations. The output is in both tabular and graphical form to provide both the detailed numbers and a regional overview. The model is available on the Lawrence Berkeley Laboratory (LBL) computer system.

The model may be used either by itself or as part of the LIRAQ system controlled by a program that helps in formulating the problem (described in Appendix G). In either case, the basic operational requirements of the model are the same - the difference is whether LIRAQ-1 is run automatically or by the individual sitting at a teletypewriter. In both modes a number of input data files must be provided, as listed in Table A-1. Detailed descriptions of the sources and structure of each of the needed input data files except QSRUN are contained in the following appendixes. The structure of the QSRUN file, which governs model operations, is described later in this appendix.

Once the data are read into the model, the model initiates the problem and then simulates the temporal and spatial evolution of the pollutant concentrations. This involves treatment of horizontal and vertical advection, horizontal subgrid scale eddy transport, deposition velocity at the surface, simple species decay, and pollutant source emissions. Data are output periodically in tabular and graphical form; the types of data output in each mode are given in Table A-2. All tabular output, except the station history information, is given to the normal output file TAPE3. Station history data are output in a QSREC file so that they may be used for post processing. Graphical output is given to a file named TAPE 100.

Figure A-1 shows the input and output relationships for the LIRAQ-1

Table A-1. Input files needed by LIRAQ-1.

Filename	Quantity	Tape reference No.	Appendix in which described
QSOR	Source emission data	5	D
QICON	Initial pollutant concentrations	8	F
QGEO	Topographic and geographic data	9	E
QSRUN	Miscellaneous code running information for LIRAQ-1	10	A
QTRANn	Meteorological data	22	C

Table A-2. Output from LIRAQ-I.

Filename	Variables
TAPE3 (tabular)	Run parameters (initial time)
	Species characteristics (initial)
	Initial conditions
	Surface average concentrations (periodic)
	Vertical average concentrations (periodic)
	Ratio of surface to vertical average concentrations (periodic)
	Pollutant mass balances (periodic)
	Meteorological data (periodic)
	Pollutant fluxes (periodic)
FILM (graphical)	Inversion base height (periodic)
	Surface concentration (periodic)
	Vertical average concentrations (periodic)
	Station and UTM history concentrations
QSREC (tabular)	Station and UTM history concentrations

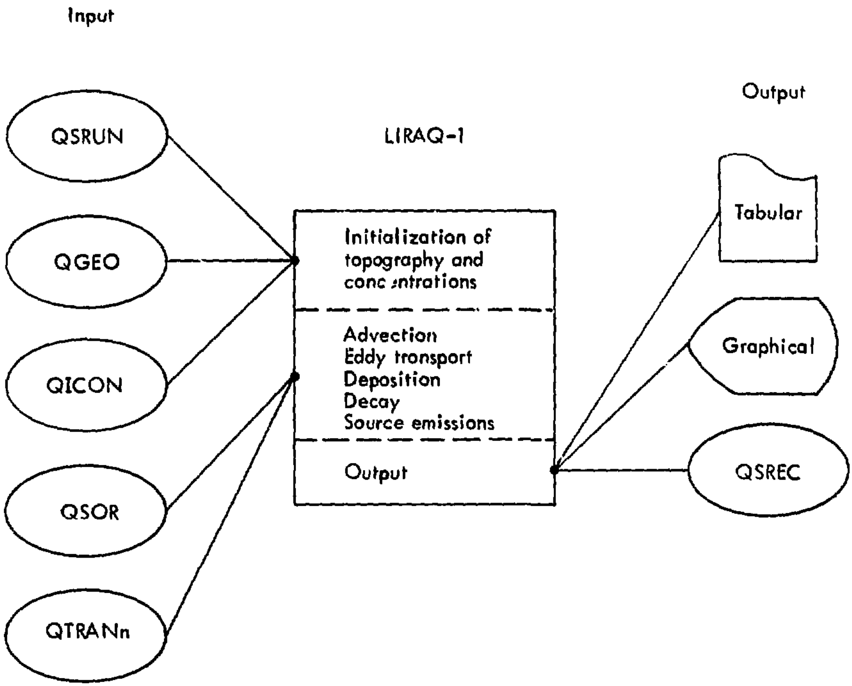

Fig. A-1. Flow of information into and out of LIRAQ-1.

model. The next section describes in detail the computer structure of the LIRAQ-1 code (the theoretical considerations are described in the Final Report). The following sections give a description of the QSRUN file, some examples of model output, and a statement about model availability.

STRUCTURE OF LIRAQ-1 MODEL

The LIRAQ-1 model has a modular structure with different tasks separated into subroutines or functions. One subroutine, LIRAQ1, operates not only as a controller that calls other subroutines in the appropriate order, but also performs the actual advancing in time and space of the pollutant concentrations, the increments for which are usually computed in subroutines.

Figure A-2 and Table A-3 together provide detailed information on actual model structure. Figure A-2 is a task-oriented flow chart of the LIRAQ1 routine, indicating where the calls to each of the various

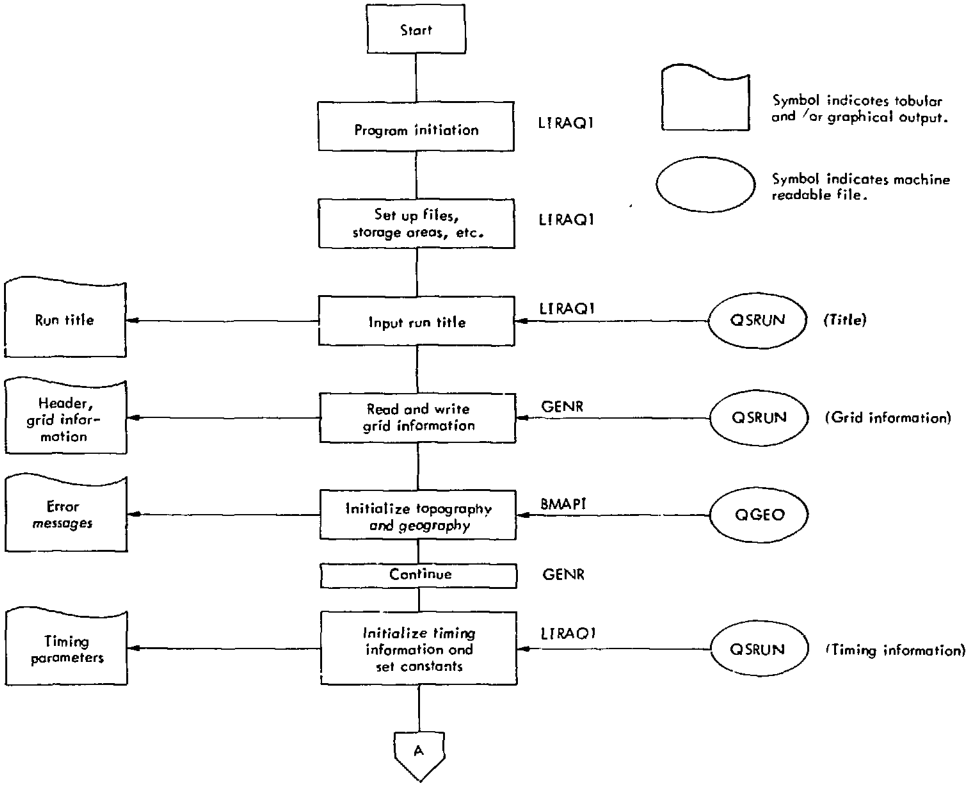

Fig. A-2. Flow chart for LIRAQ1 routine.

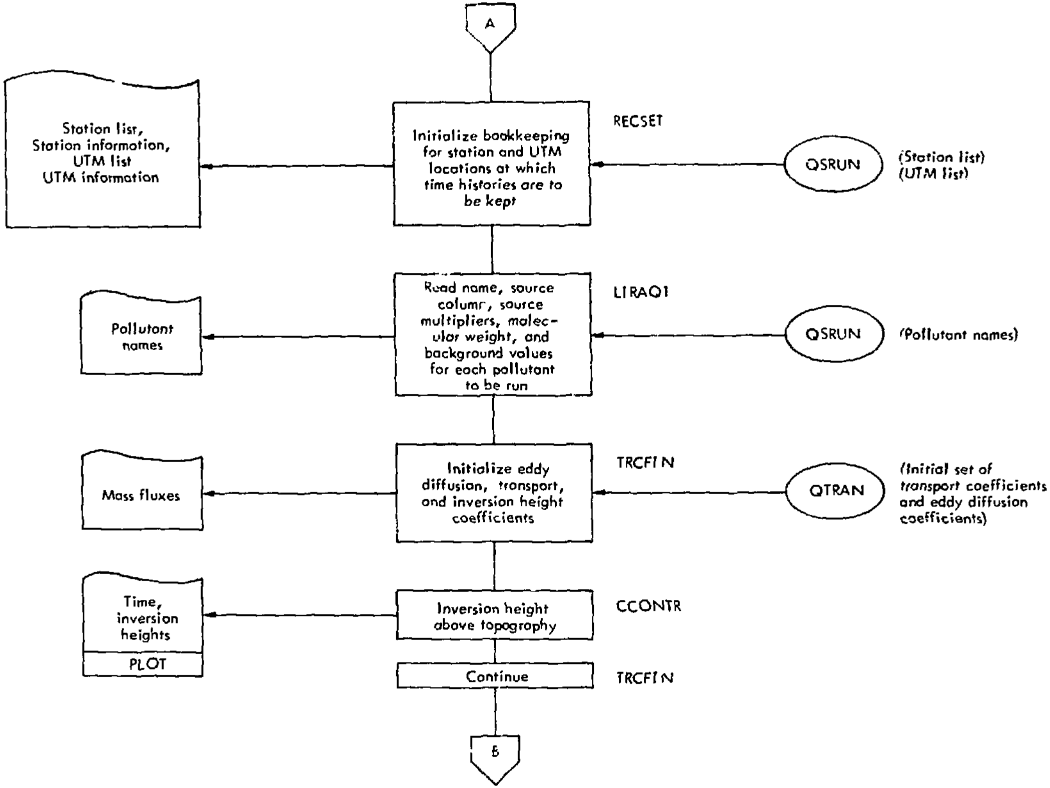

Fig. A-2. (Continued)

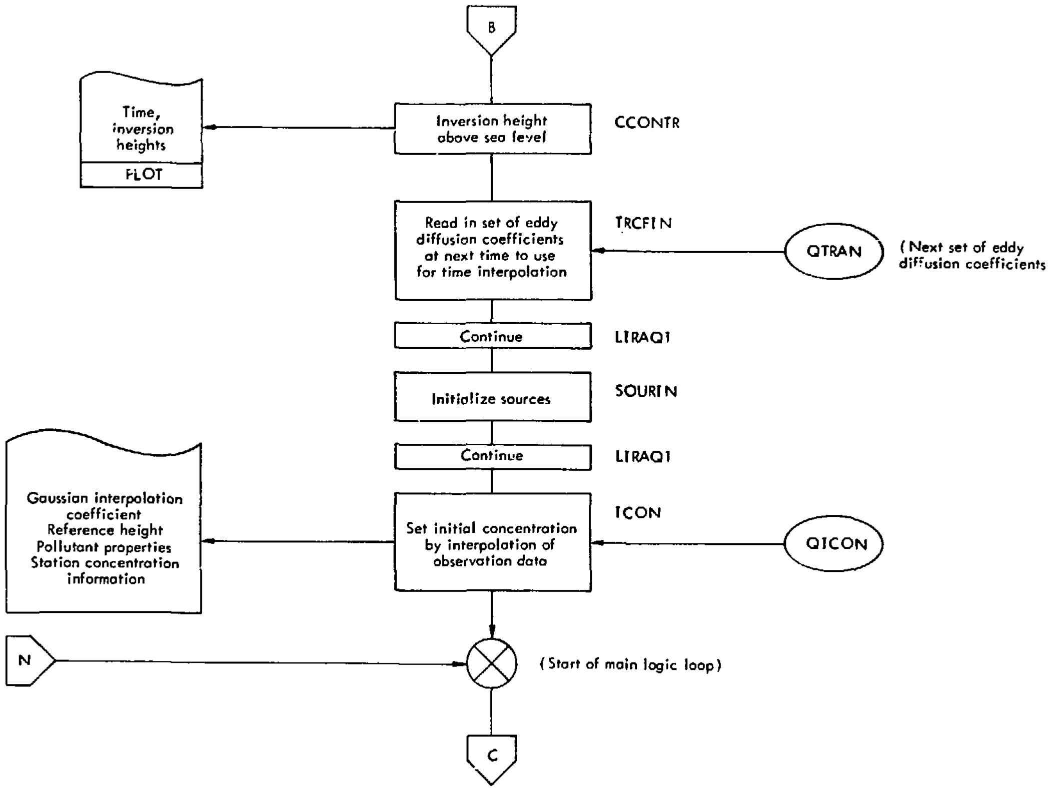

Fig. A-2. (Continued)

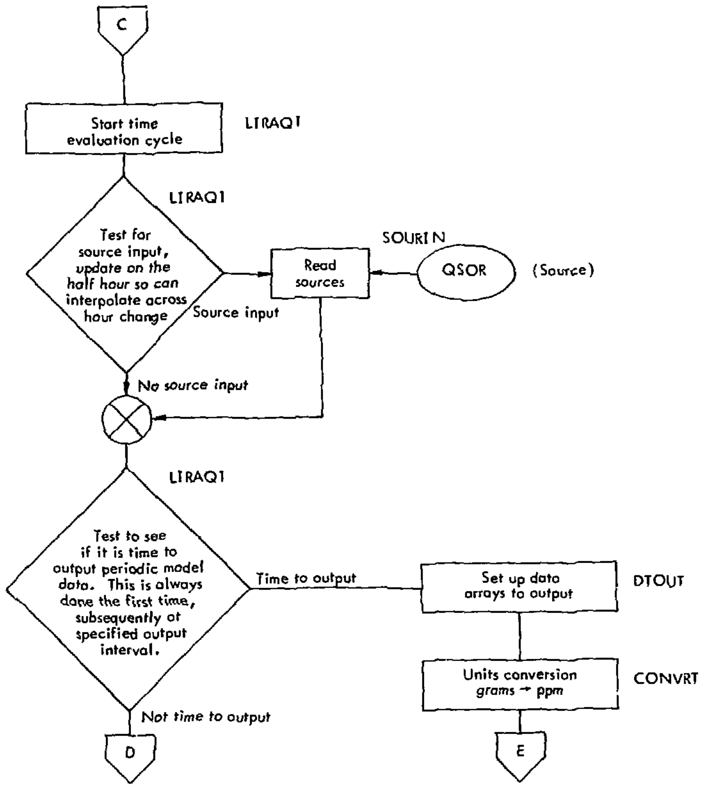

Fig. A-2. (Continued)

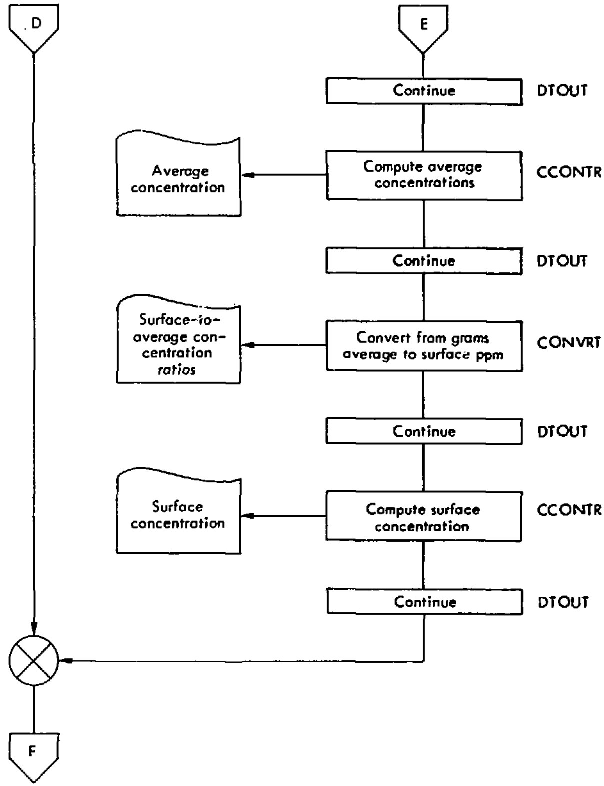

Fig. A-2. (Continued)

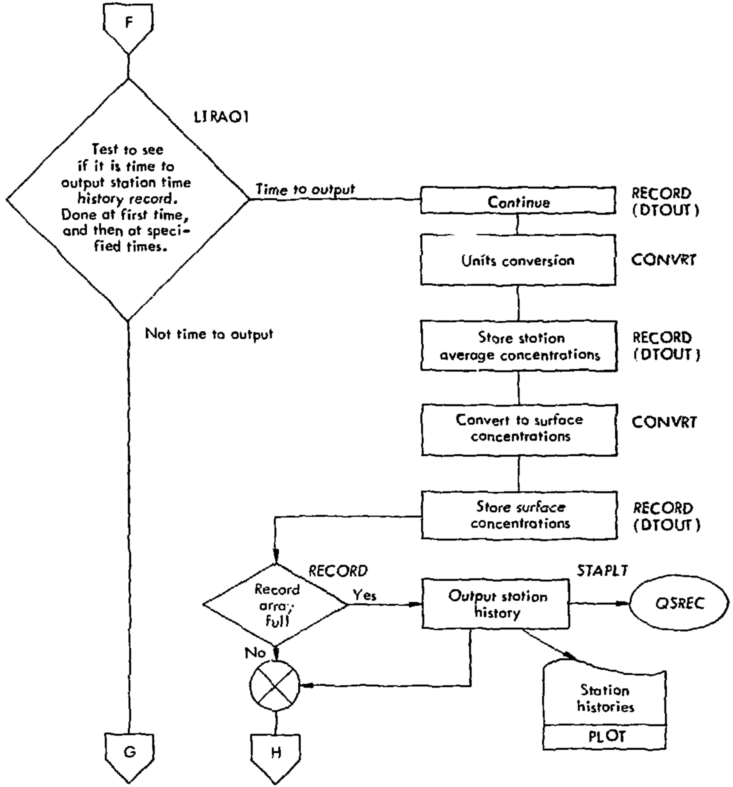

Fig. A-2. (Continued)

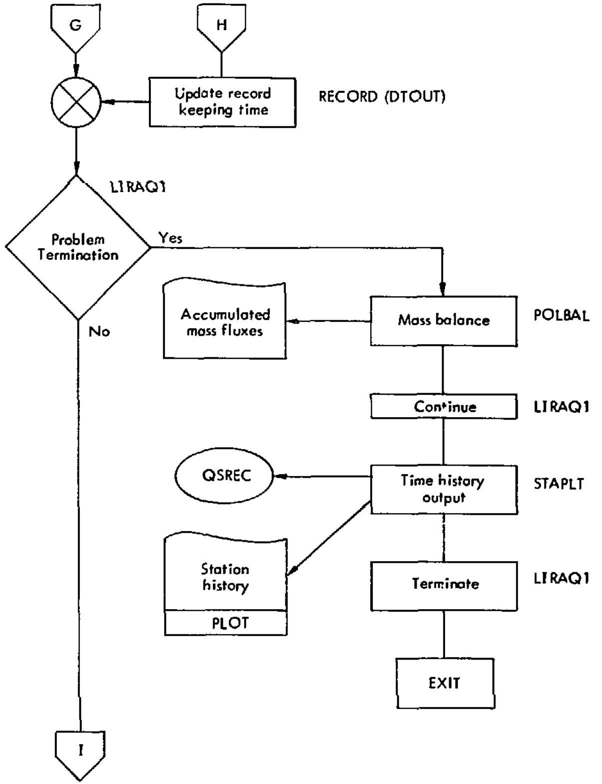

Fig. A-2. (Continued)

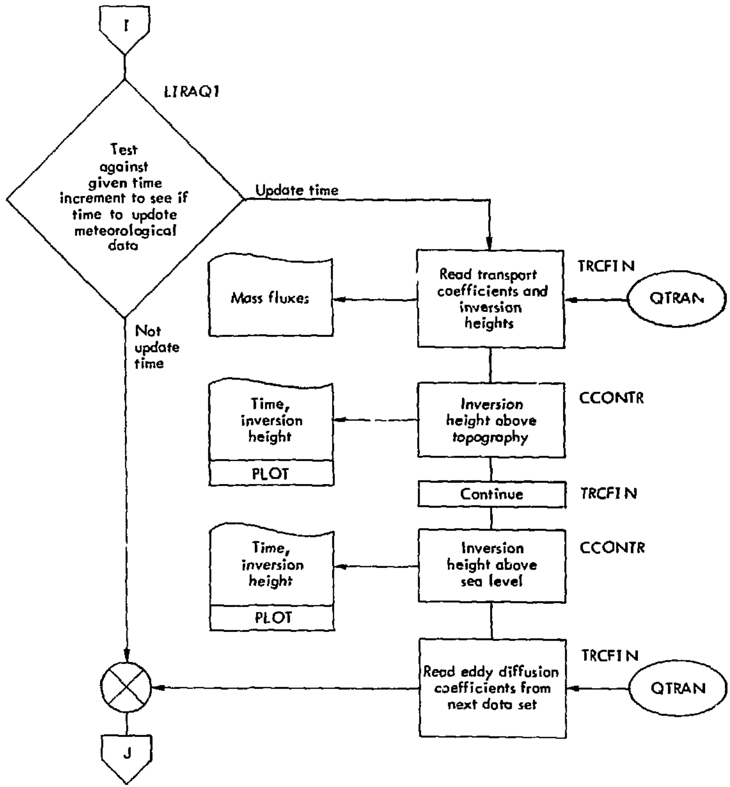

Fig. A-2. (Continued)

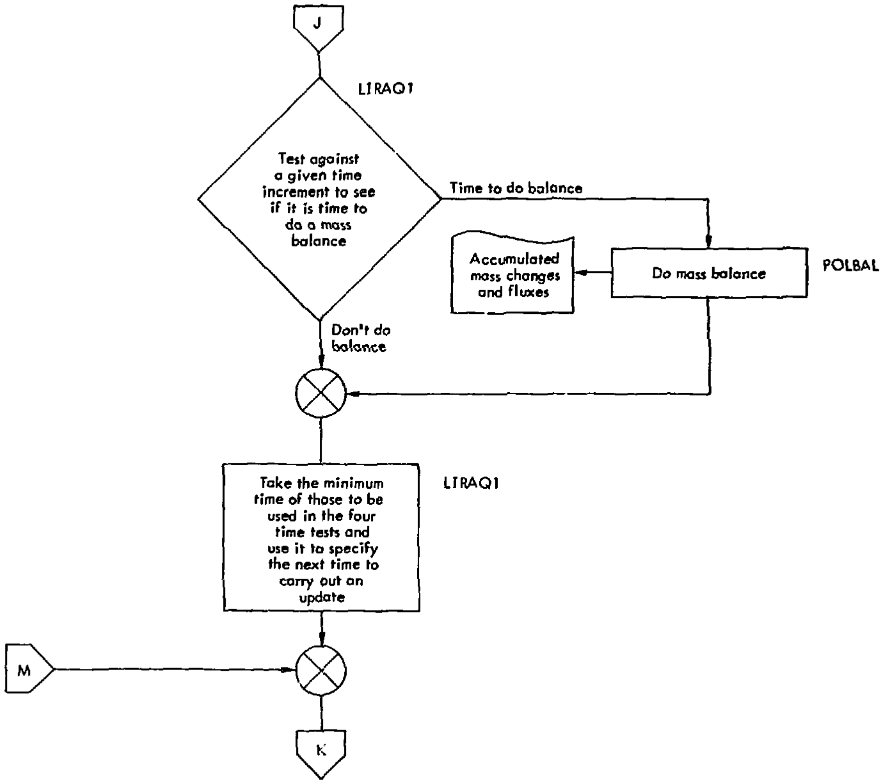

Fig. A-2. (Continued)

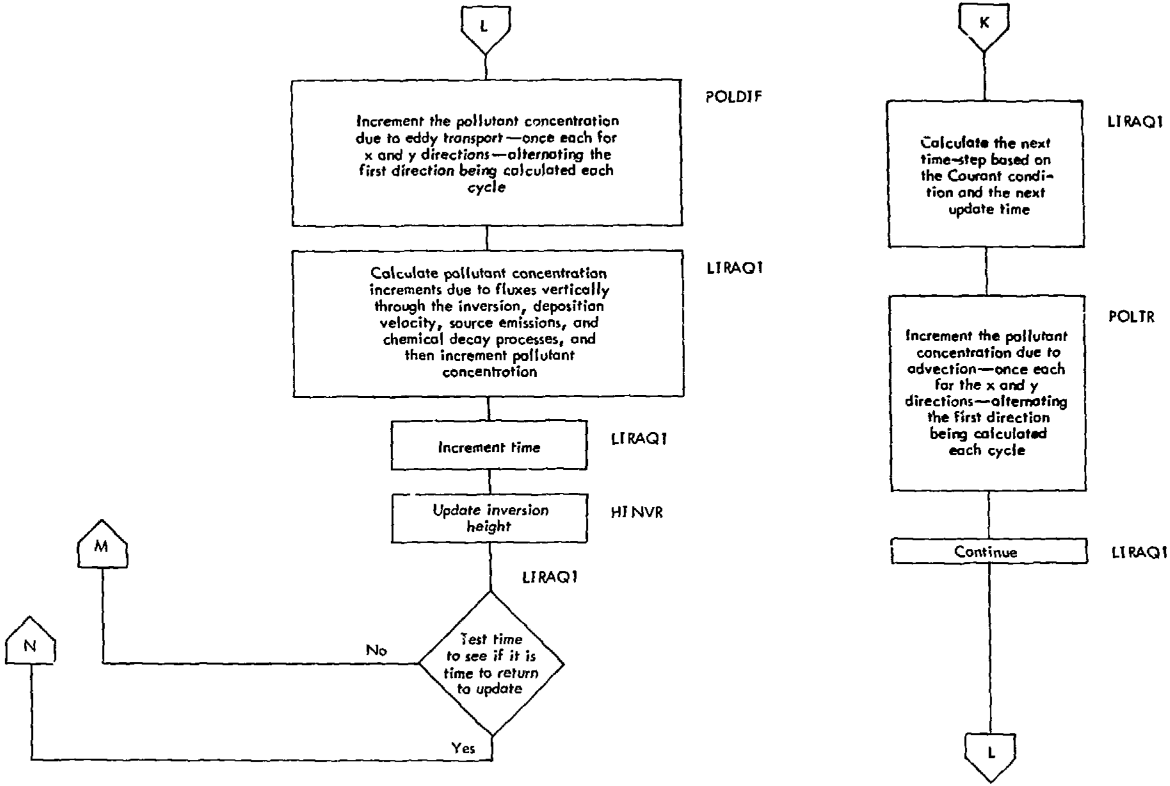

Fig. A-2. (Continued)

Table A-3. Tasks of subroutines and functions used in LIRAQ-1.

Subroutine	Task	Routine(s) calling this subroutine	Routine(s)[a] called by this subroutine
LIRAQ1	Main program that governs model operation, increments pollutant concentrations, and controls output	-	DTOUT GENR HINVR ICON POLBAL POLDIF POLTR RECORD RECSET SOUF SOURIN STAPLT TRCFIN VG
BAYMAP	Plots the contour of the shoreline, grid scale legend, UTM coordinates, and selected station symbols	CCONTR	-
BMAPI	Reads in and initializes data fields for topography, shoreline and station locations	GENR	-
BNX	Calculates correction factor relating mean-horizontal transport ($\overline{u*c}$) and vertically integrated mean-horizontal transport ($\overline{uc}$)	POLTR	VG
CCONTR	Plots graphical output in contour form for surface and average pollutant concentrations and inversion base height	DTOUT, TRCFIN	TITLE, BAYMAP, CONTLAB, CLOCKI
CLOCKI	Prints the time on the graphical output	CCONTR	-
CONVRT	Provides conversion of units between ppm, g/cm^3, and total pollutant mass in a grid cell	ICON, DTOUT	VG

[a]System-related and normal library subroutines are not included in this list. Graphics-related interface routines, which convert calls to LLL graphics routines to calls to LBL graphics routines, are also not referenced here but are listed in the microfiche attachment.

Table A-3. (Continued)

Subroutine	Task	Routine(s) calling this subroutine	Routine(s) called by this subroutine
DTOUT	Directs output of pollutant concentrations and stores station time histories	LIRAQ1	CONVRT, CCONTR, STAPLT
GENR	Sets up initial parameter defining grid of interest	LIRAQ1	BMAPI
HINVR	Updates in time the array of inversion base heights that are linearly interpolated between meteorological update times	LIRAQ1	-
ICON	Sets up initial pollutant concentrations by interpolating from station observations; sets up stations where time histories will be kept	LIRAQ1	VG, CONVRT
POLBAL	Outputs periodic flux totals and mass balances of pollutants for each grid cell	LIRAQ1	VG
POLDIF	Calculates increment to pollutant concentrations because of horizontal eddy transport	LIRAQ1	-
POLTR	Calculates increment to pollutant concentrations because of horizontal advection using flux-corrected transport	LIRAQ1	BNX
RECORD	Entry point in DTOUT	LIRAQ1	-
RECSET	Initializes bookkeeping for station and UTM locations at which time histories have been requested	LIRAQ1	-
SFKZAG	Linearly interpolates the surface vertical diffusion coefficient K_z in time	VG	-
SOUF	Returns pollutant source emissions from surface or surface plus elevated sources, interpolated in time.	VG LIRAQ1	-

Table A-3. (Continued)

Subroutine	Task	Routine(s) calling this subroutine	Routine(s) called by this subroutine
SOUFVG	Entry point in SOUF	-	-
SOURIN	Initializes and updates surface and elevated source-emission data arrays	LIRAQ1	-
STAPLT	Plots the time histories of pollutant concentrations at specified stations	LIRAQ1 DTOUT	TITLE
TITLE	Writes title on graphical output	STAPLT CCONTR	-
TRCFIN	Reads in all meteorological data from QTRAN	LIRAQ1	CCONTR
VG	Calculates surface, vertical average, and inversion height concentrations given vertical average or surface concentrations	ICON, BNX, CONVRT LIRAQ1	SFKZAG, SOUF

major subroutines are made. Table A-3 contains a brief description of the function of each subroutine, leaving the details on how each operation is carried out to comment-card documentation and the coding in the listing.

INPUT DATA FILES

As listed in Table A-1, the LIRAQ-1 model requires five input data files. The other appendixes describe how all but one of these files are generated from more basic data sources. The one exception, QSRUN file, contains the running parameters for model operation When the model is operated under the interactive control system, the QSRUN file is generated automatically from data input by the user during problem formulation (see Appendix H). When the LIRAQ-1 model is run by the user directly, this file must be generated by the user.

Figure A-3 presents a listing of a sample QSRUN file, and Table A-4 gives the formats of the data cards.

A few other variables that control various physical processes are defined in data statements internal to the code. Processes dealt with in this fashion are listed in Table A-5.

```
 SAN FRANCISCO-HALF CO EMISSIONS
LIRAQ 5 KM GRID     530.  660. 4125. 4255.
00:06:00   INITIAL TIME
00:18:00   FINAL TIME
00:01:00   DAYLIGHT TIME SHIFT
00:01:00   PRINT INTERVAL
00:00:30   TIME HISTORY RECORD INTERVAL
00:03:00   MASS BALANCE INTERVAL
THE FOLLOWING STATIONS WILL HAVE TIME HISTORIES KEPT)
  1   4   6   8   9  10  11  12  13  14  15  17  25  34  57  61  63  88 129 143
 27  48  72  73  78  93 103  -0  -0  -0
THE FOLLOWING UTM LOCATIONS WILL HAVE TIME HISTORIES KEPT)
  555.0  4185.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0      0.0
  1 CARBON MONOXIDE
SOURCE COLUMN AND MULTIPLIERS                                7   .1000E+01   .1000E+01
MOLECULAR WEIGHT      28.00
BACKGROUND VALUES  W  .100E+01 E  .100E+01 S  .100E+01 N  .100E+01 A  .100E+01
  0
```

Fig. A-3. Sample QSRUN file for LIRAQ-1.

Changes in the variables governing these processes would require recompilation of the FORTRAN deck.

SAMPLE OPERATION OF LIRAQ-1

The LIRAQ-1 model is operational on the LBL computer system and is programmed in FORTRAN IV. The options available for LIRAQ-1 operation are mainly related to those offered through QSRUN options. The problem formulation process, described in Appendix G, also provides descriptions of most of the possible options.

The sequence of control cards that are created by LIRPRB during problem formulation to run the LIRAQ-1 model is shown in Fig. A-4. When running LIRAQ-1 directly rather than automatically using the executive control system (see Appendix H), a similar sequence of operations would have to be followed in order to provide access to the necessary files, run the model, and output the results.

Sample output from LIRAQ-1 is shown in Figs. A-5 through A-10. Figure A-5 is a sample of tabular output of pollutant concentrations, given with UTM coordinates as a framework. Figure A-6 is the start of the output on the pollutant mass balance for the various grid cells. Figure A-7 shows output of horizontal mass fluxes across grid intervals shown by the UTM coordinates. Figures A-8 and A-9 show graphical output of regional patterns of vertical average and surface pollutant concentrations, respectively.* Figure A-10 shows a station history plot that indicates the temporal evolution of the vertical average and surface pollutant concentrations.*

*The figures show graphical output from the LLL computer system. Similar output is also available on microfiche from LBL.

Table A-4. Format of QSRUN data cards.

Card No.	Columns	Format	Symbol	Units	Value limits	Typical value	Description
1	1-40	4A10	NAME	--	--	BAY AREA 2 KM SIMULATION	Problem name
2	7-8	I2	DX	km	1, 2, or 5	2	Grid size
2	19-24	F6.0	UTME1	km	490 to 660[a]	540	UTM easting coordinate of west edge of domain
2	25-30	F6.0	UTME2	km	490 to 660[a] (> UTME1)	610	UTM easting coordinate of east edge of domain
2	31-36	F6.0	UTMN1	km	4090 to 4300[b]	4130	UTM northing coordinate of south edge of domain
2	37-42	F6.0	UTMN2	km	4090 to 4300[b] (> UTMN1)	4210	UTM northing coordinate of north edge of domain
3	2-3,5-6, 8-9	3(1X,I2)	T1N	day:hr:min	Depends on meteorological data file	00:04:00	Start time of model simulation
4	2-3,5-6, 8-9	3(1X,I2)	TF1N	day:hr:min	Depends on meteorological data file	00:10:00	Final time of model simulation

[a] Limit of (UTME2-UTME1)/DX is 45.

[b] Limit of (UTMN2-UTMN1)/DX is 50.

Table A-4. (Continued)

Card No.	Columns	Format	Symbol	Units	Value limits	Typical value	Description
5	2-3,5-6, 8-9	3(1X,I2)	TDLITE	day:hr:min	00:00:00 or 00:01:00	00:01:00	Shift from daylight time to standard time
6	2-3,5-6, 8-9	3(1X,I2)	TPINT	day:hr:min	00:00:30 to 00:03:00	00:01:00	Time interval between printed output of data
7	2-3,5-6, 8-9	3(1X,I2)	TRECI	day:hr:min	00:00:15 to 00:03:00	00:00:30	Time interval between keeping of data for station histories
8	2-3,5-6, 8-9	3(1X,I2)	TMBAL	day:hr:min	00:01:00 to 00:24:00	00:03:00	Time interval between mass balance calculations
9	-	-	-	-	-	-	Descriptive card
10,11	1-80	20I4	NSTHL	-	Station Nos. 1 to 146; 0 indicates no further data	43	Station numbers indicating stations at which to keep time histories
12	--	-	-	-	-	-	Descriptive card
13	1-80	10F8.0	LOCHST	Set of pairs of UTM coordinates	490 to 660, 4090 to 4300	520 4160	UTM location at which station history is to be kept
14	1-4	I4	NPL	-	1 to 4	1	Pollutant number
14	5-44	4A10	NTIT (NMPOL)	Hollerith	-	CARBON MONOXIDE	Pollutant name

Table A-4. (Continued)

Card No.	Columns	Format	Symbol	Units	Value limits	Typical value	Description
15	51-54	I4	KLMSOR	-	2, 3, 4, 5, or 7	7	Column in QSOR file in which pollutant emissions to be found
15	55-66, 67-78	2E12.4	SORMUL	-	none	1.0	Source multipliers to convert units or modify source
16	20-27	F8.0	AMOL	grams per mole	depends on pollutant	28	Molecular weight of pollutant
17	20-79	5(2X,E10.3)	PBKGL	ppm	none, but must not create excessively sharp gradients	1.0,1.0,1.0, 1.0,1.0	Boundary concentrations for pollutant on west, east, south, north and above domain
18-21	Repeat of cards 14 to 17 for second pollutant (optional)						
22-25	Repeat of cards 14 to 17 for third pollutant (optional)						
26-29	Repeat of cards 14 to 17 for fourth pollutant (optional)						
30	-	-	-	-	0	0	Indicator at end of QSRUN File

Table A-5. Processes governed by data-loaded variables.

Process	Symbol	Routine in which data loaded
Deposition velocity	DEPVEL[a]	TRCFIN
Decay rate	DECAY	TRCFIN

[a]Values of DEPVEL used in LIRAQ-1 are given in Table 4.

AVAILABILITY OF LIRAQ-1 CODE

A subroutine by subroutine listing of the LIRAQ-1 model, with internal comment cards included to provide guidelines to what processes are being treated in each section of the coding, is provided in microfiche form as an attachment to the User's Guide. The code is stored in an UPDATE program library format on the data cell at LBL.

(a) Control deck

```
LIRQ1, 3, 1000.679656,MACCRACKEN.
<NONE
*PSS
DISKHOG, 20000.
SCP,A=   800.
LIBCOPY,LIRQLIB   ,STAGE     ,SL1MT1    .
TAPE,DUMMY,X,NT,R, 14100,I=STAGE.
TAPE,DUMMY,X,NT,R, 14360,I=STAGE.
TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
EXIT.
END.
FIN.
LIBCOPY,LIRQLIB   ,MODFILE   ,MODFILE   .
LIBCOPY,LIRQLIB   ,PRBLM     ,PL1MT1    .
LINK,F=MODFILE,LO=BERX,X.
RETURN,QSOR.
RENAME,QSOR=QSORM.
COPY,QSOR       /RR,MODQSOR    /RR.
DISPOSE,MODQSOR    =MF,T=[LIRAQ      /MODQSOR   ].
EXIT.
FIN.
LIBCOPY,LIRQLIB   ,BINARY    ,LIRQ1BN   .
```

Fig. A-4. Example of LIRAQ-1 (a) control and (b) stage decks generated as a result of problem formulation.

```
REWIND,BINARY
CXIT.
END.
FIN.
GET,BINARY,MAIN.REL/LIRAQ1
REWIND,BINARY     .
REWIND,MAIN       .
WRITEF,TAPE3      .
WRITEF,TAPE11     .
WRITEF,TAPE12     .
REWIND,TAPE3      .
REWIND,TAPE11     .
REWIND,TAPE12     .
FBSIZE,QSRUN=4,QICON=34.
RFL,     144200,    1037000.
TIM.
LINK,F=MAIN,F=BINARY,LO=BERX,X.
SCP,A=0.
EXIT.
DUMP,170000.
SCP,A=0.
TIM.
FIN.
RENAME,TSTAGE=STAGE.
COPY,TAPE3       /RR,TAPEQ       .
COPY,TAPE11      /RR,TAPEQ       .
COPY,TAPE12      /RR,TAPEQ       .
STAGE,TAPEQ       , 10508,NT,W.
RENAME,STAGE=TSTAGE.
COPY,TAPE12      /RR,TAPE12A    /RR.
DISPOSE,TAPE12      =LP,T=[LIRAQ1      /TAPE12     ].
DISPOSE,TAPE12A     =MF,T=[LIRAQ1      /TAPE12A    ].
COPY,TAPE11      /RR,TAPE11A    /RR.
DISPOSE,TAPE11      =LP,T=[LIRAQ1      /TAPE11     ].
DISPOSE,TAPE11A     =MF,T=[LIRAQ1      /TAPE11A    ].
COPY,TAPE3       /RR,TAPE3A     /RR.
DISPOSE,TAPE3       =LP,T=[LIRAQ1      /TAPE3      ].
DISPOSE,TAPE3A      =MF,T=[LIRAQ1      /TAPE3A     ].
EXIT.
CXIT.
FIN.
REWIND,STAGE      .
REWIND,INPUT      .
COPYSBF,INPUT,OUTPUT.
COPYSBF,STAGE,OUTPUT.
```

Fig. A-4. (Continued)

(b) Stage deck

```
*REWIND
*FILE,QSOR
*READ,1
*REWIND
*FILE,QTRAN0
*READ,1
*FILE,QTRAN1
*READ,1
*FILE,QTRAN2
*READ,1
*FILE,QTRAN3
*READ,1
*REWIND
*FILE,QICON
*READ,1
*REWIND
*SKIPF,1
*SKIPF,1
*SKIPF,1
*SKIPF,1
*FILE,QGEO
*READ,1
```

Fig. A-4 (Continued)

AVG CONCEN CONTOURS OF CARBON MONOXIDE
THE TIME IS NOW 9.00000 HOURS

530.000	4250.000	.895E+00	.893E+00	.895E+00	.954E+00	.978E+00	.985E+00	.970E+00	.960E+00	.957E+00	.949E+00
580.000	4250.000	.938E+00	.936E+00	.944E+00	.949E+00	.934E+00	.925E+00	.927E+00	.935E+00	.935E+00	.931E+00
630.000	4250.000	.909E+00	.904E+00	.906E+00	.914E+00	.914E+00	.913E+00				
530.000	4245.000	.897E+00	.893E+00	.895E+00	.953E+00	.970E+00	.994E+00	.981E+00	.965E+00	.957E+00	.950E+00
580.000	4245.000	.942E+00	.951E+00	.954E+00	.940E+00	.939E+00	.109E+01	.165E+01	.181E+01	.181E+01	.175E+01
630.000	4245.000	.149E+01	.113E+01	.950E+00	.912E+00	.912E+00	.913E+00				
530.000	4240.000	.896E+00	.894E+00	.913E+00	.973E+00	.119E+01	.122E+01	.126E+01	.119E+01	.100E+01	.967E+00
580.000	4240.000	.963E+00	.995E+00	.977E+00	.116E+01	.114E+01	.224E+01	.403E+01	.462E+01	.462E+01	.454E+01
630.000	4240.000	.427E+01	.330E+01	.261E+01	.132E+01	.921E+00	.912E+00				
530.000	4235.000	.976E+00	.968E+00	.969E+00	.997E+00	.124E+01	.137E+01	.148E+01	.129E+01	.102E+01	.100E+01
580.000	4235.000	.102E+01	.103E+01	.114E+01	.174E+01	.252E+01	.410E+01	.509E+01	.543E+01	.556E+01	.557E+01
630.000	4235.000	.555E+01	.555E+01	.552E+01	.393E+01	.137E+01	.912E+00				
530.000	4230.000	.105E+01	.999E+00	.989E+00	.101E+01	.123E+01	.136E+01	.141E+01	.137E+01	.107E+01	.105E+01
580.000	4230.000	.107E+01	.105E+01	.114E+01	.175E+01	.269E+01	.426E+01	.513E+01	.549E+01	.555E+01	.555E+01
630.000	4230.000	.554E+01	.553E+01	.550E+01	.478E+01	.181E+01	.921E+00				
530.000	4225.000	.995E+00	.993E+00	.998E+00	.103E+01	.144E+01	.16[illegible]E+01	.163E+01	.163E+01	.117E+01	.107E+01
580.000	4225.000	.107E+01	.106E+01	.146E+01	.162E+01	.269E+01	.421E+01	.498E+01	.551E+01	.555E+01	.555E+01
630.000	4225.000	.554E+01	.552E+01	.548E+01	.550E+01	.256E+01	.106E+01				
530.000	4220.000	.981E+00	.101E+01	.101E+01	.106E+01	.146E+01	.168E+01	.169E+01	.171E+01	.149E+01	.140E+01
580.000	4220.000	.146E+01	.147E+01	.150E+01	.151E+01	.226E+01	.368E+01	.447E+01	.548E+01	.547E+01	.545E+01
630.000	4220.000	.547E+01	.548E+01	.547E+01	.547E+01	.319E+01	.126E+01				
530.000	42[illegible].000	.979E+00	.113E+01	.119E+01	.132E+01	.152E+01	.168E+01	.171E+01	.176E+01	.170E+01	.151E+01
580.000	4215.000	.149E+01	.148E+01	.151E+01	.152E+01	.166E+01	.182E+01	.330E+01	.458E+01	.513E+01	.524E+01
630.000	4215.000	.524E+01	.526E+01	.527E+01	.528E+01	.335E+01	.139E+01				
530.000	4210.000	.979E+00	.110E+01	.147E+01	.144E+01	.154E+01	.163E+01	.165E+01	.165E+01	.169E+01	.160E+01
580.000	4210.000	.149E+01	.148E+01	.151E+01	.157E+01	.163E+01	.190E+01	.330E+01	.449E+01	.507E+01	.514E+01
630.000	4210.000	.515E+01	.506E+01	.462E+01	.463E+01	.322E+01	.141E+01				
530.000	4205.000	.979E+00	.122E+01	.147E+01	.146E+01	.155E+01	.159E+01	.158E+01	.156E+01	.146E+01	.152E+01
580.000	4205.000	.152E+01	.149E+01	.155E+01	.181E+01	.182E+01	.219E+01	.352E+01	.453E+01	.504E+01	.510E+01
630.000	4205.000	.508E+01	.447E+01	.358E+01	.268E+01	.210E+01	.136E+[illegible]				
530.000	4200.000	.113E+01	.139E+01	.168E+01	.160E+01	.161E+01	.169E+[illegible]	.166E+01	.146E+01	.133E+01	.130E+01
580.000	4200.000	.145E+01	.143E+01	.166E+01	.192E+01	.193E+01	.282E+01	.389E+01	.463E+01	.484E+01	.474E+01
630.000	4200.000	.422E+01	.320E+01	.242E+01	.178E+01	.107E+01	.102E+01				
530.000	4195.000	.120E+01	.129E+01	.168E+01	.167E+01	.186E+01	.199E+01	.194E+01	.147E+01	.129E+01	.130E+01
580.000	4195.000	.137E+01	.138E+01	.170E+01	.183E+01	.197E+01	.281E+01	.402E+01	.429E+01	.422E+01	.344E+01
630.000	4195.000	.286E+01	.216E+01	.185E+01	.157E+01	.108E+01	.103E+01				
530.000	4190.000	.117E+01	.133E+01	.168E+01	.170E+01	.187E+01	.198E+01	.219E+01	.201E+01	.132E+01	.139E+01
580.000	4190.000	.136E+01	.135E+01	.170E+01	.187E+01	.206E+01	.268E+01	.280E+01	.279E+01	.276E+01	.276E+01
630.000	4190.000	.241E+01	.176E+01	.145E+01	.109E+01	.982E+00	.978E+00				
530.000	4185.000	.105E+01	.128E+01	.149E+01	.170E+01	.190E+01	.205E+01	.227E+01	.223E+01	.156E+01	.140E+01
580.000	4185.000	.139E+01	.141E+01	.166E+01	.195E+01	.219E+01	.226E+01	.262E+01	.273E+01	.272E+01	.257E+01
630.000	4185.000	.189E+01	.137E+01	.108E+01	.100E+01	.985E+00	.982E+00				
530.000	4180.000	.106E+01	.107E+01	.142E+01	.165E+01	.188E+01	.201E+01	.218E+01	.223E+01	.181E+01	.141E+01
580.000	4180.000	.139E+01	.149E+01	.159E+01	.209E+01	.214E+01	.214E+01	.219E+01	.217E+01	.213E+01	.202E+01

Fig. A-5. Sample output of CO concentrations by UTM square at 0900 for a LIRAQ-1 simulation. Columns 1 and 2 give UTM easting and UTM northing coordinates, respectively; columns 3-12 are concentrations in grid squares in successive UTM increments of the grid interval (5 km here) to the east.

MASS BALANCE IN GRAMS OF CARBON MONOXIDE
FROM 6.0000 HOURS UNTIL 9.0000 HOURS

(a) E	(b) N	(c) CHANGE =	(d) XADV +	(e) YADV +	(f) XDIF +	(g) YDIF +	(h) TOPCUT +	(i) TOPIN +	(j) BOTOUT +	(k) SOURCE +	(l) CHEMLOSS
530.	4125.	-.475E+06	-.299E+07	.124E+07	.12E+01	.76E+00	0.	.16E+07	-.29E+06	0.	0.
535.	4125.	-.121E+07	-.383E+07	.139E+07	.17E+01	.19E+01	0.	.15E+07	-.31E+06	0.	0.
540.	4125.	.193E+07	-.352E+07	.977E+06	.16E+03	.78E+02	0.	.93E+06	-.31E+06	0.	0.
545.	4125.	-.204E+07	-.167E+07	.213E+06	-.57E+02	.14E+03	-.25E+06	0.	-.33E+06	0.	0.
550.	4125.	-.253E+07	.434E+07	-.472E+07	-.20E+03	.66E+02	-.19E+07	0.	-.34E+06	.61E+05	0.
555.	4125.	-.168E+07	.929E+07	-.797E+07	.84E+02	-.78E+00	-.27E+07	0.	-.32E+06	.20E+04	0.
560.	4125.	-.368E+06	.523E+07	-.307E+07	.78E+01	-.59E-01	-.22E+07	0.	-.29E+06	.13E+05	0.
565.	4125.	-.196E+06	.282E+07	-.585E+06	.27E+01	-.36E+01	-.22E+07	0.	-.27E+06	.44E+04	0.
570.	4125.	-.115E+06	-.275E+06	.345E+06	.90E+01	.23E+01	0.	0.	-.18E+06	0.	0.
575.	4125.	.269E+05	.877E+06	-.656E+06	.25E+02	.44E+02	0.	0.	-.19E+06	0.	0.
580.	4125.	.638E+06	-.745E+07	.857E+07	.26E+02	.12E+03	-.29E+06	0.	-.25E+06	.50E+05	0.
585.	4125.	.125E+07	-.577E+06	.112E+07	.51E+02	.84E+02	0.	.78E+04	-.86E+06	.16E+07	0.
590.	4125.	.193E+07	-.391E+07	.[illegible]3E+07	-.11E+03	.29E+02	0.	.23E+06	-.13E+07	.38E+07	0.
595.	4125.	.508E+07	.891E+06	.204E+07	-.26E+02	.37E+02	0.	.50E+06	-.11E+07	.27E+07	0.
600.	4125.	.897E+07	.778E+07	-.280E+06	-.31E+03	.39E+02	0.	.72E+06	-.90E+06	.21E+07	0.
605.	4125.	.388E+07	.444E+07	-.169E+07	.26E+03	.30E+01	0.	.78E+06	-.45E+06	.81E+06	0.
610.	4125.	.157E+07	-.180E+07	.292E+07	.66E+02	.98E+01	0.	.70E+06	-.27E+06	.21E+05	0.
615.	4125.	-.926E+05	.134E+06	-.381E+05	.12E+01	-.53E+01	0.	0.	-.19E+06	0.	0.
620.	4125.	-.181E+06	.301E+04	-.797E+03	.47E+01	-.26E+00	0.	0.	-.18E+06	0.	0.
625.	4125.	-.181E+06	.215E+04	.786E+02	.62E-01	-.17E+00	0.	0.	-.18E+06	0.	0.
630.	4125.	-.180E+06	-.358E+04	.673E+04	.31E+00	-.24E-02	0.	0.	-.18E+06	0.	0.
635.	4125.	-.172E+06	.237E+04	.917E+04	.75E-01	.64E-01	0.	0.	-.18E+06	0.	0.
640.	4125.	-.161E+06	-.415E+05	.653E+05	.14E+01	-.75E+00	0.	0.	-.18E+06	0.	0.
645.	4125.	.121E+06	.226E+06	-.309E+06	.29E+01	-.16E+01	0.	.40E+06	-.20E+06	0.	0.
650.	4125.	.713E+06	.584E+06	-.442E+05	-.24E+01	.29E+00	0.	.38E+06	-.21E+06	0.	0.
655.	4125.	.107E+07	.103E+07	-.181E+04	-.23E+01	-.77E+00	0.	.25E+06	-.21E+06	0.	0.
530.	4130.	-.757E+06	-.233E+07	.124E+06	.11E+01	.12E+00	0.	.17E+07	-.27E+06	0.	0.
535.	4130.	-.157E+07	-.291E+07	-.155E+06	.49E+02	.25E+01	0.	.18E+07	-.30E+06	0.	0.
540.	4130.	-.203E+07	-.554E+07	.265E+07	.11E+03	-.24E+02	0.	.12E+07	-.32E+06	0.	0.
545.	4130.	-.199E+07	-.208E+07	.433E+06	-.15E+03	-.47E+02	-.59E+03	0.	-.34E+06	0.	0.
550.	4130.	-.237E+07	.100E+08	-.106E+08	-.93E+02	-.26E+02	-.16E+07	0.	-.35E+06	.13E+06	0.
555.	4130.	-.159E+07	.122E+08	-.114E+08	.72E+02	.16E+02	-.21E+07	0.	-.32E+06	.27E+05	0.
560.	4130.	-.368E+06	.467E+06	.145E+07	.55E+01	.95E+01	-.21E+07	0.	-.28E+06	.67E+05	0.
565.	4130.	-.154E+06	.316E+05	-.289E+06	.11E+02	.81E+02	0.	0.	-.18E+06	0.	0.
570.	4130.	-.602E+05	.847E+06	-.720E+06	.45E+02	.15E+03	0.	0.	-.19E+06	0.	0.
575.	4130.	.541E+06	-.872E+07	.102E+08	.10E+03	.18E+03	-.86E+06	0.	-.40E+06	.36E+06	0.
580.	4130.	.237E+07	-.832E+06	.213E+07	-.12E+03	-.57E+01	-.52E+06	0.	-.13E+07	.28E+07	0.
585.	4130.	.212E+07	-.238E+07	.748E+07	.10E+02	-.22E+02	-.25E+06	0.	-.14E+07	.37E+07	0.
590.	4130.	.347E+07	-.479E+06	-.102E+07	-.51E+02	-.58E+02	0.	.49E+05	-.18E+07	.67E+07	0.
595.	4130.	.781E+07	.424E+07	-.215E+07	-.45E+02	-.78E+02	0.	.31E+06	-.18E+07	.72E+07	0.

Fig. A-6. Sample output of mass balances of CO by UTM coordinates for a LIRAQ-1 simulation. Column headings are: (a) UTM easting, (b) UTM northing, (c) net change of pollutant mass, (d) x-advection, (e) y-advection, (f) x-diffusion, (g) y-diffusion, (h) fluxes out of well-mixed layer through base of inversion, (i) fluxes in to well-mixed layer through base of inversion, (j) surface sink of pollutants, (k) sources, (l) chemical loss.

CARBON MONOXIDE X-ADVECTION FLUXES

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
530.	4125.	.930E+07	.123E+09	.161E+08	.196E+08	.213E+08	.170E+08	.767E+07	.245E+07
570.	4125.	-.374E+06	-.994E+05	-.976E+06	.647E+07	.705E+07	.110E+08	.101E+08	.278E+07
610.	4125.	-.166E+07	.137E+06	.273E+04	-.288E+03	-.244E+04	.114E+04	-.123E+04	.403E+05
650.	4125.	-.186E+06	-.770E+06	-.180E+07					
530.	4130.	.984E+07	.122E+08	.151E+08	.206E+08	.227E+08	.127E+08	.504E+06	.373E+05
570.	4130.	-.279E+06	-.113E+07	.759E+07	.842E+07	.108E+08	.113E+08	.704E+07	-.282E+07
610.	4130.	.288E+07	-.772E+05	-.924E+04	-.303E+04	-.698E+03	-.866E+04	-.300E+05	.430E+06
650.	4130.	.144E+07	-.501E+06	-.413E+07					
530.	4135.	.997E+07	.117E+09	.163E+08	.195E+09	.155E+08	-.494E+06	.719E+05	-.412E+06
570.	4135.	.139E+07	.715E+07	.886E+07	.102E+08	.953E+07	.907E+07	.320E+07	.145E+07
610.	4135.	-.395E+06	.108E+05	-.121E+04	-.399E+04	-.293E+03	-.128E+04	-.616E+04	.166E+06
650.	4135.	.237E+05	-.112E+07	-.573E+07					
530.	4140.	.832E+07	.119E+08	.169E+08	.177E+08	.129E+08	.420E+06	.583E+05	-.893E+06
570.	4140.	.216E+07	.751E+07	.929E+07	.989E+07	.108E+08	.687E+07	.437E+07	.210E+07
610.	4140.	-.781E+05	-.537E+05	-.256E+05	-.129E+04	.115E+04	.252E+04	-.127E+03	-.245E+04
650.	4140.	-.102E+04	-.221E+07	-.615E+07					
550.	4145.	.969E+07	.152E+08	.203E+09	.270E+08	.102E+08	-.108E+07	-.150E+07	.103E+07
570.	4145.	.645E+07	.101E+09	.990E+07	.964E+07	.824E+07	.594E+07	.498E+07	.341E+07
610.	4145.	-.119E+06	-.540E+05	-.311E+05	-.153E+04	.491E+04	.600E+04	-.445E+03	-.572E+05
650.	4145.	.626E+06	-.176E+07	-.543E+07					
530.	4150.	.139E+08	.202E+09	.233E+08	.141E+08	-.336E+07	-.709E+06	-.347E+07	.108E+08
570.	4150.	.102E+08	.899E+07	.107E+08	.952E+07	.567E+07	.442E+07	.251E+07	.598E+07
610.	4150.	.278E+06	-.598E+05	-.790E+05	-.449E+04	-.119E+06	-.258E+06	.396E+07	.335E+07
650.	4150.	.336E+06	-.237E+07	-.460E+07					
530.	4155.	.183E+09	.224E+08	.195E+08	.634E+07	-.165E+07	-.392E+06	.182E+08	.167E+08
570.	4155.	.967E+07	.839E+07	.912E+07	.109E+08	.698E+07	.185E+07	-.118E+07	-.104E+08
610.	4155.	-.631E+07	-.268E+07	.742E+06	-.507E+06	.842E+05	.692E+07	.242E+07	.840E+06
650.	4155.	-.200E+07	-.368E+07	-.407E+07					
530.	4. 7.	.173E+08	.176E+08	.175E+08	.185E+08	.221E+08	.282E+08	.217E+08	.149E+08
570.	4160.	.128E+09	.914E+07	.941E+07	.481E+07	.179E+07	-.121E+06	-.409E+07	-.310E+07
610.	4160.	-.490E+07	-.215E+07	-.865E+06	.932E+07	.865E+07	.133E+07	-.142E+07	-.386E+07
650.	4160.	-.529E+07	-.537E+07	-.475E+07					
530.	4165.	.112E+08	.105E+08	.129E+08	.127E+08	.186E+08	.150E+08	.127E+08	.994E+07
570.	4165.	.104E+08	.577E+07	.293E+07	-.670E+06	.330E+06	-.298E+07	-.100E+07	-.550E+06
610.	4165.	.267E+07	.474E+07	.758E+07	.271E+07	.130E+07	-.279E+07	-.623E+07	-.757E+07
650.	4165.	-.692E+07	-.650E+07	-.605E+07					
530.	4170.	.854E+07	.864E+07	.757E+07	.504E+07	-.124E+07	.569E+07	.153E+07	.324E+07
570.	4170.	.471E+07	.432E+07	.131E+07	.949E+06	-.727E+06	-.218E+07	.654E+06	.780E+07
610.	4170.	.112E+08	.130E+08	.600E+07	.892E+06	-.106E+07	-.556E+07	-.612E+07	-.563E+07
650.	4170.	-.571E+07	-.531E+07	-.501E+07					
530.	4175.	.830E+07	.774E+07	.765E+07	.637E+07	.806E+07	.601E+07	-.264E+05	-.130E+07
570.	4175.	.339E+07	.499E+06	-.197E+07	-.289E+06	-.553E+07	-.680E+06	.111E+07	.811E+07

Fig. A-7. Sample output from LIRAQ-1 simulation showing mass fluxes of CO across horizontal grid faces, in grams of pollutant in the time interval between mass balances. Columns 1 and 2 give UTM easting and northing coordinates, respectively; columns 3-10 are mass fluxes in sucessive UTM increments of the grid level (5 km here) to the east.

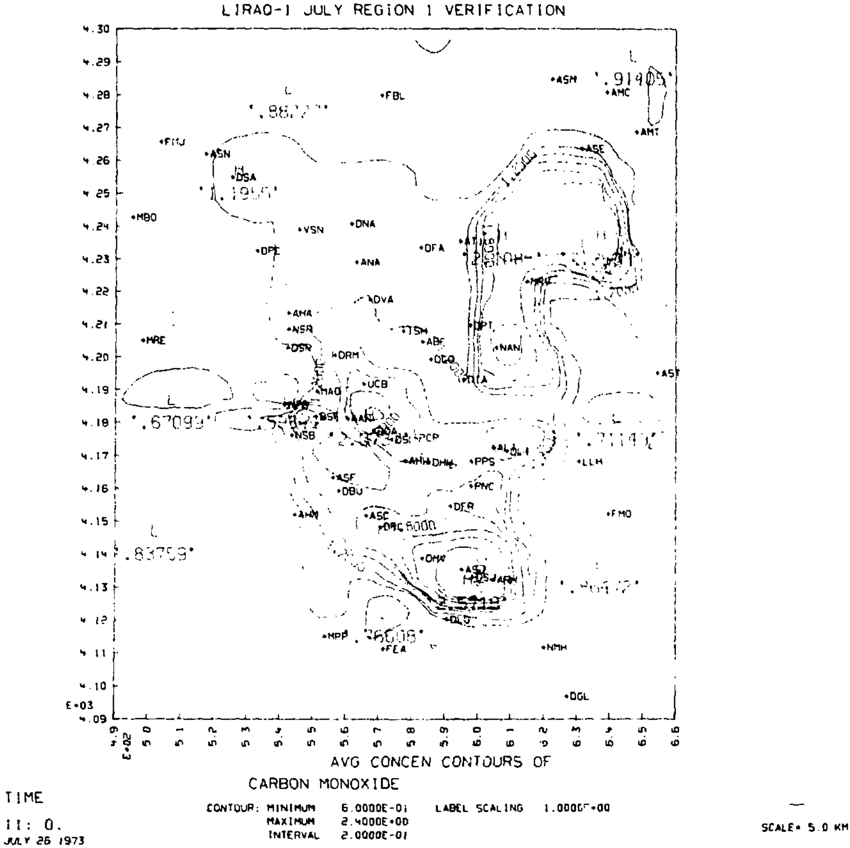

Fig. A-8. Sample graphical output from LIRAQ-1 showing contours of vertical average pollutant concentrations.

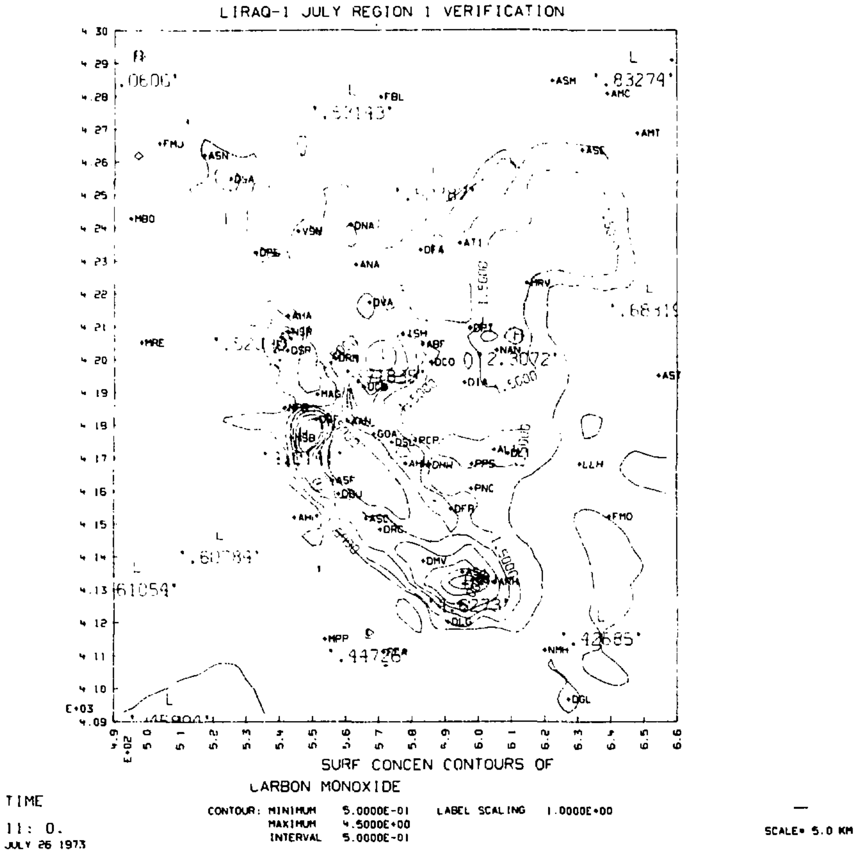

Fig. A-9. Sample graphical output from LIRAQ-1 showing contours of surface pollutant concentrations.

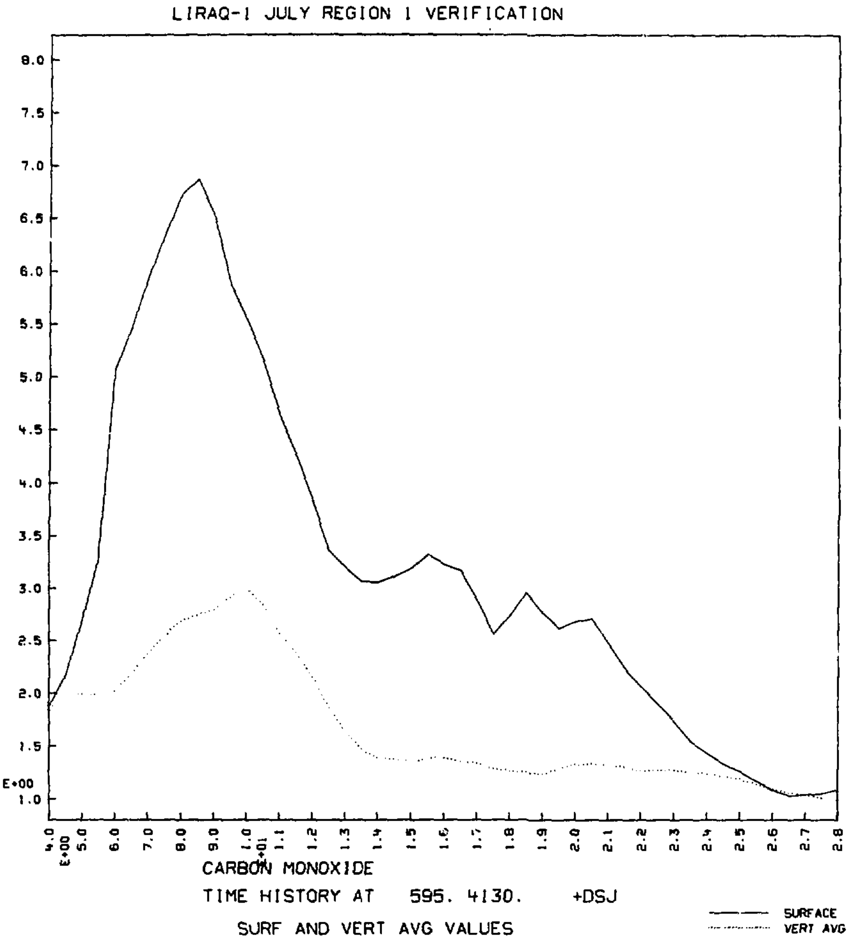

Fig. A-10. Sample graphical output from LIRAQ-1 showing time history of vertical average and surface concentrations of CO in ppm at a particular station (+DSJ indicates San Jose). Time scale is in hours.

Appendix B
The LIRAQ-2 Model

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INTRODUCTION

The LIRAQ-2 model gives the user the capability of simulating air quality conditions when photochemical processes are of primary interest. In developing LIRAQ-2, as much use as possible has been made of LIRAQ-1 subroutines and data files. Just as for LIRAQ-1, LIRAQ-2 may be run directly from a remote terminal or by the executive control system as directed during problem formulation (see Appendix G). Therefore, in addition to the information here, refer also to Appendix A, which describes general model use and some of the common subroutines and data. In this Appendix those parts of LIRAQ-2 are emphasized that are different from those in LIRAQ-1.

The data files required, as shown in Table B-1, are identical to those for LIRAQ-1 with the exception of QSRUN and with the addition of a photodissociation rate file (QRAD) and a restart tape (QREST), all of which are discussed later in this Appendix. After initialization, LIRAQ-2 calculates the evolution of each species as a result of the combined effects of sources, advective and diffusive transport, deposition, and atmospheric chemistry. At specified times the results of these calculations, in tabular and graphical form, are written into output files listed in Table B-2. At the end of a run, time-history records of surface and vertical average concentration at specified locations are printed in a special file, QSREC, which can be used in post processing. Since the time steps used by the integrator in LIRAQ-2 provide information concerning the functioning of the program, the length of the time steps and significant events, such as sunrise, sunset, and meteorological updates, are recorded on a separate file called QSTEP. QSTEP is discussed further in the output section of this appendix. QREST is a binary file.providing the user with average concentration in molecules/cm^3 at the time of each edit and at the problem beginning and end, in order that a problem may be restarted at these times. The flow of information from data files through integration to output is shown in Fig. B-1.

STRUCTURE OF LIRAQ-2 MODEL

As with LIRAQ-1 an attempt has been made to keep a modular structure. In LIRAQ-2 the main routine

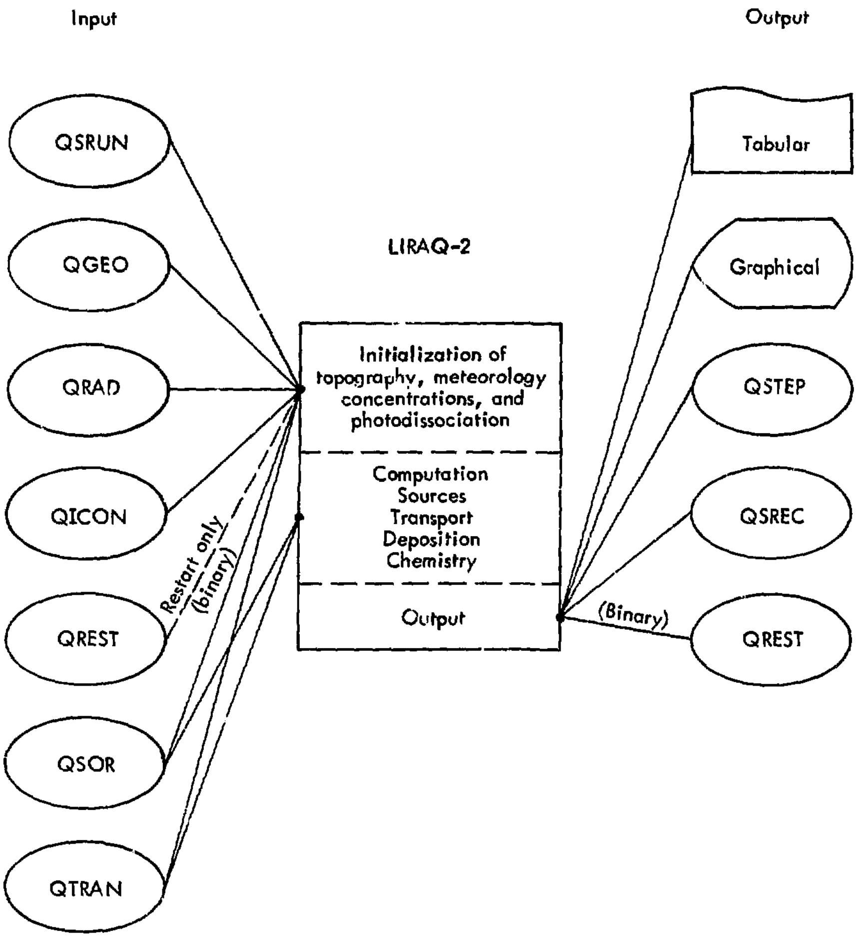

Fig. B-1. Flow of information into and out of LIRAQ-2.

Table B-1. Input files needed by LIRAQ-2.

Filename	Quantity	Tape Reference No.	Appendix in which described
QGEO	Topographic and geographic data	9	E
QICON	Initial pollutant concentrations	8	F
QSOR	Source emission data	5	D
QSRUN	Miscellaneous code-running information for LIRAQ-1 and LIRAQ-2	10	B
QTRAN	Meteorological data	22	C
QRAD	Photodissociation rate coefficients as a function of cosine of the solar zenith angle	13	B
QREST	Concentrations of all species at each grid point	6	B

LIRAQ2 sets up and identifies the tabular and graphical output files, printing out parts of the problem identification. After calling the major input routine (INPUT), a loop within LIRAQ2 calls the GEAR package driver, the output, and the meteorological update routines in the appropriate sequence. Figure B-2 details the logical flow within LIRAQ-2, and Table B-3 describes the function of the various subroutines. It should be mentioned here that by the nature of the GEAR package, when a sharp discontinuity occurs in conditions (e.g., sunrise, sunset, or meteorological update), it is necessary to reset the parameters governing the integration. This logic is also included in the LIRAQ2 subroutine.

The package of subroutines, called GEAR, used in the LIRAQ-2 code, was designed for the numerical solution of initial value problems for systems of differential equations. For a detailed description of the techniques used in GEAR see Hindmarsh (1974) or the Final Report. A flow chart depicting the structure of GEAR is also given in Fig. B-2. In Table B-4 is a description of each of the subroutines used in GEAR. The subroutines DIFFUN, JCHEM, and TSET were developed for LIRAQ-2 and designed to

Table B-2. Output from LIRAQ-2.

Filename	Variables
TAPE3 (tabular)	Run parameters (initial)
	Species characteristics (initial)
	Initial conditions
	Reaction rate coefficients (periodic)
	Vertical average concentrations in mol/cm^3 (periodic)
	Vertical average concentrations in ppm (periodic)
	Surface concentrations in ppm (periodic)
	Time steps and special messages (periodic)
FILM (graphical)	Inversion base height (periodic)
	Surface concentrations in ppm (periodic)
	Vertical average concentrations in ppm (periodic)
	Station history and UTM concentrations
QSREC (tabular)	Station history and UTM concentrations
QREST (binary)	Vertical average concentrations (periodic)
QSTEP (tabular)	Special messages and time step size (nearly every time step)

meet the specifications necessary for use in GEAR.

Input Data Files

LIRAQ-2 requires six data files (see Table B-1) with a seventh, QREST, being optional. Files QGEO, QICON, QRAD, and QSRUN are needed only for initialization. Files QSOR and QTRANn are needed throughout the problem run since they contain source and meteorological data that is updated periodically. The (n) in QTRANn denotes integers, beginning with (0), for the sequence of 6-hr periods making up the meteorological data.

The QGEO, QICON, QSOR, and QTRANn data files are identical for LIRAQ-1 and LIRAQ-2, and the user is referred to Appendices E. F, D, and C, respectively, for discussions of these.

The file QSRUN (Fig. B-3 and Table B-5) is essentially the same

Table B-3. Tasks of subroutines and functions used in LIRAQ-2.

Subroutine	Task	Routine(s) calling this subroutine	Routine(s)[a] called by this subroutine
LIRAQ2	Controls the input, initialization output, and main logic loop for the model	-	INPUT RESTART YOUT DRIVBIL TRCFIN RATES
BAYMAP	Plots the contour of the shoreline, grid scale legend, UTM coordinates, and selected station symbols	CCONTR	-
BMAPI	Reads in and initiates data fields for topography, shoreline and station locations	GENR	-
CCONTR	Plots graphical output in contour form for surface and average pollutant concentrations and inversion height	YOUT TRCFIN	TITLE BAYMAP CONTLAB CLOCKI
CLOCKI	Prints the time on the graphical output	CCONTR	-
COEF	Calculates from meteorological data the transport coefficients used in the program	DIFFUN	-
DIFFUN	Calculates the species chemical derivatives and adds to them the transport derivatives	GEAR	SOUF HINVR COEF SFKZAG PHODIS

[a]System-related and normal library subroutines are not included in this list. Graphics-related interface routines, which convert calls to LLL graphics routines to calls to LBL graphics routines, are also not referenced here but are listed in the microfiche attachment.

Table B-3. (Continued)

Subroutine	Task	Routine(s) calling this subroutine	Routine(s) called by this subroutine
DRIVEBIL (GEAR package)	The main routine of a package of routines developed at LLL by Hindmarsh. Performs the integration of the differential equations with error controls	LIRAQ2	DIFFUN SOURIN JCHEM HAX COEF HINVR PHODIS, plus other GEAR routines
GENR	Sets up initial parameters defining grid of interest	LIRAQ2	BMAPI
HAX	Determines a maximum permissible time-step based on a simplified Courant condition	DRIVBIL	-
HINVR	Updates in time the array of inversion heights that are linearly interpolated between meteorological update times	DIFFUN ICON	-
ICON	Sets up initial pollutant concentrations by interpolating from station observations, sets up stations where time histories will be kept	INPUT	VG SFKZAG HINVR
INPUT	Initializes the problem by defining fixed parameters, reading input tapes, and calling routines that generate other initial conditions	LIRAQ2	GENR TRCFIN RATES SOURIN ICON RESTART
JCHEM	Calculates the variation of chemical derivative with variation of species; for error control	GEAR	SOUF
PHODIS	Carries out a table look-up to obtain photodissociation rates for photochemical reactions	DIFFUN	-

Table 3-3. (Continued)

Subroutine	Task	Routine(s) calling this subroutine	Routine(s) called by this subroutine
RATES	Given temperature and water concentration, calculates chemical reaction rates	LIRAQ2 INPUT	-
RESTART	Stores and retrieves species concentrations throughout region.	YOUT INPUT	-
SFKZAG	Linearly interpolates the surface vertical diffusion coefficient K_z in time	INPUT DIFFUN	-
SOUF	Returns pollutant source emissions from surface or surface plus elevated sources, interpolated in time	VG DIFFUN JCHEM	-
SOURIN	Initializes and updates surface and elevated source emission data arrays	DRIVBIL INPUT	-
STAPLT	Plots the time histories of pollutant concentrations at specified stations	YOUT	TITLE
TITLE	Writes title on graphical output	STAPLT CCONTR	-
TRCFIN	Reads in all meteorological data from QTRAN	LIRAQ2 INPUT	CCONTR
VG	Calculates surface, vertical average and inversion height concentrations given vertical average or surface concentrations	ICON DIFFUN JCHEM	SOUF
YOUT	Prints out average concentration in molecules/cm^3 sets up for output in CCONTR average and surface concentrations in ppm for selected species	LIRAQ2	VG CCONTR STAPLT RESTART

Table B-4. Subroutines and functions used by GEAR.

Subroutine or function	Purpose	Routine(s) calling this subroutine	Routine(s) called by this subroutine
COSET	Sets coefficients for the integration step and for error control	STIFFBIL	-
DDSET	Determines the block diagonal part of the Jacobian matrix and processes it for use by STIFFBIL	STIFFBIL	JCHEM DECOMP
DECOMP	Performs matrix triangulation by Gaussian elimination; provides triangularized matrix A for SOLVE	DDSET	-
DIFFUN	Calculates the species chemical derivatives and adds to them the transport derivatives	STIFFBIL	SOUF MIXVR COEF SFKZAG PHODIS
DRIVBIL	Main calling routine for GEAR; is called once for each desired output time	LIRAQ2	SOURIX TSET MAX STIFFBIL INTRPL
INTRPL	Computes output values at desired times by interpolation	DRIVBIL	-
JCHEM	Calculates the variation of chemical derivative with variation of species; used for error control	DDSET	SOUF
OMEGA	Sets over-relaxation parameter used in SOLBIL	SOLBIL	-
SOLBIL	Calculates successive over-relaxation solution of linear system	STIFFBIL	SOLVE OMEGA
SOLVE	Determines solution to linear system A*X=B, where X is the solution vector	SOLBIL	-

Table B-4. (Continued)

Subroutine or function	Purpose	Routine(s) calling this subroutine	Routine(s) called by this subroutine
STIFFBIL	Core integrator routine; performs a single time step of integration and controls local error for that step	DRIVBIL	DIFFUN COSET DDSET TSET SOLBIL
TSET	Determines off-diagonal terms of Jacobian matrix	DRIVBIL STIFFBIL	

for LIRAQ-1 and LIRAQ-2. The first card is for problem identification. The second card carries grid size information and region location. Cards 3 through 8 carry data about time limits and intervals in the problem. Cards 9 through 13 give those locations at which concentration histories are to be kept. Cards 14 through 73 carry information relating to the 15 species treated in LIRAQ-2 and will always be present since all species must be calculated. Card 74 indicates the end of species data. Card 75 provides sentinels to indicate which species will have contours and station histories plotted. Card 76 contains a restart sentinel. If this is 0, initial concentrations will be obtained from QICON. If it is non-zero, the user will have the option of modifying concentrations read from QREST for his new starting conditions. The last set of cards contain an integer (i) followed by two floating-point numbers A_i, B_i. Default values for A_i and B_i are 1.0 and 0.0, respectively. If c_i^0 is the concentration of species i read from QREST, the initial concentration c_i^n of this species that will be used by the model will be

$$c_i^n = A_i \; c_i^0 + B_i \; .$$

If a zero is read for i, no further data follows.

The file QRAD is a table of photodissociation rates as a function of the cosine of the solar zenith angle (Fig. B-4 and Table B-6). This file is generated by a special LLL program (QRADGEN), which carries out a calculation described in Appendix 5-3 of the Final Report. The photodissociation rate coefficients for a purely absorbing atmosphere are evaluated for 50 equally spaced

Table B-5. Formats of QSRUN data cards.

Card No.	Columns	Format	Symbol	Units	Value limits	Typical value	Description
1	1-40	5A8	NAME	-	-	BAY AREA 5 KM SIMULATION	Problem name
2	1-18	6X,I2,10X	DX	km	1, 2 or 5	5	Grid size
2	19-24	F6.0	UTME1	km	490 to 660[a]	540	UTM easting coordinate of west edge of domain
2	25-30	F6.0	UTME2	km	490 to 660[a] (> UTME1)	640	UTM easting coordinate of east edge of domain
2	31-36	F6.0	UTMN1	km	4090 to 4300[b]	4130	UTM northing coordinate of south edge of domain
2	37-42	F6.0	UTMN2	km	4090 to 4300[b] (> UTMN1)	4230	UTM northing coordinate of north edge of domain
3	1-9	3(1X,I2)	TIN	day:hr:min	Depends on meteorological data file	00:04:00	Start time of model simulation
4	1-9	3(1X,I2)	TFIN	day:hr:min	Depends on meteorological data file	00:10:00	Final time of model simulation
5	1-9	3(1X,I2)	TDS	day:hr:min	00:00:00 or 00:01:00	00:01:00	Daylight savings time shift
6	1-9	3(1X,I2)	TPINT	day:hr:min	00:00:30 to 00:03:00	00:01:00	Time interval between printed output of data

[a] (UTME2-UTME1)/DX must be 20.

[b] (UTMN2-UTMN1)/DX must be 20.

Table B-5. (Continued)

Card No.	Columns	Format	Symbol	Units	Value limits	Typical value	Description
7	1-9	3(1X,I2)	TRECI	day:hr:min	00:00:15 to 00:03:00	00:00:30	Time interval between keeping of data for station histories
8	1-9	3(1X,I2)	TIMBAL	day:hr:min	00:01:00 to 00:24:00	00:03:00	Time interval between mass balance calculations, not used in LIRAQ-2
9	-	-	-	-	-	-	Descriptive card
10,11	1-80	20I4	LOCHST	-	Station Nos. 1 to 146; 0 indicates no further data	42	Station Nos. indicating stations at which to keep time histories
12	-	-	-	-	-	-	Descriptive card
13	1-80	10F8.0	LOCHST	Set of pairs of UTM coordinates	490 to 660, 4090 to 4300	520 4160	UTM location at which station history is to be kept
14	1-4	I4	NPL	-	1 to 15	1	Pollutant No.
14	5-44	4A10	NTIT (NMPOL)	Hollerith	-	CARBON MONOXIDE	Pollutant name
15	51-54	50X,I4	KLMSOR	-	2, 3, 4, 5, or 7	7	Column in QSOR file in which pollutant emissions to be found

Table B-5. (Continued)

Card No.	Columns	Format	Symbol	Units	Value limits	Typical value	Description
15	55-78	2E12.4	SORMUL	-	None	1.0	Source multipliers to convert units or modify sources
16	20-28	F8.0	AMOL	-	Depends on pollutant	28.	Molecular weight of pollutant
17	29-79	5(2C,E10.3)	PBKGL	ppm	None, but must not create excessively sharp gradients	1.0,1.0,1.0, 1.0,1.0	Boundary concentration for pollutant on west, east, south, north, and above domain
75	1-30	15I2	MPLT	-	0 or 1	0	MLPT=1 species contours and station records are kept; MPLT=0 none are kept
76	1-2	-	NEST	-	0 or 1	0	NEST=0 run is started from data on QICON. NEST=1 run is restarted from concentrations stored on QREST
77	1-5	I5	IS	-	1 to 15	1	Initial concentration of SPECIES
77	6-15	E10.2	SCIN	-	-	1.0E+00	IS will be SCIN times
77	16-25	E10.2	SCUP	molecules/ cm^3	-	0.00E+00	the value from QREST plus SCUP
78	Same as 77					0	If no more data, IS=0

(a) Flow chart for LIRAQ2

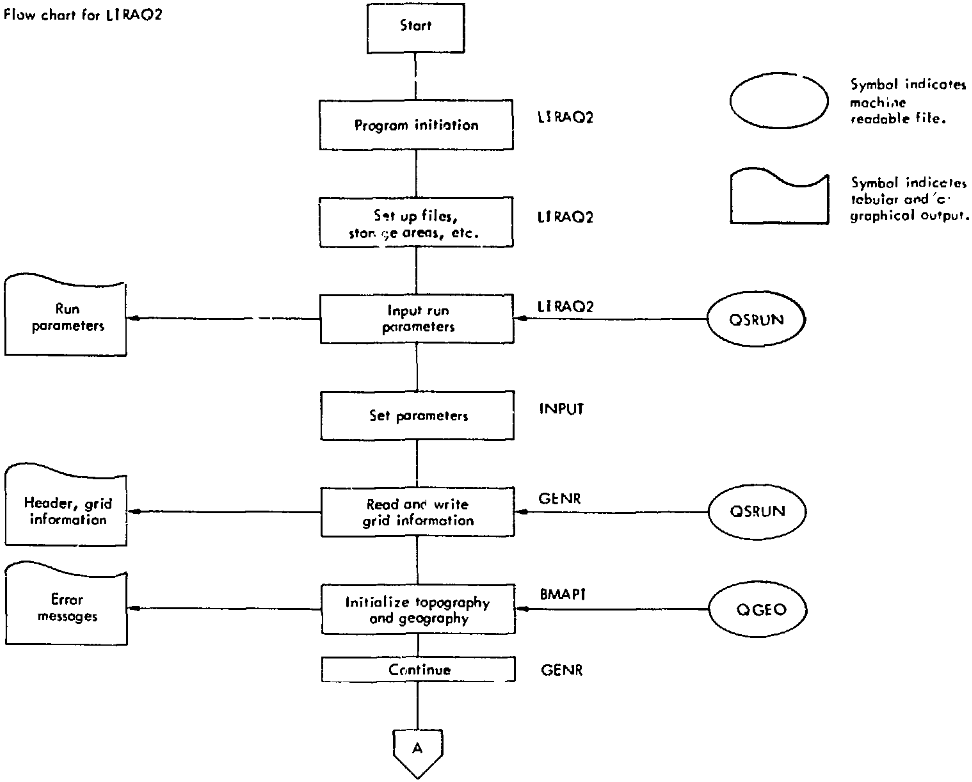

Fig. B-2. Flow charts for LIRAQ-2, GEAR, YOUT, and RESTART routines.

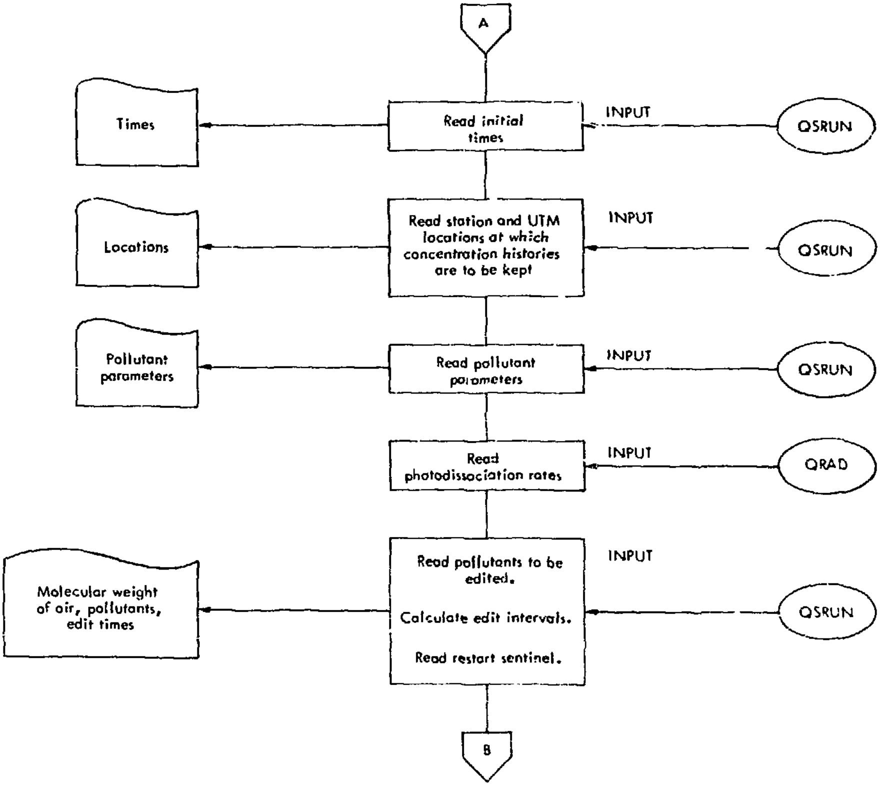

Fig. B-2. (Continued)

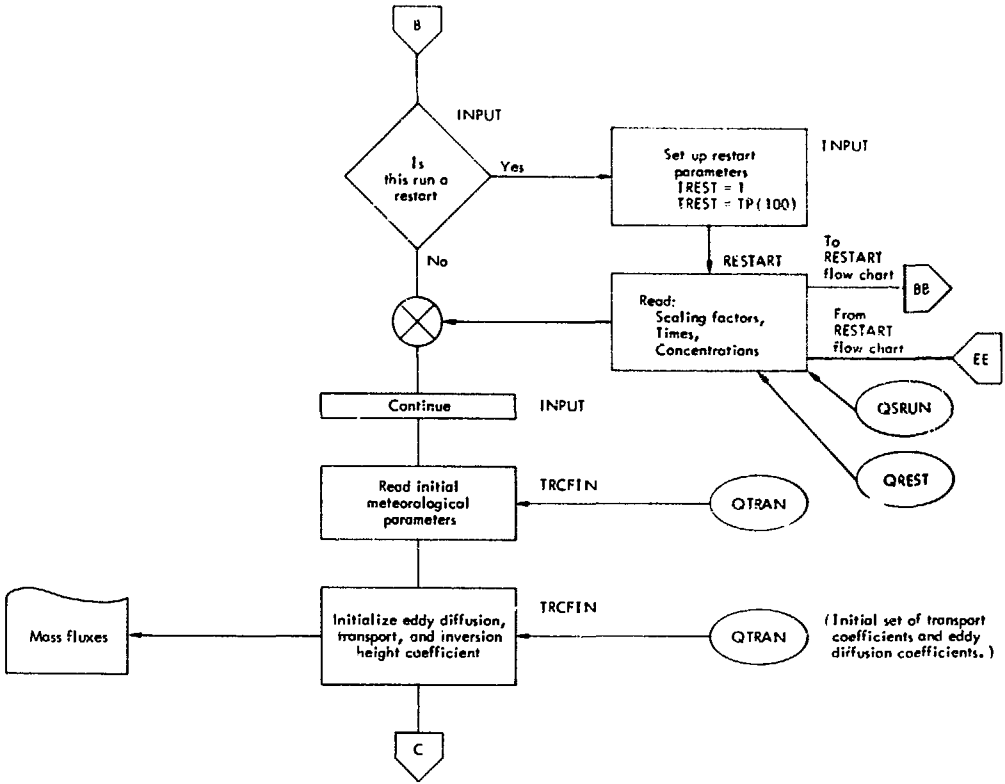

Fig. B-2. (Continued)

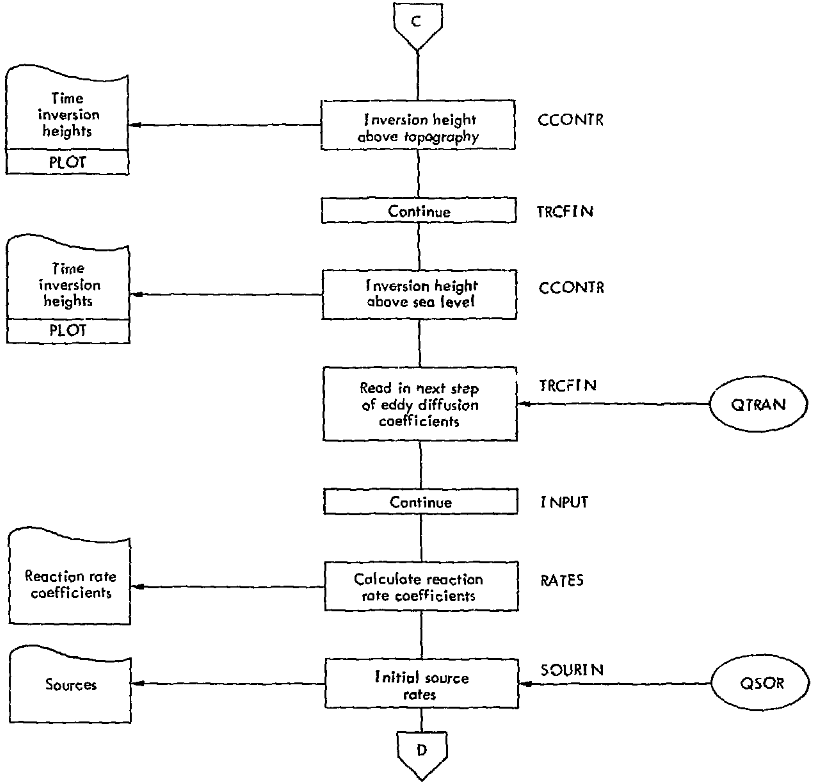

Fig. 2. (Continued)

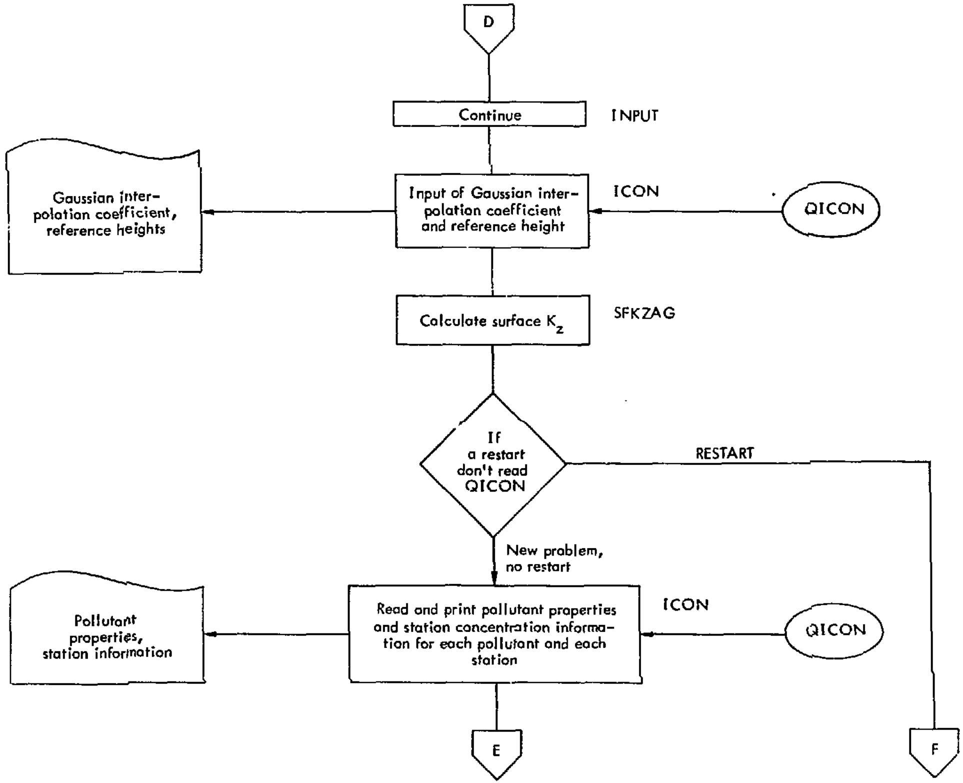

Fig. B-2. (Continued)

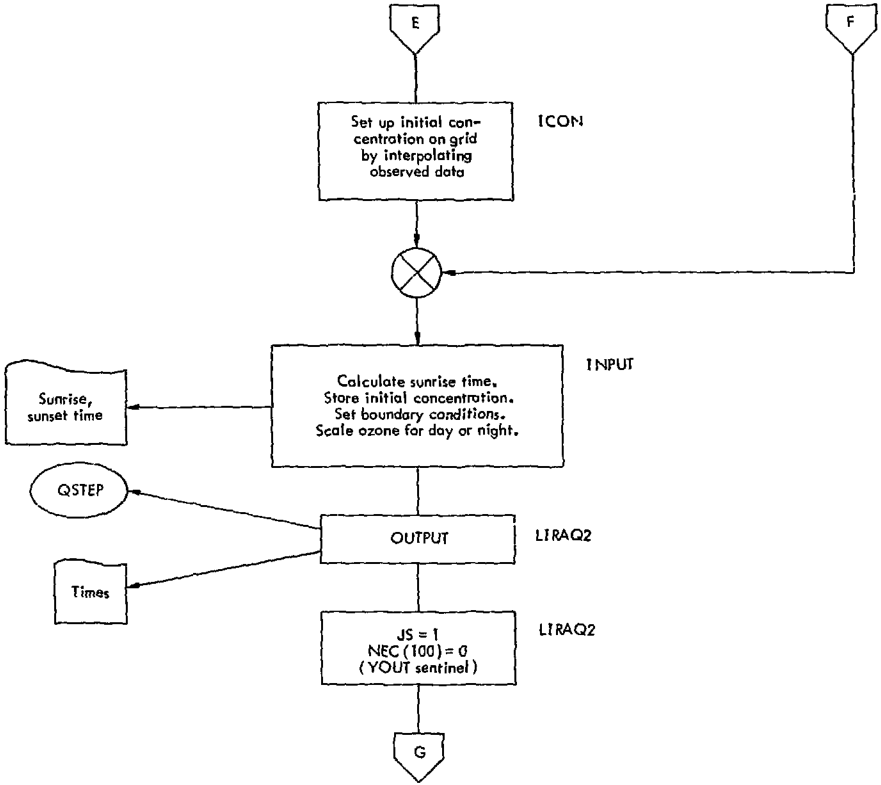

Fig. B-2. (Continued)

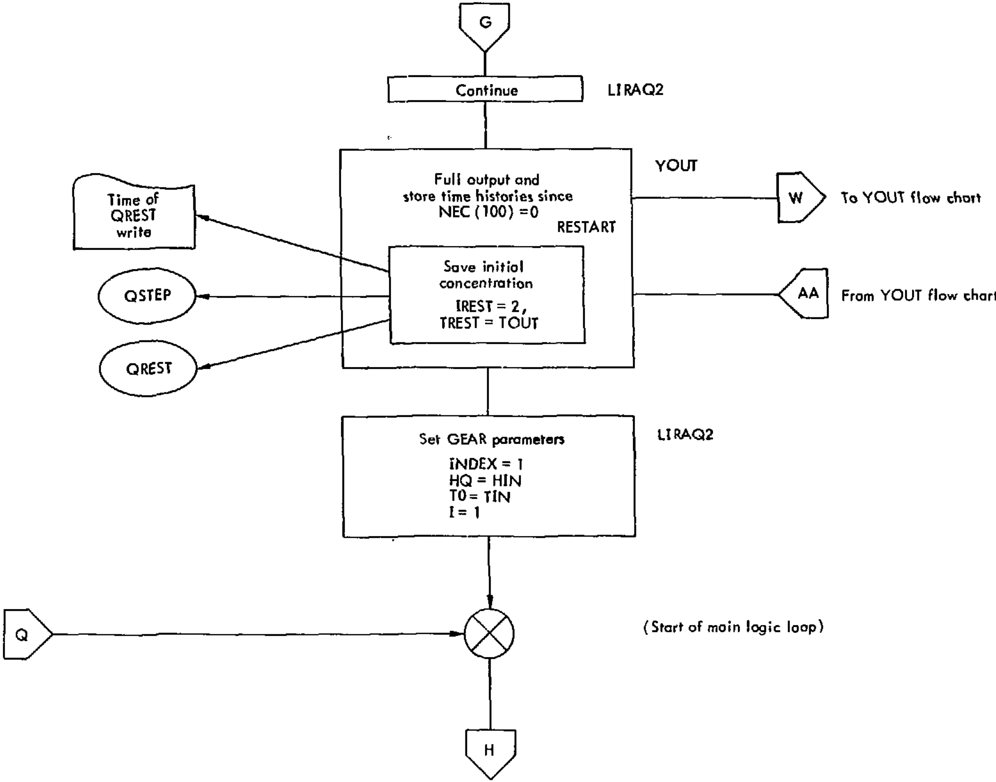

Fig. B-2. (Continued)

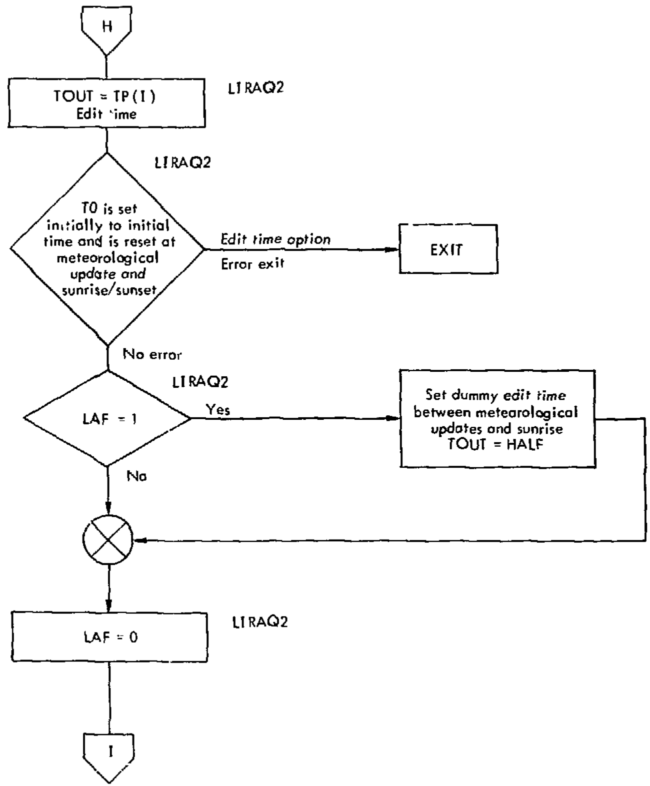

Fig. 2. (Continued)

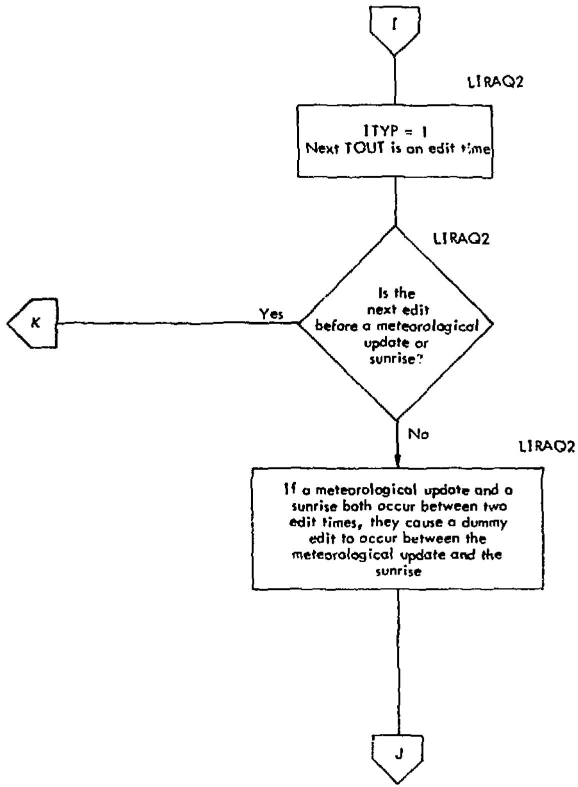

Fig. 2. (Continued)

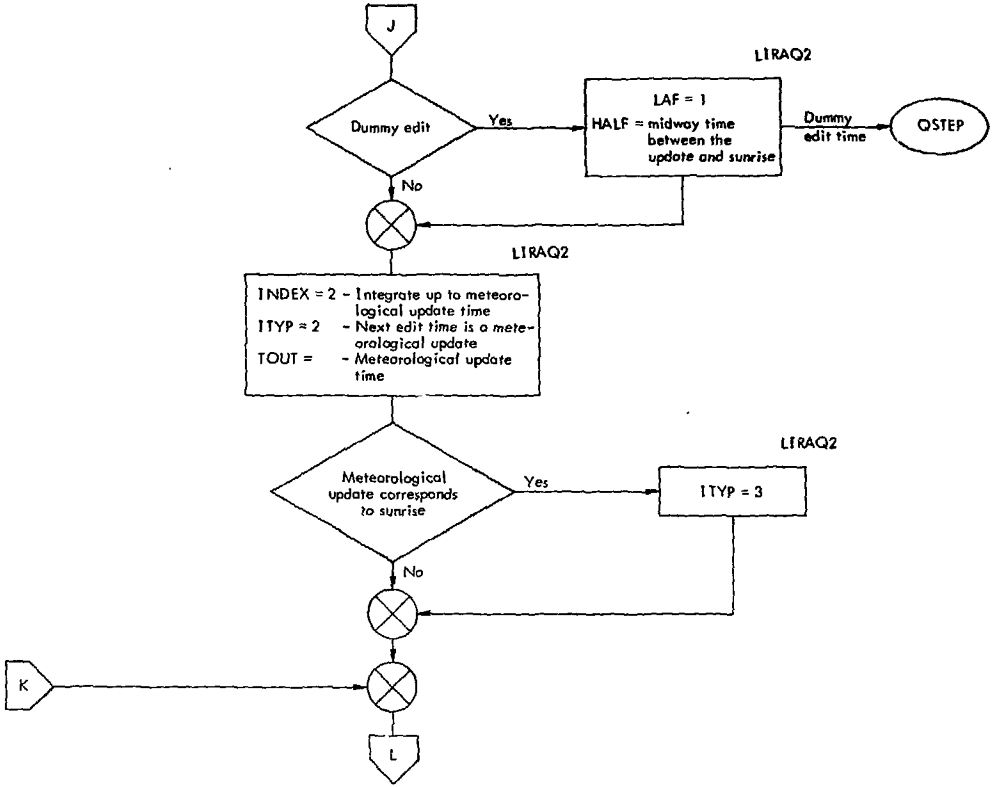

Fig. B-2. (Continued)

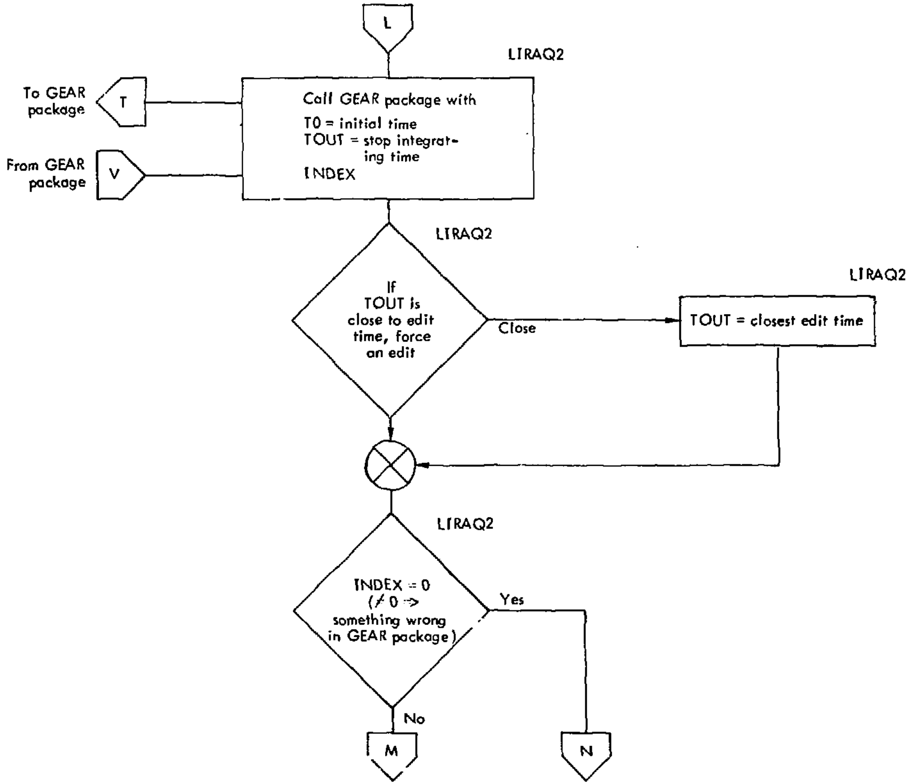

Fig. B-2. (Continued)

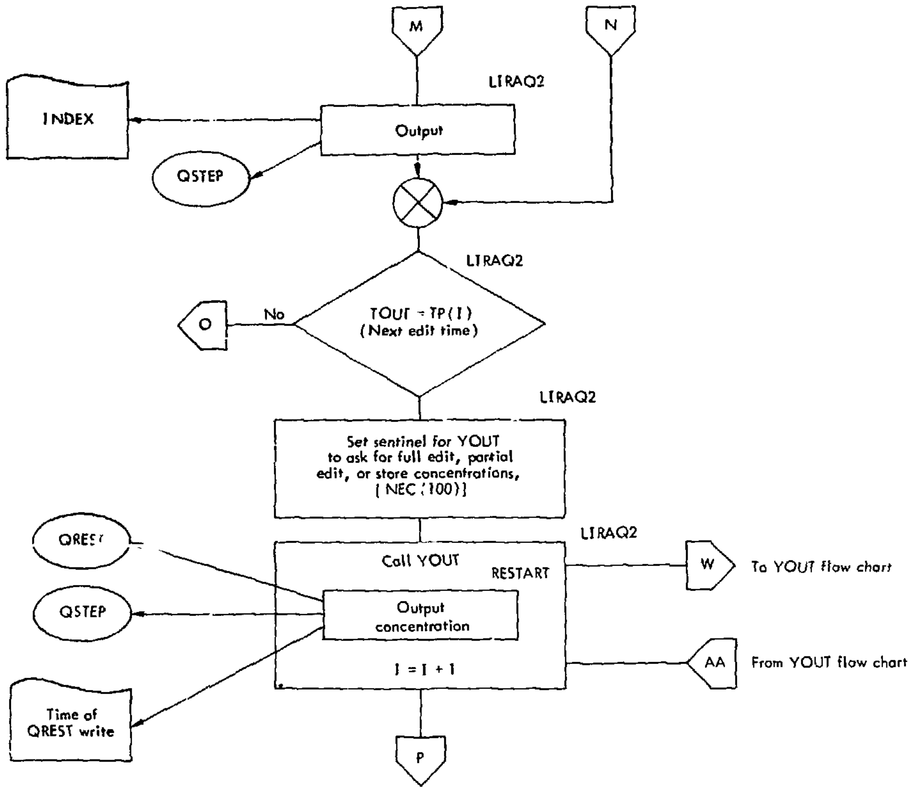

Fig. B-2. (Continued)

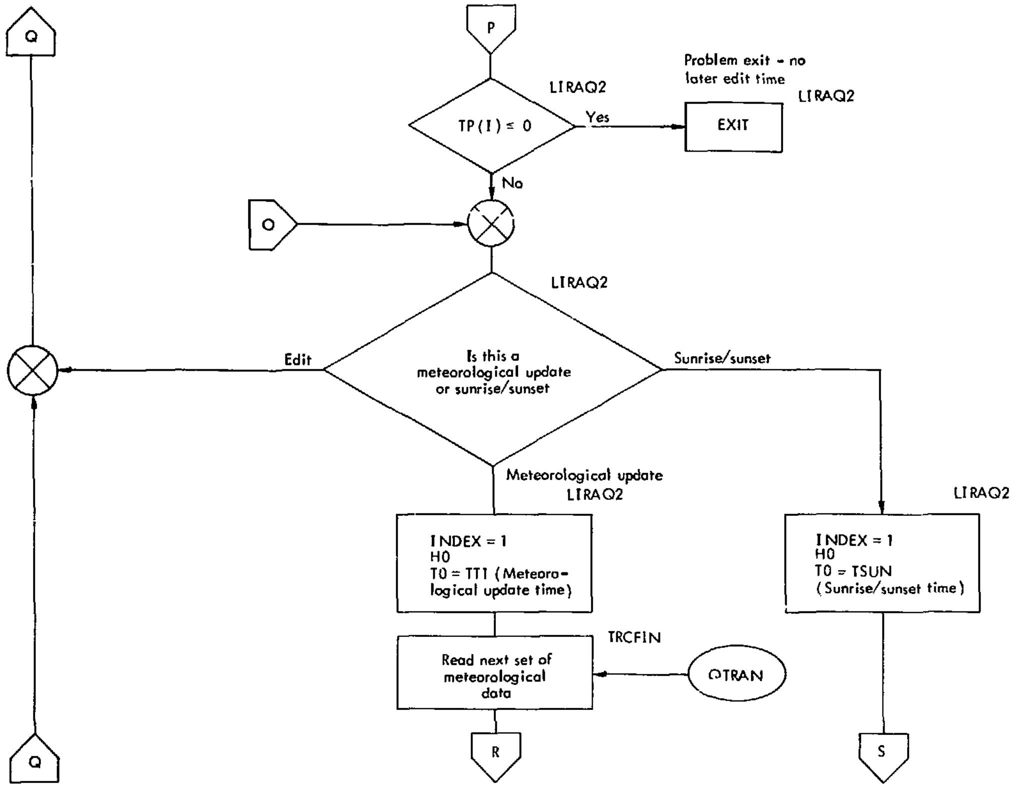

Fig. B-2. (Continued)

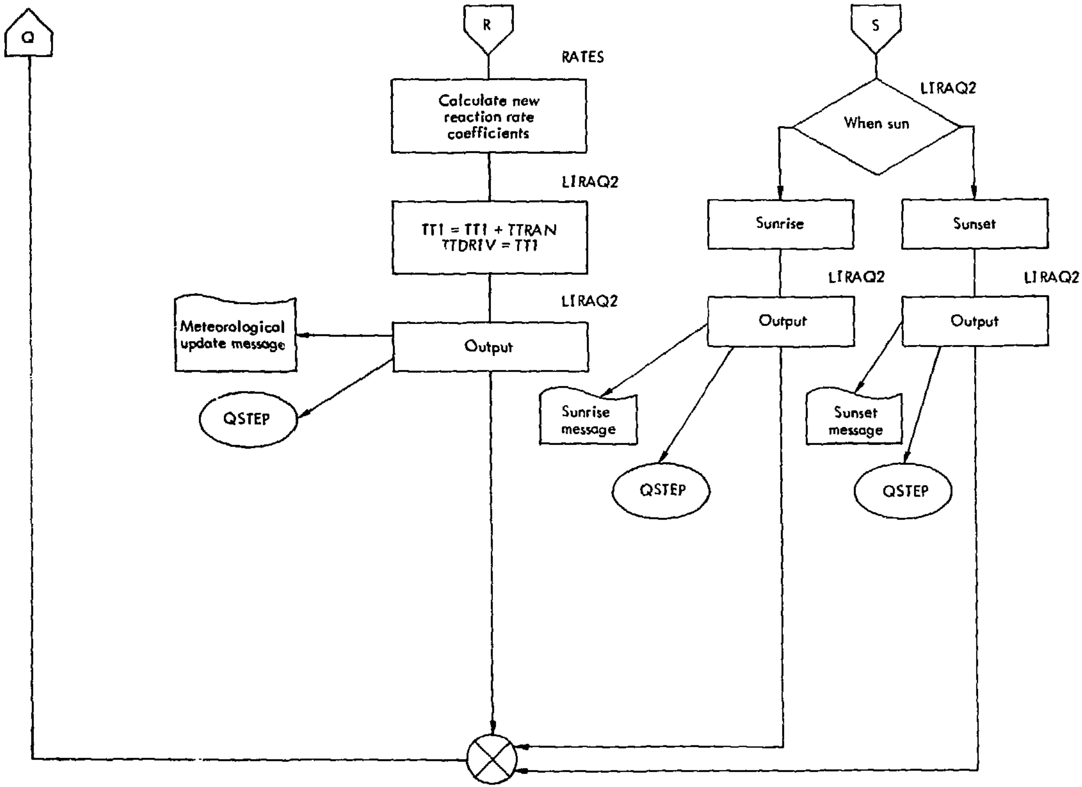

Fig. B-2. (Continued)

(b) Flow chart for GEAR package

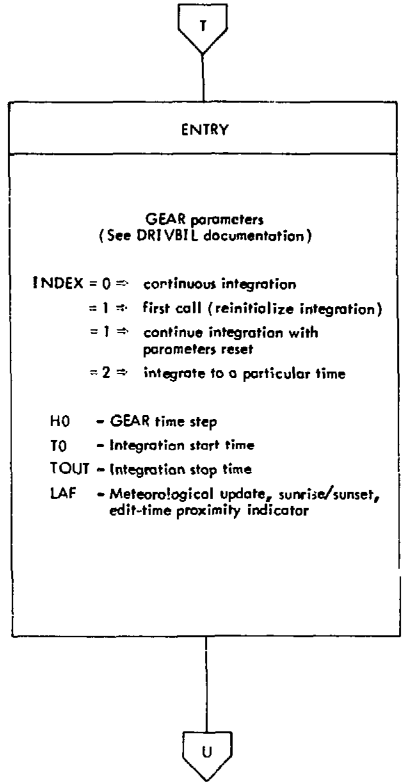

Fig. 2. (Continued)

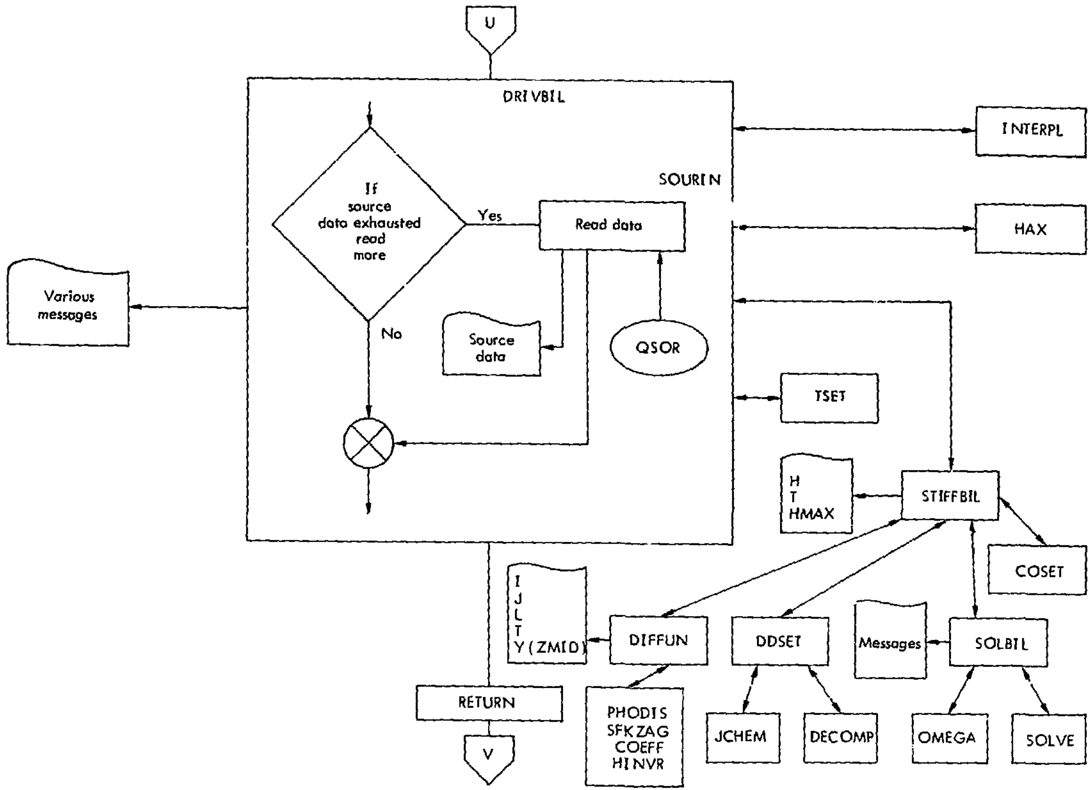

Fig. B-2. (Continued)

(c) Flow chart for YOUT package

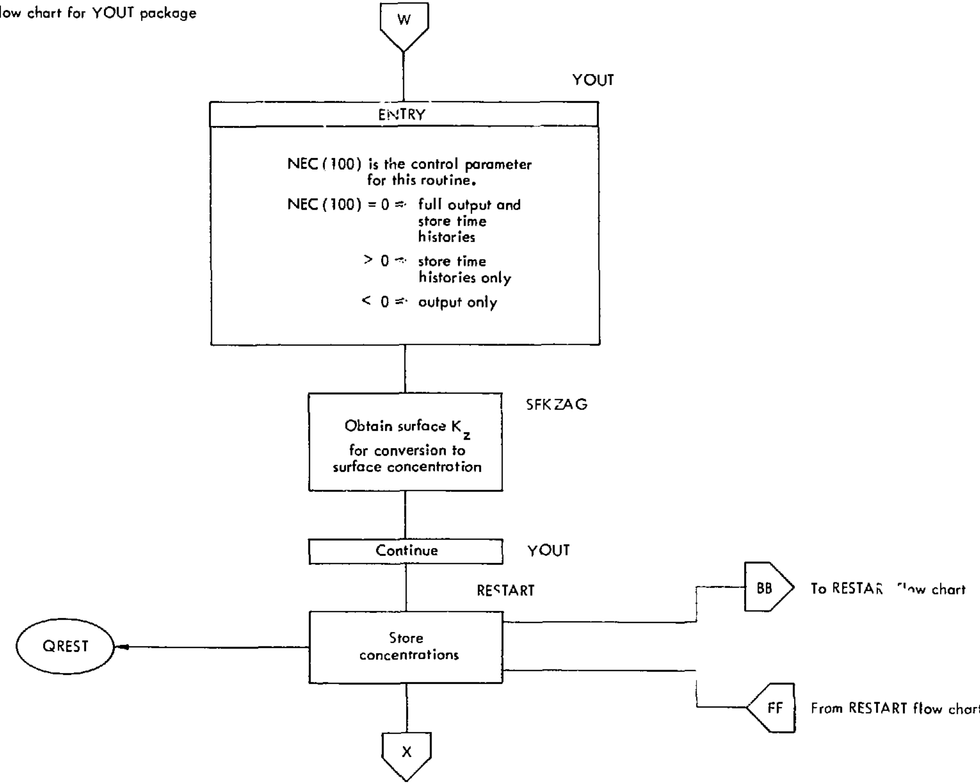

Fig. B-2. (Continued)

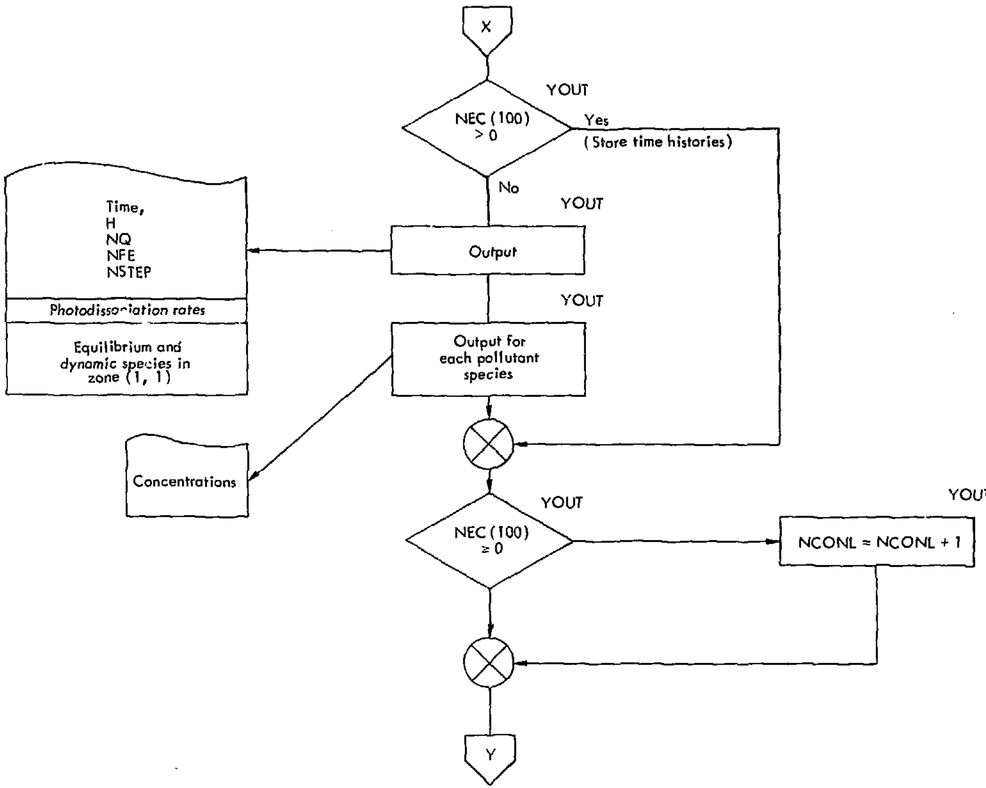

Fig. B-2. (Continued)

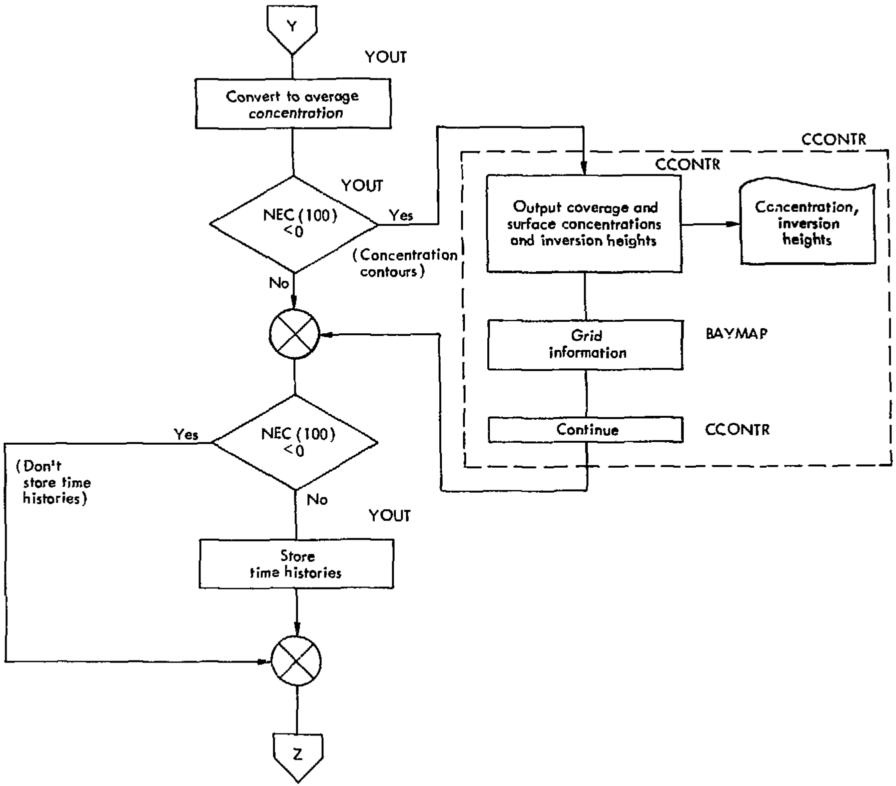

Fig. B-2. (Continued)

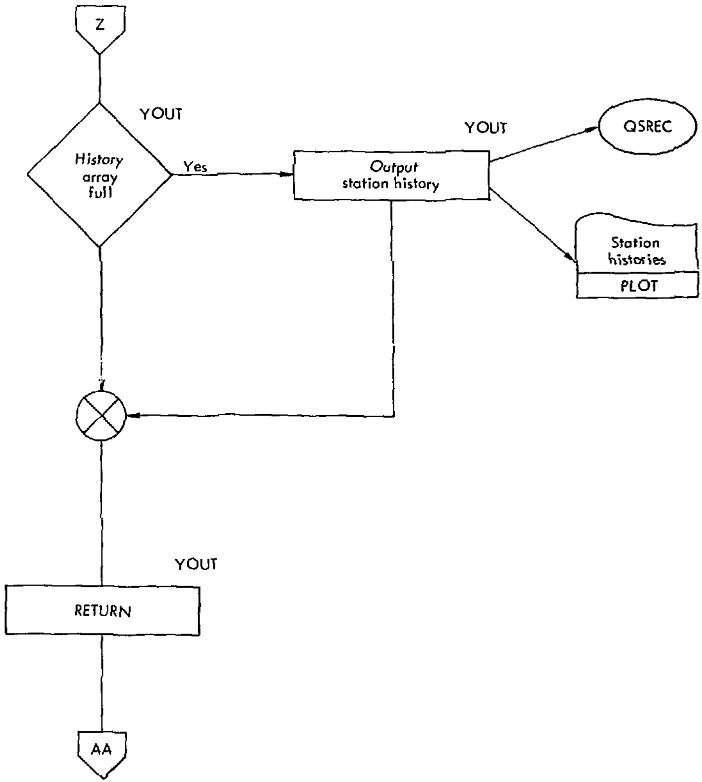

Fig. 2. (Continued)

(d) Flow chart for RESTART package

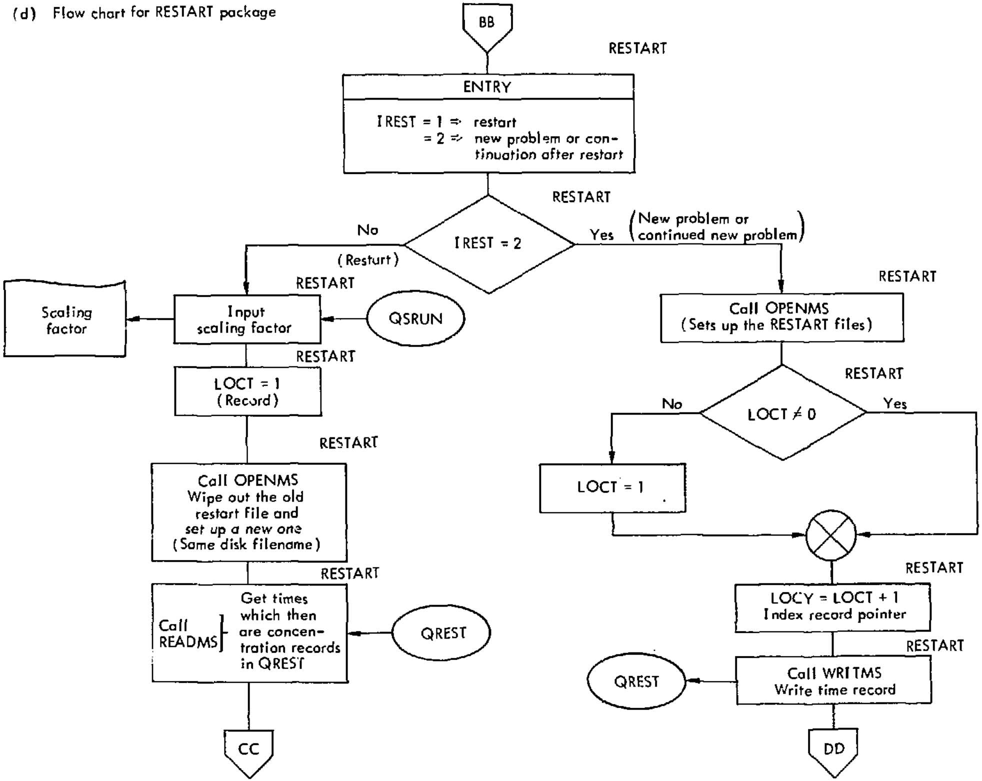

Fig. B-2. (Continued)

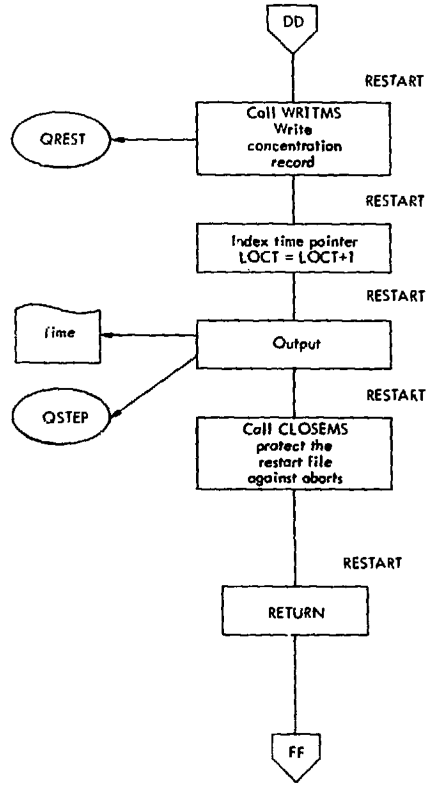

Fig. 2. (Continued)

```
 NON-LIVERMORE REDUCED BY 10-CONT
LIRAQ 5 KM GRID     530.  630. 4120. 4220.
00:07:00  INITIAL TIME
00:18:00  FINAL TIME
00:01:00  DAYLIGHT TIME SHIFT
00:01:00  PRINT INTERVAL
00:00:30  TIME HISTORY RECORD INTERVAL
00:00:00  MASS BALANCE INTERVAL
THE FOLLOWING STATIONS WILL HAVE TIME HISTORIES KEPT)
  1   4   6   8   9  10  11  12  13  14  15  17  25  34  57  61  63  88 129 143
 74 143 139 103  56   6 129 140  24  -0
THE FOLLOWING UTM LOCATIONS WILL HAVE TIME HISTORIES KEPT)
  590.0 4180.0   590.0 4165.0   615.0 4165.0   615.0 4180.0      0.0      0.0
  1 ALKENES
SOURCE COLUMN AND MULTIPLIERS                              3   .1000E+01   .1000E+01
MOLECULAR WEIGHT     44.00
BACKGROUND VALUES  W  .100E-01 E  .100E-01 S  .100E-01 N  .100E-01 A  .100E-01
  2 ALKANES
SOURCE COLUMN AND MULTIPLIERS                              2   .1000E+01   .1000E+01
MOLECULAR WEIGHT     58.00
BACKGROUND VALUES  W  .500E-01 E  .500E-01 S  .500E-01 N  .500E-01 A  .500E-01
  3 ALDEHYDES
SOURCE COLUMN AND MULTIPLIERS                              4   .1000E+01   .1000E+01
MOLECULAR WEIGHT     38.00
BACKGROUND VALUES  W  .200E-02 E  .200E-02 S  .200E-02 N  .200E-02 A  .200E-02
  4 NITROUS ACID
SOURCE COLUMN AND MULTIPLIERS                              0  0.          0.
MOLECULAR WEIGHT     47.00
BACKGROUND VALUES  W  .406E-07 E  .406E-07 S  .406F-07 N  .406E-07 A  .406E-07
  5 NITRIC ACID
SOURCE COLUMN AND MULTIPLIERS                              0  0.          0.
MOLECULAR WEIGHT     63.00
BACKGROUND VALUES  W  .406E-07 E  .406E-07 S  .406E-07 N  .406E-07 A  .406E-07
  6 HYDROGEN PEROXIDE
SOURCE COLUMN AND MULTIPLIERS                              0  0.          0.
MOLECULAR WEIGHT     34.00
BACKGROUND VALUES  W  .406E-07 E  .406E-07 S  .406E-07 N  .406E-07 A  .406E-07
  7 NITRIC OXIDE
SOURCE COLUMN AND MULTIPLIERS                              5   .1000E+01   .1000E+01
MOLECULAR WEIGHT     30.00
```

Fig. B-3. Sample QSRUN file for LIRAQ-2.

```
BACKGROUND VALUES  W  .400E-02 E  .400E-02 S  .400E-02 N  .400E-02 A  .400E-02
  8 NITROGEN DIOXIDE
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT      46.00
BACKGROUND VALUES  W  .400E-02 E  .400E-02 S  .400E-02 N  .400E-02 A  .400E-02
  9 NITROGEN PENTOXIDE
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT     108.00
BACKGROUND VALUES  W  .122E-10 E  .122E-10 S  .122E-10 N  .122E-10 A  .122E-10
 10 OZONE
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT      48.00
BACKGROUND VALUES  W  .100E-01 E  .100E-01 S  .100E-01 N  .100E-01 A  .100E-01
 11 ALKYL NITRITES
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT     100.00
BACKGROUND VALUES  W  .406E-07 E  .406E-07 S  .406E-07 N  .406E-07 A  .406E-07
 12 PEROXYACYL FREE RADICALS
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT     100.00
BACKGROUND VALUES  W  .122E-10 E  .122E-10 S  .122E-10 N  .122E-10 A  .122E-10
 13 PEROXYALKYL FREE RADICALS
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT     100.00
BACKGROUND VALUES  W  .122E-10 E  .122E-10 S  .122E-10 N  .122E-10 A  .122E-10
 14 HYDROPEROXYL FREE RADICAL
SOURCE COLUMN AND MULTIPLIERS                          0  0.         0.
MOLECULAR WEIGHT      33.00
BACKGROUND VALUES  W  .122E-10 E  .122E-10 S  .122E-10 N  .122E-10 A  .122E-10
 15 CARBON MONOXIDE
SOURCE COLUMN AND MULTIPLIERS                          7   .1000E+01   .1000E+01
MOLECULAR WEIGHT      28.00
BACKGROUND VALUES  W  .100E+01 E  .100E+01 S  .100E+01 N  .100E+01 A  .100E+01
  0
1 1 1 0 0 0 1 1 0 1 0 0 0 0 1      POLLUTANT OUTPUT SELECTION
1      RESTART FLAG
   0 -0.       -0.
```

Fig. B-3. (Continued)

2.04082E-02 INCREMENT IN THE COS OF THE ZENITH ANGLE

1.00000E+00	1.18952E-02	7.30940E-04	5.52738E-06	2.71285E-05	1.91250E-03	2.71285E-05	2.98974E-03	5.17648E-04	2.23030E-05
9.79592E-01	1.17920E-02	7.23134E-04	5.34053E-06	2.65965E-05	1.90391E-03	2.65965E-05	2.87616E-03	5.12557E-04	2.11081E-05
9.59184E-01	1.16888E-02	7.15324E-04	5.15563E-06	2.60658E-05	1.89533E-03	2.60658E-05	2.86253E-03	5.07454E-04	1.99530E-05
9.38776E-01	1.15641E-02	7.07510E-04	4.96726E-06	2.55107E-05	1.88373E-03	2.55107E-05	2.84731E-03	5.02340E-04	1.87948E-05
9.18367E-01	1.14219E-02	6.99691E-04	4.77674E-06	2.49363E-05	1.86968E-03	2.49363E-05	2.83076E-03	4.97212E-04	1.76457E-05
8.97959E-01	1.12816E-02	6.91771E-04	4.58868E-06	2.43648E-05	1.85516E-03	2.43648E-05	2.81417E-03	4.92072E-04	1.65414E-05
8.77551E-01	1.11587E-02	6.82976E-04	4.40312E-06	2.38038E-05	1.83643E-03	2.38038E-05	2.79752E-03	4.86918E-04	1.54813E-05
8.57143E-01	1.10356E-02	6.74176E-04	4.22011E-06	2.32448E-05	1.81769E-03	2.32448E-05	2.78081E-03	4.81750E-04	1.44648E-05
8.36735E-01	1.09000E-02	6.65058E-04	4.03393E-06	2.26523E-05	1.80099E-03	2.26523E-05	2.76221E-03	4.76567E-04	1.35114E-05
8.16327E-01	1.07574E-02	6.55766E-04	3.84763E-06	2.20436E-05	1.78538E-03	2.20436E-05	2.74257E-03	4.71368E-04	1.26086E-05
7.95918E-01	1.06071E-02	6.46228E-04	3.66279E-06	2.14359E-05	1.76571E-03	2.14359E-05	2.72323E-03	4.66153E-04	1.17389E-05
7.75510E-01	1.04259E-02	6.35721E-04	3.47466E-06	2.08243E-05	1.72980E-03	2.08243E-05	2.70532E-03	4.60920E-04	1.08864E-05
7.55102E-01	1.02446E-02	6.25209E-04	3.29025E-06	2.02158E-05	1.69389E-03	2.02158E-05	2.68732E-03	4.55670E-04	1.00780E-05
7.34694E-01	1.00344E-02	6.13609E-04	3.11198E-06	1.95779E-05	1.65857E-03	1.95779E-05	2.66714E-03	4.50400E-04	9.31899E-06
7.14286E-01	9.81460E-03	6.01645E-04	2.93822E-06	1.89331E-05	1.62344E-03	1.89331E-05	2.64616E-03	4.45109E-04	8.60636E-06
6.93878E-01	9.59481E-03	5.89534E-04	2.76692E-06	1.82925E-05	1.58761E-03	1.82925E-05	2.62480E-03	4.39552E-04	7.91618E-06
6.73469E-01	9.37504E-03	5.77082E-04	2.59661E-06	1.76563E-05	1.55014E-03	1.76563E-05	2.60267E-03	4.33404E-04	7.23385E-06
6.53061E-01	9.15530E-03	5.64629E-04	2.43055E-06	1.70245E-05	1.51267E-03	1.70245E-05	2.58046E-03	4.27239E-04	6.59027E-06
6.32653E-01	8.91927E-03	5.49927E-04	2.26661E-06	1.63617E-05	1.47188E-03	1.63617E-05	2.55751E-03	4.21056E-04	5.99965E-06
6.12245E-01	8.68041E-03	5.34829E-04	2.10691E-06	1.56981E-05	1.43051E-03	1.56981E-05	2.53389E-03	4.14854E-04	5.44647E-06
5.91837E-01	8.41865E-03	5.19637E-04	1.95100E-06	1.50401E-05	1.38758E-03	1.50401E-05	2.50920E-03	4.08311E-04	4.92080E-06
5.71429E-01	8.12258E-03	5.04302E-04	1.79867E-06	1.43880E-05	1.34230E-03	1.43880E-05	2.48268E-03	4.01272E-04	4.42016E-06
5.51020E-01	7.82670E-03	4.88968E-04	1.65155E-06	1.37417E-05	1.29703E-03	1.37417E-05	2.45599E-03	3.94216E-04	3.95356E-06
5.30612E-01	7.56726E-03	4.73408E-04	1.51485E-06	1.30415E-05	1.24730E-03	1.30415E-05	2.42559E-03	3.87140E-04	3.51998E-06
5.10204E-01	7.30983E-03	4.57839E-04	1.38338E-06	1.23459E-05	1.19734E-03	1.23459E-05	2.39480E-03	3.80043E-04	3.11837E-06
4.89796E-01	7.04300E-03	4.40959E-04	1.25221E-06	1.16623E-05	1.14548E-03	1.16623E-05	2.36240E-03	3.72919E-04	2.74768E-06
4.69388E-01	6.76683E-03	4.22775E-04	1.12228E-06	1.09906E-05	1.08571E-03	1.09906E-05	2.32836E-03	3.65766E-04	2.40685E-06
4.48980E-01	6.48893E-03	4.04587E-04	9.98859E-07	1.03254E-05	1.02791E-03	1.03254E-05	2.29363E-03	3.58578E-04	2.09476E-06
4.28571E-01	6.17527E-03	3.86184E-04	8.82808E-07	9.63391E-06	9.69364E-04	9.63391E-06	2.25076E-03	3.51350E-04	1.81031E-06
4.08163E-01	5.86193E-03	3.67791E-04	7.73433E-07	8.95258E-06	9.10818E-04	8.95258E-06	2.20756E-03	3.44075E-04	1.55236E-06
3.87755E-01	5.57158E-03	3.48131E-04	6.72130E-07	8.27753E-06	8.54146E-04	8.27753E-06	2.15962E-03	3.35849E-04	1.31591E-06
3.67347E-01	5.29659E-03	3.27639E-04	5.78380E-07	7.61087E-06	7.98722E-04	7.61087E-06	2.10836E-03	3.26982E-04	1.10221E-06
3.46939E-01	5.01338E-03	3.07064E-04	4.91793E-07	6.95401E-06	7.43299E-04	6.95401E-06	2.05529E-03	3.18172E-04	9.13541E-07
3.26531E-01	4.68270E-03	2.85914E-04	4.13869E-07	6.29837E-06	6.87876E-04	6.29837E-06	1.99404E-03	3.09910E-04	7.51342E-07
3.06122E-01	4.35259E-03	2.64796E-04	3.42605E-07	5.65665E-06	6.32452E-04	5.65665E-06	1.93223E-03	3.01548E-04	6.09534E-07
2.85714E-01	4.03616E-03	2.42404E-04	2.76419E-07	5.02540E-06	5.79214E-04	5.02540E-06	1.86650E-03	2.92567E-04	4.82263E-07
2.65306E-01	3.72592E-03	2.19502E-04	2.16953E-07	4.40872E-06	5.26913E-04	4.40872E-06	1.79739E-03	2.83233E-04	3.72521E-07
2.44898E-01	3.41172E-03	1.96369E-04	1.65328E-07	3.80570E-06	4.75588E-04	3.80570E-06	1.72565E-03	2.73204E-04	2.82138E-07
2.24490E-01	3.08446E-03	1.72443E-04	1.21812E-07	3.21024E-06	4.27190E-04	3.21024E-06	1.64621E-03	2.61434E-04	2.10742E-07
2.04082E-01	2.75823E-03	1.48612E-04	8.55645E-08	2.63897E-06	3.78792E-04	2.63897E-05	1.56543E-03	2.49433E-04	1.52763E-07
1.83673E-01	2.46236E-03	1.26549E-04	5.71834E-08	2.15378E-06	3.32892E-04	2.15378E-06	1.46648E-03	2.35548E-04	1.07719E-07
1.63265E-01	2.17478E-03	1.05020E-04	3.53897E-08	1.70781E-06	2.87617E-04	1.70781E-06	1.36162E-03	2.20910E-04	7.29258E-08
1.42857E-01	1.88831E-03	8.53058E-05	1.98131E-08	1.30920E-06	2.44254E-04	1.30920E-06	1.24504E-03	2.04888E-04	4.67526E-08
1.22449E-01	1.60319E-03	6.88167E-05	9.70144E-09	9.73749E-07	2.04442E-04	9.73749E-07	1.10861E-03	1.86599E-04	2.78861E-08
1.02041E-01	1.31975E-03	5.24835E-05	3.73432E-09	6.69055E-07	1.64631E-04	6.69055E-07	9.68660E-04	1.67327E-04	1.50454E-08
8.16327E-02	1.03845E-03	3.95049E-05	9.93402E-10	4.37171E-07	1.29738E-04	4.37171E-07	7.90341E-04	1.39757E-04	7.00661E-09
6.12245E-02	7.60084E-04	2.70623E-05	1.21079E-10	2.44942E-07	9.53908E-05	2.44942E-07	6.03789E-04	1.09930E-04	2.59353E-09
4.08163E-02	4.86057E-04	1.62148E-05	2.28252E-12	1.07792E-07	6.24490E-05	1.07792E-07	3.71632E-04	6.73393E-05	6.37347E-10
2.04082E-02	2.19772E-04	7.27180E-06	3.03908E-17	2.87893E-08	3.12245E-05	2.87893E-08	1.18202E-04	1.92930E-05	5.54079E-11
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

Fig. B-4. Listing of QRAD file.

Table B-6. Format of QRAD data file.

Card No.	Columns	Format	Symbol	Units
1	1-12	E12.5	DCOS	-
2-51	13-120	9E12.5	QJT	s^{-1}

values, from 0.0 to 1.0, of the cosine of the zenith angle. A correction for scattering is then applied, and the coefficients are written into the data file QRAD. This file then provides the table of values used by PHODIS in the LIRAQ-2 calculation. The first card contains the increment of DCOS, the cosine of the zenith angle, and the remaining 50 lines contain a list of the cosine of the zenith angle and the 9 photodissociation rate coefficients appropriate for that angle. The subroutine PHODIS then performs a table lookup from this list.

The file QREST is a binary file that is both a receiver of data and a potential input file. Vertical average concentrations in molecules/cm^3 are written to the file at the time of each call to YOUT and at the beginning and end of each model run. If a terminated problem is to be run (with possible modifications), QREST may be used to provide the initial conditions. The first 97 words on this file are reserved for a record of those times at which concentrations have been written on it. The remainder of the space is available for storing concentrations of all species at all grid points at the times recorded. When a problem is restarted at time TIN, the variable TP(100) is set, and the RESTART subroutine determines where on QREST the concentrations corresponding to that time are stored, buffers them in, and scales them as described in the discussion of the restart portion of QSRUN.

Although provision is not made to change the chemical reaction rates by use of input files in order to emphasize the care that must be given in undertaking such changes, all of the reaction rates are calculated in the subroutine RATES. The variable Q(J) is the reaction rate for reaction J, as identified in Table 3 in main text, and the values of the variables A and C given in that table have been inserted into the calculation of Q(J).

Thus, changing the reaction rates requires only the altering of the values presently being used. Also specified in subroutine RATES are 1) the absolute humidity (H2O) and 2) the air temperature (TEMP). If sufficient information was available, both of these variables could be a function of meteorological condition.

The remainder of the information required to run LIRAQ-2 is contained within the program itself, primarily within subroutine INPUT. A description of these data will be found in Table B-7.

Output Files

LIRAQ-2 makes use of the same tabular (TAPE3) and graphical (TAPE100) files as those described in Appendix A for LIRAQ-1 and shown in Fig. B-1. Two additional files unique to LIRAQ-2 are QREST and QSTEP. QREST has already been described in the section on input files because of its dual role. The second, QSTEP, contains brief messages relating to the problem that is running. Problem identification is given followed by information concerning sunrise time, and the initial times at which source and meteorological data are read. Subsequently, the occurrences of sunrise and meteorological updates are also recorded along with error messages, if any. The remaining information consists of lines containing three floating-point numbers that are, respectively, current time step, current time, and maximum permissible time step based on a Courant-like condition, all in seconds.

SAMPLE OPERATION OF LIRAQ-2

The LIRAQ-2 model is operational on the LBL computer system and is programmed in FORTRAN IV. The options available for model operation have been outlined in the preceding sections, being mainly related to options using QSRUN parameters. The problem formulation process, as described in Appendix G, also provides descriptions of most of the available options.

The sequence of control cards that are created by LIRPRB during problem formulation to run the LIRAQ-2 model is shown in Fig. B-5. When running LIRAQ-2 directly rather than automatically using the executive control system (see Appendix H), a similar sequence of operations would have to be followed to provide access to the necessary files, run the model, and output the results.

Figure B-6 is a sample of tabular output of pollutant concentrations (in units of mol/cm^3) from LIRAQ-2, given with UTM coordinates as a framework. Output is also given in ppm as shown in Fig. A-5. Because of its advection and solution scheme, LIRAQ-2 does not output mass balance or flux information as does LIRAQ-1.

Table B-7. Variables specified in subroutine INPUT.

Name	Description
NAMTYM	Labels for problem time limits and intervals. (Hollerith)
MONTH	Month labels used in coding to determine time of sunrise. (Hollerith)
DAYS	Day on which each month starts; used also in determining sunrise.
AVNO	Avagadro's number ($6.0247 \cdot 10^{23}$)
NP	Number of species (always 15)
PLN	Wind power law (0.143). Not used in LIRAQ-2 at present.
AIRMWT	Molecular weight of air (28.88)
RHOAR	Air density ($1.18 \cdot 10^{-3}$ gm/cm^3)
NAMES	Chemical formula for species.
YMM	Minimum value for each species to be used by GEAR in its error control.
DEPVEL	Species deposition velocity
ZM	Air density (molecules/cm^3)
O_2	Oxygen density (molecules/cm^3)
ALP,OMA	α, $1-\alpha$ used in chemical rates (see Final Report, Ch 9)
EPS	GEAR error control parameter (10^{-3})
HIN	Initial GEAR time step (10^{-6} sec)
FRC	Parameter used in JCHEM in calculating a Jacobian numerically.
TSUNIN	Time of first sunrise in the current problem run.
FRIC	Ratio of concentration just outside of boundary to that just inside. Defined in COEF (0.95).
YFRC	A species and location dependent number ($0.0 \leq$ YFRC < 1.0) related to the boundary condition (see Appendix 5-3 in the Final Report).

Graphical output from LIRAQ-2 is identical in format to that for LIRAQ-1, shown in Figs. A-8 through A-10.

CODE LISTINGS

A listing of the LIRAQ-2 code is included with this User's Guide as a microfiche attachment. The comment cards included in the programs provide guideposts to understanding the model design and operation. The LIRAQ-2 code is stored in an UPDATE program library format on the IBM Data Cell.

(a) Control deck

```
LIRQ2, 3,12000.679656,MACCRACKEN.
*NONE
*PSS
DISKHOG, 20000.
SCP,A= 11800.
LIBCOPY,LIRQLIB    ,STAGE       ,SL2MT3     .
TAPE,DUMMY,X,NT,R,  10509,I=STAGE.
TAPE,DUMMY,X,NT,R,  14100,I=STAGE.
TAPE,DUMMY,X,NT,R,  14360,I=STAGE.
TAPE,DUMMY,X,NT,R,  15784,I=STAGE.
TAPE,DUMMY,X,NT,R,  15784,I=STAGE.
TAPE,DUMMY,X,NT,R,  15784,I=STAGE.
EXIT.
EXIT.
END.
FIN.
LIBCOPY,LIRQLIB    ,MODFILE    ,MODFILE    .
LIBCOPY,LIRQLIB    ,PRBLM      ,PL2MT3     .
LINK,F=MODFILE,LO=BERX,X.
RETURN,QSOR.
RENAME,QSOR=QSORM.
COPY,QSOR        /RR,MODQSOR    /RR.
DISPOSE,MODQSOR    =MF,T=[LIRAQ      /MODQSOR    ].
. 26 NOV  08.42  DATA CELL 5 IS DOWN
EXIT.
FIN.
LIBCOPY,LIRQLIB    ,BINARY     ,LIRQ2BN    .
REWIND,BINARY     .
EXIT.
END.
FIN.
GET,BINARY,MAIN.REL/LIRAQ2
REWIND,BINARY     .
REWIND,MAIN       .
WRITEF,TAPE3      .
WRITEF,TAPE12     .
WRITEF,QSTEP      .
```

Fig. B-5. Example of LIRAQ-2 (a) control and (b) stage decks generated as a result of problem formulation.

```
REWIND,TAPE3      .
. 26 NOV  08.43  DATA CELL 5 IS DOWN
REWIND,TAPE12     .
REWIND,QSTEP      .
FBSIZE,QSRUN=4,QRAD=4,QICON=34.
RFL,     141000,    667000.
TIM.
LINK,F=MAIN,F=BINARY,LO=BERX,X.
SCP,A=0.
. 26 NOV  08.43  DATA CELL 5 IS DOWN
EXIT.
DUMP,170000.
SCP,A=0.
TIM.
FIN.
RENAME,TSTAGE=STAGE.
COPY,TAPE3       /RR,0FXF,NULL,1F,TAPE0       .
COPY,QSTEP       /RR,0FXF,NULL,1F,TAPE0       .
COPY,TAPE12      /RR,0FXF,NULL,1F,TAPE0       .
COPY,QREST       /RR,TAPE0       .
STAGE,TAPE0      , 10508,MT,W.
RENAME,STAGE=TSTAGE.
COPY,TAPE3       /RR,TAPE3A      /RR.
DISPOSE,TAPE3        =LP,T=[LIRA02     /TAPE3      ].
DISPOSE,TAPE3A       =MF,T=[LIRA02     /TAPE3A     ].
COPY,QSTEP       /RR,QSTEPA      /RR.
DISPOSE,QSTEP        =LP,T=[LIRA02     /QSTEP      ].
DISPOSE,QSTEPA       =MF,T=[LIRA02     /QSTEPA     ].
COPY,TAPE12      /RR,TAPE12A     /RR.
DISPOSE,TAPE12       =LP,T=[LIRA02     /TAPE12     ].
DISPOSE,TAPE12A      =MF,T=[LIRA02     /TAPE12A    ].
EXIT.
CXIT.
FIN.
REWIND,STAGE      .
REWIND,INPUT      .
COPYSBF,INPUT,OUTPUT.
COPYSBF,STAGE,OUTPUT.
```

Fig. B-5. (Continued)

(b) Stage deck

```
*REWIND
*SKIPF,1
*SKIPF,1
*SKIPF,1
*FILE,QREST
*READ,*-**
*REWIND
*FILE,QSOR
*READ,1
*REWIND
*FILE,QTRAN0
*READ,1
*FILE,QTRAN1
*READ,1
*FILE,QTRAN2
*READ,1
*FILE,QTRAN3
*READ,1
*REWIND
*FILE,QICON
*READ,1
*REWIND
*SKIPF,1
*SKIPF,1
*SKIPF,1
*FILE,QRAD
*READ,1
*REWIND
*SKIPF,1
*SKIPF,1
*SKIPF,1
*SKIPF,1
*FILE,QGEO
*READ,1
```

Fig. B-5. (Continued)

HCl CONCENTRATIONS (NO./CM3) AT T = .70000E+01 HOURS

I = J	1 12	2 13	3 14	4 15	5 16	6 17	7 18	8 19	9 20	10	11
20	.232E+12	.279E+12	.438E+12	.537E+12	.567E+12	.463E+12	.439E+12	.457E+12	.422E+12	.390E+12	.447E+12
	.579E+12	.764E+12	.979E+12	.115E+13	.139E+13	.152E+13	.149E+13	.137E+13	.993E+12		
19	.232E+12	.272E+12	.548E+12	.715E+12	.699E+12	.453E+12	.411E+12	.433E+12	.410E+12	.419E+12	.446E+12
	.569E+12	.796E+12	.105E+13	.131E+13	.155E+13	.173E+13	.181E+13	.172E+13	.130E+13		
18	.232E+12	.245E+12	.542E+12	.671E+12	.607E+12	.411E+12	.383E+12	.332E+12	.330E+12	.387E+12	.470E+12
	.556E+12	.797E+12	.115E+13	.142E+13	.164E+13	.179E+13	.182E+13	.170E+13	.130E+13		
17	.239E+12	.613E+12	.717E+12	.681E+12	.670E+12	.456E+12	.354E+12	.237E+12	.234E+12	.259E+12	.322E+12
	.443E+12	.697E+12	.168E+13	.165E+13	.177E+13	.173E+13	.164E+13	.146E+13	.107E+13		
16	.275E+12	.559E+12	.600E+12	.658E+12	.711E+12	.379E+12	.362E+12	.236E+12	.233E+12	.256E+12	.294E+12
	.395E+12	.615E+12	.107E+13	.111E+13	.132E+13	.135E+13	.130E+13	.110E+13	.713E+12		
15	.402E+12	.522E+12	.527E+12	.490E+12	.479E+12	.320E+12	.406E+12	.296E+12	.234E+12	.272E+12	.276E+12
	.417E+12	.587E+12	.678E+12	.713E+12	.878E+12	.915E+12	.906E+12	.706E+12	.439E+12		
14	.372E+12	.389E+12	.305E+12	.391E+12	.380E+12	.311E+12	.372E+12	.346E+12	.255E+12	.253E+12	.266E+12
	.302E+12	.467E+12	.543E+12	.539E+12	.540E+12	.555E+12	.552E+12	.419E+12	.302E+12		
13	.272E+12	.284E+12	.305E+12	.398E+12	.443E+12	.270E+12	.306E+12	.347E+12	.301E+12	.239E+12	.251E+12
	.269E+12	.318E+12	.415E+12	.451E+12	.420E+12	.401E+12	.384E+12	.360E+12	.283E+12		
12	.268E+12	.195E+12	.265E+12	.451E+12	.462E+12	.339E+12	.320E+12	.258E+12	.306E+12	.277E+12	.326E+12
	.312E+12	.383E+12	.377E+12	.403E+12	.397E+12	.397E+12	.381E+12	.321E+12	.278E+12		
11	.291E+12	.260E+12	.303E+12	.470E+12	.485E+12	.441E+12	.488E+12	.419E+12	.409E+12	.516E+12	.472E+12
	.247E+12	.466E+12	.489E+12	.433E+12	.449E+12	.453E+12	.360E+12	.313E+12	.271E+12		
10	.323E+12	.308E+12	.361E+12	.464E+12	.544E+12	.546E+12	.625E+12	.654E+12	.722E+12	.699E+12	.651E+12
	.526E+12	.440E+12	.537E+12	.426E+12	.410E+12	.349E+12	.329E+12	.301E+12	.243E+12		
9	.353E+12	.337E+12	.374E+12	.432E+12	.558E+12	.623E+12	.731E+12	.868E+12	.102E+13	.929E+12	.854E+12
	.697E+12	.538E+12	.503E+12	.449E+12	.317E+12	.284E+12	.280E+12	.270E+12	.238E+12		
8	.363E+12	.345E+12	.371E+12	.450E+12	.586E+12	.666E+12	.809E+12	.102E+13	.116E+13	.113E+13	.101E+13
	.894E+12	.681E+12	.490E+12	.362E+12	.263E+12	.244E+12	.245E+12	.231E+12	.231E+12		
7	.352E+12	.338E+12	.361E+12	.401E+12	.432E+12	.620E+12	.922E+12	.105E+13	.116E+13	.124E+13	.104E+13
	.964E+12	.796E+12	.561E+12	.400E+12	.303E+12	.232E+12	.231E+12	.231E+12	.231E+12		

Fig. B-6. Sample tabular output of pollutant number density from LIRAQ-2, ordered by grid square.

Appendix C
Meteorological Data Analysis

T. W. Stullich

INTRODUCTION

To run an air quality problem with LIRAQ, regional meteorological information must be specified so that the processes of advection and diffusion (as well as other processes) are modeled in a realistic manner for the calendar day selected. As pointed out in the introduction to this User's Guide, this is done by the meteorological data-processing model, MASCON, which processes observed or *hypothetical* meteorological data so that the advection and diffusion processes are treated in a mass-consistent manner. (Refer to Chapter 8 of the Final Report for details of the MASCON model.) In this appendix, we provide the information needed to operate this model. In doing this, we give brief descriptions of the input files that the LIRAQ user must supply to run an air quality problem.

During the course of this project, data for a number of meteorological case studies have been assembled. The processed data files are available to the user for use with LIRAQ at the Lawrence Berkeley Laboratory (LBL) Computer Center. These case studies were carried out at LLL using the MASCON meteorological submodel, which was not developed for use at Berkeley for the purposes of this contract. Thus, additional meteorological case studies that the user may wish to construct, must, at present, be run at LLL.

In carrying out meteorological analyses with MASCON, the user must provide input files that describe the meteorological evolution in time (at some hourly interval) of the atmosphere over the region of interest in terms of wind speed, wind direction, *inversion base height*, and atmospheric transmissivity (LIRAQ-2 only). Supplementing these files with other standard input files (containing run parameters, topographic data, station lists, etc.), the MASCON model can be run at LLL on a CDC 7600 computer over a maximum 65 by 65 mesh (the user selects the grid interval: 1, 2, or 5 km) in 5 to 40 min of computer time, depending primarily on the amount of raw data to be processed, the number of mesh points in the grid selected, and the number of hours being simulated. Computer graphics, tabular output, and the required output files for LIRAQ (compatible with the LBL operating system) are output to the user.

Figure C-1 is a diagram of input and output files in relation to MASCON.

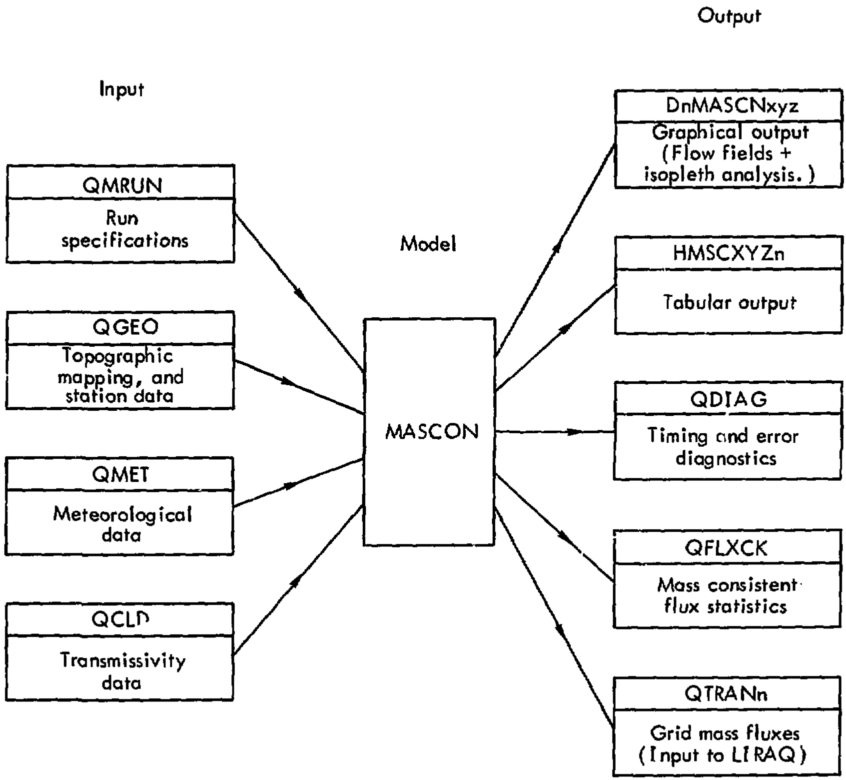

Fig. C-1. Schematic flow chart of input and *output* files used by MASCON.

The structure of the QGEO file is described in Appendix E, and the other input files are described in this appendix. In terms of output files, the key link between MASCON and LIRAQ are the QTRAN files. The QTRAN family of files contain information as to vertical eddy diffusivities, horizontal and vertical transfer coefficients, inversion base heights, atmospheric transmissivities, and source multiplier flags. These files are described in greater detail below. The other output files are treated more briefly.

Because the MASCON model is not available at LBL, detailed documentation of the model, including a flow chart, are not included with this User's Guide. It may be useful, however, to review briefly the philosophy embodied in the MASCON model used in treating the meteorological data.

As explained more fully in the Final Report, because of the almost constant presence of a subsidence inversion and its importance as a lid to vertical mixing upwards from the surface, we have modeled the air quality of the Bay Area by considering only the subinversion layer. This led naturally to the consideration of a one-layer model.

Since the vast majority of the observational data available now (and probably in the foreseeable future) in this area is for the surface, it was also most natural to select the surface as the primary data level and to approximate vertical variations through the subinversion layer by suitable prescriptions. Wind has been assumed to remain constant in direction but with a power-law increase in speed with altitude above the ground. The inversion base height, another critical factor, is generally observed only twice a day at the Oakland radiosonde station. This occasionally led to use of a nomogram to estimate inversion base heights at other locations from surface temperature data and the Oakland observation (see MacCracken et al., 1972). Because pollutants having surface sources or sinks would not be expected to instantaneously mix uniformly through the subinversion layer, an exponential profile was adapted relating the vertical variations in concentration to the strength of the surface source or sink and to the surface vertical eddy diffusion coefficient. And because atmospheric chemistry is dependent on the amount of light present, information on the radiation reaching the subinversion layer was needed.

Because even the special observation network used during our study days to monitor these meteorological variables (wind, inversion base height, eddy diffusivity, and atmospheric transmissivity) is inadequate to provide a comprehensive regional pattern for the Bay Area, especially in view of the complex topography, a computer program has been developed that interpolates and extrapolates the data throughout the area of interest. For the coupled wind and inversion base height fields, this could only be done in a physically meaningful way by adopting the constraint that the mass flow between the surface and the inversion base must remain constant along a streamline. It was, however, found necessary to modify this constraint to account for the following facts:

- The inversion base height changes with time.
- Increases of inversion base height with diurnal heating are accompanied by entrainment of air from above the inversion.
- Lowering of the inversion base height in the afternoon and evening is generally a discontinuous process (i.e., a new lower inversion usually forms).
- Observational data are neither error-free nor consistently representative of the scales of motion of concern.

As described in the Final Report, the mass consistent flux field program, MASCON, was designed with all of these considerations in mind.

In dealing with the limited amount of data usually available in the Bay Area, it was found that even these constraints were insufficient to provide a satisfactory wind field without additional observations. It had been anticipated that for the model validation episodes these would be supplied by aircraft, but they never became available in the quantity desired. It was, therefore, found necessary to supplement the objective analysis with considered meteorological judgment in the form of supplemental synthesized data. Some of the considerations involved in doing this are described in the Appendixes 8-1 through 8-3 of the Final Report. Such synthesized data were found to be most helpful around the boundaries of the analysis area.

The following sections discuss the input files needed for operation of the MASCON model.

INPUT DATA FILES

Four input data files are needed by MASCON: QMET, QCLD, QMRUN, and QGEO. The first three are specific to this model and are discussed below; the fourth, QGEO (also used by LIRAQ) is discussed in Appendix E.

Of most importance is the QMET file that contains all of the meteorological transport information (wind speed and direction, inversion base height) for the particular period to be studied. In all of our studies to date, these data have been based on observations, although the potential for developing hypothetical days or meteorological situations can be treated.

The second input file, QCLD, contains information on the radiative properties of the atmosphere, and again may be based on observed or hypothetical data. Of most importance, the values in this file are intended to provide a representation of the regional cloudiness.

Finally, the QMRUN file provides MASCON with such parameters as grid size and domain, which are needed to develop the QTRAN file that is desired.

The QMET File

The QMET file structure has the capability for treating a number of slightly different forms of input meteorology to provide flexibility in handling observed data from different sources and to allow refinement of data in regions of sparse observations for the purposes of interpolation to a grid. The time of all data is referenced to Pacific Standard Time (PST) and input data are expected to be of a time-averaged nature centered on the hour. In the Bay Area case studies, these data are entered at 3-hr intervals. MASCON has been run on sets of data of up to 48-hr duration. The mass-consistent calculations are then centered at the mid periods between the three hourly input sequences and are considered applicable over the 3-hr period, interpolation of the resulting variables in time being done in the LIRAQ model.

There are six possible subsections of input data in every three hourly input cycle:

(1) MSL inversion base height (metres above sea level) by station location.

(2) MSL inversion base height (metres above sea level) by UTM coordinate location.

(3) Surface vector wind (m/s and whole degrees) by station location.

(4) Mean layer vector wind and inversion base height (m/s, whole degrees, metres above sea level) by station location.

(5) Surface vector wind (m/s and whole degrees) by UTM coordinate location.

(6) Mean layer vector wind and inversion base height (m/s, whole degrees, metres above

sea level) by UTM coordinate location.

The MASCON code, presently configured to run on a CDC 7600 computer over as large a grid as possible, requires nearly all of available small- and large-core memory, primarily caused by large array sizes. Array size restrictions led to the following input limitations regarding the above forms of input:

Input data type	Maximum allowable no. of records
1	150
2	575
3, 4	150
5, 6	575

Stations for which various types of input data were potentially available are indicated in Table C-1. (See Appendix I, Table I-1 for definitions of codes used in this table.) For most of these stations, the potential was not realized and, typically, there were 20 to 30 data points during each 3-hr interval. Mean layer vector winds were derived from vertical profiles taken from pibals, radiosondes and specially instrumented aircraft. To establish the validity of these data over a thickness of an air column, inversion base height information was also required for this type of input. Inversion base heights entered on these cards must also be input in subsections (1) and (2). Figure C-2 gives an example of portions of a QMET file, and Table C-2 gives a description of card format.

The QCLD File

As described more fully in Appendix 8-3 of the Final Report, Eppley pyranometer data provide an indication of atmospheric transmissivity for use in calculating photochemical dissociation rates. The Bay Area Air Pollution Control District (BAAPCD) operates Eppley pyranometers at nine stations: Redwood City, Vallejo, San Jose, San Rafael, Pittsburg, Napa, Richmond, San Francisco, and Livermore.

The task of developing input data for MASCON (and thus LIRAQ) from these instruments involved a sequence of special operations. At each of these stations a continuous indicating recorder is used to record the data on strip charts. The mean ordinate for each hour beginning at 0400 PST and ending at 2200 PST was read from the strip charts and then summed every 3 hr, this interval corresponding to meteorological update times in the LIRAQ codes. A special processing program developed by the BAAPCD was used to integrate

Table C-1. Surface observation stations used in field data collection program.

Station name	Station No.	Identification	Agency	County	Elevation (m)	UTM-north	UTM-east	Zone	Sensor elevation (m)[a]
SAN FRANCISCO	1	DSF	BA	SF	25	4181.8	551.1	Z1	57.0
SANTA ROSA	2	DSA	BA	SN	50	4254.7	525.1	Z4	
PETALUMA	3	DPE	BA	SN	4	4232.4	532.7	Z4	
SAN RAFAEL	4	DSR	BA	MA	6	4202.7	542.3	Z4	
NAPA	5	DNA	BA	NA	13	4240.7	561.6	Z3	
VALLEJO	6	DVA	BA	SL	6	4217.4	567.1	Z3	
RICHMOND-JADE ST	7	DRI	BA	CC	3	4201.0	555.4	Z4	
PITTSBURG	8	DPT	BA	CC	2	4209.4	597.3	Z2	
LIVERMORE	9	DLI	BA	AL	150	4171.2	608.6	Z2	
FREMONT	10	DFR	BA	AL	12	4154.6	591.8	Z1	
SAN JOSE	11	DSJ	BA	SC	25	4133.0	598.5	Z1	
MOUNTAIN VIEW	12	DMV	BA	SC	23	4138.8	583.3	Z1	
REDWOOD CITY	13	DRC	BA	SM	4	4148.5	570.5	Z1	
BURLINGAME	14	DBU	BA	SM	10	4159.1	557.8	Z1	
CONCORD-TREAT BLVD	15	DCO	BA	CC	25	4199.3	585.7	Z2	
BENICIA	16	DBE	BA	SL	40	4211.8	574.3	Z2	
RICHMOND-13TH ST	17	DRM	BA	CC	12	4200.4	556.6	Z4	
MARTINEZ-FIRE STA	18	DMF	BA	CC	3	4207.4	576.1	Z2	
POINT RICHMOND	19	DPR	BA	CC	5	4197.6	554.1	Z4	
SONOMA CO ARPT	20	ASN	FA	SN	36	4262.0	517.2	Z4	
HAMILTON AFB	21	AHA	AF	MA	1	4213.2	542.4	Z4	4.0
NAPA CO ARPT	22	ANA	FA	NA	4	4229.0	563.1	Z3	
TRAVIS AFB 1	23	AT1	AF	SL	14	4235.4	594.4	Z3	
LIVERMORE ARPT	24	ALI	FA	AL	122	4172.5	604.5	Z2	
BUCHANAN FIELD	25	ABF	FA	CC	6	4204.5	583.0	Z2	
OAKLAND INTL ARPT	26	AOA	FA	AL	1	4172.7	569.3	Z1	3.1
ALAMEDA NAS	27	AAN	NV	AL	2	4181.2	560.5	Z1	4.6
HAYWARD ARPT	28	AHW	FA	AL	9	4168.5	577.9	Z1	
SAN JOSE ARPT	29	ASJ	FA	SC	14	4135.4	595.1	Z1	
MOFFETT FIELD NAS	30	AMN	NV	SC	8	4140.5	584.1	Z1	
REID HILLVIEW ARPT	31	ARH	FA	SC	38	4132.4	604.7	Z1	4.6
SAN FRANCISCO ARPT	32	ASF	NW	SM	1	4163.2	556.2	Z1	
SAN CARLOS ARPT	33	ASC	FA	SM	1	4151.8	566.2	Z1	
HALF MOON BAY ARPT	34	AHM	FA	SM	16	4151.9	544.6	Z1	
SAC'TO METRO ARPT	35	ASM	FA	SA	5	4284.6	622.2	Z3	
SAC'TO EXEC ARPT	36	ASE	FA	SA	5	4263.6	631.1	Z3	
MATHER AFB	37	AMT	AF	SA	5	4268.6	647.8	Z3	
MCCLELLAN AFB	38	AMC	AF	SA	5	4280.6	638.9	Z3	
STOCKTON ARPT	39	AST	FA	SJ	7	4195.1	654.4	Z2	
ANGEL ISLAND	40	MAG	CG	MA	3	4189.4	551.2	Z4	
POINT REYES	41	MRE	CG	MA	73	4205.1	498.1	Z4	
BODEGA BAY	42	MBO	CG	SN	1	4242.7	495.2	Z4	
POINT ARENA	43	MPA	CG	ME	1	4311.9	435.9	Z4	
RIO VISTA	44	MRV	CG	SL	2	4223.1	614.6	Z2	
PORT CHICAGO	45	MPC	CG	CC	15	4210.8	586.3	Z2	9.1
PIGEON POINT	46	MPP	CG	SM	12	4115.0	553.9	Z1	
PILLAR POINT	47	MPI	CG	SM	60	4150.0	544.4	Z1	
POINT BONITA	48	MPB	CG	MA	24	4185.3	541.5	Z4	
SONOMA-1ST ST WEST	49	DSO	BA	SN	29	4238.6	547.5	Z4	
MT JACKSON	50	FMJ	FO	SN	500	4265.5	503.5	Z4	
BERRYESSA LO	51	FBL	FO	NA	930	4279.6	570.5	Z3	

[a]Sensor elevations are taken to be 6.1 m above ground level, except as indicated.

Table C-1. (Continued)

Station name	Station No.	Identification	Agency	County	Elevation (m)	UTM-north	UTM-east	Zone	Sensor elevation (m)
ALLEN LO	52	FAL	FO	SM	710	4137.9	562.5	Z1	
LOMA PRIETA	53	FLP	FO	SC	1160	4107.6	602.8	Z1	
EAGLE ROCK	54	FEA	FO	SZ	760	4111.3	571.6	Z1	
MOUNT OSO	55	FMO	FO	ST	976	4152.2	639.5	Z2	
PLEASANT HILL	56	DPH	BA	CC	26	4197.9	581.1	Z2	
SAN LEANDRO	57	DSL	BA	AL	14	4174.7	573.9	Z1	
LOS GATOS	58	DLG	BA	SC	116	4120.3	590.6	Z1	
FAIRFIELD	59	DFA	BA	SL	5	4233.3	582.6	Z3	
MORGAN HILL ARPT	60	NMH	MS	SC	193	4111.8	619.9	Z1	
SHELL,MARTINEZ	61	ISH	CM	CC	30	4208.0	577.1	Z2	30.5
SMITH ARPT,S RAFAEL	62	NSR	MS	MA	3	4208.4	542.4	Z4	
PHILLIPS,MARTINEZ	63	IPH	CM	CC	4	4208.6	582.4	Z2	50.3
ANTIOCH ARPT	64	NAN	MS	CC	93	4202.7	605.4	Z2	
PG & E,PITTSBURG	65	EGP	PG	CC	2	4210.2	596.7	Z2	
UNION,OLEUM	66	IUN	CM	CC	14	4210.7	567.1	Z2	3.1
STD OIL,GARDEN TRACT	67	IGT	CM	CC	2	4202.1	554.8	Z4	
STD OIL,GERTRUDE ST	68	IGS	CM	CC	3	4200.7	554.7	Z4	9.1
ALLIED,RICHMOND	69	IAC	CM	CC	2	4199.2	554.9	Z4	19.8
PG & E MOSS LANDING	70	EGL	PG	MR	1	4074.1	608.7	Z1	76.2
CSUSJ	71	USJ	DM	SC	27	4132.2	599.1	Z1	
HAYWARD ST COLLEGE	72	UHW	MS	AL	137	4167.7	583.6	Z1	22.9
U. C. BERKELEY	73	UCB	MS	AL	94	4191.7	565.3	Z1	
LLL. WEST TOWER	74	LLT	LL	AL	177	4172.3	613.8	Z2	
LLL. SITE 300	75	LLH	LL	SJ	360	4168.2	630.4	Z2	
SAN JOSE EMSU	76	GEM	DM	SC	32	4131.0	600.3	Z1	
OAKLAND RADIOSONDE	77	GOA	NW	AL	2	4177.4	568.3	Z1	
SAN FRANCISCO BEACH	78	NSB	MS	SF	0	4176.1	543.6	Z1	
MT SUTRO TOWER	79	UMS	DM	SF	277	4178.9	547.9	Z1	
S. J. CIVIL DEFENSE	80	GSD	MS	SC	20	4134.0	597.2	Z1	
MT TAMALPAIS	81	TAM	FO	MA	785	4197.8	537.2	Z4	
MT DIABLO	82	DIA	FO	CC	1175	4193.1	595.6	Z2	
SUNOL FORESTRY	83	FSU	FO	AL	73	4161.2	598.6	Z2	
OAKLAND SEWAGE PLANT	84	OSW	MS	AL	3	4186.5	562.1	Z1	
AL CHEM,PORT CHICAGO	85	IAP	CM	CC	1	4211.3	589.0	Z2	
CHABOT REGIONAL PARK	86	PCP	DM	AL	122	4175.3	581.1	Z2	
MODESTO ARPT	87	AMO	FA	ST	28	4166.2	679.6	Z2	
HAYWARD	88	DHW	BA	AL	259	4167.8	585.2	Z1	
SUNNYVALE	89	DSY	BA	SC	31	4136.7	585.9	Z1	
GILROY	90	DGL	BA	SC	60	4096.8	627.2	Z1	
EAST SAN JOSE	91	DEJ	BA	SC	64	4138.8	602.5	Z1	
BUCHANAN FIELD	92	PBF	BA	CC	6	4204.5	583.0	Z2	
EAST SAN FRANCISCO	93	DFC	BA	SF	5	4178.7	553.9	Z1	
OCEANICS CONCORD	94	VCO	NO	CC	6	4204.5	583.0	Z2	
OCEANICS OAKLAND	95	VOK	NO	AL	1	4172.7	569.3	Z1	
OCEANICS GNOSS FIELD	96	VGF	NO	MA	2	4221.6	539.8	Z4	
OCEANICS NILES CANY.	97	VNC	NO	AL	73	4160.7	597.9	Z2	
SAN RAFAEL, 4TH ST	98	DRA	BA	MA	6	4202.6	542.5	Z4	
RICHMOND, NEVIN AVE	99	DRH	BA	CC	9	4198.8	556.7	Z4	
FREMONT, UNION ST	100	DFM	BA	AL	15	4154.4	592.1	Z1	
SAN JOSE, ALMA AVE	101	DJO	BA	SC	33	4130.1	599.6	Z1	
BURLINGAME, BAYSHORE	102	DBG	BA	SM	2	4161.1	556.1	Z1	

Table C-1. (Continued)

Station name	Station No.	Identification	Agency	County	Elevation (m)	UTM-north	UTM-east	Zone	Sensor elevation (m)
OAKLAND, JACKSON ST	103	OAK	RB	AL	11	4183.7	564.7	Z1	
NAPA, 1ST ST	104	DNP	BA	NA	5	4238.8	562.5	Z3	
SANTA ROSA, 4TH ST	105	DSS	BA	SN	49	4254.5	525.0	Z4	
VALLEJO TRAILER	106	DVT	BA	SL	5	4217.3	566.9	Z3	
POINT MONTARA	107	MPM	CG	SM	17	4154.3	542.6	Z1	
SAN CARLOS	108	VSC	MS	SM	2	4149.7	567.6	Z1	
MARTINEZ	109	VMA	MS	CC	2	4208.4	575.4	Z2	
ANTIOCH	110	VAT	MS	CC	0	4208.2	605.1	Z2	
RIO VISTA	111	VRV	MS	SL	23	4224.6	613.9	Z2	
TRACY	112	VTY	MS	SJ	20	4176.6	637.6	Z2	
ALTAMONT PASS	113	VAP	MS	AL	174	4175.4	614.8	Z2	
DUBLIN	114	VDU	MS	AL	99	4173.6	595.1	Z2	
WALNUT CREEK	115	VWC	MS	CC	50	4194.2	582.9	Z2	
WINTERS	116	VWT	MS	YO	38	4264.0	590.6	Z3	
DIXON	117	VDX	MS	SL	17	4256.0	604.1	Z3	
CACHE	118	VCH	MS	SL	0	4232.3	613.3	Z3	
BENICIA	119	VBE	MS	SL	5	4214.2	576.1	Z2	
VALLEJO	120	VVA	MS	SL	36	4219.6	567.6	Z3	
NAPA	121	VNA	MS	NA	10	4239.1	561.8	Z3	
BODEGA BAY	122	VBO	MS	SN	0	4238.0	496.4	Z4	
SANTA ROSA	123	VSA	MS	SN	52	4253.5	526.4	Z4	
SONOMA	124	VSN	MS	SN	24	4238.8	545.6	Z4	
RICHMOND HARBOR	125	VRD	MS	CC	0	4195.2	557.6	Z4	
BOLINAS BAY	126	VBY	MS	MA	0	4193.2	527.4	Z4	
PETALUMA	127	VPE	MS	SN	17	4233.9	533.8	Z4	
SAN RAFAEL	128	VSR	MS	MA	9	4201.8	542.3	Z4	
NILES CANYON	129	PNC	DM	AL	73	4160.7	597.9	Z2	
DUMBARTON BRIDGE	130	RDB	DM	SM	3	4150.7	577.5	Z1	
CSUSJ	131	RSJ	DM	SC	32	4131.0	600.4	Z1	
RIO VISTA	132	RRV	DM	SL	0	4222.3	614.6	Z2	
TRAVIS AFB	133	RTR	DM	SL	17	4235.5	592.7	Z3	
SANTA ROSA	134	RSA	DM	SN	41	4253.6	523.3	Z4	
FRESNO ARPT	135	VFA	RB	FR	100	4074.7	793.1	Z7	
SALINAS ARPT	136	VSS	RB	MR	23	4058.4	624.6	Z7	
SACRAMENTO ARPT	137	VSM	RB	SA	5	4284.6	622.2	Z7	
OCEANICS SAN JOSE	138	VSJ	NO	SC	14	4135.4	595.1	Z1	
OCEANICS LIVERMORE	139	VLV	NO	AL	122	4172.5	604.5	Z2	
HAYWARD	140	PHW	DM	AL	76	4172.1	584.3	Z1	
GILROY	141	PGY	DM	SC	58	4095.4	627.9	Z1	
TRACY	142	PTY	DM	SJ	14	4177.9	638.1	Z2	
PLEASANTON	143	PPS	DM	AL	95	4168.2	597.8	Z2	
MARE ISLAND	144	PMI	DM	SL	6	4216.0	563.9	Z3	
DAVIS	145	PDV	DM	YO	13	4266.4	609.4	Z3	
PETALUMA	146	PPE	DM	SN	3	4231.9	532.0	Z4	

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**THE INVERSION AND WIND DATA FOLLOWING WAS TAKEN AT          0400  AUG  20 1973
  THE FOLLOWING DATA 'S INVERSION HGT BY STATION, FOR CM MULT BY        100.
+ABF     25       300.                                  0400 PST AUGUST 20 1973
+NAN     64         0.                                  0400 PST AUGUST 20 1973
+PTY    142       350.                                  0400 PST AUGUST 20 1973
+NSR     62       125.                                  0400 PST AUGUST 20 1973
+NMH     60       300.                                  0400 PST AUGUST 20 1973
+AHM     34       750.                                  0400 PST AUGUST 20 1973
+ALI     24       450.                                  0400 PST AUGUST 20 1973
+AHW     28       500.                                  0400 PST AUGUST 20 1973
+ASJ     29       500.                                  0400 PST AUGUST 20 1973
+ASC     33       475.                                  0400 PST AUGUST 20 1973
+NSB     78       400.                                  0400 PST AUGUST 20 1973
+RRV    132         0.                                  0400 PST AUGUST 20 1973
+VFA    135         0.                                  0400 PST AUGUST 20 1973
+VSM    137       150.                                  0400 PST AUGUST 20 1973
+VSS    136       325.                                  0400 PST AUGUST 20 1973
+AST     39       650.                                  0400 PST AUGUST 20 1973
+ASE     36       750.                                  0400 PST AUGUST 20 1973
+PPE    146       200.                                  0400 PST AUGUST 20 1973
+RSA    134       300.                                  0400 PST AUGUST 20 1973
+ASN     20       225.                                  0400 PST AUGUST 20 1973
+DMF     18       100.                                  0400 PST AUGUST 20 1973
          0         0.
  THE FOLLOWING DATA IS INVERSION HGT BY UTMC,    FOR CM MULT BY        100.
         0.         0.         0.
  THE FOLLOWING DATA IS SURF VECT WIND BY STAT, FOR CM/SEC MUL BY       100.
+ORC     13         0.         0.                           0400 PST AUGUST 20 1973
+DSF      1         3.       270.                           0400 PST AUGUST 20 1973
+DSJ     11         0.         0.                           0400 PST AUGUST 20 1973
+MPP     46        5.0       320.                           0400 PST AUGUST 20 1973
+USJ     71         2.       340.                           0400 PST AUGUST 20 1973
+AOA     26         2.       340.                           0400 PST AUGUST 20 1973
+ASJ     29         2.       360.                           0400 PST AUGUST 20 1973
+GSD     80         0.         0.                           0400 PST AUGUST 20 1973
+NMH     60         6.       300.                           0400 PST AUGUST 20 1973
+UCB     73         2.       180.                           0400 PST AUGUST 20 1973
+AAN     27         4.       260.                           0400 PST AUGUST 20 1973
+AMN     30         1.        20.                           0400 PST AUGUST 20 1973
+ASF     32         5.       300.                           0400 PST AUGUST 20 1973
+EGL     70         0.         0.                           0400 PST AUGUST 20 1973
+DLI      9         0.         0.                           0400 PST AUGUST 20 1973
+IAP     85         5.       250.                           0400 PST AUGUST 20 1973
+IPH     63         6.       280.                           0400 PST AUGUST 20 1973
+ISH     61         3.       310.                           0400 PST AUGUST 20 1973
+IUN     66         0.         0.                           0400 PST AUGUST 20 1973
+AST     39         4.        40.                           0400 PST AUGUST 20 1973
+EGP     65         6.       280.                           0400 PST AUGUST 20 1973
+AMC     38         3.       150.                           0400 PST AUGUST 20 1973
+AMT     37         2.       140.                           0400 PST AUGUST 20 1973
+ATI     23         7.       240.                           0400 PST AUGUST 20 1973
+DNA      5         0.         0.                           0400 PST AUGUST 20 1973
+DVA      6         3.       270.                           0400 PST AUGUST 20 1973
+DRM     17         4.       180.                           0400 PST AUGUST 20 1973
+DSA      2         1.       230.                           0400 PST AUGUST 20 1973
+DSR      4         0.         0.                           0400 PST AUGUST 20 1973
+IAC     69         3.       160.                           0400 PST AUGUST 20 1973
+IGS     68         7.       170.                           0400 PST AUGUST 20 1973
+IGT     67         4.       180.                           0400 PST AUGUST 20 1973
          0         0.         0.
  THE FOLLOWING DATA IS MEAN LAYER VECT WIND AND HGT BY STAT, CM/SEC MUL BY 100.
+PPS    143        1.0       130.       345.          0400 PST AUGUST 20 1973
+PTY    142        1.0       070.       265.          0400 PST AUGUST 20 1973
+RRV    132        8 0       220.       150.          0400 PST AUGUST 20 1973
+GOA     77        3.0       300.       350.          0400 PST AUGUST 20 1973
          0         0.         0.         0.
  THE FOLLOWING DATA IS SURF WIND COMPNTS BY GRD PT,FOR CM/SEC BY      100.
          0         0.         0.
```

Fig. C-2. Sample section of a QMET file.

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 69   THE FOLLOWING DATA IS MEAN LAYER VECT WIND AND HGT BY UTMC, CM/SEC MUL BY 100.
 70        0.          0.          0.          0.          0.
 71   THE INVERSION AND WIND DATA FOLLOWING WAS TAKEN AT          0700  AUG  20 1973
 72   THE FOLLOWING DATA IS INVERSION HGT BY STATION, FOR CM MULT BY        100.
 73 +ABF     25      475.                                 0700 PST AUGUST 20 1973
 74 +NAN     64       75.                                 0700 PST AUGUST 20 1973
 75 +PTY    142      400.                                 0700 PST AUGUST 20 1973
 76 +NSR     62      175.                                 0700 PST AUGUST 20 1973
 77 +NMH     60      350.                                 0700 PST AUGUST 20 1973
 78 +AHM     34      700.                                 0700 PST AUGUST 20 1973
 79 +ALI     24      550.                                 0700 PST AUGUST 20 1973
 80 +AHW     28      600.                                 0700 PST AUGUST 20 1973
 81 +ASJ     29      400.                                 0700 PST AUGUST 20 1973
 82 +ASC     33      400.                                 0700 PST AUGUST 20 1973
 83 +NSB     78      375.                                 0700 PST AUGUST 20 1973
 84 +RRV    132      150                                  0700 PST AUGUST 20 1973
 85 +VSS    136      325.                                 0700 PST AUGUST 20 1973
 86 +AST     39      850.                                 0700 PST AUGUST 20 1973
 87 +ASE     36      800                                  0700 PST AUGUST 20 1973
 88 +PPE    146      250.                                 0700 PST AUGUST 20 1973
 89 +RSA    134      400.                                 0700 PST AUGUST 20 1973
 90 +ASN     20      450.                                 0700 PST AUGUST 20 1973
 91 +DMF     18      200.                                 0700 PST AUGUST 20 1973
 92           0        0.
 93   THE FOLLOWING DATA IS INVERSION HGT BY UTMC,     FOR CM MULT BY        100.
 94      4143.5      583.4      121.                         0700 PST AUGS 20 1973
 95      4175.7      619.1      822.                         0700 PST AUGS 20 1973
 96      4171.5      637.7     1127.                         0700 PST AUGS 20 1973
 97      4176.4      636.4      975.                         0700 PST AUGS 20 1973
 98      4172.0      640.1      792.                         0700 PST AUGS 20 1973
 99      4185.7      628.3      883.                         0700 PST AUGS 20 1973
100      4224.1      622.7     1036.                         0700 PST AUGS 20 1973
101      4225.0      619.0      182.                         0700 PST AUGS 20 1973
102      4226.8      615.8      182.                         0700 PST AUGS 20 1973
103      4227.0      620.2      426.                         0700 PST AUGS 20 1973
104          0.         0.        0.
105   THE FOLLOWING DATA IS SURF VECT WIND BY STAT, FOR CM/SEC MUL BY        100.
106 +DRC     13         0.        0.                         0700 PST AUGUST 20 1973
107 +DSF      1         2.      270.                         0700 PST AUGUST 20 1973
108 +DSJ     11         0.        0.                         0700 PST AUGUST 20 1973
109 +MPP     46         7.      320.                         0700 PST AUGUST 20 1973
110 +USJ     71         1.      350.                         0700 PST AUGUST 20 1973
111 +AHW     28         2.      360.                         0700 PST AUGUST 20 1973
112 +AOA     26         3.      360.                         0700 PST AUGUST 20 1973
113 +ASJ     29         2.      350.                         0700 PST AUGUST 20 1973
114 +GSD     80         1.      360.                         0700 PST AUGUST 20 1973
115 +NMH     60         8.      290.                         0700 PST AUGUST 20 1973
116 +OSW     84         1.      200.                         0700 PST AUGUST 20 1973
117 +UCB     73         1.      180.                         0700 PST AUGUST 20 1973
118 +UHW     72         0.        0.                         0700 PST AUGUST 20 1973
119 +AAN     27         3.      260.                         0700 PST AUGUST 20 1973
120 +AMN     30         0.        0.                         0700 PST AUGUST 20 1973
121 +ASF     32         5.      290                          0700 PST AUGUST 20 1973
122 +EGL     70         0.        0.                         0700 PST AUGUST 20 1973
123 +DLI      9         1.       90.                         0700 PST AUGUST 20 1973
124 +MPC     45         6.      250.                         0700 PST AUGUST 20 1973
125 +MRV     44         8.      250.                         0700 PST AUGUST 20 1973
126 +IAP     85         6.      240.                         0700 PST AUGUST 20 1973
127 +ISH     61         5.      300.                         0700 PST AUGUST 20 1973
128 +IUN     66         3.      240.                         0700 PST AUGUST 20 1973
129 +ABF     25         2.      360.                         0700 PST AUGUST 20 1973
130 +ALI     24         2.      110.                         0700 PST AUGUST 20 1973
131 +AMO     87         4.      340.                         0700 PST AUGUST 20 1973
132 +AST     39         4.      360.                         0700 PST AUGUST 20 1973
133 +EGP     65         6.      270.                         0700 PST AUGUST 20 1973
134 +AMC     38         4.      180.                         0700 PST AUGUST 20 1973
135 +AMT     37         1.      170.                         0700 PST AUGUST 20 1973
136 +ATI     23         6.      240.                         0700 PST AUGUST 20 1973
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Fig. C-2. (Continued)

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137 +DNA     5        1.       320.                     0700 PST AUGUST 20 1973
138 +DWA     6        3.       230.                     0700 PST AUGUST 20 1973
139 +ANA    22        3.       330.                     0700 PST AUGUST 20 1973
140 +ASE    36        3.       150.                     0700 PST AUGUST 20 1973
141 +ASM    35        4.       180.                     0700 PST AUGUST 20 1973
142 +AHA    21        2.       340.                     0700 PST AUGUST 20 1973
143 +DRM    17        2.       180.                     0700 PST AUGUST 20 1973
144 +DSA     2        1.       230.                     0700 PST AUGUST 20 1973
145 +DSR     4        0.         0.                     0700 PST AUGUST 20 1973
146 +MAG    40        8.       230.                     0700 PST AUGUST 20 1973
147 +MBO    42        3.       140.                     0700 PST AUGUST 20 1973
148 +MPA    43        4.        20.                     0700 PST AUGUST 20 1973
149 +MRE    41        4.       200.                     0700 PST AUGUST 20 1973
150 +IAC    69        3.       160.                     0700 PST AUGUST 20 1973
151 +IGS    68        5.       160                      0700 PST AUGUST 20 1973
152 +IGT    67        3.       180.                     0700 PST AUGUST 20 1973
153          0        0.         0.
154    THE FOLLOWING DATA IS MEAN LAYER VECT WIND AND HGT BY STAT, CM/SEC MUL BY 100.
155 +RSJ   131       2.0       320.      332.         0700 PST AUGUST 20 1973
156 +PPS   143       1.5       080.      445.         0700 PST AUGUST 20 1973
157 +AHA    21       ?.0       320.      100.         0700 PST AUGUST 20 1973
158 +RRV   132       4.0       240.      150.         0700 PST AUGUST 20 1973
159 +LLH    75       1.5       280.     1050.         0700 PST AUGUST 20 1973
160 +PTY   142       1.0       160.      400.         0700 PST AUGUST 20 1973
161          0        0.         0.        0.
162    THE FOLLOWING DATA IS SURF WIND COMPNTS BY GRD PT, FOR CM/SEC BY      100.
163          0        0.         0.
164    THE FOLLOWING DATA IS MEAN LAYER VECT WIND AND HGT BY UTMC, CM/SEC MUL BY 100.
165         0.        0.         0.        0.       0.
166    THE INVERSION AND WIND DATA FOLLOWING WAS TAKEN AT          1000  AUG  20 1973
167    THE FOLLOWING DATA IS INVERSION HGT BY STATION, FOR CM MULT BY        100.
168 +ABF    25     ?00.                                   1000 PST AUGUST 20 1973
169 +NAN    64    1300.                                   1000 PST AUGUST 20 1973
170 +PTY   142    1500.                                   1000 PST AUGUST 20 1973
171 +NSR    62     325.                                   1000 PST AUGUST 20 1973
172 +NMH    60     400.                                   1000 PST AUGUST 20 1973
173 +AHM    34     600.                                   1000 PST AUGUST 20 1973
174 +ALI    24     200.                                   1000 PST AUGUST 20 1973
175 +AHW    28     700.                                   1000 PST AUGUST 20 1973
176 +ASJ    29    1000.                                   1000 PST AUGUST 20 1973
177 +ASC    33     300.                                   1000 PST AUGUST 20 1973
178 +NSB    78     400.                                   1000 PST AUGUST 20 1973
179 +RRV   132     325.                                   1000 PST AUGUST 20 1973
180 +AST    39    1400.                                   1000 PST AUGUST 20 1973
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 •
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241 +RSA   134    1300.                                   2200 PST AUGUST 20 1973
242 +ASN    20    1500.                                   2200 PST AUGUST 20 1973
243 +DMF    18     350.                                   2200 PST AUGUST 20 1973
244          0        0.
245    THE FOLLOWING DATA IS INVERSION HGT BY UTMC,    FOR CM MULT BY        100.
246         0.        0.         0.
247    THE FOLLOWING DATA IS SURF VECT WIND BY STAT, FOR CM/SEC MUL BY        100.
248 +DRC    13        1.       360.                     2200 PST AUGUST 20 1973
249 +DSF     1        3.       230.                     2200 PST AUGUST 20 1973
250 +DSJ    11        1.       320.                     2200 PST AUGUST 20 1973
251 +MPP    46       7.0       320.                     2200 PST AUGUST 20 1973
252 +USJ    71        4.       320.                     2200 PST AUGUST 20 1973
253 +ADA    26        5.       270.                     2200 PST AUGUST 20 1973
254 +GSD    80        1.       320.                     2200 PST AUGUST 20 1973
255 +NMH    60        6.       280.                     2200 PST AUGUST 20 1973
256 +UCB    73        0.         0.                     2200 PST AUGUST 20 1973
257 +AAN    27        1.       260.                     2200 PST AUGUST 20 1973
258 +AMN    30        0.         0.                     2200 PST AUGUST 20 1973
259 +ASF    32        5.       320.                     2200 PST AUGUST 20 1973
260 +EGL    70        2.       160.                     2200 PST AUGUST 20 1973
261 +DLI     9        3.       230.                     2200 PST AUGUST 20 1973
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Fig. C-2. (Continued)

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262 +DPT      8       3.      270.                              2200 PST AUGUST 20 1973
263 +IAP     85       3.      210.                              2200 PST AUGUST 20 1973
264 +ISH     61       8.      240.                              2200 PST AUGUST 20 1973
265 +IUN     66       4.      200.                              2200 PST AUGUST 20 1973
266 +ABF     25       5.      190.                              2200 PST AUGUST 20 1973
267 +AMO     87       4.      350.                              2200 PST AUGUST 20 1973
268 +AST     39       4.      290.                              2200 PST AUGUST 20 1973
269 +EGP     65       6.      260.                              2200 PST AUGUST 20 1973
270 +AMC     38       4.      150.                              2200 PST AUGUST 20 1973
271 +AMT     37       2.      120.                              2200 PST AUGUST 20 1973
272 +ATI     23       6.      240.                              2200 PST AUGUST 20 1973
273 +DNA      5       2.      140.                              2200 PST AUGUST 20 1973
274 +DVA      6       3.      270.                              2200 PST AUGUST 20 1973
275 +ANA     22       4.      210.                              2200 PST AUGUST 20 1973
276 +ASE     36       5.      150.                              2200 PST AUGUST 20 1973
277 +ASM     35       3.      180.                              2200 PST AUGUST 20 1973
278 +AHA     21       0.        0.                              2200 PST AUGUST 20 1973
279 +DRM     17       4.      180.                              2200 PST AUGUST 20 1973
280 +DSA      2       2.      230.                              2200 PST AUGUST 20 1973
281 +DSR      4       0.        0.                              2200 PST AUGUST 20 1973
282 +IAC     69       5.      140.                              2200 PST AUGUST 20 1973
283 +IGS     68       7.      160.                              2200 PST AUGUST 20 1973
284 +IGT     67       4.      160.                              2200 PST AUGUST 20 1973
285           0       0.        0.
286    THE FOLLOWING DATA IS MEAN LAYER VECT WIND AND HGT BY STAT, CM/SEC MUL BY 100.
287           0       0.        0.        0.
288    THE FOLLOWING DATA IS SURF WIND COMPNTS BY GRD PT,FOR CM/SEC BY      100.
289           0       0.        0.
290    THE FOLLOWING DATA IS MEAN LAYER VECT WIND AND HGT BY UTMC, CM/SEC MUL BY 100.
291         0.        0.        0.        0.        0.
292    ALL SETS OF WIND AND INVERSION DATA HAVE BEEN READ IN        -10  AUG 1973
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Fig. C-2. (Continued)

Table C-2. Card-by-card format of the QMET file.

Reference line in example, Fig. C-2 (card no.)	Description	Variables	Format
1	First card of deck. Presence of ** in first field indicates load point for processing. (Processing can start from a full deck at a later point in time). Observation hr, mo, da, yr.	IACHK,IHR,IMN, IDAY,IYR	A2,58X,A6,A6,A3, A5
2	Start of subsection (1); scale factor.	WK2	69X,F11.6
3-24	Station symbol, station no. and inversion base height. Note zero fields to signal end of subsection input.	IK3,IK1,WK1	X,A3,I6,F10.5

Table C-2. (Continued)

Reference line in example, Fig. C-2 (card no.)	Description	Variables	Format
25	Start of subsection (2); scale factor.	WK2	69X,F11.6
26	UTM-north, UTM-east, inversion base height.	UTMNN,UTMEE,WK1	3F10.0
27	Start of subsection (3); scale factor.	WK2	69X,F11.6
28-60	Start on symbol, station no., wind speed, wind direction.	IK3,IK1,WK1, THETA	X,A3,I6,2F10.5
61	Start of subsection (4); scale factor.	WK2	76X,F4.0
62-66	Station symbol, station no., wind speed, wind direction, and inversion base height.	IK3,IK1,WK1, THETA,HTB	X,A3,3X,I3, 2F10.0,5X,F5.0
67	Start of subsection (5); scale factor.	WK2	69X,F11.6
68	UTM-north, UTM-east, wind speed, wind direction.	UTMNN,UTMEE,WK1 THETA	4F10.0
69	Start of subsection (6); scale factor	WK2	76X,F4.0
70	UTM-north, UTM-east, wind speed, wind direction, inversion base height.	UTMNN,UTMEE,WK1,	4F10.0,5X,F5.0
. . .			
591	Same as card No. 1. Note use of negative hour to signal end of QMET input.	Same as card No. 1.	Same as card No. 1.

numerically Milankovitch's formula (List, 1968) at 3-hr intervals for a range of transmission coefficients from 0.55 to 0.97 for each of the nine stations and for each of the case study days. By comparing the pyranometer data with the appropriate numerical integrations, those transmission coefficients that most closely fit the observations were identified. The nine transmission coefficients so determined for each of the 3-hr periods were plotted on topographical maps of the Bay Area and then isopleths were drawn over the region.

The isopleth data for the case studies were then digitized in sufficient density to allow an interpolation scheme in MASCON (inverse Gaussian weighting) to approximate the analysis at the mesh points. The maximum allowable number of input records for any given time period is 500. The digitized data so developed become the QCLD file, a sample portion of which is shown in Fig. C-3 using the format shown in Table C-3.

Table C-3. Card-by-card format of the QCLD file.

Reference line in example, Fig. C-3 (card no.)	Description	Variables	Format
1	First card of deck; load point flag, initial hr, final hr, mo, da, yr. Note: position of load point flag must agree with position of similar flag in QMET.	IBCHK,IHR1B, 1HR2B,IMNB, IDAYE,IYRB	A2,50X,I4,4X,I4, 5X,A3,1X,I2,1X,I4
2-2069	UTM-east, UTM-north, transmissivity value. Zero field card used to signal end-of-time section.	UTMEE,UTMNN, CLDGP	3F10.0
2071, 2073	Note use of negative values to signal hours of low light intensity. MASCON assumes 0 values for these periods.	Same as card No. 2.	Same as card No. 2.

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 1 **THE FOLLOWING DATA IS TRANSMISSIVITY VALUES VALID  400 TO  700 PST JUL 26 1973
 2      572.2     4090.1        0.84                            530 PST JUL 26 1973
 3      569.0     4093.1        0.84                            530 PST JUL 26 1973
 4      565.7     4095.0        0.84                            530 PST JUL 26 1973
 5      563.7     4097.4        0.84                            530 PST JUL 26 1973
 6      561.7     4100.0        0.84                            530 PST JUL 26 1973
 7      558.8     4103.4        0.84                            530 PST JUL 26 1973
 8      557.7     4104.7        0.84                            530 PST JUL 26 1973
 9      555.8     4110.0        0.84                            530 PST JUL 26 1973
10      553.9     4114.4        0.84                            530 PST JUL 26 1973
11      552.6     4119.9        0.84                            530 PST JUL 26 1973
12      552.1     4124.7        0.84                            530 PST JUL 26 1973
13      550.9     4130.2        0.84                            530 PST JUL 26 1973
14      549.6     4135.0        0.84                            530 PST JUL 26 1973
15      549.1     4136.8        0.84                            530 PST JUL 26 1973
16      547.7     4139.8        0.84                            530 PST JUL 26 1973
17      546.0     4145.1        0.84                            530 PST JUL 26 1973
18      544.9     4150.0        0.84                            530 PST JUL 26 1973
19      543.9     4155.1        0.84                            530 PST JUL 26 1973
20      544.1     4159.5        0.84                            530 PST JUL 26 1973
21      544.3     4164.7        0.84                            530 PST JUL 26 1973
22      544.6     4169.5        0.84                            530 PST JUL 26 1973
23      544.0     4172.7        0.84                            530 PST JUL 26 1973
24      543.3     4175.0        0.84                            530 PST JUL 26 1973
25      541.0     4179.2        0.84                            530 PST JUL 26 1973
26      539.1     4181.5        0.84                            530 PST JUL 26 1973
27      536.0     4184.5        0.84                            530 PST JUL 26 1973
28      534.3     4186.5        0.84                            530 PST JUL 26 1973
29      529.8     4189.8        0.84                            530 PST JUL 26 1973
30      524.8     4193.7        0.84                            530 PST JUL 26 1973
31      523.4     4194.8        0.84                            530 PST JUL 26 1973
32      519.9     4198.9        0.84                            530 PST JUL 26 1973
33      516.9     4206.1        0.84                            530 PST JUL 26 1973
34      516.2     4209.6        0.84                            530 PST JUL 26 1973
35      514.8     4214.8        0.84                            530 PST JUL 26 1973
36      514.4     4219.8        0.84                            530 PST JUL 26 1973
37      513.6     4224.4        0.84                            530 PST JUL 26 1973
38      511.2     4229.9        0.84                            530 PST JUL 26 1973
39      509.9     4231.8        0.84                            530 PST JUL 26 1973
40      505.0     4234.4        0.84                            530 PST JUL 26 1973
41      500.2     4235.4        0.84                            530 PST JUL 26 1973
42      494.7     4236.3        0.84                            530 PST JUL 26 1973
43      490.4     4239.6        0.84                            530 PST JUL 26 1973
44      624.6     4090.6        0.88                            530 PST JUL 26 1973
45      623.3     4092.7        0.88                            530 PST JUL 26 1973
46      621.9     4095.0        0.88                            530 PST JUL 26 1973
47      618.7     4099.9        0.88                            530 PST JUL 26 1973
48      615.2     4104.9        0.88                            530 PST JUL 26 1973
49      613.6     4106.2        0.88                            530 PST JUL 26 1973
50      609.2     4109.9        0.88                            530 PST JUL 26 1973
51      603.8     4114.1        0.88                            530 PST JUL 26 1973
52      602.2     4115.0        0.88                            530 PST JUL 26 1973
53      599.3     4117.0        0.88                            530 PST JUL 26 1973
54      595.0     4119.3        0.88                            530 PST JUL 26 1973
55      589.4     4123.8        0.88                            530 PST JUL 26 1973
56      587.6     4124.9        0.88                            530 PST JUL 26 1973
57      584.4     4127.9        0.88                            530 PST JUL 26 1973
58      581.8     4129.9        0.88                            530 PST JUL 26 1973
59      578.8     4133.0        0.88                            530 PST JUL 26 1973
60      575.9     4134.6        0.88                            530 PST JUL 26 1973
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Fig. C-3. Sample section of a QCLD file.

755	505.6	4299.7	0.80	830	PST	JUL	26	1973
756	509.4	4296.7	0.80	830	PST	JUL	26	1973
757	511.0	4294.9	0.80	830	PST	JUL	26	1973
758	514.4	4292.2	0.80	830	PST	JUL	26	1973
759	517.5	4289.7	0.80	830	PST	JUL	26	1973
760	518.9	4288.8	0.80	830	PST	JUL	26	1973
761	524.9	4285.5	0.80	830	PST	JUL	26	1973
762	526.1	4284.8	0.80	830	PST	JUL	26	1973
763	529.1	4282.5	0.80	830	PST	JUL	26	1973
764	534.1	4280.2	0.80	830	PST	JUL	26	1973
765	538.8	4277.7	0.80	830	PST	JUL	26	1973
766	542.8	4276.3	0.80	830	PST	JUL	26	1973
767	544.9	4277.0	0.80	830	PST	JUL	26	1973
768	544.1	4280.0	0.80	830	PST	JUL	26	1973
769	542.7	4283.1	0.80	830	PST	JUL	26	1973
770	541.4	4284.8	0.80	830	PST	JUL	26	1973
771	538.9	4289.4	0.80	830	PST	JUL	26	1973
772	536.5	4291.0	0.80	830	PST	JUL	26	1973
773	535.2	4289.8	0.80	830	PST	JUL	26	1973
774	533.7	4287.8	0.80	830	PST	JUL	26	1973
775	531.6	4287.5	0.80	830	PST	JUL	26	1973
776	528.8	4288.7	0.80	830	PST	JUL	26	1973
777	527.4	4289.6	0.80	830	PST	JUL	26	1973
778	524.2	4294.2	0.80	830	PST	JUL	26	1973
779	0.	0.	0.					
780	THE FOLLOWING DATA IS TRANSMISSIVITY VALUES VALID 1000 TO			1300	PST	JUL	26	1973
781	569.3	4184.5	0.60	1130	PST	JUL	26	1973
782	569.5	4189.4	0.60	1130	PST	JUL	26	1973
783	563.9	4194.7	0.60	1130	PST	JUL	26	1973
784	563.8	4197.6	0.60	1130	PST	JUL	26	1973
785	566.2	4199.6	0.60	1130	PST	JUL	26	1973
786	564.1	4203.2	0.60	1130	PST	JUL	26	1973
787	559.7	4203.5	0.60	1130	PST	JUL	26	1973
788	556.7	4203.9	0.60	1130	PST	JUL	26	1973
789	554.1	4204.9	0.60	1130	PST	JUL	26	1973
790	550.3	4204.7	0.60	1130	PST	JUL	26	1973
791	549.3	4200.1	0.60	1130	PST	JUL	26	1973
792	554.0	4197.5	0.60	1130	PST	JUL	26	1973
793	559.3	4195.0	0.60	1130	PST	JUL	26	1973
794	559.6	4192.7	0.60	1130	PST	JUL	26	1973
795	560.2	4189.6	0.60	1130	PST	JUL	26	1973
796	563.6	4184.5	0.60	1130	PST	JUL	26	1973
797	568.9	4183.2	0.60	1130	PST	JUL	26	1973
798	558.9	4241.8	0.60	1130	PST	JUL	26	1973
799	558.2	4239.1	0.60	1130	PST	JUL	26	1973
800	559.4	4236.6	0.60	1130	PST	JUL	26	1973
801	561.7	4235.9	0.60	1130	PST	JUL	26	1973
802	564.5	4239.3	0.60	1130	PST	JUL	26	1973
803	564.1	4242.5	0.60	1130	PST	JUL	26	1973
804	563.0	4244.7	0.60	1130	PST	JUL	26	1973
805	560.7	4247.3	0.60	1130	PST	JUL	26	1973
806	578.0	4196.3	0.64	1130	PST	JUL	26	1973
807	580.2	4199.6	0.64	1130	PST	JUL	26	1973
808	580.0	4203.0	0.64	1130	PST	JUL	26	1973
809	578.9	4206.7	0.64	1130	PST	JUL	26	1973
810	574.0	4209.1	0.64	1130	PST	JUL	26	1373
811	569.1	4209.9	0.64	1130	PST	JUL	26	1973
812	563.9	4209.5	0.64	1130	PST	JUL	26	1973
813	559.0	4209.3	0.64	1130	PST	JUL	26	1973
814	554.0	4209.1	0.64	1130	PST	JUL	26	1973

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Fig. C-3. (Continued)

2003	614.4	4156.5	0.84	2030 PST JUL 26 1973
2004	610.6	4154.3	0.84	2030 PST JUL 26 1973
2005	609.0	4152.9	0.84	2030 PST JUL 26 1973
2006	607.3	4148.6	0.84	2030 PST JUL 26 1973
2007	608.3	4144.0	0.84	2030 PST JUL 26 1973
2008	610.6	4139.3	0.84	2030 PST JUL 26 1973
2009	613.4	4133.9	0.84	2030 PST JUL 26 1973
2010	615.0	4130.9	0.84	2030 PST JUL 26 1973
2011	616.4	4129.0	0.84	2030 PST JUL 26 1973
2012	619.3	4123.7	0.84	2030 PST JUL 26 1973
2013	622.6	4118.9	0.84	2030 PST JUL 26 1973
2014	624.0	4116.7	0.84	2030 PST JUL 26 1973
2015	628.3	4109.4	0.84	2030 PST JUL 26 1973
2016	631.5	4103.9	0.84	2030 PST JUL 26 1973
2017	635.3	4100.1	0.84	2030 PST JUL 26 1973
2018	636.0	4104.6	0.84	2030 PST JUL 26 1973
2019	634.4	4110.0	0.84	2030 PST JUL 26 1973
2020	634.1	4114.2	0.84	2030 PST JUL 26 1973
2021	635.7	4120.1	0.84	2030 PST JUL 26 1973
2022	639.0	4122.4	0.84	2030 PST JUL 26 1973
2023	639.5	4119.2	0.84	2030 PST JUL 26 1973
2024	639.3	4114.5	0.84	2030 PST JUL 26 1973
2025	638.7	4108.8	0.84	2030 PST JUL 26 1973
2026	639.5	4103.7	0.84	2030 PST JUL 26 1973
2027	643.7	4101.1	0.84	2030 PST JUL 26 1973
2028	643.5	4104.5	0.84	2030 PST JUL 26 1973
2029	643.2	4109.8	0.84	2030 PST JUL 26 1973
2030	642.5	4114.6	0.84	2030 PST JUL 26 1973
2031	642.2	4119.4	0.84	2030 PST JUL 26 1973
2032	644.7	4124.5	0.84	2030 PST JUL 26 1973
2033	649.6	4129.7	0.84	2030 PST JUL 26 1973
2034	644.3	4134.8	0.84	2030 PST JUL 26 1973
2035	640.0	4138.7	0.84	2030 PST JUL 26 1973
2036	644.3	4143.6	0.84	2030 PST JUL 26 1973
2037	648.7	4144.6	0.84	2030 PST JUL 26 1973
2038	649.6	4148.8	0.84	2030 PST JUL 26 1973
2039	644.6	4151.9	0.84	2030 PST JUL 26 1973
2040	642.4	4148.5	0.84	2030 PST JUL 26 1973
2041	639.0	4151.4	0.84	2030 PST JUL 26 1973
2042	637.7	4154.6	0.84	2030 PST JUL 26 1973
2043	634.1	4159.1	0.84	2030 PST JUL 26 1973
2044	628.7	4162.8	0.84	2030 PST JUL 26 1973
2045	624.1	4163.4	0.84	2030 PST JUL 26 1973
2046	618.5	4159.9	0.84	2030 PST JUL 26 1973
2047	531.4	4299.7	0.84	2030 PST JUL 26 1973
2048	530.2	4297.5	0.84	2030 PST JUL 26 1973
2049	526.3	4295.9	0.84	2030 PST JUL 26 1973
2050	527.4	4293.9	0.84	2030 PST JUL 26 1973
2051	530.6	4289.3	0.84	2030 PST JUL 26 1973
2063	523.3	4289.1	0.84	2030 PST JUL 26 1973
2064	520.7	4230.2	0.84	2030 PST JUL 26 1973
2065	515.9	4292.5	0.84	2030 PST JUL 26 1973
2066	512.9	4294.5	0.84	2030 PST JUL 26 1973
2067	510.9	4296.7	0.84	2030 PST JUL 26 1973
2068	508.0	4299.3	0.84	2030 PST JUL 26 1973
2069	0.	0.	0.	
2070	THE FOLLOWING DATA IS TRANSMISSIVITY VALUES VALID 2200 TO			100 PST JUL 26 1973
2071	-1.0	-1.0	-1.00	2330 PST JUL 26 1973
2072	THE FOLLOWING DATA IS TRANSMISSIVITY VALUES VALID 100 TO			400 PST JUL 27 1973
2073	-1.0	-1.0	-1.00	230 PST JUL 27 1973

Fig. C-3. *(Continued)*

The QMRUN File

The QMRUN file identifies the problem being run in space and time according to the following specifications:

(1) A textual title or problem name,

(2) The beginning and ending dates and times.

(3) The number of grid zones, the size of a zone, and the physical coordinates of the southwest corner of the modeling area.

These are key parameters that directly affect the running time of the MASCON model. While actual running time depends on many other factors as well (e.g., initial meteorology, boundary conditions, topography), the following run-times were typically encountered in assembling the library of QTRAN files developed for the San Francisco Bay Area.

Here, run time is defined as the total computer time (CPU + I/O + SYSTEM). *Note that the current state of the* MASCON code is diagnostic, in that many calculations and graphical displays (contour plots, streamline analyses) are generated in order to assist the user in developing a consistent treatment of meteorological data. If the code were stripped of its auxiliary coding, it is estimated that the above times would be cut in half or better.

MASCON is presently designed to run problems up to 48 hr (simulation time) on grids as large as 65 by 65 with grid sizes of 1, 2, or 5 km. The area being modeled need not be square, but grid size must be constant in the x and y directions, with no rotation of the mesh allowed.

An example of a QMRUN file is given in Fig. C-4 and a card format description in Table C-4.

OUTPUT DATA FILES

As shown in Fig. C-1, there are five output files from MASCON. The family of QTRAN files provide the results of the processing of data by MASCON to the LIRAQ model. As such *they are both input files for LIRAQ*

Case study date	No. of zones	Simulation time (hr)	CDC 7600 run time (min)
July 26-27, 1973	4225	24	24-30
August 20, 1973	4225	18	21-23
September 26-28, 1973	1428	48	15
September 26-28, 1973	4225	48	36-40

```
1  BAY AREA PROBLEM - QMETJUL3
2  INITIAL TIME = 04:00 26 JULY        1973  FINAL TIME = 04:00 27 JULY        1973
3  DATA ON GRID      65 BY      65 WITH DX=  2.000E+05 AND DY=   2.000E+05 CM
4  THE FOLLOWING CARD GIVES PARAMETERS SWE AND SWN FOR UTM CONVERSION
5    510.000              4120.000
```

Fig. C-4. Sample of a QMRUN file.

Table C-4. Card-by-card format of the QMRUN file.

Reference in example, Fig. C-4 (card No.)	Description	Variables	Format
1	User's name or description of his problem. Limited to 40 characters.	NAME	4A10
2	Initial and final time/dates for the problem. Data must be left-justified within its fields, without abbreviation.	ITINT,ITFIN	16X,A10,A10,A4, 15X,A10,A10,A4
3	Numbers of grid squares in the x direction, y direction and grid sizes (in centimeters ... model is in CGS units).	NGX,NGY,DX,DY	15X,I5,5X,I5,10X, E10.3,10X,E10.3
4	Fixed comment.	None.	None.
5	UTM coordinates of southwest corner of modeling area.	SWE,SWN	F10.0,10X,F10.0

and indicators of how the meteorological patterns are being represented. Because they are so important, their structure is described in a separate subsection below.

Of the other output files, the next most important provides the graphical output. The DnMASCNxyz files present the input data, the time and space interpolated fields, and the mass consistent flux fields (in the form of streamline analyses). (For each model run, a random-character assignment is made for the x, y, z field of the filename to identify each run uniquely where n represents a file sequence digit.) These graphical presentations are useful in understanding whether the input meteorological scenario desired and are excellent tools in the iterative process generally required to develop adequate input meteorology. The HMSCxyzn files contain primarily numerical information about key parameter fields at various stages of the mass consistent adjustment. The specific types of data available are listed in Table C-5. The QDIAG file is a diagnostics file containing information on the timing of sections of the code as well as any error conditions detected in the run. QFLXCK is another iterative diagnostic tool that shows how flux directions and magnitudes change from input through the interpolation process to their eventual state after mass consistency has been achieved. QFLXCK is helpful in understanding pollutant spatial distributions, after mass consistent alterations of input fields have been made.

CONTENTS OF QTRAN AND FORMAT

The QTRAN files actually consist of a family of files: QTRAN0, QTRAN1, QTRAN2, ... with (after two lines of identification in the first file) data covering two complete time cycles per file. The data within a time cycle consist of basically three sections:

(1) Surface vertical eddy diffusivities.

(2) Vertical and horizontal transfer coefficients in and out of a grid volume.

(3) Inversion base heights, atmospheric transmissivities, and source multiplier flags.

Of these variables, all except the "source multiplier flags" are described fully in chapter 8 of the Final Report. The source multiplier flags are used to indicate that an individual grid cell is isolated from transport mechanisms acting in the sub-inversion well-mixed layer. This occurs when the inversion base descends below topography and thus puts the region in the above inversion layer. Under these conditions, the LIRAQ model does not emit the pollutant source emissions into the isolated air volume (maintained at a 50-m thickness) associated with that grid square.

Figure C-5 shows sample sections of a QTRAN file and Table C-6 gives a detailed breakdown of each section. (Refer to Appendixes A and B for further information concerning the use of these files.)

Table C-5. Data output to file HMSCxyzn.

Item No.	Description
1.	Domain identification.
2.	Meteorological data (wind speed, direction, inversion base height) input to QMET.
3.	Spatially interpolated inversion base height (above mean sea level and above topography) at input time.
4.	Spatially interpolated surface wind components (eastward, northward) in cm/s at input time.
5.	Repeat of items 2-4 at next input time.
6.	Surface wind components interpolated in time to mid-time between time for which last two input data sets are valid.
7.	Information indicating status of internal boundaries (created by inversion base height intersecting topography) for each grid cell and integral of total boundary fluxes of air.
8.	Inversion base height above topography and above sea level, interpolated in time to mid-time between time for which last two data sets are valid.
9.	List by grid square of inversion base height at start and end time of interval, volume of grid box at mid-time of interval, and surface vertical eddy diffusivity at mid-time of interval.
10.	Mass consistency check on adjusted fluxes for each grid cell in units of relative error per second.
11.	Recycle output for items 5 through 10 for each following time interval.

```
1. JULY CASE STUDY - REGION 6                            +MSC/AMO   U 06/19/75  02:29:11
2. FOLLOWING CARDS ARE TRAN COEFF AND INVR HGHTS FOR 4225 GRID SQUARES
3. THE FOLLOWING DATA IS VALID FROM  14400 TO  25200 SEC    JULY 26 1973
4. FOLLOWING CARDS PROVIDE K(SURF) TO USE FOR VERT PROFILE DETERMINATION
5. 4100.000  540.000    4.00000E+01
   4100.000  541.000    4.00000E+01
   4100.000  542.000    4.00000E+01
   4100.000  543.000    4.00000E+01
   4100.000  544.000    4.00000E+01
   4100.000  545.000    1.79639E+02
   4100.000  546.000    7.36010E+02
   4100.000  547.000    1.20650E+03
   4100.000  548.000    1.26079E+03
   4100.000  549.000    1.26132E+03
   4100.000  550.000    1.26133E+03
   4100.000  551.000    1.26133E+03
   4100.000  552.000    1.26133E+03
   4100.000  553.000    1.26133E+03
   4100.000  554.000    1.26133E+03
   4100.000  555.000    1.26133E+03
   4100.000  556.000    1.26133E+03
   4100.000  557.000    1.26133E+03
   4100.000  558.000    1.26133E+03
   4100.000  559.000    1.26133E+03
   4100.000  560.000    1.26133E+03
   4100.000  561.000    1.26133E+03
   4100.000  562.000    1.26133E+03
   4100.000  563.000    1.26133E+03
   4100.000  564.000    1.26133E+03
   4100.000  565.000    1.26133E+03
   4100.000  566.000    1.26133E+03
   4100.000  567.000    1.26133E+03
   4100.000  568.000    1.26133E+03
   4100.000  569.000    1.13903E+03
   4100.000  570.000    8.94439E+02
   4100.000  571.000    5.89107E+02
   4100.000  572.000    4.06072E+02
   4100.000  573.000    2.23036E+02
   4100.000  574.000    4.00000E+01
   4100.000  575.000    4.00000E+01
   4100.000  576.000    4.00000E+01
   4100.000  577.000    4.00000E+01
   4100.000  578.000    4.00000E+01
   4100.000  579.000    4.00000E+01
   4100.000  580.000    2.29734E+02
   4100.000  581.000    5.09762E+02
   4100.000  582.000    3.55492E+02
   4100.000  583.000    7.54645E+01
   4100.000  584.000    4.00000E+01
   4100.000  585.000    4.00000E+01
   4100.000  586.000    6.02847E+01
   4100.000  587.000    8.29323E+01
   4100.000  589.000    9.56480E+01
   4100.000  589.000    1.18058E+02
   4100.000  590.000    1.30014E+02
   4100.000  591.000    1.29368E+02
   4100.000  592.000    1.27525E+02
   4100.000  593.000    1.99465E+02
   4100.000  594.000    1.91138E+02
   4100.000  595.000    9.74497E+01
     •
     •
     •
```

Fig. C-5. Sample section of a QTRAN file.

4164.000	587.000	4.00000E+01
4164.000	588.000	4.00000E+01
4164.000	589.000	4.00000E+01
4164.000	590.000	4.00000E+01
4164.000	591.000	4.00000E+01
4164.000	592.000	4.00000E+01
4164.000	593.000	4.00000E+01
4164.000	594.000	4.00000E+01
4164.000	595.000	4.00000E+01
4164.000	596.000	5.47294E+01
4164.000	597.000	7.25995E+01
4164.000	598.000	6.40917E+01
4164.000	599.000	5.21250E+01
4164.000	600.000	5.06422E+01
4164.000	601.000	7.39398E+01
4164.000	602.000	9.65964E+01
4164.000	603.000	8.78668E+01
4164.000	604.000	1.07461E+02
0.	0.	

6. FOLLOWING CARDS ARE TRANSFER COEFFICIENTS--UNITS ARE GM/SEC

7.	4100.000	540.000	1.0625730E+07	1.0625730E+07	0.
			0.	0.	2.1685164E+04
	4100.000	541.000	1.1746015E+07	2.2371746E+07	1.9007494E+06
			0.	0.	4.5656624E+04
	4100.000	542.000	1.4319970E+07	3.6691708E+07	1.9039596E+06
			0.	0.	7.4881050E+04
	4100.000	543.000	1.9122415E+07	5.5813263E+07	1.9158836E+06
			0.	0.	1.1390615E+05
	4100.000	544.000	2.7671152E+07	8.3373480E+07	1.9577996E+06
			0.	0.	1.7034931E+05
	4100.000	545.000	4.4318249E+07	1.1324938E+08	2.0778634E+06
			0.	0.	2.5716197E+05
	4100.000	546.000	1.8861307E+08	-1.1839769E+08	2.8179573E+06
			0.	0.	3.6511662E+05
	4100.000	547.000	4.8443113E+08	-5.4366912E+08	7.1155146E+06
			0.	0.	2.1177770E+05
	4100.000	548.000	5.7708874E+08	-6.8508652E+08	8.0784823E+06
			0.	0.	7.2568327E+04
	4100.000	549.000	5.9861242E+08	-7.4943244E+08	8.1842381E+06
			0.	-4.6089997E+04	0.
	4100.000	550.000	6.1431765E+08	-8.0124532E+08	8.2410408E+06
			0.	-1.4551481E+05	0.
	4100.000	551.000	6.2810744E+08	-8.4255464E+08	8.2695526E+06
			0.	-2.2324585E+05	0.
	4100.000	552.000	6.4362434E+08	-8.7706657E+08	8.3229924E+06
			0.	-2.8139703E+05	0.
	4100.000	553.000	6.6652144E+08	-9.0655739E+08	8.4297126E+06
			0.	-3.1711651E+05	0.
	4100.000	554.000	7.0416802E+08	-9.3358661E+08	8.6225307E+06
			0.	-3.2016774E+05	0.
	4100.000	555.000	7.6678479E+08	-9.8169438E+08	8.9663561E+06
			0.	-2.7513473E+05	0.
	4100.000	556.000	8.5243332E+08	-1.0622475E+09	9.6910072E+06
			0.	-2.2721522E+05	0.
	4100.000	557.000	9.4996175E+08	-1.1930156E+09	1.0554869E+07
			0.	-1.9183611E+05	0.
	4100.000	558.000	1.0638594E+09	-1.3717465E+09	1.1845068E+07
			0.	-2.5278372E+05	0.
	4100.000	559.000	1.1369335E+09	-1.4759622E+09	1.2492034E+07
			0.	-3.3493912E+05	0.

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•
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Fig. C-5. (Continued)

		0.	0.	0.
4165.000	598.000	0.	8.0415806E+07	0.
		0.	0.	0.
4165.000	599.000	0.	5.7759478E+07	0.
		0.	0.	0.
4165.000	600.000	0.	4.0244361E+07	0.
		0.	0.	0.
4165.000	601.000	0.	4.4805705E+07	0.
		0.	0.	0.
4165.000	602.000	0.	4.2769500E+07	0.
		0.	0.	0.
4165.000	603.000	0.	1.8684783E+07	0.
		0.	0.	0.
4165.000	604.000	0.	3.8030913E+07	0.
		0.	0.	0.
4165.000	605.000	0.	0.	0.
		0	0.	0.
0.	0.	0.	0.	0.
		0.	0.	0.

8. FOLLOWING ARE INVERSION HEIGHTS(CM), IF NOT GIVEN ASSUMED TO BE 5000.00

9.	4100.000	540.000	10009.31	10000.00	0.84	1.0
	4100.000	541.000	10034.97	10000.00	0.84	1.0
	4100.000	542.000	10130.55	10000.00	0.84	1.0
	4100.000	543.000	10471.42	10000.00	0.84	1.0
	4100.000	544.000	11504.31	10000.00	0.84	1.0
	4100.000	545.000	13688.60	10000.00	0.84	1.0
	4100.000	546.000	16437.36	10000.00	0.84	1.0
	4100.000	547.000	18422.29	10000.00	0.84	1.0
	4100.000	548.000	19289.96	10000.00	0.84	1.0
	4100.000	549.000	19627.76	10000.00	0.84	1.0
	4100.000	550.000	19813.01	10000.01	0.84	1.0
	4100.000	551.000	19991.06	10000.08	0.84	1.0
	4100.000	552.000	20339.68	10000.59	0.94	1.0
	4100.000	553.000	20991.14	10004.35	0.84	1.0
	4100.000	554.000	22143.70	10032.00	0.84	1.0
	4100.000	555.000	24323.42	10228.86	0.84	1.0
	4100.000	556.000	26760.23	11374.64	0.84	1.0
	4100.000	557.000	28472.22	14625.96	0.84	1.0
	4100.000	558.000	29465.85	18163.38	0.84	1.0
	4100.000	559.000	29821.67	19670.13	0.84	1.0
	4100.000	560.000	29935.89	19953.11	0.84	1.0
	4100.000	561.000	29977.54	19993.57	0.84	1.0
	4100.000	562.000	29992.15	19999.12	0.84	1.0
	4100.000	563.000	29997.20	19999.88	0.84	1.0
	4100.000	564.000	29998.97	19999.98	0.84	1.0
	4100.000	565.000	29999.59	20000.00	0.84	1.0
	4100.000	566.000	28449.81	18450.00	0.84	1.0
	4100.000	567.000	25424.89	15425.00	0.84	1.0
	4100.000	568.000	23024.92	13025.00	0.84	1.0
	4100.000	569.000	18399.94	9025.00	0.84	1.0
	4100.000	570.000	11599.94	5475.00	0.84	1.0
	4100.000	571.000	7049.93	5000.00	0.84	1.0
	4100.000	572 000	5799.89	5000.00	0.84	1.0
	4100.000	573.000	5499.93	5000.00	0.84	1.0
	4100.000	574.000	5000.00	5000.00	0.84	0.
	4100.000	575.000	5000.00	5000.00	0.84	0.
	4100.000	576.000	5000.00	5000.00	0.84	0.
	4100.000	577.000	5000.00	5000.00	0.84	0.
	4100.000	578.000	5000.00	5000.00	0.85	0.
	4100.000	579.000	5000.00	5000.00	0.88	0.

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•
•

Fig. C-5. (Continued)

4164.000	594.000	5000.00	5000.00	0.83	0.9
4164.000	595.000	5000.00	5000.00	0.84	0.9
4164.000	596.000	5128.75	5000.00	0.84	0.9
4164.000	597.000	9935.46	5323.16	0.85	1.0
4164.000	598.000	16852.02	7549.33	0.86	1.0
4164.000	599.000	19017.79	9268.42	0.87	1.0
4164.000	600.000	17559.69	7650.27	0.87	1.0
4164.000	601.000	13704.56	5608.03	0.88	1.0
4164.000	602.000	11505.78	5000.00	0.88	1.0
4164.000	603.000	16344.50	7616.19	0.88	1.0
4164.000	604.000	26634.56	12416.19	0.88	1.0

0.

THE FOLLOWING DATA IS VALID FROM 25200 TO 36000 SEC JULY 26 1973

FOLLOWING CARDS PROVIDE K(SURF) TO USE FOR VERT PROFILE DETERMINATION

4100.000	540.000	4.00000E+01
4100.000	541.000	4.00000E+01
4100.000	542.000	4.00000E+01
4100.000	543.000	4.00000E+01
4100.000	544.000	4.00000E+01
4100.000	545.000	1.01780E+02
4100.000	546.000	3.64048E+02
4100.000	547.000	5.90862E+02
4100.000	548.000	6.17448E+02
4100.000	549.000	6.17712E+02
4100.000	550.000	6.17715E+02
4100.000	551.000	6.17715E+02
4100.000	552.000	6.17715E+02
4100.000	553.000	6.17715E+02
4100.000	554.000	6.17715E+02
4100.000	555.000	6.17715E+02
4100.000	556.000	6.17715E+02
4100.000	557.000	6.17715E+02
4100.000	558.000	6.17715E+02
4100.000	559.000	6.17715E+02
4100.000	560.000	6.17715E+02
4100.000	561.000	6.17884E+02
4100.000	562.000	6.35935E+02
4100.000	563.000	6.66655E+02
4100.000	564.000	6.79461E+02
4100.000	565.000	6.79469E+02
4100.000	566.000	6.79469E+02
4100.000	567.000	6.79469E+02
4100.000	568.000	6.79469E+02
4100.000	569.000	5.19602E+02
4100.000	570.000	1.99867E+02
4100.000	571.000	4.00000E+01
4100.000	572.000	4.00000E+01
4100.000	573.000	4.00000E+01
4100.000	574.000	4.00000E+01
4100.000	575.000	4.00000E+01
4100.000	576.000	4.00000E+01
4100.000	577.000	4.00000E+01
4100.000	578.000	4.00000E+01
4100.000	579.000	4.00000E+01
4100.000	580.000	4.00000E+01
4100.000	581.000	1.34019E+02
4100.000	582.000	2.28379E+02
4100.000	583.000	7.43596E+01
4100.000	584.000	4.00000E+01
4100.000	585.000	4.00000E+01

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Fig. C-5. (Continued)

4164.000	547.000	19012.61	14338.98	0.	1.0
4164.000	548.000	17928.78	15056.17	0.	1.0
4164.000	549.000	20965.80	19822.46	0.	1.0
4164.000	550.000	24066.20	23357.08	0.	1.0
4164.000	551.000	25743.98	23568.44	0.	1.0
4164.000	552.000	25412.05	22161.23	0.	1.0
4164.000	553.000	24155.11	21264.48	0.	1.0
4164.000	554.000	22616.86	20663.01	0.	1.0
4164.000	555.000	21413.42	20304.80	0.	1.0
4164.000	556.000	20751.05	20140.69	0.	1.0
4164.000	557.000	20381.59	20063.89	0.	1.0
4164.000	558.000	20188.23	20028.12	0.	1.0
4164.000	559.000	20111.67	20011.75	0.	1.0
4164.000	560.000	20098.71	20004.15	0.	1.0
4164.000	561.000	20112.15	20000.82	0.	1.0
4164.000	562.000	20084.51	20000.00	0.	1.0
4164.000	563.000	20020.93	20000.00	0.	1.0
4164.000	564.000	20000.00	20000.00	0.	1.0
4164.000	565.000	20000.00	20000.00	0.	1.0
4164.000	566.000	20332.62	20000.00	0.	1.0
4164.000	567.000	20708.84	20000.00	0.	1.0
4164.000	568.000	20776.08	20000.00	0.	1.0
4164.000	569.000	20822.11	20014.90	0.	1.0
4164.000	570.000	20867.01	20041.58	0.	1.0
4164.000	571.000	20913.30	20078.80	0.	1.0
4164.000	572.000	20962.02	20138.47	0.	1.0
4164.000	573.000	21013.61	20271.92	0.	1.0
4164.000	574.000	21019.95	20454.76	0.	1.0
4164.000	575.000	21012.73	20847.87	0.	1.0
4164.000	576.000	21015.71	21653.04	0.	1.0
4164.000	577.000	21110.39	22867.29	0.	1.0
4164.000	578.000	21566.46	24386.29	0.	1.0
4164.000	579.000	22830.47	25898.30	0.	1.0
4164.000	580.000	25389.70	27200.17	0.	1.0
4164.000	581.000	28087.32	28110.45	0.	1.0
4164.000	582.000	29647.99	28584.19	0.	1.0
4164.000	583.000	29436.62	27926.08	0.	1.0
4164.000	584.000	27143.40	26138.48	0.	1.0
4164.000	585.000	23018.81	24626.19	0.	1.0
4164.000	586.000	16698.15	21386.99	0.	1.0
4164.000	587.000	10165.21	15617.17	0.	1.0
4164.000	588.000	6510.11	10025.00	0.	1.0
4164.000	589.000	5309.80	6250.00	0.	1.0
4164.000	590.000	5000.00	5000.00	0.	1.0
4164.000	591.000	5000.00	5000.00	0.	0.
4164.000	592.000	5000.00	5000.00	0.	1.0
4164.000	593.000	5000.00	5000.00	0.	1.0
4164.000	594.000	5000.00	5000.00	0.	0.
4164.000	595.000	5300.94	5000.00	0.	1.0
4164.000	596.000	10637.27	9579.10	0.	1.0
4164.000	597.000	20496.68	19022.14	0.	1.0
4164.000	598.000	27358.65	25595.10	0.	1.0
4164.000	599.000	29205.24	26570.37	0.	1.0
4164.000	600.000	27495.41	23857.51	0.	1.0
4164.000	601.000	23122.82	18845.77	0.	1.0
4164.000	602.000	18944.10	14635.50	0.	1.0
4164.000	603.000	16989.37	13246.79	0.	1.0
4164.000	604.000	17035.53	13822.12	0.	1.0

0.

THE FOLLOWING DATA IS VALID FROM -1000 TO -1000 SEC JULY 27 1973

Fig. C-5. (Continued)

Table C-6. Card-by-card format of the QTRAN file.

Reference line in example, Fig. C-5 (card No.)	Description	Variables	Format
1	Textual information identifying the run, name, date, time, etc...	NAME,ID	4A10,5X,A10,3X, 2A10
2	Indicates the number of grid squares or zones over which problem was run. The first two cards appear once; the rest of file format repeats on a 3-hr cycle.	NGDBXO	51X,I5,13X
3	Starting and ending hours and mo/da/yr between which next cycle of data is valid.	TDT1,TDT2,IMN, IDAY1,IYR	34X,I7,3X,I7, 6X,A6,I3,A5
4	Text description. Begins surface K_z data section.	None	None
5 to 6	UTM-north, UTM-east lower left coordinates of zone where the given surface diffusivity coefficient applies. Note 0 fields for UTM coordinates to signal end of this section. SFKZG is given in cm^2/s.	UTMN,UTME,SFKZG	1X,2F9.3,E15.5
6	Text description.	None	None

Table C-6. (Continued)

Reference line in example, Fig. C-5 (card No.)	Description	Variables	Format
7 to 8	Begins transfer coefficient data section. UTM-north,UTM-east, lower left coordinates of zone of following transfer coefficients. Note there are six TRAN values (two lines) per zone. Zero field UTM's signal end of section. Units of TRAN are g/s.	UTMN,UTME,TRAN	1X,2F9.3,3E20.7/ 19X,3E20.7
8	Minimum inversion height of a zone... applies if a zone has been omitted from the list. Units are cm.	HINMIN	65X,F15.2
9	Begins section containing UTM-north, UTM-east coordinates of zone of applicability; average inversion base height (cm) at center of zone at beginning of period and end of period, atmospheric transmissivity value, and source multiplier flag. Note zero UTM-north value signals end of this section.	UTMN,UTME, HINVR1G,HINVR2G, WOIK2,SRMTC	1X,2F9.3,2F15.2, 5X,F5.2,2X,F5.1
10	Negative hour values signal end of QTRAN data.	Same as Card No. 3.	Same as Card No. 3.

Appendix D
Processing Routines for Source Emissions Data

D. M. Hardy

W. E. Johnston

INTRODUCTION

The primary factor in determining air quality is the quantity of pollutant emissions. Although meteorological factors can intensify or dilute the concentrations, without sources of undesirable species, there would be no anthropogenic contribution to air quality problems. And although ambient levels of various species resulting from natural processes or emissions can be important, in the urbanized region that this air quality model has been developed to treat, emissions from man-made devices are of primary importance.

To study air quality, therefore, it is important to develop a comprehensive inventory. The general approach is described in Chapter 6 of the Final Report. This appendix focuses on the methods used so that the codes developed to treat the data may be applied both to keep the source inventory up-to-date and to develop inventories for other times (for example; other seasons or other years) or for other regions.

The appendix is organized into several sections:

- General information about the source emissions data and the manner in which such data files are produced.
- The general method used to process data for a given source-origin.
- The combination of data for all source-origins to yield a data file (QSOR) for use in the LIRAQ model.
- A description of the separate processor codes which are required for each source-origin.

A FORTRAN listing of the processor codes on microfiche is included in this User's Guide as an attachment. The six source programs (FGEN, POINT, AIR, POP, VEHIC, and ADD) are stored in card image format on the IBM Data Cell at LBL.

By defining a few terms in Table D-1, we can greatly simplify the discussion in the remainder of this

Table D-1. Definition of terms for Appendix D.

Term	Definition
x and y coordinates	The location in Universal Transverse Mercator (UTM) coordinates of the lower left-hand corner (LLHC) of a square.
assignment square	A 1-km by 1-km square to which emissions are assigned in the input files of the processor codes.
emission grid square	A combination of one or more assignment squares to form another square (n km by n km) in size, where n is usually 1, 2 or 5.
emission period	The period of time for which specified emission rates are valid. The first period extends from 0000:00 to 0059:59. The 24th period extends from 2300:00 to 2359:59.
basic pollutants	Particulates, organics, nitrogen dioxide, sulfur dioxide, and carbon monoxide. These pollutants are associated with assignment squares.
final pollutants	Particulates, alkanes, alkenes, aldehydes, nitric oxide, sulfur dioxide, and carbon monoxide. These pollutants are associated with emission grid squares.

appendix. Three conventions employed by the Bay Area Air Pollution Control District (BAAPCD) in reporting data for basic pollutants should also be noted. Rates are usually reported in units of tons per day. Emissions of NO_x (largely NO) are reported as equivalent NO_2 emissions. All hydrocarbon emissions are designated as organics. One function of the processor codes, then, must be to formulate the inventory in terms appropriate for LIRAQ. Thus, those processor codes convert emission rates to g/s, normalize the equivalent NO_2 emissions to represent NO emissions (which may subsequently be converted to NO_2 by photochemical processes in LIRAQ-2), and subdivide the hydrocarbon emissions into three classes: alkanes, alkenes and aldehydes.

DATA PROCESSING REQUIREMENTS

Source emissions data for the LIRAQ model are needed for each hour of the day as area emissions in g/s. Such emissions must be based on emission grid squares defined by Universal Transverse Mercator (UTM) coordinates, and separated into elevated and ground-based sources.

Sets of source emission data, each component represented by a QSOR file,* have been constructed for different subregions within the Bay Area and for different size emission grid squares (1 km by 1 km, 2 km by 2 km, and 5 km by 5 km). Together, these files compose the QSOR library. The QSOR files contain data for seven pollutant types: particulates, alkanes, alkenes, aldehydes, nitric oxide, sulfur dioxide, and carbon monoxide. The current version of LIRAQ does not, however, use the sulfur dioxide or particulate emissions data.

The QSOR files are obtained by separately processing input data files for four source-origin types: airport, major-industrial, population-dependent, and vehicular. These processor codes exist primarily to transform basic data files into the appropriate form. The files processed can be very large, and for the coding as presently written, use as much as 750K 60-bit words of memory. All codes are written for a CDC 7600 computer and operate on the LBL Computer Center system. All coding is written in standard FORTRAN IV.

*The separate data files are identified by adding additional numbers to the filename, such that QSORabbcc means that this file is applicable to quarter a (1 = Jan-March) of year 19bb for region cc, where the region designation is given in Table 1 of the main section of this report.

Execution time is quite rapid, so that computer time to construct a typical QSOR file is not a major concern. Construction of the various input data files that are used to generate the QSOR files, however, can be time consuming in terms of machine and personnel time. A flow chart summary of the procedure used to create a QSOR file is given in Fig. D-1.

SOURCE-ORIGINS

Four pollutant source-origins are treated. The primary data for each differ in content and format. In each case, however, data for the five basic pollutants are input. The organic emissions are always then subdivided into three types: alkanes, alkenes, and aldehydes. This results in output of data for seven, rather than five, pollutants. In addition, emissions of nitrogen dioxide, the chemical available in the BAAPCD data, are multiplied by a scaling factor to convert them to equivalent nitric oxide for use in the LIRAQ-2 model.

All pollutants are assumed to be emitted at ground level except some of those from major industrial operations. Ground level emissions are intended to include all emissions that will affect air quality in the range of several kilometres from the emission site. For this study,

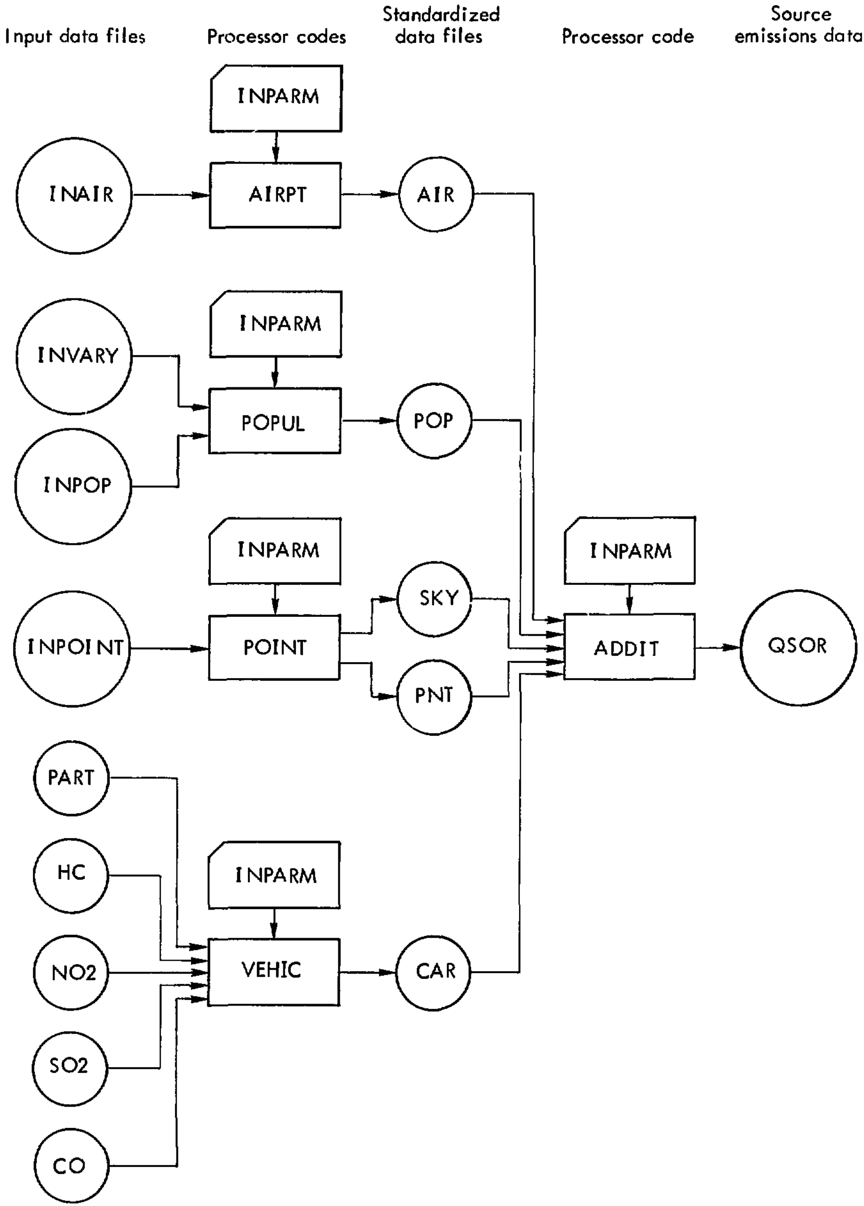

Fig. D-1. Schematic flow chart of steps followed in generating a QSOR file.

this has been defined as including those emissions 30.5 m (100 ft) or less above local topography. Using this criterion, emissions from some of the strong point sources must be divided into both ground-based and elevated emissions.

For each source-origin, a file in a standardized format is generated. These files contain 24 blocks of information, each arranged into 9 columns. Each block is associated with an hour of the day, the first block corresponding to the first emission period (from 0000:00 to 0059:59) The nine columns of information contain the x and y coordinates of the emission grid square and the emission rates for the seven pollutants in g/s. Data for the seven pollutants are listed in the following order, proceeding from left to right: particulates, alkanes, alkenes, aldehydes, nitric oxide, sulfur dioxide, and carbon monoxide. A data line in which two zeroes are substituted for the x and y coordinates of the emission grid square followed by seven blank columns of information is used to mark the end of each hourly block.

The format for these data is (1X, I4, 1X, I4 7E10.3), so that each data line represents an 80-column card image. The individual processors used to create these standard-format files are described in a later section. Figure D-2 shows a portion of such a standard-format file.

COMBINATION OF SOURCE-ORIGIN DATA

The standard-format files described in the previous section are combined to form a final QSOR file. There are only two differences in form between a QSOR file and the standardized source-origin files. First, the QSOR file contains alphabetic and numeric "header" information to describe the file contents and to identify the period of time for which the data are valid. Second, for each hour of the day, the elevated emissions data are first presented and then the ground-based emissions data. A (zero,zero) record is inserted in columns 5 and 10 to mark the end of each emission period for elevated and ground-based data, so that there is a total of 48 such records in the complete 24-hr QSOR file. The LIRAQ model uses these (zero,zero) records to determine the end of the data records for each emission period.

The format for the emissions data in the QSOR file is (1X, I4, 1X, I4, 7E10.3). A portion of a final QSOR file is shown in Fig. D-3.

PROCESSOR CODES

Five individual processor codes are used: AIRPT, POINT, POPUL, VEHIC, and ADDIT. Each processor code requires input values for some or all

581	4163	.898E-01	.519E+00	.225E+00	.310E-01	.109E+01	.347E-01	.429E+01
581	4164	.906E-01	.517E+00	.224E+00	.302E-01	.104E+01	.394E-01	.421E+01
582	4118	.412E-04	.301E-03	.130E-03	.179E-04	.431E-03	.159E-04	.259E-02
582	4119	.219E-04	.160E-03	.691E-04	.953E-05	.229E-03	.845E-05	.137E-02
582	4123	.203E-02	.148E-01	.640E-02	.883E-03	.212E-01	.783E-03	.127E+00
582	4124	.390E-03	.308E-02	.133E-02	.184E-03	.394E-02	.151E-03	.271E-01
582	4125	.632E-03	.459E-02	.200E-02	.261E-03	.580E-02	.270E-03	.386E-01
582	4126	.259E-03	.148E-02	.659E-03	.693E-04	.178E-02	.137E-03	.104E-01
582	4128	.112E-04	.120E-03	.521E-04	.718E-05	.971E-04	.433E-05	.115E-02
582	4129	.329E-03	.353E-02	.153E-02	.211E-03	.285E-02	.127E-03	.337E-01
582	4130	.726E-02	.495E-01	.220E-01	.235E-02	.410E-01	.398E-02	.384E+00
582	4131	.187E-01	.120E+00	.527E-01	.649E-02	.172E+00	.855E-02	.977E+00
582	4132	.417E-01	.278E+00	.121E+00	.161E-01	.440E+00	.171E-01	.235E+01
582	4133	.991E-02	.383E-01	.179E-01	.101E-02	.434E-01	.632E-02	.162E+00
582	4134	.216E-01	.168E+00	.733E-01	.937E-02	.182E+00	.961E-02	.144E+01
582	4135	.552E-01	.302E+00	.132E+00	.172E-01	.621E+00	.230E-01	.240E+01
582	4136	.670E-01	.394E+00	.171E+00	.229E-01	.768E+00	.270E-01	.324E+01
582	4137	.101E+00	.685E+00	.298E+00	.392E-01	.104E+01	.424E-01	.580E+01
582	4138	.897E-01	.614E+00	.267E+00	.356E-01	.930E+00	.367E-01	.522E+01
582	4139	.521E-01	.340E+00	.147E+00	.203E-01	.587E+00	.201E-01	.294E+01
582	4140	.878E-01	.492E+00	.214E+00	.287E-01	.103E+01	.352E-01	.401E+01
582	4152	.269E-03	.621E-03	.306E-03	0.	.387E-03	.351E-03	.494E-03
582	4153	.858E-02	.701E-01	.303E-01	.419E-02	.858E-01	.331E-02	.626E+00
582	4154	.548E-02	.398E-01	.172E-01	.237E-02	.576E-01	.212E-02	.342E+00
582	4158	.713E-03	.163E-02	.812E-03	0.	.102E-02	.935E-03	.132E-02
582	4161	.646E-01	.352E+00	.153E+00	.198E-01	.678E+00	.332E-01	.276E+01
582	4162	.114E+00	.711E+00	.308E+00	.424E-01	.133E+01	.438E-01	.601E+01
582	4163	.312E-01	.256E+00	.111E+00	.149E-01	.292E+00	.144E-01	.230E+01
582	4164	.148E-01	.116E+00	.507E-01	.621E-02	.935E-01	.103E-01	.997E+00
583	4117	.459E-04	.334E-03	.145E-03	.200E-04	.480E-03	.177E-04	.288E-02
583	4118	.172E-04	.126E-03	.544E-04	.750E-05	.180E-03	.666E-05	.108E-02
583	4123	.296E-02	.255E-01	.110E-01	.152E-02	.288E-01	.114E-02	.230E+00
583	4124	.163E-03	.129E-02	.559E-03	.770E-04	.165E-02	.631E-04	.113E-01
583	4130	.137E-01	.102E+00	.450E-01	.532E-02	.923E-01	.682E-02	.839E+00
583	4131	.181E-01	.107E+00	.461E-01	.636E-02	.216E+00	.698E-02	.895E+00
583	4132	.921E-01	.514E+00	.223E+00	.297E-01	.106E+01	.375E-01	.413E+01
583	4133	.685E-01	.398E+00	.174E+00	.225E-01	.735E+00	.290E-01	.320E+01
583	4134	.107E+00	.775E+00	.336E+00	.454E-01	.113E+01	.432E-01	.671E+01
583	4135	.222E-01	.112E+00	.494E-01	.574E-02	.216E+00	.104E-01	.812E+00
583	4136	.266E-02	.748E-02	.368E-02	0.	.686E-02	.190E-02	.579E-02
583	4137	.447E-01	.341E+00	.148E+00	.196E-01	.421E+00	.188E-01	.296E+01
583	4138	.567E-01	.438E+00	.190E+00	.261E-01	.595E+00	.219E-01	.389E+01
583	4139	.187E-01	.967E-01	.424E-01	.522E-02	.197E+00	.831E-02	.727E+00
583	4140	.871E-01	[illegible]	.155E+00	.185E-01	.714E+00	.279E-01	.267E+01
583	4141	.277E-01	.370E-01	.158E-01	0.	.199E-01	.378E-02	.116E+00
583	4142	.277E-01	.320E-01	.158E-01	0.	.199E-01	.378E-02	.116E+00
583	4153	.625E-02	.671E-01	.291E-01	.401E-02	.541E-01	.241E-02	.641E+00
583	4154	.119E-01	.863E-01	.380E-01	.447E-02	.675E-01	.911E-02	.725E+00
583	4155	.823E-02	.851E-01	.368E-01	.508E-02	.728E-01	.318E-02	.802E+00
583	4156	.675E-04	.725E-03	.314E-03	.433E-04	.585E-03	.261E-04	.692E-02
583	4159	.264E-01	.147E+00	.636E-01	.878E-02	.325E+00	.102E-01	.121E+01
583	4160	.760E-01	.433E+00	.187E+00	.258E-01	.927E+00	.294E-01	.357E+01
583	4161	.556E-01	.339E+00	.147E+00	.196E-01	.594E+00	.257E-01	.277E+01
583	4163	.755E-02	.811E-01	.351E-01	.484E-02	.654E-01	.292E-02	.774E+00
583	4164	.166E-01	.171E+00	.741E-01	.102E-01	.146E+00	.640E-02	.161E+01
584	4116	.505E-04	.368E-03	.159E-03	.220E-04	.528E-03	.195E-04	.317E-02
584	4117	.126E-04	.917E-04	.397E-04	.548E-05	.132E-03	.486E-05	.789E-03
584	4122	.208E-04	.585E-04	.288E-04	0.	.538E-04	.149E-04	.453E-04
584	4123	.207E-02	.216E-01	.935E-02	.129E-02	.181E-01	.798E-03	.205E+00
584	4125	.183E-02	.514E-02	.253E-02	0.	.472E-02	.131E-02	.398E-02
584	4129	.110E-01	.311E-01	.153E-01	0.	.285E-01	.787E-02	.239E-01
584	4130	.251E-01	.255E+00	.110E+00	.152E-01	.223E+00	.970E-02	.239E+01

Fig. D-2. Standard format source-origin data file (partial listing). Files of this type are output from the codes AIRPT, POINT, POPUL, and VEHIC.

```
INPUT FORMAT FOR  7 COLUMNS OF ELEVATED SOURCE DATA   (1X,I4,I5,7E10.3)
INPUT FORMAT FOR  7 COLUMNS OF  SURFACE SOURCE DATA   (1X,I4,I5,7E10.3)
THE FOLLOWING DATA SET IS VALID BETWEEN THE HOURS OF   0 TO   1
ELEVATED SOURCE DATA
 580 4130  .262E+00 0.        0.        0.        .571E+01 0.        0.
 583 4152  .875E-01 0.        0.        0.        .285E-01 0.        0.
 584 4162 0.        0.        0.        0.       0.        0.        .437E-01
 588 4160 0.        0.        0.        0.        .696E-01 0.        0.
 593 4135  .437E-01  .293E-01  .144E-01 0.        .285E-01 0.        0.
   0    0
SURFACE SOURCE DATA
 542 4154  .476E-02  .468E-01  .203E-01  .280E-02  .427E-01  .184E-02  .435E+00
 542 4155  .439E-02  .432E-01  .187E-01  .258E-02  .394E-01  .170E-02  .401E+00
 542 4156  .314E-02  .309E-01  .134E-01  .185E-02  .282E-01  .122E-02  .287E+00
 543 4152  .659E-02  .332E-01  .148E-01  .159E-02  .279E-01  .221E-02  .253E+00
 543 4153  .689E-02  .551E-01  .240E-01  .313E-02  .493E-01  .253E-02  .489E+00
 543 4154  .434E-02  .117E-01  .547E-02  .312E-03  .838E-02  .135E-02  .544E-01
 543 4156  .202E-02  .198E-01  .859E-02  .118E-02  .181E-01  .779E-03  .184E+00
 543 4157  .618E-02  .607E-01  .263E-01  .363E-02  .554E-01  .238E-02  .564E+00
 543 4158  .618E-02  .607E-01  .263E-01  .363E-02  .554E-01  .238E-02  .564E+00
 543 4159  .632E-02  .610E-01  .264E-01  .363E-02  .555E-01  [illegible]  .564E+00
 543 4160  .106E-01  .834E-01  .363E-01  .478E-02  .832E-01  .395E-02  .732E+00
 543 4161  .915E-04  .900E-03  .389E-03  .537E-04  .820E-03  .353E-04  .835E-02
 544 4151  .198E-02  .192E-01  .832E-02  .114E-02  .175E-01  .761E-03  .178E+00
 544 4152  .241E-02  .237E-01  .102E-01  .141E-02  .216E-01  .930E-03  .220E+00
 544 4156  .640E-03  .109E-02  .539E-03 0.        .609E-03  .192E-03  .996E-03
 544 4160  .244E-01  .417E-01  .205E-01 0.        .232E-01  .734E-02  .380E-01
 544 4161  .835E-02  .767E-01  .332E-01  .458E-02  .779E-01  .323E-02  .699E+00
 544 4162  .235E-02  .232E-01  .100E-01  .138E-02  .211E-01  .910E-03  .215E+00
 544 4164  .313E-02  .540E-02  .266E-02 0.        .299E-02  .946E-03  .490E-02
 545 4150  .132E-02  .130E-01  .564E-02  .778E-03  .119E-01  .512E-03  .121E+00
 545 4151  .316E-02  .311E-01  .135E-01  .186E-02  .283E-01  .122E-02  .289E+00
 545 4158  .368E-05  .631E-05  .311E-05 0.        .349E-05  .110E-05  .573E-05
 545 4159  .947E-02  .162E-01  .800E-02 0.        .901E-02  .285E-02  .147E-01
 545 4160  .111E-01  .191E-01  .940E-02 0.        .106E-01  .335E-02  .174E-01
 545 4162  .155E-01  .820E-01  .364E-01  .401E-02  .694E-01  .524E-02  .637E+00
 545 4163  .355E-01  .312E+00  .135E+00  .183E-01  .299E+00  .135E-01  .281E+01
 545 4164  .380E-01  .235E+00  .102E+00  .138E-01  .420E+00  .145E-01  .195E+01
 546 4149  .248E-02  .244E-01  .106E-01  .146E-02  .222E-01  .959E-03  .226E+00
 546 4150  .324E-02  .318E-01  .138E-01  .190E-02  .290E-01  .125E-02  .296E+00
 546 4160  .113E-01  .193E-01  .953E-02 0.        .107E-01  .340E-02  .175E-01
 547 4148  .374E-02  .367E-01  .159E-01  .219E-02  .335E-01  .144E-02  .341E+00
 547 4149  .198E-02  .195E-01  .844E-02  .116E-02  .178E-01  .766E-03  .181E+00
 547 4150  .541E-02  .926E-02  .456E-02 0.        .515E-02  .163E-02  .844E-02
 547 4152  .216E-02  .370E-02  .182E-02 0.        .205E-02  .650E-03  .336E-02
 547 4158  .282E-02  .484E-02  .238E-02 0.        .269E-02  .851E-03  .440E-02
 547 4164  .242E-02  .414E-02  .204E-02 0.        .230E-02  .728E-03  .377E-02
 548 4146  .792E-03  .670E-02  .290E-02  .400E-03  .777E-02  .306E-03  .602E-01
 548 4147  .446E-02  .439E-01  .190E-01  .262E-02  .400E-01  .172E-02  .408E+00
 548 4148  .729E-03  .717E-02  .310E-02  .428E-03  .654E-02  .282E-03  .665E-01
 548 4164  .795E-02  .136E-01  .672E-02 0.        .757E-02  .240E-02  .125E-01
 549 4142  .555E-02  .405E-01  .175E-01  .242E-02  .581E-01  .214E-02  .348E+00
 549 4143  .565E-02  .412E-01  .178E-01  .246E-02  .591E-01  .218E-02  .354E+00
 549 4144  .801E-02  .638E-01  .276E-01  .381E-02  .808E-01  .309E-02  .563E+00
 549 4145  .745E-02  .577E-01  [illegible]  .344E-02  .763E-01  .288E-02  .507E+00
 549 4146  .191E-01  .158E+00  .663E-01  .942E-02  .189E+00  .739E-02  .139E+01
 549 4147  .304E-02  .246E-01  .106E-01  .147E-02  .300E-01  .117E-02  .211E+00
 549 4161  .221E-04  .378E-04  .186E-04 0.        .210E-04  .664E-05  .343E-04
 549 4163  .101E-01  .173E-01  .852E-02 0.        .962E-02  .304E-02  .157E-01
 549 4164  .333E-01  .149E+00  .658E-01  .736E-02  .226E+00  .116E-01  .107E+01
 550 4137  .112E-02  .817E-02  .353E-02  .488E-03  .117E-01  .433E-03  .703E-01
```

Fig. D-3. Example of a partial listing of a final QSOR file to be used with the LIRAQ model.

of the following parameters: ESW, NSW, DELTA, IMAX, JMAX, IH1, IH2, ORG2, ORG3, ORG4, and SEASON. Code ADDIT does not use the values specified for ORG2, ORG3, and ORG4, and the only code that uses SEASON is POINT. These data are given in the input file INPARM and are read free-form by the subroutine FFINP, which is included with the codes. For use by FFINP, the parameters must be punched, one per card, anywhere in columns 1 to 72. These cards must be in the order indicated by the above list of parameters. The data punched on these cards must be blank delimited (both sides), but may be punched using a fixed-point (integer), floating-point, or exponential format. Descriptive text may be punched with the data. Such text is optional and will be ignored, but may not contain the following characters:
0 1 2 3 4 5 6 7 8 9 . + - * " / # .
The parameters ESW and NSW are the x and y values in UTM coordinates of the lower left-hand corner of the region to be processed. DELTA is the grid size to be used (usually 1, 2, or 5 km). IMAX and JMAX give the number of grid intervals to be used in the east-west and north-south directions, respectively. A maximum of 65 is allowed for each. Therefore, a region of size (IMAX*DELTA) km by (JMAX*DELTA) km is processed, with upper right-hand corner coordinates of ESW + (JMAX*DELTA), NSW + (JMAX*DELTA). IH1 and IH2 are the beginning and ending emission periods to be processed (where period 1 = 0000 hr to 0100 hrs and period 24 = 2300 to 2400). ORG2, ORG3 and ORG4 are the fractions into which the organic emissions will be divided to yield alkanes, alkenes and aldehydes. SEASON specifies the season of operation for the major point sources, usually assumed to be season three. INPARM is common to all processor codes. Different values for ORG2, ORG3, ORG4 are, however, used with the code VEHIC.

Code AIRPT

Code AIRPT processes airport emissions data into the standard format described earlier. Part of an input file (INAIR) for AIRPT is shown in Fig. D-4, along with the INPARM file.

Each group of records in INAIR contains all of the data needed to describe a single airport. Each data record for a given airport begins with four alphabetic characters that identify the data with that airport. The first record of each group of records gives the number of assignment squares to which the emissions will be assigned, followed by the emissions, in tons per day, of the

```
ALAM 07  0.33  0.74  0.41  0.04  2.23
ALAM 0.83 0.83 0.83 0.83 0.83 0.83 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50 7.50
ALAM 7.50 7.50 7.50 0.83 0.83 0.83 0.83 0.83 0.83
ALAM 559 4181
ALAM 560 4181
ALAM 561 4181
ALAM 559 4182
ALAM 560 4182
ALAM 561 4182
ALAM 559 4183
BUCH 04  0.04  0.28  0.09  0.01  1.36
BUCH 0.00 0.00 0.00 0.00 3.33 3.33 6.66 6.66 6.66 6.66 6.66 6.66 6.66 6.66 6.66
BUCH 6.66 6.66 6.66 3.33 3.33 3.33 3.33 0.00 0.00
BUCH 582 4204
BUCH 583 4204
BUCH 582 4205
BUCH 583 4205
```

(a) AIRPT data input file INAIR (partial listing)

```
MODEL AREA  UTM LOWER LEFT CORNER( E$W COORD)= 540 (DATA CARD ONE$REGION SIX)
MODEL AREA  UTM LOWER LEFT CORNER(N$S COORD)= 4100 (DATA CARD TWO$REGION SIX)
MODEL SQUARE SIZE= 1                               (DATA CARD THREE$REGION SIX)
NUMBER OF MODEL SQUARES  E$W DIRECTION= 65         (DATA CARD FOUR$REGION SIX)
NUMBER OF MODEL SQUARES  N$S DIRECTION= 65         (DATA CARD FIVE$REGION SIX)
STARTING PERIOD= 1                                 (DATA CARD SIX$REGION SIX)
STOPPING PERIOD= 24                                (DATA CARD SEVEN$REGION SIX)
ORGTWO= 0.67                                       (DATA CARD EIGHT$REGION SIX)
ORGTHREE= 0.33                                     (DATA CARD NINE$REGION SIX)
ORGFOUR= 0.00                                      (DATA CARD TEN$REGION SIX)
```

(b) AIRPT parameter file INPARM (complete listing)

Fig. D-4. Listing of sample data for input to code AIRPT.

five basic pollutants [FORMAT (6X, I2, 5F6.2)]. The next two records give the <u>percent</u> of the daily total emitted for each hour of the day [FORMAT (5X, 15F5.2/5X, 9F5.2)]. The following records list the x and y coordinates of each assignment square [FORMAT (5X, I4, I5)].

The AIRPT processor converts the emissions from tons per day to grams per second, divides emissions equally among the specified assignment squares, adjusts emissions for variation throughout the day, assigns and totals these emissions for emission grid squares as defined by ESW, NSW, and DELTA, and outputs the results for all periods between IH1 and IH2 in the standard format as file AIR.

<u>Code POINT</u>

Code POINT processes major industrial emissions. Part of an input file (INPOINT) for POINT is shown in Fig. D-5, along with the INPARM file.

```
564 4235 1 0.20 100            20 30 30 20 5 5 5 5 0817 0817 0817 0817
564 4235 4 0.40 100            20 30 30 20 5 5 5 5 0817 0817 0817 0817
607 4207 1 0.10 100            25 25 25 25 5 5 5 5 0816 0816 0816 0816
602 4128 2 2.2  100            10 40 40 10 5 5 5 5 0817 0817 0817 0817
602 4128 5 0.7  100            10 40 40 10 5 5 5 5 0817 0817 0817 0817
562 4181 1 0.3  100            25 25 25 25 7 7 7 7 0618 0618 0618 0618
562 4181 2   0.5 100           25 25 25 25 7 7 7 7 0618 0618 0618 0618
562 4181 3   0.3 100           25 25 25 25 7 7 7 7 0618 0618 0618 0618
562 4181 5   0.9 100           25 25 25 25 7 7 7 7 0618 0618 0618 0618
569 4212 1   0.4 100           25 25 25 25 5 5 5 5 0024 0024 0024 0024
569 4212 3   2.4 100           25 25 25 25 5 5 5 5 0024 0024 0024 0024
566 4208 1   1.2  20 80        25 25 25 25 7 7 7 7 0024 0024 0024 0024
566 4208 3   1.0     100       25 25 25 25 7 7 7 7 0024 0024 0024 0024
566 4208 4   4.6     100       25 25 25 25 7 7 7 7 0024 0024 0024 0024
598 4141 2   7.4 100           25 25 25 25 6 6 6 6 0624 0624 0624 0624
595 4121 2   0.1 100           10 40 40 10 5 5 5 5 1113 0915 0915 1113
595 4121 5   2.0 100           10 40 40 10 5 5 5 5 1113 0915 0915 1113
568 4180 1   0.6     100       25 25 25 25 7 7 7 7 0024 0024 0024 0024
568 4180 3   4.7     100       25 25 25 25 7 7 7 7 0024 0024 0024 0024
568 4180 4   0.3     100       25 25 25 25 7 7 7 7 0024 0024 0024 0024
```

(a) POINT data input file INPNT (partial listing)

```
MODEL AREA  UTM LOWER LEFT CORNER( E$W COORD)= 540 (DATA CARD ONE$REGION SIX)
MODEL AREA  UTM LOWER LEFT CORNER(N$S COORD)= 4100 (DATA CARD TWO$REGION SIX)
MODEL SQUARE SIZE= 1                               (DATA CARD THREE$REGION SIX)
NUMBER OF MODEL SQUARES  E$W DIRECTION= 65         (DATA CARD FOUR$REGION SIX)
NUMBER OF MODEL SQUARES  N$S DIRECTION= 65         (DATA CARD FIVE$REGION SIX)
STARTING PERIOD= 1                                 (DATA CARD SIX$REGION SIX)
STOPPING PERIOD= 24                                (DATA CARD SEVEN$REGION SIX)
ORGTWO= 0.67                                       (DATA CARD EIGHT$REGION SIX)
ORGTHREE= 0.33                                     (DATA CARD NINE$REGION SIX)
ORGFOUR= 0.00                                      (DATA CARD TEN$REGION SIX)
SEASON= 3          POINT                           (DATA CARD ELEVEN$REGION SIX)
```

(b) POINT parameter file INPARM (complete listing)

Fig. D-5. Listing of sample data for input to code POINT.

One or more data records are used to describe each major source. Each data record includes the x and y coordinates of an assignment square, an index to identify the basic pollutant, the quantity emitted in tons per day, the percent emitted in each of six successive 30.5-m (100-ft) intervals above ground, the percent emitted during each quarter of the year, the number of days per week of operation by quarter, and the start and stop hours of the emissions during a day, using FORMAT (1X,I3,1X,I4,1X,I1,1X,F4.1,1X,I13,25X,I2,8X,I1,13X,2I2). The first quarter consists of January, February, March.

The POINT processor uses these parameters to normalize emissions for quarter, day-of-the-week, and hour-of-the-day variations and to assign and total emissions for

(a) POPUL data input file INPOP (partial listing)

```
4090622 2.39E-02 2.18E-01 5.70E-02 1.01E-02 7.08E-02
4091625 1.87E-02 1.71E-01 4.47E-02 7.88E-03 5.55E-02
4092631 1.28E-01 1.17E+00 3.06E-01 5.40E-02 3.80E-01
4094628 1.05E-02 9.58E-02 2.50E-02 4.42E-03 3.11E-02
4094649 1.59E-02 1.45E-01 3.80E-02 6.71E-03 4.72E-02
4095627 1.98E-01 1.81E+00 4.72E-01 8.33E-02 5.86E-01
4096626 3.11E-01 2.84E+00 7.43E-01 1.31E-01 9.23E-01
4096627 2.75E-01 2.52E+00 6.58E-01 1.16E-01 8.18E-01
4097625 3.84E-01 3.51E+00 9.19E-01 1.62E-01 1.14E+00
```

(b) INPUT data file INVARY (complete listing)

```
1.65 1.65 1.65 1.65 1.65 1.65 1.70 1.70 8.28 8.28 8.28 8.28 8.28 8.28 8.28 8.28
8.28 1.99 1.73 1.73 1.73 1.73 1.65 1.65
0.75 0.75 0.75 0.75 0.75 0.75 2.49 2.49 9.01 9.01 9.01 9.01 9.01 9.01 9.01 9.01
9.01 2.74 0.98 0.98 0.98 0.98 0.75 0.75
2.73 2.73 2.73 2.73 2.73 2.73 3.05 3.05 6.19 6.19 6.19 6.19 6.19 6.19 6.19 6.19
6.19 4.29 3.00 3.00 3.00 3.00 2.73 2.73
2.79 2.79 2.79 2.79 2.79 2.79 2.91 2.91 6.20 6.20 6.20 6.20 6.20 6.20 6.20 6.20
6.20 3.84 3.06 3.06 3.06 3.06 2.79 2.79
1.21 1.21 1.21 1.21 1.21 1.21 3.30 3.30 7.98 7.98 7.98 7.98 7.98 7.98 7.98 7.98
7.98 6.77 1.30 1.30 1.30 1.30 1.21 1.21
```

(c) POPUL parameter file INPARM (complete listing)

```
MODEL AREA  UTM LOWER LEFT CORNER( E$W COORD)= 540 (DATA CARD ONE$REGION SIX)
MODEL AREA  UTM LOWER LEFT CORNER(N$S COORD)= 4100 (DATA CARD TWO$REGION SIX)
MODEL SQUARE SIZE= 1                               (DATA CARD THREE$REGION SIX)
NUMBER OF MODEL SQUARES  E$W DIRECTION= 65         (DATA CARD FOUR$REGION SIX)
NUMBER OF MODEL SQUARES  N$S DIRECTION= 65         (DATA CARD FIVE$REGION SIX)
STARTING PERIOD= 1                                 (DATA CARD SIX$REGION SIX)
STOPPING PERIOD= 24                                (DATA CARD SEVEN$REGION SIX)
ORGTWO= 0.67                                       (DATA CARD EIGHT$REGION SIX)
ORGTHREE= 0.33                                     (DATA CARD NINE$REGION SIX)
ORGFOUR= 0.00                                      (DATA CARD TEN$REGION SIX)  =
```

Fig. D-6. Listing of sample data for input to code POPUL.

appropriate emission grid squares. The data are also converted to units of grams per second. Emissions are divided into elevated and ground-based, where elevated emissions are taken to be those at least 30.5 m (100 ft) above ground. These data are output as two separate files, SKY and PNT, each ' the standard form. File SKY contains all elevated emissions data.

Code POPUL

Code POPUL processes population-dependent emissions. Input files INVARY, INPOP, and INPARM are used by POPUL. Figure D-6 shows parts of these files.

A record group in INPOP consists of a single data record. The first file shown (INVARY) gives the variation by period of the day in percent for the five basic pollutants [FORMAT

(16F5.2/8F5.2)]. The second file gives the y and x coordinates, respectively, of the assignment square and the emission rates for the five basic pollutants in grams per second (FORMAT I4, I3, 5E9.2).

The POPUL processor assigns an hourly variation to the emissions based upon the data given in INVARY, assigns and totals emissions for the appropriate emission grid squares, and produces a standard format file POP containing these results.

Code VEHIC

Code VEHIC processes vehicular-dependent emissions, which have been generated as described in Appendix J. Five input files corresponding to the five basic pollutants are merged into one file. The input data files are names PART, HC, NO2, SO2, and CO. These files contain data for particulates, hydrocarbons, nitrogen dioxide, sulfur dioxide and carbon monoxide, respectively. Part of such a file is shown in Fig. D-7, along with the INPARM file used with the code VEHIC.

Each input file has the same form and contains the results of extensive traffic modeling and vehicular emissions calculations. An input record group contains data for the x and y coordinates of an assignment square and the total emissions in grams for that square for each period of the day [FORMAT (//11X,I3,5X,I4,8E12.3/23X,8E12.3/23X,8E12.3)]. In addition, the data labeled VM and VH give the total number of vehicle-miles and vehicle-hours assigned to the square, respectively.

The VEHIC processor assigns and totals data for appropriate emission grid squares and produces a standard format file CAR. Data are input into VEHIC for all 24 hr of the day at once, but output in hour-by-hour blocks. The large number of assignment squares for which data of five types are stored for 24 hr of the day results in very large data storage requirements.

Code ADDIT

Code ADDIT combines the standard-format files produced by AIRPT, POINT, POPUL, and VEHIC into a single file of similar form named QSOR for use by the LIRAQ models. Emissions from the four source-origins that occur in the same emission grid square are added for each emission period. Elevated and surface emissions remain distinct. Alphabetic descriptive information is also written into the QSOR output file. Figure D-3 gives an example of a final QSOR file, and Fig. D-8 shows the INPARM parameter file used with ADDIT.

Code FGEN

Code FGEN reads the binary tape TOTHIST (which is the primary

(a) VEHIC input data file PART (partial listing). There are five such files, one for each basic pollutant type. These files are created by the code FGEN. The first part of the PART file is illustrated. This file contains data for particulate emissions.

```
 STUDY YEAR     1973           EMISSION  HYDROCARBONS

2   X=   629 Y=  4086   1.839E+02  1.103E+02  5.516E+01  1.839E+01  5.516E+01  5.516E+01  3.125E+02  1.085E+03
 VM=  5037 VH=    78    1.140E+03  6.435E+02  8.273E+02  9.928E+02  1.066E+03  9.744E+02  1.158E+03  1.471E+03
                        1.544E+03  1.471E+03  1.287E+03  1.416E+03  9.376E+02  7.354E+02  4.964E+02  3.493E+02

2   X=   629 Y=  4087   3.762E+02  2.257E+02  1.129E+02  3.762E+01  1.129E+02  1.129E+02  6.395E+02  2.220E+03
 VM= 10307 VH=   159    2.332E+03  1.317E+03  1.693E+03  2.031E+03  2.182E+03  1.994E+03  2.370E+03  3.010E+03
                        3.160E+03  3.010E+03  2.633E+03  2.897E+03  1.919E+03  1.505E+03  1.016E+03  7.148E+02

2   X=   629 Y=  4088   3.762E+02  2.257E+02  1.129E+02  3.762E+01  1.129E+02  1.129E+02  6.395E+02  2.220E+03
 VM= 10307 VH=   159    2.332E+03  1.317E+03  1.693E+03  2.031E+03  2.182E+03  1.994E+03  2.370E+03  3.010E+03
                        3.160E+03  3.010E+03  2.633E+03  2.897E+03  1.919E+03  1.505E+03  1.016E+03  7.148E+02

2   X=   628 Y=  4089   1.094E+02  6.566E+01  3.283E+01  1.094E+01  3.283E+01  3.283E+01  1.860E+02  6.457E+02
 VM=  2998 VH=    46    6.785E+02  3.830E+02  4.925E+02  5.909E+02  6.347E+02  5.800E+02  6.894E+02  8.755E+02
                        9.193E+02  8.755E+02  7.660E+02  8.426E+02  5.581E+02  4.377E+02  2.955E+02  2.079E+02

2   X=   629 Y=  4089   3.043E+02  1.826E+02  9.129E+01  3.043E+01  9.129E+01  9.129E+01  5.173E+02  1.795E+03
 VM=  8118 VH=   132    1.887E+03  1.065E+03  1.369E+03  1.643E+03  1.765E+03  1.613E+03  1.917E+03  2.434E+03
                        2.556E+03  2.434E+03  2.130E+03  2.343E+03  1.552E+03  1.217E+03  8.216E+02  5.781E+02

2   X=   632 Y=  4089   3.035E+01  1.821E+01  9.104E+00  3.035E+00  9.104E+00  9.104E+00  5.159E+01  1.790E+02
 VM=   634 VH=    16    1.881E+02  1.062E+02  1.366E+02  1.639E+02  1.760E+02  1.608E+02  1.912E+02  2.428E+02
                        2.549E+02  2.428E+02  2.124E+02  2.337E+02  1.548E+02  1.214E+02  8.193E+01  5.766E+01

2   X=   628 Y=  4090   1.919E+02  1.152E+02  5.758E+01  1.919E+01  5.758E+01  5.758E+01  3.263E+02  1.132E+03
 VM=  5121 VH=    83    1.190E+03  6.718E+02  8.637E+02  1.036E+03  1.113E+03  1.017E+03  1.209E+03  1.536E+03
                        1.612E+03  1.536E+03  1.344E+03  1.478E+03  9.789E+02  7.678E+02  5.182E+02  3.647E+02

2   X=   629 Y=  4090   2.372E+02  1.423E+02  7.115E+01  2.372E+01  7.115E+01  7.115E+01  4.032E+02  1.399E+03
 VM=  6327 VH=   103    1.470E+03  8.301E+02  1.067E+03  1.281E+03  1.376E+03  1.257E+03  1.494E+03  1.897E+03
                        1.992E+03  1.897E+03  1.660E+03  1.826E+03  1.210E+03  9.487E+02  6.404E+02  4.506E+02

2   X=   631 Y=  4090   1.766E+02  1.060E+02  5.298E+01  1.766E+01  5.298E+01  5.298E+01  3.002E+02  1.042E+03
 VM=  3699 VH=    92    1.095E+03  6.181E+02  7.947E+02  9.536E+02  1.024E+03  9.360E+02  1.113E+03  1.413E+03
                        1.483E+03  1.413E+03  1.236E+03  1.360E+03  9.007E+02  7.064E+02  4.768E+02  3.355E+02
```

Fig. D-7. Listing of sample data for input to code VEHIC.

```
2   X=   632 Y=  4090   8.789E+01   5.273E+01   2.637E+01   8.789E+00   2.637E+01   2.637E+01   1.494E+02   5.186E+02
  VM=  1841 VH=    46   5.449E+02   3.076E+02   3.955E+02   4.746E+02   5.098E+02   4.658E+02   5.537E+02   7.031E+02
                        7.383E+02   7.031E+02   6.152E+02   6.768E+02   4.482E+02   3.516E+02   2.373E+02   1.670E+02

2   X=   628 Y=  4091   3.766E+02   2.260E+02   1.130E+02   3.766E+01   1.130E+02   1.130E+02   6.403E+02   2.222E+03
  VM=  9868 VH=   166   2.335E+03   1.318E+03   1.695E+03   2.034E+03   2.184E+03   1.996E+03   2.373E+03   3.013E+03
                        3.164E+03   3.013E+03   2.636E+03   2.900E+03   1.921E+03   1.507E+03   1.017E+03   7.156E+02

2   X=   629 Y=  4091   3.357E+02   2.014E+02   1.007E+02   3.357E+01   1.007E+02   1.007E+02   5.707E+02   1.981E+03
  VM=  7918 VH=   161   2.081E+03   1.175E+03   1.511E+03   1.813E+03   1.947E+03   1.779E+03   2.115E+03   2.686E+03
                        2.820E+03   2.686E+03   2.350E+03   2.585E+03   1.712E+03   1.343E+03   9.065E+02   6.379E+02
```

(b) VEHIC parameter file INPARM (complete listing)

```
MODEL AREA  UTM LOWER LEFT CORNER( E$W COORD)= 540 (DATA CARD ONE$REGION SIX)
MODEL AREA  UTM LOWER LEFT CORNER(N$S COORD)= 4100 (DATA CARD TWO$REGION SIX)
MODEL SQUARE SIZE= 1                               (DATA CARD THREE$REGION SIX)
NUMBER OF MODEL SQUARES  E$W DIRECTION= 65         (DATA CARD FOUR$REGION SIX)
NUMBER OF MODEL SQUARES  N$S DIRECTION= 65         (DATA CARD FIVE$REGION SIX)
STARTING PERIOD= 1                                 (DATA CARD SIX$REGION SIX)
STOPPING PERIOD= 24                                (DATA CARD SEVEN$REGION SIX)
ORGTWO= 0.67        VEHIC                          (DATA CARD EIGHT$REGION SIX)
ORGTHREE= 0.29      VEHIC                          (DATA CARD NINE$REGION SIX)
ORGFOUR= 0.04       VEHIC                          (DATA CARD TEN$REGION SIX)  =
```

Fig. D-7. (Continued)

```
MODEL AREA  UTM LOWER LEFT CORNER( E$W COORD)= 540 (DATA CARD ONE$REGION SIX)
MODEL AREA  UTM LOWER LEFT CORNER(N$S COORD)= 4100 (DATA CARD TWO$REGION SIX)
MODEL SQUARE SIZE= 1                               (DATA CARD THREE$REGION SIX)
NUMBER OF MODEL SQUARES  E$W DIRECTION= 65         (DATA CARD FOUR$REGION SIX)
NUMBER OF MODEL SQUARES  N$S DIRECTION= 65         (DATA CARD FIVE$REGION SIX)
STARTING PERIOD= 1                                 (DATA CARD SIX$REGION SIX)
STOPPING PERIOD= 24                                (DATA CARD SEVEN$REGION SIX)
```

Fig. D-8. List of the ADDIT parameter file INPARM (complete listing).

vehicular emissions data file), reformats it and writes the five BCD coded files, PART, HC, NO2, SO2, and CO, which are read by code VEHIC. Code FGEN requires no parameter file. Figure D-9 shows a schematic flow chart of files related to FGEN.

CODE LISTINGS

The codes given in this section are for use with the LBL CDC 7600 computer system. Notes concerning file handling and control cards for that system are given below.

The two primary data storage facilities at LBL are magnetic tape and IBM Data Cells. Small input data files are kept on the IBM Data Cell (e.g., the input files for AIRPT, POINT, and POPUL). Large data files and all output files, including those intermediate files that serve as input to the ADDIT code, are kept on magnetic tape. The output data files from those programs that generate more than one output data file are combined with the LBL utility routine GATHER before they are written on tape. Such files are subsequently reconstructed with the routine SCATTER.

All files, whether they reside on the IBM Data Cell or magnetic tape, are compressed with the utility routine COPY67 before writing, and expanded after reading with the routine COPY76.

Sample control card decks and code listings are given in the microfiche attachment to this User's Guide.

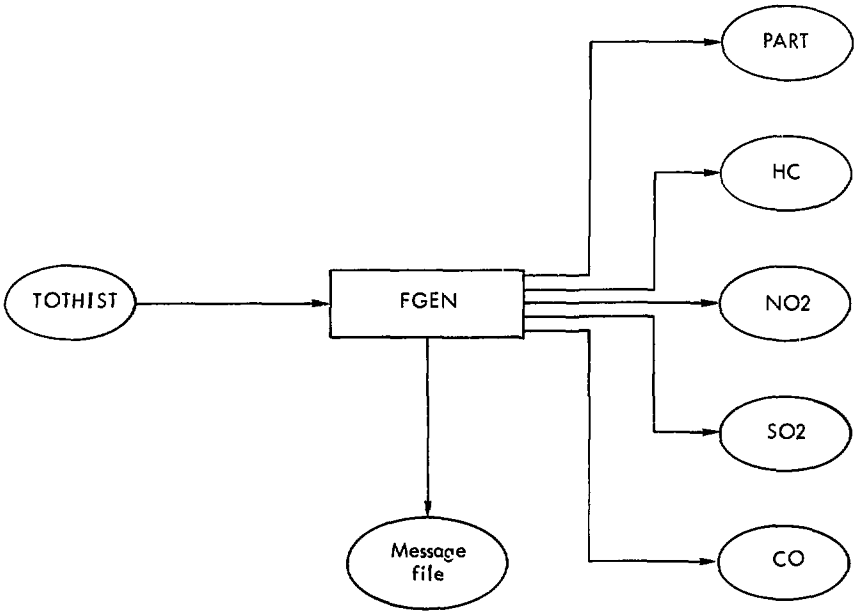

Fig. D-9. Schematic flow chart of the files related to FGEN.

Appendix E
Topographic Data

K. E. Grant

INTRODUCTION

In order for the mass consistent flux model (MASCON) and the LIRAQ models to realistically treat complex air-flow patterns in the Bay Area, it is necessary for topography data to be input for the domain of interest. These data, contained in file QGEO, are based on a 1-km UTM (Universal Tranverse Mercator) grid covering the entire area of interest (i.e., the region 1 domain given in Table 1 in the main section). During a model run, topography data points are selected, without averaging, for the region and grid scale (1, 2, or 5 km) of interest. Because of the lack of averaging, subgrid scale features are not necessarily wellrepresented on the 2- and 5-km grids.

In addition to topography data, QGEO contains Bay Area shoreline data (consisting of 369 ordered x-y points obtained by digitizing the shoreline in UTM coordinates) and station definition data. The shoreline data are used in graphical output to produce a shore outline of the coast and bay. All of the observation and monitoring stations are also input by specifying station plotting symbol, station number, and UTM coordinates to provide the reference points for observed concentrations and concentration time histories.

The detailed format of QGEO is given in Table E-1, and a sample listing of the first 360 cards in QGEO is provided in Fig. E-1. QGEO is read by the subroutine BMAPI, which is common to LIRAQ-1, LIRAQ-2 and MASCON.

PREPROCESSING OF TOPOGRAPHY DATA

Topography data for the San Francisco Bay Area were taken from the California topography tape released by the U. S. Geological Survey (Robins et al, 1973). These data, covering all of California, are logically blocked into 15- by 15-min quadrants, each quadrant preceded by a record specifying the USGS quadrant name and the geographical coordinates (latitude and longitude) of its northwest corner. Each quadrant is further subdivided into 225 1- by 1-min compartments, with the average elevation of each compartment given at its center. A MASTER CONTROL (Hampel and Wade,

Table E-1. Format of the QGEO file.

Item No.	Columns	Format	Description
1	1-5	15	The number of stations to be plotted on contour maps
2	1-80	2014	List by station number of stations to be plotted on contour maps
3	1-5	15	The number of stations for which to read defining information
4			Station information, one station per card, as follows:
4a	1-4	A4	Station plotting symbol
4b	5-14	F10.0	UTM easting of station
4c	15-24	F10.0	UTM northing of station
4d	25-30	16	Station number
5	1-5	15	The number of shore outline UTM coordinate pairs
6	1-80	8F10.3	A list of shore outline UTM easting-northing pairs to satisfy item 5.
7	1-80		Comment card marking start of topography data
8			Topography grid boundary card
8a	3-5	not read	Central meridian of UTM projection
8b	6-15	F10.3	Westmost easting of grid
8c	16-25	F10.3	Southmost northing of grid
8d	26-35	F10.3	Eastmost easting of grid
8e	36-45	F10.3	Northmost northing of grid
9			Topography data cards; each card gives UTM coordinates for the first data point on the card followed by eight or less elevations in metres. There is an increment of 1 km in UTM easting between successive data points on a card.

Table E-1. (Continued)

Item No.	Columns	Format	Description
9a	2-9	not read	UTM easting of first point
9b	10-18	F9.3	UTM northing of all points on this card
9c	21-76	8F7.0	Elevation data points

1969) data base was created to contain and facilitate handling of these data. This allowed the extraction of desired quadrants either by USGS name or by specifying the minimum and maximum latitude and longitude of a desired region. The quadrants containing topographic data for the Bay Area study region were obtained by extracting from the data base all quadrants with latitudes between 37° and 39° north, and with longitudes between 121° 15' and 120° 15' west. A sample listing with the names and coordinates of all extracted quadrants and with the actual data for the first several quandrants is provided in Fig. E-2.

After extracting the Bay Area quadrants from the topographic data base, the data were transformed from 15- by 15-min quadrants onto a Cartesian grid more suitable for model input. A processing routine, TGC (Topographic Grid Converter), was developed for this purpose. TGC uses a combination of UTM projection and bilinear interpolation to obtain topography on a 1-km UTM grid. For purposes of interpolation, each 15- by 15-min quadrant is approximated as a trapezoid with 225 1- by 1-min trapezoidal subquadrants. A particular subquadrant is specified by superimposing a cotrapezoidal i-j grid within each quadrant. Such a trapezoidal approximation accounts for the skewness in the vertices of a quadrant (because of conformal transformation of a curved surface onto a plane), but neglects the slight curvature in the joining edges. The operation of TGC can be summarized as follows:

(1) Initialization. Set up processing specifications from data-directed control cards. Read in all supplied quadrants. To eliminate the need for adjoining quadrants when a point

```
   62 NUMBER OF STATIONS TO BE PLOTTED ON BAY MAP
    1    2    3    4    5    6    8    9   10   11   12   13   14   15   17   20   21   22   23   24
   25   27   28   29   31   32   33   34   35   36   37   38   39   40   41   42   44   46   48   50
   51   54   55   57   58   59   60   61   62   64   73   75   77   78   82   86   87   88   90  124
  129  143
  144 NUMBER OF STATIONS TO BE READ IN
+DSF      551.1     4181.8      1
+DSA      525.1     4254.7      2
+DPE      532.7     4232.4      3
+DSR      542.3     4202.7      4
+DNA      561.6     4240.7      5
+DVA      567.1     4217.4      6
+DRI      555.4     4201.0      7
+DPT      597.3     4209.4      8
+DLI      608.6     4171.2      9
+DFR      591.8     4154.6     10
+DSJ      598.5     4133.0     11
+DMV      583.3     4138.8     12
+DRC      570.5     4148.5     13
+DBU      557.8     4159.1     14
+DCO      585.7     4199.3     15
+DBE      574.3     4211.8     16
+DRM      556.6     4200.4     17
+DMF      576.1     4207.4     18
+DPR      554.1     4197.6     19
+ASN      517.2     4262.0     20
+AHA      542.4     4213.2     21
+ANA      563.1     4229.0     22
+ATI      594.4     4235.4     23
+ALI      604.5     4172.5     24
+ABF      583.0     4204.5     25
+AOA      569.3     4172.7     26
+AAN      560.5     4181.2     27
+AHW      577.9     4168.5     28
+ASJ      595.1     4135.4     29
+AMN      584.1     4140.5     30
+ARH      604.7     4132.4     31
+ASF      556.2     4163.2     32
+ASC      566.2     4151.8     33
+AHM      544.6     4151.9     34
+ASM      622.2     4284.6     35
+ASE      631.1     4263.6     36
+AMT      647.8     4268.6     37
+AMC      638.9     4280.6     38
+AST      654.4     4195.1     39
+MAG      551.2     4189.4     40
+MRE      498.1     4205.1     41
+MBO      495.2     4242.7     42
+MPA      435.9     4311.9     43
+MRV      614.6     4223.1     44
+MPC      586.3     4210.8     45
+MPP      553.9     4115.0     46
+MPI      544.4     4150.0     47
+MPB      541.5     4185.3     48
+DSO      547.5     4238.6     49
+FMJ      503.5     4265.5     50
+FBL      570.5     4279.6     51
+FAL      562.5     4137.9     52
+FLP      602.8     4107.6     53
+FEA      571.6     4111.3     54
```

Fig. E-1. Partial listing of the QGEO data file.

+FMO	639.5	4152.2	55
+DPH	581.1	4197.9	56
+DSL	573.9	4174.7	57
+DLG	590.6	4120.3	58
+DFA	582.6	4233.3	59
+NMH	619.9	4111.8	60
+ISH	577.1	4208.0	61
+NSR	542.4	4208.4	62
+IPH	582.4	4208.6	63
+NAN	605.4	4202.7	64
+EGP	596.7	4210.2	65
+IUN	567.1	4210.7	66
+IGT	554.8	4202.1	67
+IGS	554.7	4200.7	68
+IAC	554.9	4199.2	69
+EGL	608.7	4074.1	70
+USJ	599.1	4132.2	71
+UHW	583.6	4167.7	72
+UCB	565.3	4191.7	73
+LLT	613.8	4172.3	74
+LLH	630.4	4168.2	75
+GEM	600.3	4131.0	76
+GOA	568.3	4177.4	77
+NSB	543.6	4176.1	78
+UMS	547.9	4178.9	79
+GSD	597.2	4134.0	80
+TAM	537.2	4197.8	81
+DIA	595.6	4193.1	82
+FSU	598.6	4161.2	83
+OSW	562.1	4186.5	84
+IAP	589.0	4211.3	85
+PCP	581.1	4175.3	86
+AMO	679.6	4166.2	87
+DHW	585.2	4167.8	88
+DSY	585.9	4136.7	89
+DGL	627.2	4096.8	90
+DEJ	602.5	4136.8	91
+PBF	583.0	4204.5	92
+DFC	553.9	4178.7	93
+VCO	583.0	4204.5	94
+VOK	569.3	4172.7	95
+VGF	539.8	4221.6	96
+VNC	597.9	4160.7	97
+VOS	527.0	4178.2	100
+VCF	547.8	4183.9	101
+VAN	560.5	4181.2	102
+VAO	583.8	4161.9	103
+VSL	597.9	4161.3	104
+VAV	589.2	4142.2	105
+VGY	625.9	4099.5	106
+VLG	591.0	4121.3	107
+VSC	567.6	4149.7	108
+VMA	575.4	4208.4	109
+VAT	605.1	4208.2	110
+VRV	613.9	4224.6	111
+VTY	637.6	4176.6	112
+VAP	614.8	4175.4	113
+VDU	595.1	4173.6	14
+VWC	582.9	4194.2	115
+VWT	590.6	4264.0	116

Fig. E-1. (Continued)

+VDX	604.1	4256.0	117
+VCH	613.3	4232.3	118
+VBE	576.1	4214.2	119
+VVA	567.6	4219.6	120
+VNA	561.8	4239.1	121
+VBO	496.4	4238.0	122
+VSA	526.4	4253.5	123
+VSN	545.6	4238.8	124
+VRD	557.6	4195.2	125
+VBY	527.4	4193.2	126
+VPE	533.8	4233.9	127
+VSR	542.3	4201.8	128
+PNC	597.9	4160.7	129
+ROB	577.5	4150.7	130
+RSJ	600.4	4131.0	131
+RRV	614.6	4222.3	132
+RTR	592.7	4235.5	133
+RSA	523.3	4253.6	134
+VFA	793.1	4074.7	135
+VSS	624.6	4058.4	136
+VSM	622.2	4284.6	137
+VSJ	595.1	4135.4	138
+VLV	604.5	4172.5	139
+PHW	584.3	4172.1	140
+PGY	627.9	4095.4	141
+PTY	638.1	4177.9	142
+PPS	597.8	4168.2	143
+PMI	563.9	4216.0	144
+PDV	609.4	4266.4	145
+PPE	532.0	4231.9	146

369 BAY AREA SHORE OUTLINE POINTS - UTM COORDINATES

455.973	4287.560	458.446	4285.790	459.148	4285.790	459.867	4283.690
461.629	4282.970	461.997	4280.870	463.051	4280.870	467.675	4273.490
467.330	4272.800	468.740	4272.090	469.800	4271.380	470.516	4269.620
470.524	4268.580	476.523	4265.030	476.888	4263.280	491.008	4254.440
492.056	4255.130	493.462	4255.120	491.365	4253.740	489.609	4253.750
491.382	4251.640	491.744	4250.240	491.755	4248.840	492.806	4249.180
492.817	4247.780	493.887	4245.680	494.253	4243.930	494.264	4242.530
493.569	4241.490	494.999	4238.330	495.699	4238.680	495.337	4240.080
499.209	4239.000	501.687	4236.530	503.117	4233.380	502.777	4231.980
503.136	4230.930	503.488	4230.930	504.190	4230.920	504.201	4229.520
504.553	4229.520	505.609	4229.160	506.312	4229.160	506.660	4229.500
506.671	4228.110	507.390	4226.000	513.434	4216.870	514.844	4216.160
515.558	4214.760	515.566	4213.710	515.929	4212.310	507.772	4222.160
506.339	4225.660	501.018	4232.340	500.321	4231.650	503.161	4227.780
503.178	4225.690	504.237	4224.980	504.248	4223.580	504.611	4222.190
502.224	4213.110	499.469	4206.150	498.421	4205.460	502.647	4204.030
503.347	4204.370	501.925	4206.480	504.365	4208.900	505.067	4208.900
506.121	4208.890	503.645	4211.010	503.994	4211.350	504.699	4211.000
503.988	4212.050	503.975	4213.800	505.042	4212.040	506.071	4215.180
506.090	4212.730	507.139	4213.430	507.490	4213.420	507.498	4212.370
506.104	4210.990	507.169	4209.580	507.520	4209.580	507.863	4210.620
508.566	4210.620	508.580	4208.870	509.993	4207.810	515.981	4205.670
519.181	4200.750	519.546	4199.000	523.781	4196.520	523.792	4195.120
524.151	4194.070	525.916	4193.010	527.661	4194.390	527.299	4195.790
527.288	4197.190	527.993	4196.840	536.836	4189.080	537.087	4189.420
542.143	4184.150	542.835	4185.540	543.894	4184.830	545.294	4185.520
546.699	4185.510	546.690	4186.560	547.387	4187.250	542.428	4192.530
541.715	4193.930	543.839	4191.820	544.530	4193.210	547.708	4191.090
549.456	4192.130	543.441	4197.760	545.883	4199.840	544.823	4200.550

Fig. E-1. (Continued)

544.461	4201.950	545.164	4201.940	548.303	4204.720	544.411	4208.240
545.775	4213.470	545.415	4214.520	545.407	4215.570	540.783	4222.950
544.334	4218.030	548.549	4217.990	549.951	4218.330	552.380	4222.160
550.835	4218.940	565.097	4212.970	565.443	4213.670	563.302	4217.880
553.645	4218.920	567.202	4213.300	570.020	4212.230	571.069	4212.920
574.252	4210.100	576.352	4211.130	583.656	4220.160	585.061	4220.150
586.463	4220.490	589.285	4219.070	586.497	4216.300	590.380	4213.820
591.431	4214.160	592.136	4213.810	593.187	4214.150	595.646	4214.130
593.912	4211.350	597.076	4210.970	600.569	4213.390	605.844	4212.650
613.870	4219.230	614.551	4222.020	617.333	4225.490	621.208	4224.060
622.959	4224.750	626.087	4228.920	626.449	4227.510	621.571	4222.660
617.347	4223.740	613.541	4216.430	613.550	4215.350	611.802	4214.350
610.748	4214.360	606.563	4210.550	606.920	4209.850	606.936	4207.750
614.631	4211.880	616.003	4216.060	618.110	4216.050	622.317	4217.060
625.493	4215.290	625.150	4214.250	632.559	4209.990	634.313	4210.330
633.621	4208.940	629.392	4210.770	628.341	4210.380	624.815	4212.150
624.475	4210.760	625.545	4208.650	624.843	4208.660	624.140	4208.660
623.737	4207.620	622.743	4207.630	620.649	4205.890	616.078	4206.630
613.647	4205.600	609.461	4207.[illegible]50	607.647	4206.700	597.790	4209.570
597.087	4209.570	596.036	4209.230	592.864	4210.660	591.461	4210.320
588.997	4211.040	587.943	4211.040	584.428	4211.420	583.028	4210.730
581.969	4211.440	574.623	4207.650	570.731	4211.180	567.567	4211.550
565.114	4210.870	561.983	4207.050	559.875	4207.070	557.779	4205.690
556.365	4206.750	555.666	4206.400	556.036	4203.960	554.291	4202.570
554.299	4201.520	552.551	4200.490	551.135	4201.900	550.084	4201.560
550.803	4199.450	553.995	4195.590	555.754	4195.220	556.802	4195.910
559.624	4194.490	560.697	4192.040	560.357	4190.640	561.419	4189.590
562.143	4186.780	560.387	4186.800	559.339	4186.110	561.103	4185.050
559.355	4184.010	568.519	4180.100	567.819	4179.750	559.021	4181.920
567.130	4178.010	568.878	4179.040	569.581	4179.040	570.294	4177.640
569.597	4176.940	569.960	4175.540	567.492	4176.610	566.793	4176.260
568.209	4174.860	567.155	4174.860	566.809	4174.170	569.987	4172.050
571.030	4173.440	575.292	4167.460	575.323	4163.620	576.036	4162.210
576.410	4159.420	578.542	4156.250	578.205	4154.510	579.640	4150.650
581.048	4150.290	581.745	4150.990	582.807	4149.930	584.209	4150.270
587.736	4148.490	587.330	4147.800	584.220	4148.870	584.580	4147.820
584.237	4146.770	586.696	4146.750	587.747	4147.100	589.157	4146.390
588.109	4145.700	586.353	4145.710	585.653	4145.370	586.361	4144.660
584.608	4144.330	583.554	4144.330	582.846	4145.040	581.795	4144.700
578.620	4146.470	577.184	4150.320	576.127	4150.680	574.728	4149.990
572.250	4152.460	571.550	4152.120	572.609	4151.410	572.620	4150.010
570.856	4151.070	570.159	4150.380	569.105	4150.390	571.536	4153.860
569.423	4154.580	567.343	4151.100	566.978	4152.850	568.715	4155.280
567.656	4155.990	565.919	4153.560	565.905	4155.300	566.945	4157.040
561.665	4158.480	560.948	4160.240	559.895	4160.240	556.017	4162.020
556.714	4162.720	557.071	4162.010	558.119	4162.700	555.998	4164.470
555.298	4164.120	554.230	4165.880	555.624	4167.270	554.208	4168.680
554.905	4169.370	554.891	4171.120	554.532	4172.170	554.875	4173.210
555.577	4173.210	555.563	4174.960	556.271	4174.250	557.322	4174.590
557.314	4175.640	554.136	4177.760	555.184	4178.450	554.097	4182.650
551.976	4184.420	550.574	4184.080	548.463	4184.450	547.412	4184.100
546.710	4184.110	544.268	4182.030	543.214	4182.040	543.228	4180.290
543.944	4178.540	543.972	4175.050	545.443	4166.650	544.771	4162.810
544.779	4161.760	544.088	4160.370	543.059	4157.230	543.772	4155.830
543.098	4152.340	545.227	4149.530	546.630	4149.870	548.754	4147.750
549.835	4144.250	549.855	4141.800	553.428	4134.090	553.091	4132.340
553.116	4129.200	552.781	4127.100	552.797	4125.010	552.131	4120.470
553.196	4119.0[illegible]	554.637	4114.510	556.042	4114.500	557.817	4112.040
557.472	4111.340	559.590	4109.930	559.950	4108.870	559.961	4107.480
562.420	4107.460	564.895	4105.340	572.352	4095.150	578.714	4090.210

Fig. E-1. (Continued)

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  584.348   4088.420    586.098   4089.100    587.155   4088.740    589.246   4090.820
  592.067   4089.400    595.560   4091.820    597.671   4091.460    601.562   4087.930
  604.765   4082.660    607.633   4075 300    609.404   4073.540    608.712   4072.150
  607.697   4067.260
THE FOLLOWING CARDS GIVE BAY AREA TOPOGRAPHY ON A 1 KM GRID
 123    490.000  4090.000    660.000   4300 000
 490.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 498.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 506.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 514.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 522.000 4090.000        0.       0        0.       0.       0.       0.       0        0.
 530.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 538.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 546.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 554.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 562.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 570.000 4090.000        0.       0.       0.       0.       0.       0.       0.       0.
 578.000 4090.000        0.       0.       9.      16.      13.      14.      15.       9.
 586.000 4090.000        7.       6.       0.       0.       0.       0.       0.       0.
 594.000 4090.000        0.       0.       0.       0.       0.       8.      37.      57.
 602.000 4090.000       77.      96.     101.      93.      69.      58.      50.      45.
 610.000 4090.000       39.      33.      27.      38.      58.      88.     157.     232.
 618.000 4090.000      311.     342.     324.     264.     218.     207.     222.     235.
 626.000 4090.000      208.     154.     104.      68.      45.      45.      44.      43.
 634.000 4090.000       44.      45.      45.      45.      47.      48.      51.      56.
 642.000 4090.000       64.      78.      76.      86.     129.     146.     176.     242.
 650.000 4090.000      271.     307.     365.     442.     517.     589.     601.     629.
 658.000 4090.000      689.     651.     596.
 490.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 498.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 506.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 514.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 522.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 530.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 538.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 546.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 554.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 562.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 570.000 4091.000        0.       0.       0.       0.       0.       0.       0.       0.
 578.000 4091.000        8.      36.      47.      48.      43.      43.      44.      32.
 586.000 4091.000       22.      14.       7.       5.       7.      11.       7.       2.
 594.000 4091.000        0.       0.       0.       0.       6.      23.      57.      80.
 602.000 4091.000       94.     101.     103.      97.      79.      67.      58.      52.
 610.000 4091.000       46.      41.      35.      50.      85.     138.     236.     333.
 618.000 4091.000      425.     385.     318.     234.     225.     225.     233.     236.
 626.000 4091.000      209.     162.     121.      80.      47.      46.      45.      44.
 634.000 4091.000       43.      43.      43.      43.      45.      47.      51.      59.
 642.000 4091.000       75.     107.      94.     100.     167.     174.     191.     245.
 650.000 4091.000      267.     305.     378.     451.     501.     520.     535.     585.
 658.000 4091.000      681.     727.     734.
 490.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 498.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 506.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 514.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 522.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 530.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 538.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 546.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 554.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
 562.000 4092.000        0.       0.       0.       0.       0.       0.       0.       0.
```

Fig. E-1. (Continued)

570.000	4092.000	0.	0.	0.	0.	0.	0.	3.	28.
578.000	4092.000	59.	89.	92.	81.	76.	77.	77.	58.
586.000	4092.000	35.	16.	18.	17.	17.	19.	17.	14.
594.000	4092.000	10.	9.	12.	21.	29.	42.	64.	96.
602.000	4092.000	115.	115.	109.	99.	83.	81.	75.	63.
610.000	4092.000	52.	50.	56.	73.	132.	229.	305.	371.
618.000	4092.000	425.	390.	350	311.	336.	339.	325.	275.
626.000	4092.000	212.	144.	97.	68.	50.	47.	46.	45.
634.000	4092.000	44.	44.	44.	44.	45.	52.	74.	97.
642.000	4092.000	119.	144.	113.	114.	198.	212.	236.	298.
650.000	4092.000	316.	347.	404.	461.	487.	471.	505.	564.
658.000	4092.000	655.	736.	788.					
490.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
498.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
506.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
514.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
522.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
530.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
538.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
546.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
554.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
562.000	4093.000	0.	0.	0.	0.	0.	0.	0.	0.
570.000	4093.000	0.	0.	0.	0.	0.	22.	42.	74.
578.000	4093.000	111.	133.	136.	129.	125.	128.	125.	79.
586.000	4093.000	49.	29.	30.	31.	31.	31.	30.	28.
594.000	4093.000	29.	29.	33.	45.	56.	67.	80.	105.
602.000	4093.000	124.	126.	118.	107.	94.	97.	92.	75.
610.000	4093.000	64.	65.	81.	108.	186.	309.	349.	387.
618.000	4093.000	415.	380.	368.	374.	418.	418.	384.	295.
626.000	4093.000	206.	124.	74.	56.	53.	49.	47.	46.
634.000	4093.000	46.	46.	46.	46.	46.	59.	104.	144.
642.000	4093.000	173.	183.	133.	128.	227.	254.	296.	377.
650.000	4093.000	398.	416.	439.	471.	473.	438.	508.	565.
658.000	4093.000	611.	668.	735.					
490.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
498.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
506.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
514.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
522.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
530.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
538.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
546.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
554.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
562.000	4094.000	0.	0.	0.	0.	0.	0.	0.	0.
570.000	4094.000	0.	0.	0.	0.	27.	60.	85.	123.
578.000	4094.000	163.	174.	180.	183.	182.	188.	179.	98.
586.000	4094.000	63.	48.	44.	46.	49.	46.	44.	45.
594.000	4094.000	53.	54.	58.	70.	86.	98.	105.	109.
602.000	4094.000	118.	135.	130.	122.	114.	117.	110.	91.
610.000	4094.000	84.	92.	114.	163.	250.	364.	338.	349.
618.000	4094.000	380.	329.	341.	387.	397.	364.	302.	224.
626.000	4094.000	152.	91.	66.	56.	53.	50.	48.	48.
634.000	4094.000	52.	71.	84.	72.	79.	111.	190.	227.
642.000	4094.000	230.	184.	129.	129.	226.	293.	345.	389.
650.000	4094.000	388.	410.	463.	476.	465.	427.	506.	546.
658.000	4094.000	551.	605.	668.					
490.000	4095.000	0.	0.	0.	0.	0.	0.	0.	0.
498.000	4095.000	0.	0.	0.	0.	0.	0.	0.	0.
506.000	4095.000	0.	0.	0.	0.	0.	0.	0.	0.
514.000	4095.000	0.	0.	0.	0.	0.	0.	0.	0.

Fig. E-1. (Continued)

(a) Quadrants of interest

INDEX OF QUADRANTS

HOPLAND	39	00	123	15	1	269
STROS LAND 3	38	45	123	15	1	273
STROS LAND 1	38	30	123	15	1	275
STRS OCEAN 2	38	15	123	15	1	277
KELSEYVILLE	39	00	123	00	1	278
LOWER LAKE	39	00	122	45	1	279
MORGAN VALLY	39	00	122	30	1	280
GUINDA	39	00	122	15	1	281
HEALDSBURG	38	45	123	00	1	282
CALISTOGA	38	45	122	45	1	283
ST. HELENA	38	45	122	30	1	284
LAK BERRYESA	38	45	122	15	1	285
SEBASTOPOL	38	30	123	00	1	286
SANTA ROSA	38	30	122	45	1	287
SONOMA	38	30	122	30	1	288
MT. VACA	38	30	122	15	1	289
POINT REYES	38	15	123	00	1	290
PETALUMA	38	15	122	45	1	291
MARE ISLAND	38	15	122	30	1	292
CARQUINEZ	38	15	122	15	1	293
DUNNIGAN	39	00	122	00	1	294
KNIGHTS LAND	39	00	121	45	1	295
LINCOLN	39	00	121	30	1	296
AUBURN	39	00	121	15	1	297
WOODLAND	38	45	122	00	1	298
DAVIS	38	45	121	45	1	299
FAIR OAKS	38	45	121	30	1	300
FOLSOM	38	45	121	15	1	301
VACAVILLE	38	30	122	00	1	302
COURTLAND	38	30	121	45	1	303
FRANKLIN	38	30	121	30	1	304
SLOUGHHOUSE	38	30	121	15	1	305
PITTSBURG	38	15	122	00	1	306
RIO VISTA	38	15	121	45	1	307
LODI	38	15	121	30	1	308
BELLOTA	38	15	121	15	1	309
SF OCEAN 4	38	00	123	15	1	349
SF OCEAN 5	38	00	123	00	1	350
MT TAMALPAIS	38	00	122	45	1	351
RICHMOND	38	00	122	30	1	352
CONCORD	38	00	122	15	1	353
SF OCEAN 1	37	45	122	45	6	354
SAN MATEO	37	45	122	30	1	355
HAYWARD	37	45	122	15	1	356
SF OCEAN 2	37	30	122	45	6	357
HALF MOON BY	37	30	122	30	1	358
PALO ALTO	37	30	122	15	1	359
SF OCEAN 3	37	15	122	45	6	360
ANO NUEVO	37	15	122	30	6	361
BEN LOMOND	37	15	122	15	6	362

Fig. E-2. Listing of (a) quadrants of interest for the Bay Area and (b) topographic data available for several quadrants.

(a) Quadrants of interest cont'd

MT DIABLO	38	00	122	00	1	363
BRENTWOOD	38	00	121	45	1	364
STOCKTON	38	00	121	30	1	365
MANTECA	38	00	121	15	1	366
LIVERMORE	37	45	122	00	1	367
ALTAMONT	37	45	121	45	1	368
TRACY	37	45	121	30	1	369
MODESTO WEST	37	45	121	15	1	370
SAN JOSE	37	30	122	00	1	371
MT HAMILTON	37	30	121	45	1	372
MT BOARDMAN	37	30	121	30	1	373
ORESTIMBA	37	30	121	15	1	374
LOS GATOS	37	15	122	00	1	375
MORGAN HILL	37	15	121	45	1	376
GILROY HT SP	37	15	121	30	1	377
PACHECO PASS	37	15	121	15	1	378
SC OCEAN 1	37	00	122	45	6	439
SC OCEAN 2	37	00	122	30	6	440
SC OCEAN 6	37	00	122	15	6	441
CAPITOLA	37	00	122	00	6	447
SN JUAN BAUT	37	00	121	45	1	448
HOLLISTER	37	00	121	30	1	449
QUIEN SABE	37	00	121	15	1	450

(b) Topographic data

HOPLAND		39 00 123 15 1			269				
1350	1100	1000	950	800	700	1050	600	530	750HOPLAND 01
1000	900	1500	2100	2450	1500	1400	1880	1900	1500HOPLAND 02
950	650	650	500	550	600	750	900	1350	1900HOPLAND 03
2600	2500	2700	1950	1300	950	800	700	550	600HOPLAND 04
680	850	900	1100	1600	2500	2900	2950	2700	2150HOPLAND 05
1700	2100	1400	1000	500	700	950	1000	1250	1500HOPLAND 06
1550	2000	2350	2500	2500	2100	2000	1700	1425	900HOPLAND 07
900	700	900	1600	1750	.150	1200	1400	1500	1650HOPLAND 08
1800	1950	1550	1000	900	950	675	950	1400	1650HOPLAND 09
1450	1350	1100	1009	900	900	1250	1400	1400	1000HOPLAND 10
900	500	1000	1650	2250	1250	1300	1400	1500	1400HOPLAND 11
1100	950	1000	1350	1450	1300	650	750	1400	2200HOPLAND 12
1200	1400	1400	1450	1100	1000	1200	1250	1700	1500HOPLAND 13
1000	800	600	800	1600	1200	1350	1350	1450	1000HOPLAND 14
1050	1250	1300	1050	1400	1450	975	1200	750	800HOPLAND 15
1600	1350	1250	1100	900	1000	1100	1300	1100	900HOPLAND 16
1200	1300	600	400	350	1800	1350	1200	1250	1000HOPLAND 17
900	1000	1500	1200	800	950	1300	1050	400	325HOPLAND 18
1250	1075	1000	900	1100	700	900	1150	1000	700HOPLAND 19
700	1050	950	450	300	1850	1500	1550	1600	1725HOPLAND 20
1250	1000	800	700	600	600	700	900	650	400HOPLAND 21
1900	1600	1500	14 0	1400	1550	1050	1300	950	600HOPLAND 22
800	900	700	600	600					HOPLAND 23
STROS LAND 3	38 45 123 15 1				273				
1200	1025	1300	1300	1850	1450	1500	1250	1075	700STRS L 301
650	900	1025	1050	900	850	1450	1525	1950	2100STRS L 302
2250	1600	1300	800	825	925	875	600	550	600STRS L 303
800	750	1050	1350	1400	1600	2100	1500	1250	925STRS L 304
650	700	900	700	600	950	700	800	900	1400STRS L 305
1500	1650	1300	1075	1125	1450	1175	700	600	825STRS L 306
650	625	600	750	950	1300	1650	1500	1000	1075STRS L 307
1050	1475	1675	1250	700	650	650	750	825	750STRS L 308
900	1150	1750	1800	1425	1100	950	775	1200	775STRS L 309
725	675	625	750	1050	1200	1200	1725	1650	1725STRS L 310
1450	1000	800	700	575	1100	1150	800	775	825STRS L 311
1000	1500	1400	1325	1050	1375	1575	1125	800	1100STRS L 312

Fig. E-2. (Continued)

(b) Topographic data cont'd

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 950   1300   1350   1200   1150   1450    950   1200   1650    900STRS L 313
1150   1300   1700   1550   1400    700   1100   1500   1300   1400STRS L 314
1350    800    800    950    900    800    850    825   1100   1100STRS L 315
1100    900   1000   1150   1600   1750   1450   1000    650   1000STRS L 316
 750    700    800    950   1150   1000    900    875   1200   1300STRS L 317
1100   1225   1100    900    600    550    500    750    850   1200STRS L 318
 950   1200   1150   1150   1300   1050    775    875    750    550STRS L 319
 500    850    700    500    450    575    900   1350   1200   1150STRS L 320
1425   1175   1075   1100    700    550    400    700    500    450STRS L 321
  25    375    875   1350   1100   1050   1375   1550   1500    800STRS L 322
 400    600    600    400    500                                   STRS L 323

STROS LAND 1 38 30 123 15 1            275
-150    -90    -10    600    950    600    725    800   1100    900STRS L 101
 800    600    800    600    350   -200   -170   -150    -90    -20STRS L 102
 250    450    775    900    700    600    550    600    400    300STRS L 103
-230   -200   -150   -110   -100    -40    200    450    600    350STRS L 104
 600    300    250    850    500   -270   -240   -190   -150   -110STRS L 105
 -90    -55     75    200    200    350    400    550    900    950STRS L 106
-280   -260   -240   -220   -180   -130    -90    -30    200    450STRS L 107
 500    350    350    750    900   -290   -280   -260   -240   -210STRS L 108
-180   -125    -90    -40    350    900    850    850    750    800STRS L 109
-300   -280   -280   -250   -240   -220   -180   -120    -90    -40STRS L 110
 300    350    600    500    700   -310   -300   -290   -270   -260STRS L 111
-240   -210   -180   -120    -90     80    550    500    375    300STRS L 112
-310   -300   -290   -280   -270   -260   -240   -210   -170   -100STRS L 113
 -30    250    325    275    250   -310   -300   -290   -290   -270STRS L 114
-270   -260   -220   -190    -75    -30     75    250    425    400STRS L 115
-320   -310   -300   -290   -280   -270   -270   -240   -250   -125STRS L 116
   1     50     50    250    300   -330   -320   -310   -290   -290STRS L 117
-280   -270   -250   -220   -160    -50     75    -20     50    250STRS L 118
-330   -320   -310   -290   -290   -280   -270   -260   -240   -180STRS L 119
-120    -50    -60    -60    -30   -330   -320   -330   -310   -300STPS L 120
-290   -280   -270   -260   -200   -180   -150   -110    -70    -60STRS L 121
-340   -330   -320   -310   -300   -290   -290   -270   -260   -250STRS L 122
-230   -210   -170   -120    -70                                   STRS L 123
STRS OCEAN 2 38 15 123 15 1            277
-340   -340   -330   -315   -310   -300   -290   -280   -270   -250STRS O 201
-240   -230   -200   -150    -75   -345   -330   -330   -315   -310STRS O 202
-300   -290   -270   -260   -260   -250   -240   -230   -210   -180STRS O 203
-350   -340   -333   -320   -310   -300   -290   -270   -260   -260STRS O 204
-250   -240   -230   -210   -180   -350   -345   -330   -320   -310STRS O 205
-290   -280   -270   -260   -250   -240   -240   -230   -220   -185STRS O 206
-360   -350   -340   -320   -310   -300   -280   -270   -260   -250STRS O 207
-240   -240   -230   -220   -200   -360   -350   -340   -330   -310STRS O 208
-300   -280   -270   -260   -250   -240   -240   -230   -210   -210STRS O 209
-370   -350   -340   -330   -310   -290   -290   -260   -260   -240STRS O 210
-230   -220   -220   -220   -190   -380   -370   -360   -340   -310STRS O 211
-290   -280   -260   -250   -240   -230   -230   -220   -210   -180STRS O 212
-370   -370   -350   -340   -320   -280   -270   -260   -240   -240STRS O 213
-230   -230   -220   -200   -180   -380   -370   -350   -330   -310STRS O 214
-290   -270   -250   -240   -220   -220   -220   -210   -180   -170STRS O 215
-390   -370   -350   -330   -310   -300   -280   -250   -230   -220STRS O 216
-210   -200   -200   -180   -150   -370   -370   -350   -330   -310STRS O 217
-290   -280   -240   -230   -220   -200   -190   -150   -160   -150STRS O 218
-370   -370   -350   -340   -310   -300   -270   -245   -230   -210STRS O 219
-195   -195   -180   -160   -100   -370   -360   -350   -340   -320STRS O 220
-300   -280   -250   -230   -200   -190   -180   -160   -130    -30STRS O 221
-370   -360   -350   -350   -330   -310   -280   -260   -240   -220STRS O 222
-180   -160   -100    -90     25                                   STRS O 223
```

Fig. E-2. (Continued)

(b) Topographic data cont'd

KELSEYVILLE 39 00 123 00 1 278

2500	2000	1850	1600	1600	1380	1360	1360	1360	1360KELSEYV101
1360	1520	2200	2700	2325	2600	2500	2000	1850	1800KELSEYV102
1475	1390	1380	1400	1400	1400	1850	2600	3600	3000KELSEYV103
1850	2200	1900	1850	1850	1525	1390	1440	1450	1440KELSEYV104
1550	1850	2200	2625	2400	2075	2325	2200	1875	1825KELSEYV105
1575	1440	1550	1525	1500	1675	1775	1900	1975	2000KELSEYV106
2100	2575	2675	2300	1750	1850	1725	1590	1585	1675KELSEYV107
2175	1975	2150	2150	2150	1900	2650	2700	2550	2350KELSEYV108
2400	2150	1800	1600	1750	2200	2575	2425	2400	2425KELSEYV109
2300	2000	2000	2400	2375	2500	2425	2175	2000	2000KELSEYV110
2350	2625	2775	2800	2950	2700	2625	2200	2075	2775KELSEYV111
2400	2550	2850	2825	2450	2400	2575	2575	2800	3000KELSEYV112
2200	2250	2550	2400	2400	2600	2600	3000	2925	3000KELSEYV113
3000	2600	2600	2425	2400	1600	1800	2050	2025	1600KELSEYV114
2000	2000	1975	1750	1850	2500	2900	2800	2600	2500KELSEYV115
625	1200	1150	1200	1150	1175	1275	1250	1800	2400KELSEYV116
2400	2400	2800	3100	3000	550	1050	1200	1200	850KELSEYV117
1400	1950	1825	1500	1500	1900	2350	3000	3150	3700KELSEYV118
300	875	1350	1500	1200	975	1425	1600	1825	1800KELSEYV119
2300	2350	2000	2350	3200	300	400	600	1050	1325KELSEYV120
1375	1375	1750	2400	2500	2250	2950	3075	2800	2600KELSEYV121
400	320	320	600	800	1000	1450	1575	1800	2450KELSEYV122
2200	2400	2325	2500	2950					KELSEYV123

LOWER LAKE 39 00 122 45 1 279

1350	1320	1320	1500	1425	1800	1775	1575	1550	1600LOWER LK01
1400	1250	1100	1100	1400	1400	1320	1320	1325	1400LOWER LK02
1400	1675	1400	1450	1575	1775	1950	1375	1200	1200LOWER LK03
1900	1575	1660	1325	1320	1320	1340	1450	1775	1850LOWER LK04
1800	1725	1475	1825	2100	1850	1925	1850	1700	1625LOWER LK05
1575	1325	1400	1520	1600	1525	1400	1775	2250	2475LOWER LK06
2000	1880	1880	1800	1800	1700	1325	1330	1400	1375LOWER LK07
1525	1800	2150	2150	2575	2550	2100	2050	2075	2075LOWER LK08
2000	1600	1450	1400	1400	1475	1775	1800	2100	2675LOWER LK09
2950	2700	2600	2400	2100	1800	1675	1600	1450	1450LOWER LK10
1575	1725	1600	1700	2150	3000	2750	3200	2475	2200LOWER LK11
2200	2125	1725	1475	1450	1700	1700	1450	1325	1700LOWER LK12
2900	2900	2900	2600	2175	2100	1900	1675	1800	1900LOWER LK13
1775	1600	1475	1325	1250	2475	2950	3150	2750	2200LOWER LK14
1825	1750	1825	1625	1725	1975	1900	1775	1650	1250LOWER LK15
3200	2750	2975	3275	3075	2375	1600	1350	1450	1400LOWER LK16
1300	1725	1775	1800	1350	4275	3725	2650	3000	3200LOWER LK17
2700	1900	1425	1125	1025	1050	1150	1300	1375	1575LOWER LK18
3575	2675	2200	1900	2300	1900	2000	1550	1100	1325LOWER LK19
1100	950	975	1175	1250	3450	2800	1950	1575	1500LOWER LK20
1400	1375	1300	1100	1075	1000	955	975	950	1125LOWER LK21
2825	3000	2575	2050	2375	1500	1125	1125	1075	1100LOWER LK22
1175	1200	1400	1075	1025					LOWER LK23

Fig. E-2. (Continued)

falls on a quadrant boundary, shift each quadrant by half a minute of latitude and longitude, converting elevations from a 15- by 15-element-centered grid to a 16-by-16 intersection grid. Project the corners of each quadrant into UTM coordinates, and set up directories of quadrant coordinates and relative locations.

(2) Interpolation of a 1-km UTM grid. For each desired grid point:

a) Determine the quadrant and subquadrant in which the grid point lies. In whichever quadrant is considered to be the currently active quadrant, attempt to interpolate the subquadrant in which the grid point lies. If the grid point is actually inside the quadrants, the interpolation will succeed. Otherwise, iterative application of the interpolation scheme will provide information for a directed walk to the correct quadrant.

b. Interpolate the UTM coordinates of the subquadrant into which the grid point falls, using the tabulated coordinates of the quadrant corners and the trapezoidal approximation and I-J coordinate system discussed above.

c. Interpolate the elevation in metres to the grid point, using the known elevations at the corners of the subquadrant and the results of step (1) b. Trapezoidal approximation is again used.

(3) Optional interpolation of an arbitrary rectangular grid. From the 1-km UTM grid produced by steps (1) and (2), a rectangular x-y grid of arbitrary orientation and grid scaling (greater than or equal to 1 km) can be interpolated. This grid must be completely contained within the original 1-km grid.

TGC has been coded for use at LLL. Thus, the listing of the code is not included in the microfiche attachment of codes available at LBL.

The topography data in QUEO was taken directly from the IGC 1-km UTM grid, avoiding the extra interpolation in step (1). After processing by IGC, the data were reformatted into their present form and negative elevations (ocean depths) were set to zero.

Resolution and accuracy are inherently limited by the resolution and accuracy of the original quadrant data. These data are said to be 98% accurate to ±30 m for most of central and northern California (Robbins et al., 1973). Elevations were averaged over 1- by 1-min subquadrants (about 1.5- by 1.8-km in the Bay Area); thus subsequent interpolation to a 1-km grid resulted in very minimal smoothing. The greatest loss of representational accuracy results from the selection of grid points off the 1-km grid, without averaging, to obtain a 5-km grid. To provide a graphical indication of the results, two perspective views of region 1 (a worst-case 5-km grid) are shown in Figs. E-3 and E-4.

Fig. E-3. Perspective view of region 1 (5 km) from the northwest. The vertical scale is exaggerated to accentuate details.

Fig. E-4. Perspective view of region 1 (5 km) from the southeast. The vertical scale is exaggerated to accentuate details.

Appendix F
Initial Condition Data

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J. J. Walton

INTRODUCTION

The programs LIRAQ-1 and LIRAQ-2 include subroutines that can generate regional patterns of initial concentrations for each species through Gaussian interpolation from observations at specific points within the region of interest. These observational data are organized in time and by observation point in the QICON files that are input to the LIRAQ models. These files are the result of a two-step process. The first step uses MASTER CONTROL to search out appropriate data from the raw data base maintained at LLL. These are then organized as input to the program QICGEN that reads the data, performs prescribed scalings, and further organizes the input to form the QICON file.

DATA PREPROCESSING

The pollutant data used to initialize concentrations for the LIRAQ models are contained within the data base of air quality and meteorological data maintained at LLL (see Appendix I). Using the MASTER CONTROL data management system, the data base was searched for all records available over the time period selected containing pollutants and monitoring stations of interest. Pollutants for which observational data were available and which are directly applicable to the LIRAQ models are: carbon monoxide, hydrocarbons (with methane), nitrogen dioxide, nitric oxide, and oxidant. The results of the search are then ordered, using MASTER CONTROL, by pollutant, station, and date, and made available as an intermediate digitized data file for further processing into an input file (QICON) for the LIRAQ models. An example of the intermediate data file is shown in Fig. F-1.

CODE QICGEN

The program QICGEN takes observational data on species concentrations and creates a file

CO	DPT	8	99	99	99	5	5	6	5	5	5	5	99	99	99	99	99	99	99	1	1	1	1	1	1	1
CO	DSR	4	99	99	99	2	2	3	5	4	4	4	5	5	5	5	4	4	4	4	3	4	3	3	2	2
CO	DRC	13	99	99	99	3	4	5	6	3	3	4	4	4	4	4	3	3	3	3	2	2	3	3	3	3
CO	DSA	2	99	99	99	4	4	5	7	10	9	6	5	5	5	4	4	4	4	3	3	4	4	4	4	4
CO	DRM	17	99	99	99	1	1	2	2	3	3	3	2	2	1	1	1	2	2	1	1	1	1	1	1	1
CO	DVA	6	99	99	99	3	3	4	4	5	5	5	5	4	4	4	3	3	3	3	3	3	3	3	2	3
CO	DSF	1	99	99	99	1	1	2	5	7	6	6	5	3	2	1	1	99	6	6	6	4	4	4	4	4
CO	DBU	14	99	99	99	3	3	3	6	6	5	5	5	4	4	3	3	3	3	3	3	3	3	4	3	4
CO	DLI	9	99	99	99	2	2	3	5	4	3	3	3	2	3	2	2	3	3	3	3	3	3	3	3	3
CO	DNA	5	99	99	99	3	3	3	4	5	4	3	4	99	99	99	4	4	3	3	3	4	4	3	3	3
CO	DFR	10	99	99	99	3	3	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	3	4	3	3
CO	DSJ	11	99	99	99	4	3	5	7	7	5	4	4	4	4	3	3	4	4	3	2	3	4	3	3	2
HM	DRM	17	99	99	99	2	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
HM	DSR	4	99	99	99	5	5	5	6	4	4	4	4	4	5	3	3	3	4	3	3	3	3	3	3	3
HM	DSA	2	99	99	99	2	3	3	3	4	4	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1
HM	DVA	6	99	99	99	2	2	3	3	3	3	4	3	3	3	2	2	1	2	2	1	1	1	1	1	1
HM	DSF	1	99	99	99	2	2	2	2	2	2	3	2	2	2	2	2	99	3	3	3	2	2	2	2	2
HM	DRC	13	99	99	99	6	6	7	7	5	4	4	5	4	4	4	3	3	3	3	2	2	2	2	3	3
HM	DPT	8	99	99	99	5	6	6	5	5	5	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
HM	DBU	14	99	99	99	5	5	4	6	6	5	5	5	5	5	4	3	3	4	3	4	5	4	5	4	6
HM	DNA	5	99	99	99	2	2	3	2	2	2	2	2	1	2	2	2	1	1	0	1	1	1	1	1	1
HM	DSJ	11	99	99	99	5	5	6	7	6	7	5	5	5	4	3	3	3	3	3	3	3	3	4	3	3
HM	DLI	9	99	99	99	4	4	4	5	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
HM	DFR	10	99	99	99	4	4	4	4	5	99	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3
N2	DRM	17	99	99	99	2	2	2	2	3	99	5	6	6	3	3	2	2	1	1	1	1	1	1	1	1
N2	DNA	5	99	99	99	4	3	3	3	5	6	5	5	6	5	99	99	99	3	2	2	4	3	3	3	3
N2	DSR	4	99	99	99	3	3	3	4	5	6	7	11	11	99	99	6	7	7	6	5	7	7	5	2	2
N2	DVA	6	99	99	99	5	4	4	4	5	6	8	8	8	99	99	5	5	4	3	4	4	4	2	2	3
N2	DSF	1	99	99	99	3	3	3	4	5	7	12	9	8	5	3	99	3	4	4	4	3	2	3	3	2
N2	DRC	13	99	99	99	2	2	3	3	4	4	5	7	8	7	7	5	5	6	5	4	3	3	3	2	2
N2	DSA	2	99	99	99	2	2	2	2	6	7	6	99	3	3	2	2	2	2	2	1	2	2	1	1	1
N2	DPT	8	99	99	99	4	4	5	5	7	8	7	6	5	99	99	3	4	4	4	3	3	4	3	3	4
N2	DLI	9	99	99	99	4	3	4	6	6	8	7	4	3	2	2	2	3	5	5	5	5	6	7	7	7
N2	DCO	15	99	99	99	3	3	3	4	8	11	7	5	3	3	3	3	3	3	5	5	5	5	3	3	2
N2	DSJ	11	99	99	99	4	4	4	5	9	11	10	9	9	7	99	99	4	6	5	3	4	6	6	3	2
NO	DRC	13	99	99	99	4	6	5	11	10	2	2	2	2	0	0	0	0	1	1	1	1	1	1	1	2
NO	DVA	6	99	99	99	0	1	1	3	4	2	2	1	1	99	99	0	0	0	0	0	0	0	0	0	1
NO	DSA	2	99	99	99	1	1	3	7	9	1	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
NO	DSF	1	99	99	99	3	4	5	10	15	11	9	8	7	5	4	99	4	5	5	5	5	4	4	4	3
NO	DSR	4	99	99	99	5	5	10	26	9	7	7	4	2	99	99	0	0	0	0	0	4	3	1	0	0
NO	DNA	5	99	99	99	0	0	1	1	1	1	0	0	0	0	99	99	99	0	0	0	0	0	0	0	0
NO	DSJ	11	99	99	99	5	7	7	3	11	9	4	2	1	1	99	99	1	2	1	1	1	2	2	1	0
NO	DPT	8	99	99	99	1	3	6	8	5	3	2	0	0	99	99	0	0	0	0	0	0	0	0	0	0
OG	DRC	13	99	99	99	1	1	1	1	1	2	3	3	7	12	10	4	3	3	3	2	1	1	1	1	1
OG	DMV	12	99	99	99	1	1	1	1	1	2	3	4	9	14	16	12	8	6	4	2	2	1	1	1	1
OG	DPE	3	99	99	99	1	1	1	1	1	2	3	7	10	10	8	6	6	6	5	5	4	4	3	3	2
OG	DPH	56	99	99	99	1	1	1	1	1	2	5	11	11	13	14	16	14	10	9	7	6	5	5	5	5
OG	DSL	57	99	99	99	1	1	1	1	1	2	3	7	12	14	12	7	7	5	3	2	1	1	1	1	1
OG	DLG	58	99	99	99	1	99	7	99	7	99	7	99	7	99	2	99	1	99	2	99	1	99	1	99	3
OG	DFA	59	99	99	99	1	1	1	1	1	3	6	9	11	11	10	9	15	9	6	6	5	4	2	2	2
OG	DRM	17	99	99	99	1	1	1	1	1	1	2	5	7	7	5	5	4	3	3	3	2	2	1	1	1
OG	DSA	2	99	99	99	1	1	1	1	1	3	4	7	11	12	10	9	8	8	8	6	4	3	3	2	2
OG	DVA	6	99	99	99	1	1	1	1	1	1	3	3	7	14	14	6	4	6	4	1	1	1	1	1	1
OG	DSR	4	99	99	99	1	1	1	1	1	1	1	1	5	8	5	5	4	3	4	4	2	2	2	3	2
OG	DSF	1	99	99	99	1	1	1	1	1	1	2	1	2	2	2	2	3	2	2	1	1	1	1	1	1
OG	DCO	15	99	99	99	1	1	1	1	1	5	8	12	14	15	16	20	17	11	8	7	3	3	3	4	4
OG	DPT	8	99	99	99	1	1	1	1	1	2	4	99	99	99	99	99	7	6	5	5	3	2	2	1	1
OG	DLI	9	99	99	99	1	1	1	1	3	3	5	10	12	12	12	17	22	17	11	7	6	3	2	2	1
OG	DSJ	11	99	99	99	1	1	1	1	1	1	3	6	9	16	10	8	6	6	6	8	3	1	1	3	4
OG	DBU	14	99	99	99	1	1	1	1	1	2	3	5	7	7	3	9	7	3	2	1	1	1	1	1	1
OG	DNA	5	99	99	99	0	0	0	0	1	3	5	6	7	12	15	15	6	6	5	4	2	2	1	0	0
OG	DFR	10	99	99	99	1	1	1	1	1	99	3	4	8	11	13	14	12	6	3	1	1	1	1	1	1

Fig. F-1. Partial listing of available data at various stations for various pollutants.

QICON in a form that can be read by the LIRAQ models. Figure F-1 contains an example of the data input to QICGEN. The first column contains the species symbol. The sequence of species is ordered alphabetically with all data for a given species being completed before beginning data on the next pollutant. The symbols are: CO for carbon monoxide, HM for total hydrocarbon, N2 for nitrogen dioxide, NO for nitric oxide, and OG for oxidant (which is used to initialize the ozone concentration in LIRAQ-2).* Observation station symbol and station number appear in the second and third data columns. The remaining 24 columns of data are the hourly observations of the species concentration, a 99 denoting the lack of an observation.

The program processes data over any time interval desired, usually the full period over which data are available. A certain amount of manipulation of the numerical values of these data must also be performed. For example, whereas observations of carbon monoxide and total hydrocarbon are in the desired units (ppm), those for nitrogen dioxide, nitric oxide and ozone are in pphm and so must be scaled by a factor of 0.01 since QICON requires all input to be in ppm. In addition, since LIRAQ-2 deals with alkenes, alkanes, and aldehydes, total hydrocarbon concentration is partitioned into these species classifications based on the prescription described in Chapter 9 of the Final Report.

So that the "knowledgeable user" may, through his insight, make up for deficiencies in the observational data, before reading any of these observations, a series of interrogations and responses are permitted which can add synthesized observations at stations and UTM locations.

When, for a given hour, all data are assembled for a species, this information, with the appropriate header lines, is written into a QICON file in the format required for input to LIRAQ. The program then passes on to the next species, continuing to the end of the data file. Since at this point initial conditions have been provided for only seven species, the program supplies default data for the remainder. The default data are an indicator to LIRAQ that the boundary value concentrations of these species should be used in establishing the initial concentrations. The program then returns to

*In LIRAQ-2, nighttime oxidant observations are rescaled downward in order to initialize the ozone, as explained in Chapter 12 of the Final Report.

the beginning of the data file and processes observations for the next hour. This continues until the time interval of interest has been finished. Figure F-2 contains an example of the form of the resulting QICON file.

INTERPOLATION OF INITIAL CONCENTRATION BY THE LIRAQ SUBROUTINE ICON

To appreciate the final use of these data, it is useful to understand how the LIRAQ model uses them. The LIRAQ subroutine ICON searches through the observation data sets in QICON until the set valid at the initial model run time is found. Data for the pollutants of interest are then extracted. If surface observations have been inputted, they are converted to vertical average concentrations before interpolating to a regular grid covering the region. Grid elements where the inversion base height is below topography and where the elevation is also above 100 are added as pseudo-observation points at the concentration specified in QSRUN for background above the inversion. These inversion points, treated identically to real observations, act as barriers to interpolation of observations across such topographic obstructions as the coastal hills.

For a grid element P, the initial concentration is given by

$$C(P) = \left(\sum_{m=1}^{4} B_m \epsilon_m (P) + \sum_{n=1}^{N} C_n \beta_n (P) \right) /W,$$

where B_m (for m varying from 1 to 4) are the background values at the west, east, south, and north boundaries of the domain, respectively. The other terms are given by:

$\epsilon_m (P) = e^{-q_1 d_m^2(P)}$ is a boundary weighting function,

C_n; n=1,..., N are the observations and pseudo-observations,

$\beta_n (P) = e^{-q_1 r_n^2(P)}$ is an observation weighting function,

and

$$W = \sum_{m=1}^{4} \epsilon_m (P) + \sum_{n=1}^{N} \beta_n (P),$$

where

q_1 is the Gaussian weighting factor read from QICON,

d_m (P) is the perpendicular distance (in grid increments) from P to the mth boundary, and

r_n (P) is the distance (in grid increments) between P and the nth observation point.

To ensure continuity at the boundaries, the boundary values have been included in the interpolation. If no observations are given and

```
USE      0.1000 AS THE GAUSSIAN DISTANCE CONSTANT FOR INTERPOLATION
REFERENCE HEIGHT OF OBSERVATIONS IN CM                100.
THE FOLLOWING DATA SET IS VALID UNTIL 00: 4:00 (DAY:HOUR:MINUTE)
*POLLUTANT  CARBON MONOXIDE
SURFACE   OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
+DPT      8        5.00E+00
+DSR      4        2.00E+00
+DRC     13        3.00E+00
+DSA      2        4.00E+00
+DRM     17        1.00E+00
+DVA      6        3.00E+00
+DSF      1        1.00E+00
+DBU     14        3.00E+00
+DLI      9        2.00E+00
+DNA      5        3.00E+00
+DFR     10        3.00E+00
+DSJ     11        4.00E+00
+AHM     34        1.00E+00
+TAM     81        1.00E+00
          0
UTM OBSERVATIONS
         0.
*POLLUTANT  ALKENES
SURFACE   OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
+DRM     17        1.00E-02
+DSR      4        7.00E-02
+DSA      2        1.00E-02
+DVA      6        1.00E-02
+DSF      1        1.00E-02
+DRC     13        9.00E-02
+DPT      8        7.00E-02
+DBU     14        7.00E-02
+DNA      5        1.00E-02
+DSJ     11        9.00E-02
+DLI      9        5.00E-02
+DFR     10        5.00E-02
+AHM     34        1.00E-02
+TAM     81        1.00E-02
          0
UTM OBSERVATIONS
         0.
*POLLUTANT  ALKANES
SURFACE   OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
+DRM     17        8.90E-02
+DSR      4        6.23E-01
+DSA      2        8.90E-02
+DVA      6        8.90E-02
+DSF      1        8.90E-02
+DRC     13        8.01E-01
+DPT      8        6.23E-01
```

Fig. F-2. Partial listing of sample QICON file.

```
+DBU     14          6.23E-01
+DNA      5          8.90E-02
+DSJ     11          8.01E-01
+DLI      9          4.45E-01
+DFR     10          4.45E-01
+AHM     34          8.90E-02
+TAM     81          8.90E-02
          0
UTM OBSERVATIONS
         0.
*POLLUTANT   ALDEHYDES
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
+DRM     17          1.00E-03
+DSR      4          7.00E-03
+DSA      2          1.00E-03
+DVA      6          1.00E-03
+DSF      1          1.00E-03
+DRC     13          9.00E-03
+DPT      8          7.00E-03
+DBU     14          7.00E-03
+DNA      5          1.00E-03
+DSJ     11          9.00E-03
+DLI      9          5.00E-03
+DFR     10          5.00E-03
+AHM     34          1.00E-03
+TAM     81          1.00E-03
          0
UTM OBSERVATIONS
         0.
*POLLUTANT   NITROGEN DIOXIDE
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
+DRM     17          1.00E-02
+DNA      5          2.00E-02
+DSR      4          1.50E-02
+DVA      6          2.50E-02
+DSF      1          1.50E-02
+DRC     13          1.00E-02
+DSA      2          1.00E-02
+DPT      8          2.00E-02
+DLI      9          2.00E-02
+DCO     15          1.50E-02
+DSJ     11          2.00E-02
+AHM     34          1.00E-03
+TAM     81          1.00E-03
          0
UTM OBSERVATIONS
         0.
*POLLUTANT   NITRIC OXIDE
SURFACE    OBSERVATION DATA FOLLOWS
```

Fig. F-2. (Continued)

```
STATION OBSERVATIONS
+DRC     13          4.00E-02
+DVA      6          2.00E-03
+DSA      2          1.00E-02
+DSF      1          3.00E-02
+DSR      4          5.00E-02
+DNA      5          2.00E-03
+DSJ     11          5.00E-02
+DPT      8          1.00E-02
+AHM     34          2.00E-03
+TAM     81          2.00E-03
          0
UTM OBSERVATIONS
         0.
*POLLUTANT  OZONE
SURFACE   OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
+DRC     13          1.00E-02
+DMV     12          1.00E-02
+DPE      3          1.00E-02
+DPH     56          1.00E-02
+DSL     57          1.00E-02
+DLG     58          1.00E-02
+DFA     59          1.00E-02
+DRM     17          1.00E-02
+DSA      2          1.00E-02
+DVA      6          1.00E-02
+DSR      4          1.00E-02
+DSF      1          1.00E-02
+DCO     15          1.00E-02
+DPT      8          1.00E-02
+DLI      9          1.00E-02
+DSJ     11          1.00E-02
+DBU     14          1.00E-02
+DNA      5          2.00E-03
+DFR     10          1.00E-02
+AHM     34          2.00E-02
+TAM     81          2.00E-02
          0
UTM OBSERVATIONS
         0.
*POLLUTANT  NITROUS ACID
SURFACE   OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
         0.
*POLLUTANT  NITRIC ACID
SURFACE   OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
```

Fig. F-2. (Continued)

```
          0
UTM OBSERVATIONS
          0.
*POLLUTANT   HYDROGEN PEROXIDE
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
          0.
*POLLUTANT   ALKYL NITRITES
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
          0.
*POLLUTANT   NITROGEN PENTOXIDE
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
          0.
*POLLUTANT   PEROXYACYL FREE RADICALS
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
          0.
*POLLUTANT   PEROXYALKYL FREE RADICALS
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
          0.
*POLLUTANT   HYDROPEROXYL FREE RADICAL
SURFACE    OBSERVATION DATA FOLLOWS
STATION OBSERVATIONS
          0
UTM OBSERVATIONS
          0.
*ENDSET*
```

Fig. F-2. (Continued)

no pseudo-observations added, the boundary values alone are used to determine the initial concentration field. To minimize the effect of the boundaries on the interpolation interior to the grid, the boundary points are arbitrarily weighted so that their effective distance from the point being interpolated is three times their actual distance (thus the factor 9 in the exponential of the boundary weighting function).

CODE LISTINC

Because the QICGEN code has not been transferred to LBL, nor is the MASTER CONTROL data base system with which QICGEN interfaces available at LBL, a listing is not contained in the microfiche attachment to this User's Guide. Thus, for model operation on scenarios not in the QICON library at LBL, the QICON file must be generated in the format specified by using an alternative approach.

Appendix G
Problem Formulation for the LIRAQ Model

T. W. Stullich

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INTRODUCTION

Because of the complexity of the problem of regional air quality, numerical simulation of the problem is in itself a complex task, both in terms of the physics and chemistry (discussed in the Final Report) and in terms of the computer-related operations necessary to assemble the models and data in the proper way. To simplify the use of the models, an automated problem formulation program (LIRPRB) has been developed. This program provides a straightforward option for simple operation as an alternative to the still available - and sometimes necessary and involved - task of assembling the data files and running the model as an individual code. Examples of setting up problems interactively are given in Section 4 of the main text of this User's Guide.

In taking advantage of the problem formulation approach, the use of the LIRAQ models is reduced to two phases:

(1) Problem Formulation: The user runs LIRPRB in an interactive mode and responds to a series of queries that allows him to select a variety of options (described in this appendix) to run a specific problem of interest. This is done on the LBL CDC 6600 computer, remotely if desired, and an instruction file called PRBLM is created that will contain all necessary specifications for running the given problem of interest (i.e., scenario). The files containing the control card staging information are also created at this time.

(2) Execution: The user initiates the control deck that has been created to execute the problem of interest. The control deck will select appropriate codes and data files from a library of tapes, modify them as specified by the instruction file, run the problem according to user specifications in batch mode on the CDC 7600 computer, and provide for the form and delivery of model output. This sequence of operations is described in Appendix H.

Because there may be a future need to augment the number of source, meteorological, and initial condition files in the data libraries and that are to be considered by LIRPRB, the instructions to do this are also given in Appendix H.

LIRPRB OPERATION

As mentioned above, the problem formulation stage (using program LIRPRB) is used to set up the specific problem and the control deck required to run it. The problem formulation stage may either be run interactively, in which case the user will be queried about each detail of the problem, or a file containing the essence of the problem may be constructed beforehand and the interactive steps bypassed. Details on operating the model on the LBL computer system are presented in Appendix H. A microfiche listing of the code is attached to this User's Guide.

All of the input to LIRPRB is done via a "free-form input" routine, FFINP. The input is either numbers (in integer, decimal, or exponential format) or text strings delimited by the ≠ character, or # character (see Table G-1). Each individual input item (either number or text string) must be preceded and followed by one or more blanks (e.g., the data are blank deliminated). Certain characters (given in Table G-1) have special significance, but all other characters are ignored and may be used, or not, at the user's convenience. The FFINP routine traps many kinds of errors and will request you to retype the line if it detects an error. Figure G-1 provides a listing of some comments that may be useful in using FFINP.

Normally FFINP will continue to request input until the variables required by the program have been set. However, in some cases the number of data items required by a particular question will vary, in which case you will be requested to terminate the data list with a $. For a specific example, see Section C ("Pollutant of Interest") below.

The data required for a particular prompt are described in the section on detailed input.

Table G-1. LIRPRB special-case characters. The input record is analyzed for significant characters on the basis shown here.

Group	Character name (on TTY)	Keypunch character	TTY character	Significance
Number construction	Decimal point	.	.	May occur only as a decimal point in real numbers
	Plus sign Minus sign	+ -	+ -	Indicates the sign of integers, real numbers, or exponents
	Asterisk	*	*	Denotes replication of a number. e.g., N*X places X in the next N words
	Apostrophe	'	'	Leave whatever quantity is in this word alone
Special symbols	Right slash	/	/	An editing character: used to delete the last number entered
	At sign	=	@	An editing character used to delete all numbers input in this record
	Pound sign	≠	#	Text delimiter
	Dollar sign	$	$	Terminates the input (this overrides the specification in the mode array when typed before the end of the list.)
Numerals	Numerals	0123456789	(Same)	Except in text strings, may appear only in the context of a number being input
Others	All other characters			Ignored (except in text string)

```
C   MISC USER NOTES -----------------------------------------
C
C
C  EXAMPLES----------
C
C              CONCIDER THE FOLLOWING INPUT LINE -
C
C          RUN=3 TIME] 16.42 DIR COS=-.672 ENERGY=+3.71E-3 DATE] 1 6 73
C
C   *FFINP* WOULD INTERPERATE THE DATA AS -
C
C         3.        16.42      -.672      .00371
C         1         6          73
C
C  PLUS SIGNS ARE OPTIONAL IN ALL POSITIVE QUANTITIES.
C
C
C
C  SPECIAL CHARACTERS -----------
C
C
C  THE ASTERISK  (*)  IS  A  REPEATER.   IF  THE  SAME NUMBER IS TO BE
C  ENTERED N CONSECUTIVE TIMES, THE * MAY BE USED AS FOLLOWS]
C
C          3.47*3  IS EQUIVALENT TO  3.47  3.47  3.47
C
C
C THE APOSTROPHE (') MEANS LEAVE THE VALUE OF X(N) UNCHANGED. FOR
C  EXAMPLE, SUPPOSE THIS INPUT WAS TO FILL AN ARRAY *X*, WHICH WAS
C PREVIOUSLY GIVEN THE VALUE ZERO, THEN THE *FFINP* INPUT LINE -
C
C          8   '   21   '   6.4
C
C  WOULD PRODUCE THE RESULT]
C
C          X(1)=8.  X(2)=0.  X(3)=21.  X(4)=0.  X(5)=6.4
C
C
C  THE SLASH  (/) ERASES THE  PREVIOUS  NUMBER.   CONSECUTIVE  SLASHES
C  ERASE NUMBERS  IN  REVERSE  SEQUENCE,  FOR  EXAMPLE]
C
C          1  2  3  4  ///  5  6  7
C
C  WOULD PRODUCE THE *FFINP* OUTPUT]
C
C          1.  5.  6.  7.
C
C
C THE CONTENTS OF DELIMITED TEXT STRINGS ARE COMPLETELY PROTECTED, AND
C ANY CHARACTER (EXCEPT THE TEXT DELIMITER) MAY APPEAR IN THEM.  BECAUSE
C OF THIS THE EDITING CHARACTERS ARE INOPERATIVE INSIDE A TEXT STRING.
C
C
C  SYNTAX ERRORS ----------
C
C
C
C  IF ILLOGICAL NUMBERS ARE ENCOUNTERED  (IE  NUMBERS  WITH ALPHABETIC
C  CHARACTERS, OR  SIGNS  OUT  OF  CONTEXT) FFINC WILL ASSIGN THE MOST
C  LIKELY VALUE TO EACH VARIABLE  AND  RETURN  WITH  A  POSITIVE ERROR
C  SENTINEL, OR RECYCLE, ASKING FOR THE INPUT TO BE RETYPED.
```

Fig. G-1. Listing of notes taken from the free-form input routine (FFINP). Comment statements give some examples and rules for interactive data.

```
C
C
C  DELIMITERS ----------
C
C
C  THE *FFINP*  INPUT  NUMBERS  MAY  BE  BLANK OR COMMA DELIMITED.  EACH
C  NUMBER MUST BE FOLLOWED IMMEDIATELY BY THE SYMBOL CHOSEN]
C
C          BLANK DELIMITED]  1 2 27.4   3E-4  61.2 0 0 0
C
C          COMMA DELIMITED]  1,2,27.4,  3E-4, 61.2,0,0,0,
C
C  BOTH LINES ABOVE ARE EQUIVALENT.   NOTE  THAT  WITH COMMA DELIMITED
C  INPUT, A  STRING  OF  COMMAS  IS  READ AS ZEROS WHEREAS SUPERFLUOUS
C  BLANKS ARE IGNORED BY BOTH OPTIONS.
C  NOTE THAT IN COMMA DELIMITED MODE, THE LAST NUMBER MUST BE FOLLOWED
C    BY A COMMA.
C
C
C  MODE -----------
C
C   THE MODE (REAL OR INTEGER)OF A NUMBER IS CONTROLED COMPLETELY BY
C    WHAT MODE WAS REQUESTED BY THE PROGRAM, THE PRESENCE OR ABSENCE
C     OF DECIMAL POINTS IN THE INPUT IS NOT SIGNIFICANT.
C
C
```

Fig. G-1. (Continued)

Preliminary Input

Before subsection input is requested, the problem formulator (LIRPRB) will ask you to respond to several general queries. If detailed descriptions of expected input are desired, enter the response #FULL# when asked for; otherwise enter #BRIEF#. In the latter case, only brief prompts such as "A." or "*" will be given. If an input logic error is detected, the question will be recycled with a detailed prompt. You should then consult the detailed instructions in this appendix before proceeding. You will also be asked if LIRPRB will be used in a conversational (i.e., interactive) mode. The possible responses are #YES# or #NO#. If #NO#, it is expected that a previously prepared file (which has been named INPT) is available on disk that contains the user's instructions. All instructions within this file must be in the formats described within Sections A through L, and must be in sequential order. Specifically, the instructions given will, in general, require a variable number of input lines dependent upon the logic implicit within your instruction set. If insufficient information is given, or if information is given out of order, the results are unpredictable and no recovery is possible, short of restarting LIRPRB. It is suggested that the interactive mode with full help package be used initially, until familiarity permits the use of the simplified options. Note that each input is followed by a "RETURN" (carriage return on the teletypewriter) and that the order of the numbers entered when multiple variables are being initialized must be the same as that given in the detailed input description.

Brief Guide to LIRPRB Responses

Tables G-2 and G-3 are abbreviated examples of sample responses that those familiar with the input to LIRPRB may find useful. (The slight differences from the Final Report are a result of more recent updates.) Table G-2 shows an example of input responses for a carbon monoxide scenario, and Table G-3 shows an example for zero emissions in the Livermore Valley. A detailed description of the meaning of the input is presented in the next section of this appendix. Full examples are given in Section 4.

Table G-2. Brief guide to LIRAQ-1 problem formulation for treatment of regional CO concentrations with some source modifications.

Section	Description
A.	Problem name NAME= #BAY AREA CARBON MONOXIDE#
B.	Selection of model MODEL= 1
C.	Selection of pollutants POLNUMS= 15 $
D.	Selection of region of interest REGION= 1 EMIN= 530. EMAX= 630. NMIN= 4120. NMAX= 4230.
E.	Selection of emission source EMISSION= 1973 SEASON= 3 TIME= 1
F.	Changes to elevated sources #YES# Input of changes POL= 15 POLVAL= 10.1 CHGOPT= 3 UTME= 592. UTMN= 4137. START= 8 STOP= 17 POL= 0 $

Table G-2. (Continued)

Section	Description
	Changes to surface sources #YES# Input of changes POL= 15 POLVAL= 0.25 CHGOPT= 4 UTME1= 560. UTME2= 570. UTMN1= 4145. UTMN2= 4155. START=4 STOP=21 POL=0 $
G.	Selection of meteorological scenario METEOR= 1
H.	Selection of start time and problem duration RUNSTAR= 4 NUMHRS= 24
I.	Specification of initial concentrations #NO#

J.	Specification of pollutant boundary conditions
	#YES#
	POLNUM= 15 WEST = .05 SOUTH= .075 EAST= .04 NORTH= .075
	ABOVE= .1
	POLNUM= 0 $

K.	Selection of specific stations to be followed STATION= 1 4 75 101 120 $ Selection of specific UTM coordinate positions to be followed UTME= 550. UTMN= 4150. UTME= 595. UTMN= 4200. UTME= 0 $ Specification of tape number for QSREC and QREST output 11811 Specification of IBM Data Cell subsets to save the problem files #PRBSV# #CNTSV# #STGSV# Selection of output options CODE= 4

L.	Specification of computer usage and priority
	CUS= 5000
	PRIOR= 5
	ACCNT= 123456
	UNAM= #ROBINSON#
	ROUT= #SEND TO EXPEDITER SERVICES#

Table G-3. Brief guide to LIRAQ-2 problem formulation for case of setting Livermore Valley emissions to zero.

```
A.  Problem name
        NAME= #LIVERMORE VALLEY EMISSIONS EQUAL ZERO#

B.  Selection of model
        MODEL= 2

C.  Selection of pollutants
        POLNUMS= 1 2 3 7 8 10 15 $

D.  Selection of region of interest
        REGION= 1
        EMIN= 530.   EMAX= 630.   NMIN= 4120.   NMAX= 4220.

E.  Selection of emission sources
        EMISSION= 1973   SEASON= 3   TIME= 1

F.  Changes to elevated sources
        #NO#
    Changes to surface sources
        #YES#
    Input of changes
        POL= 1   POLVAL= 0   CHGOPT= 1
        UTME1= 590.   UTME2= 620.   UTMN1= 4165.   UTMN2= 4185.
        START= 0   STOP= 24
        POL= 2 ' '
        ' ' ' '
        ' '
        POL= 3 ' '
        ' ' ' '
        ' '
        7 ' '
        ' ' ' '
        ' '
        15 ' '
        ' ' ' '
        ' '
        0 $

G.  Selection of meteorological scenario
        METEOR= 1

H.  Selection of start time and problem duration
        RUNSTAR= 6   NUMHRS= 12

I.  Specification of initial concentrations
        #QREST#
    Specification of input tape
        CONTPE= 10509
    Specification of QREST multipliers
        #NO#

J.  Specification of pollutant boundary conditions
        #NO#
```

Table G-3. (Continued)

K. Selection of specific stations to be followed

```
STATION= 24 139 129 97 75 $
```

Selection of specific UTM coordinate positions to be followed

```
UTME= 590.   UTMN= 4180.
' 4165.
615. '
' 4180.
0 $
```

Specification of tape number for QSREC and QREST output

```
RESTPE= 10508
```

Selection of output options

```
CODE= 3
```

L. Specification of computer usage and priority

```
CUS= 12000
PRIOR= 3
ACCT= 123456
UNAM= #MACCRACKEN#
ROUT= #NONE#
```

Specification of IBM Data Cell subsets to save the problem files

```
#PRBL2#
#CNTL2#
#STGL2#
```

DETAILED SUBSECTION INPUT FOR PROBLEM FORMULATION

The following pages describe in detail the available input options that are acceptable responses to queries from the problem formulation program. Not only is a description given of the variable requested, but also included are the name of the variable used in the program, the mode (or format) that must be adhered to, value limits for the input, the units the model requires of any numerical input, an example of an acceptable input, and some remarks indicating limitations and offering advice.

One general convention used in model input is in referring to the UTM coordinates of a grid square. A grid square is referenced by the coordinates of its lower left-hand (southwest) corner. However, a boundary, such as the edge of a domain, is referenced by the UTM coordinate of the line.

Section A

1.	Description:	Name of the problem
2.	Variable:	NAME
3.	Mode:	Delimited text
4.	Value limits:	Any 40 alphanumeric characters
5.	Units:	None
6.	Examples:	NAME= #SOUTH BAY REFINERY PROBLEM#
7.	Remarks:	None

Section B

1.	Description:	Selection of model
2.	Variable:	MODEL
3.	Mode:	Number
4.	Value limits:	1 or 2
5.	Units:	None
6.	Examples:	MODEL = 1 or 1
7.	Remarks:	1 = LIRAQ-1 (conventional pollutants) 2 = LIRAQ-2 (photochemistry)

Section C

1. Description: Selection of pollutants
2. Variable: POLNUMS
3. Mode: Number
4. Value limits: Integers between 1 and 15 according to the following table:

POLNUMS	Symbol	Pollutant name
1	HC1	Alkenes*
2	HC2	Alkanes*
3	HC4	Aldehydes*
4	HNO2	Nitrous acid
5	HNO3	Nitric acid
6	H2O2	Hydrogen peroxide
7	NO	Nitric oxide
8	NO2	Nitrogen dioxide
9	N2O5	Nitrogen Pentoxide
10	O3	Ozone
11	RNO2	Alkyl nitrites
12	RCO3	Acylperoxyl radicals
13	RO2	Alkylperoxyl radicals
14	HO2	Hydroperoxyl free radical
15	CO	Carbon monoxide

5. Units: None
6. Examples: POLUMS = 1 2 3 7 $

   or

   1 2 3 7 $

*The correspondence of HC classes to types of organic compounds is inexact.

7. Remarks: Acceptable choices of pollutants for LIRAQ-1 are 1, 2, 3, 7, and 15. Limit is four pollutants. Acceptable choices of pollutants for LIRAQ-2 are 1-15, inclusive. Limit is 15 pollutants. If you want a standard set of pollutants (CO, NO, NO_2, HC1, HC2, HC4, and O_3) output under LIRAQ-2, POLNUMS = #STANDARD# may be entered. Terminate the list with a $.

Section D

(Part 1)

1. Description: Selection of region of interest
2. Variable: REGION
3. Mode: Number
4. Value limits: Integers between 1 and 11 according to the following table:

REGION	Name	Grid size (km)	UTME (min) - UTME (max)	UTMN (min) - UTMN (max)	E-W zones	N-S zones
1	Greater Bay Area	5	490 - 660	4090 - 4300	34	42
2	South Bay Area	2	530 - 660	4090 - 4220	65	65
3	Central Bay Area	2	510 - 640	4120 - 4250	65	65
4	North Bay Area	2	490 - 620	4170 - 4300	65	65
5	Santa Clara	1	580 - 645	4090 - 4155	65	65
6	San Mateo	1	540 - 605	4100 - 4165	65	65
7	East Bay	1	555 - 620	4140 - 4205	65	65
8	Golden Gate	1	520 - 585	4150 - 4215	65	65
9	Carquinez	1	550 - 615	4180 - 4245	65	65
10	Marin	1	490 - 555	4205 - 4270	65	65
11	Napa-Sonoma	1	505 - 570	4225 - 4290	65	65

5. Units: None

6. Examples: REGION = 1

or

1

7. Remarks: Each of the above regions defines the domain of a QTRAN file. (LIRAQ-1 and LIRAQ-2 are then able to use parts of these grids as their domain.) As indicated in Section G, QTRAN files do not exist for all regions for each meteorological scenario. The user must choose a region for which a QTRAN file is available or be prepared to supply a QTRAN file of his own selection in part 2 of Section G.

(Part 2)

1. Description: Selection of subarea within region of interest to be treated by LIRAQ-1 or LIRAQ-2.

2. Variables: EMIN, EMAX, NMIN, NMAX

3. Mode: Number

4. Value limits: Selection of EMIN and EMAX must be within the UTME window selected in part 1 of this section; similarly, NMIN and NMAX must be within the UTMN window. Values will be truncated to whole kilometres, and the grid will be established at the next lowest UTM grid line evenly divisible by the grid size.

5. Units: UTM coordinates, kilometres

6. Examples: EMIN = 490. EMAX = 520. NMIN = 4100. NMAX = 4150.

or

490 520 4100 4150

7. Remarks: This subsection provides for specification of the air quality study subgrid for the LIRAQ-1 or LIRAQ-2 models within the allowable meteorological data domain specified in (a) below. Certain restrictions exist on this choice, including:

(a) EMIN must be less than EMAX.

(b) NMIN must be less than NMAX.

(c) For a 5-km grid size, each UTM coordinate must be divisible by 5.

For a 2-km grid size, each UTM coordinate must be divisible by 2.

For all grids, UTM coordinates must be specified in whole kilometres.

(d) The number of zones determined by your choice of coordinates and grid size are limited according to model and direction as:

LIRAQ-1: maximum of 45 East-West
maximum of 50 North-South

LIRAQ-2: must be 20 in both directions

Section E

1. Description: Choice of emissions pattern and season (actually quarter) of the year
2. Variables: EMISS, SEASON, TIME
3. Mode: Number
4. Value limits: Present restrictions require that EMISSION be set to 1973 only, and SEASON be set to summer only; TIME should be set to 1 during the summer to indicate that source pattern is on daylight savings time.
5. Units: None

6. Examples: EMISS = 1973 SEASON = 3 TIME = 1

or

1973 3 1

7. Remarks: The BAAPCD plans to expand the available choices to include other years, such as 1980, as available. Choices for SEASON and TIME are according to the following tables:

SEASON

1 = Winter (Jan-March)

2 = Spring (April-June)

3 = Summer (July-Sept)

4 = Fall (Oct-Dec)

TIME

0 = PST

1 = PDT

Note: All model output will be in PST. Source input is provided in local time ("watch" time), which is PDT for some months and PST for other months. During months when PDT is in use (e.g., during the summer), TIME should be set equal to 1.

Section F

(Part 1)

1. Description: Modifications in the elevated source pattern

2. Variable: None. Respond #YES# or #NO#.

3. Mode: Text

4. Value limits: YES or NO

5. Units: None

6. Example: #YES#

7. Remarks: The user is asked if he wants to change elevated sources.

(Part 2)

1. Description: Changes in elevated point sources
2. Variables: POL, POLVAL, CHGOPT, UTME, UTMN, START, STOP
3. Mode: Number
4. Value limits: (a) POL; integer values according to the table:

POL	Symbol	Pollutant name
15	CO	Carbon monoxide
7	NO	Nitric oxide
1	HC1	Alkenes
2	HC2	Alkanes
3	HC4	Aldehydes

(b) POLVAL; none (user's choice of scaling factor on quantities in units of g/s)

(c) CHGOPT; integer values 0 through 4, according to the table:

CHGOPT	Function
0	No change (terminates this part)
1	Emissions set to 0
2	Emissions set to POLVAL
3	POLVAL (positive or negative) added to current emissions
4	POLVAL (positive) multiplied times current emissions

(d) UTME, UTMN: UTM coordinates must be within the subregion specified in Section D. Values will be truncated to whole kilometres and applied to the zone in which the point lies.

(e) START, STOP: beginning and ending times (does not include the upcoming hour) for change to take place within the daily emissions cycle. Values must be between 0 and 24, inclusive. Note: these times are not problem times, but source emission times.

5. Units: POLVAL (none); UTME, UTMN (UTM coordinates, kilometres); START, STOP (whole hours); other variables (not applicable).

6. Examples:

```
POL = 3 POLVAL = 1.5 CHGOPT = 4
UTME = 500. UTMN = 4150.
START = 6 STOP = 9
  or
3 1.5 4
500 4150
6 9
  or
2 ' '
' '
' '
```

7. Remarks: Variable assignments may be entered on one line or spread over a number of lines, but the groups {POL, POLVAL, CHGOPT}, {UTME, UTMN}, {START, STOP}, may not be intermixed on one line. Each group is handled by a separate call to the input routine, FFINP. Multiple changes will be made in the order submitted. To terminate these changes in elevated sources, enter "POL = 0 $" Drop-through value assignments are permitted. For example, if, after the change in the example above, one wishes to apply the same changes to pollutant 2 (HC2), type "2" followed by two space-delimited apostrophes after the prompt, two after the second prompt and two after the third

prompt (see example above). Changes may only be made within the subarea of the region specified in Section D. A maximum of 50 change lines are allowed. Note that in the example the change will be made for the emission periods 6 to 7, 7 to 8, and 8 to 9. Because the LIRAQ model interpolates the hourly emission rates from 15 min before an hour to 15 min after an hour in order to maintain continuity, changes made between hours indicated are thus not exactly reflected in the LIRAQ hourly results. Note also that in the modified QSOR file (described in Appendix D), changes made in a grid element already having emissions are made in the line already present for that grid square. If there are no prior emissions shown for that grid square, a new line for that grid square is introduced at the end of the emissions section for the particular hour. If all emissions in a grid square are zero, that line is removed from the QSOR file for that hour.

(Part 3)

1. Description:	Modification of surface sources
2. Variable:	None. Respond #YES# or #NO#
3. Mode:	Text
4. Value limits:	YES or NO
5. Units:	None
6. Example	#NO#
7. Remarks:	The user is asked if he wants to change <u>surface</u> sources.

(Part 4)

1. Description:	Changes in surface sources
2. Variables:	POL, POLVAL, CHGOPT, UTME1, UTME2, UTMN1, UTMN2, START, STOP
3. Mode:	Same as in Part 2
4. Values limits:	Same as in Part 2
5. Units:	Same as in Part 2
6. Example:	POL = 1 POLVAL = 1.E-02 CHGOPT = 2 UTME1 = 500 UTME2 = 510 UTMN1 = 4150 UTMN2 = 4160 START = 0 STOP = 12 or 1 1E-02 2 500 510 4150 4160 0 12
7. Remarks:	Changes in surface sources are analogous to changes in elevated sources (see remarks for Part 2), except that changes to surface sources are over an area rather than at a point location. The area specified must be within the subarea selected in Section D. (UTME1,UTMN1) represents the lower left corner of the area and (UTME2, UTMN2) represents the upper right corner. Note that zone reference by lower left coordinates does not apply in this section, since the boundaries of an area are being requested. Thus, in the above example, four grid squares (assuming a 5-km grid) will be modified; i.e., those with lower left coordinates (500, 4150), (500, 4155), (505, 4150), (505, 4155). The total number of change lines submitted for elevated and surface sources is not permitted to exceed 50.

Section G

(Part 1)

1. Description: Selection of meteorological scenario
2. Variable: METEOR
3. Mode: Number
4. Value limits: Integer values 1 through 4, according to the table:

METEOR	Date Set
1	July 26-27, 1973 (available for regions 1-11)
2	August 20, 1973 (available for regions 1-4, 6)
3	September 26-28, 1973 (available for regions 1-4, 6)
4	To be specified (Part 2)

5. Units: None
6. Example: METEOR = 2
   or
   2
7. Remarks: Sets 1-3 are data sets that have been analyzed and refined, and the choice of one of these implies the selection of a given set of transfer coefficients to run either model. Only files for the regions indicated have been processed. If the user stipulates METEOR = 4, he will be asked (Part 2) to specify additional information that will identify a non-standard scenario, and the name of the file containing the appropriate transfer coefficients.

(Part 2)

1. Description: Specification of non-standard QTRAN file
2. Variable: METPE
3. Mode: Number

4. Value limits: A valid LBL tape library number.

5. Units: None

6. Example: METPE = 123456

7. Remarks: The desired number is the LBL tape library number for the tape that contains the QTRAN file(s). The tape must be a 9-track tape.

(Part 3)

1. Description: Identification of date(s) of non-standard meteorological scenario

2. Variables: MONTH, DAY1, DAY2, YEAR

3. Mode: Delimited text

4. Value limits: Alphanumeric strings up to nine characters for MONTH, two characters for DAY1 and DAY2, and four characters for YEAR

5. Units: None

6. Example: MONTH = #SEPTEMBER# DAY1 = #27# DAY2 = #28# YEAR = #1975#

7. Remarks: Selection of METEOR = 4 implies that the user will also supply a file containing initial condition information (Section I).

Section H

1. Description: Determination of model run period

2. Variables: RUNSTAR, NUMHRS

3. Mode: Integer

4. Value limits: Determined by the meteorological set selected in Section G according to the table:

METEOR	RUNSTAR	RUNSTART + NUMHRS
1	≥ 4	≤ 28
2	≥ 4	≤ 22
3	≥ 4	≤ 52
4	Free to choose, but consistent with the QTRAN provided.	

5. Units: Hours

6. Examples: RUNSTAR = 4 NUMHRS = 24

or

4 24

7. Remarks: In general, one may start at the initial time or at any even hour increment from that time (e.g., 4, 5, 6,...) and run for any number of hours up to the limits specified above. Because sunrise and sunset typically require large amounts of computer time for the LIRAQ-2 model, it is advisable, when possible, to avoid calculating these times. For the standard meteorological cases available, these times are as follows:

	Sunrise	*Sunset*
July 26-27, 1973	0503	1908
August 20, 1973	0527	1844
September 26-28, 1973	0612	1758

We have also found that, for LIRAQ-2, initializing the model run in the middle of the day may lead to unrealistic simulation of photochemically active species. For this reason, when not restarting from a QREST file, LIRAQ-2 simulations should start at or before 0800.

Section I

(Part 1)

1. Description: Pollutant initial conditions
2. Variable: None. Respond #YES#, #NO#, or #QREST#
3. Mode: Text
4. Value limits: YES, NO, or QREST
5. Units: None
6. Example: #NO#

7. Remarks: The user is asked if he wants to specify initial concentrations. If the answer is "NO", they will be taken from a standard set of files corresponding to the actual day being modeled as determined by the meteorological set chosen in Section G. To start from some other QICON file, the answer should be "YES", and the tape number containing the file will be asked for in Part 3. For LIRAQ-2 only, there also exists the option to start from a QREST file, which is a record of concentrations from some previous run. Under this option, initial concentrations will be taken from the specified QREST file at the time given as RUNSTAR in Section H. If the user has specified METEOR = 4 in Section G, then the answer must be either "YES" or "QREST," that is the user must provide a file of initial concentrations in the prescribed format or start from a QREST file.

(Part 2) (Encountered if response to Part 1 was YES or QREST)

1. Description: Specification of tape number containing the initial concentrations
2. Variable: CONTPE
3. Mode: Number
4. Value limits: Valid LBL library tape number
5. Units: None
6. Examples: 5658
7. Remarks: Non-standard QICON's and QREST's must reside on tape, this section specifies that tape number.

If the YES option has been taken in Part 1, the file provided must be in the format for QICON files as indicated in Appendix F.

If the answer to Part 1 is QREST, then the file must have been generated in a previous LIRAQ2 run covering exactly the same domain and including information at the time given by RUNSTAR in Section H. The QREST information is assumed to start after the fourth end-of-file mark on the tape and run through the end of information. The tape must be 9-track.

(Part 3) (Encountered if response to part 1 was QREST)

1. Description: Specification of QREST multipliers
2. Variables: POLQ, POLVAL1, POLVAL2
3. Mode: Integer (POLQ); floating point (POLVAL1, POLVAL2)
4. Value limits:
   (a) POLQ; integer values from 1 to 15 as given in Section C.
   (b) POLVAL1; must be positive (user's choice of scaling factor)
   (c) POLVAL2; no limitations (user's choice of species concentration)
5. Units: POLVAL2 must be in units of molecules/cm^3
6. Example: POLQ = 2 POLVAL1 = 1.2 POLVAL2 = 1.0E+00
7. Remarks: The option is intended to allow initial concentrations of various species given by QREST to be reset according to the relation

$$c_{new} = POLVAL1 \times c_{old} + POLVAL2,$$

where c_{new} is the desired concentration and c_{old} is the concentration given on QREST. This rescaling may be done for up to 15 pollutants. Sequence must be terminated by inputting "POLQ = 0 $". If values for

POLVAL1 or POLVAL2 are not given, their assumed values are POLVAL1 = 1.0 and POLVAL2 = 0.0.

Section J

(Part 1)

1. Description:	Pollutant boundary conditions
2. Variable:	None. Respond #YES# or #NO#
3. Mode:	Text
4. Value limits:	YES or NO
5. Units:	None
6. Example:	#YES#
7. Remarks:	The user is asked if he wants to specify pollutant boundary conditions. In LIRAQ-1 this sets the boundary condition, and in LIRAQ-2 this sets the floor concentration to which a fraction of the concentration inside the adjacent grid square is added, as described in Appendix 5-3 of the Final Report.

(Part 2)

1. Description:	Specification of pollutant boundary conditions.
2. Variables:	POLNUM, WEST, SOUTH, EAST, NORTH, ABOVE
3. Mode:	Integer (POLNUM); floating point (WEST, SOUTH, EAST, NORTH, ABOVE).
4. Value limits:	POLNUM; see Section F, Part 2, Item 4(a).
5. Units:	POLNUM (none); WEST, SOUTH, EAST, NORTH, ABOVE (ppm)
6. Example:	POLNUM = 1 WEST = 1.0 SOUTH = 0.5 EAST = 0.5 NORTH = 0.5 ABOVE = 0.25 0 $

7. Remarks:	This part is skipped if user specified "NO" in Part 1. Drop throughs are allowed (see Section F, Part 2, Item 7). All input may be on one line or spread over several lines, but the data input must be in order. To terminate a set of specifications, enter "POLNUM = 0 $".

<u>Section K</u>

(Part 1)

1. Description:	Selection of additional stations for output of station history data.
2. Variable:	STATIONS
3. Mode:	Integer
4. Value limits:	Integers between 0 and 146 (see Table G-4)
5. Units:	None
6. Example:	STATIONS = 1 31 100 115 $
7. Remarks:	A maximum of 10 stations as supplemental locations is permitted. If none are desired, enter "STATIONS = 0 $". The station numbers correspond to the list given in Table G-4. Those stations marked with an asterisk are automatically outputted. This standard set is data loaded into the program MODFILE and may be altèred if desired.

(Part 2)

1. Description:	Selection of UTM locations for output
2. Variables:	UTME, UTMN
3. Mode:	Floating point
4. Value limits:	Values must be within the subregion specified in Section D. Values will be truncated to whole kilometres and applied to zone within which point lies.
5. Units:	UTM coordinates, kilometres

Table G-4. Listing of stations at which pollution concentrations may be selected.

Station name [a]	Station No.	Symbol	Agency	County	Elevation (m)	UTMN-north	UTME-east	Zone
*SAN FRANCISCO	1	DSF	BA	SF	25	4181.8	551.1	Z1
SANTA ROSA	2	DSA	BA	SN	50	4254.7	525.1	Z4
PETALUMA	3	DPE	BA	SN	4	4232.4	532.7	Z4
*SAN RAFAEL	4	DSR	BA	MA	6	4202.7	542.3	Z4
NAPA	5	DNA	BA	NA	13	4240.7	561.6	Z3
*VALLEJO	6	DVA	BA	SL	6	4217.4	567.1	Z3
RICHMOND-JADE ST	7	DRI	BA	CC	3	4201.0	555.4	Z4
*PITTSBURG	8	DPT	BA	CC	2	4209.4	597.3	Z2
*LIVERMORE	9	DLI	BA	AL	150	4171.2	608.6	Z2
*FREMONT	10	DFR	BA	AL	12	4154.6	591.8	Z1
*SAN JOSE	11	DSJ	BA	SC	25	4133.0	598.5	Z1
*MOUNTAIN VIEW	12	DMV	BA	SC	23	4138.8	583.3	Z1
*REDWOOD CITY	13	DRC	BA	SM	4	4148.5	570.5	Z1
*BURLINGAME	14	DBU	BA	SM	10	4159.1	557.8	Z1
*CONCORD-TREAT BLVD	15	DCO	BA	CC	25	4199.3	585.7	Z2
BENICIA	16	DBE	BA	SL	40	4211.8	574.3	Z2
*RICHMOND-13TH ST	17	DRM	BA	CC	12	4200.4	556.6	Z4
MARTINEZ-FIRE STA	18	DMF	BA	CC	3	4207.4	576.1	Z2
POINT RICHMOND	19	DPR	BA	CC	5	4197.6	554.1	Z4
SONOMA CO ARPT	20	ASN	FA	SN	36	4262.0	517.2	Z4
HAMILTON AFB	21	AHA	AF	MA	1	4213.2	542.4	Z4
NAPA CO ARPT	22	ANA	FA	NA	4	4229.0	563.1	Z3
TRAVIS AFB 1	23	ATI	AF	SL	14	4235.4	594.4	Z3
LIVERMORE ARPT	24	ALI	FA	AL	122	4172.5	604.5	Z2
*BUCHANAN FIELD	25	ABF	FA	CC	6	4204.5	583.0	Z2
OAKLAND INTL ARPT	26	AOA	FA	AL	1	4172.7	569.3	Z1
ALAMEDA NAS	27	AAN	NV	AL	2	4181.2	560.5	Z1
HAYWARD ARPT	28	AHW	FA	AL	9	4168.5	577.9	Z1
SAN JOSE ARPT	29	ASJ	FA	SC	14	4135.4	595.1	Z1
MOFFETT FIELD NAS	30	AMN	NV	SC	8	4140.5	584.1	Z1
REID HILLVIEW ARPT	31	ARH	FA	SC	38	4132.4	604.7	Z1
SAN FRANCISCO ARPT	32	ASF	NW	SM	1	4163.2	556.2	Z1
SAN CARLOS ARPT	33	ASC	FA	SM	1	4151.8	566.2	Z1
*HALF MOON BAY ARPT	34	AHM	FA	SM	16	4151.9	544.6	Z1
SAC'TO METRO ARPT	35	ASM	FA	SA	5	4284.6	622.2	Z3
SAC'TO EXEC ARPT	36	ASE	FA	SA	5	4263.6	631.1	Z3
MATHER AFB	37	AMT	AF	SA	5	4268.6	647.8	Z3
MCCLELLAN AFB	38	AMC	AF	SA	5	4280.6	638.9	Z3
STOCKTON ARPT	39	AST	FA	SJ	7	4195.1	654.4	Z2
ANGEL ISLAND	40	MAG	CG	MA	3	4189.4	551.2	Z4
POINT REYES	41	MRE	CG	MA	73	4205.1	498.1	Z4
BODEGA BAY	42	MBO	CG	SN	1	4242.7	495.2	Z4
POINT ARENA	43	MPA	CG	ME	1	4311.9	435.9	Z4
RIO VISTA	44	MRV	CG	SL	2	4223.1	614.6	Z2
PORT CHICAGO	45	MPC	CG	CC	15	4210.8	586.3	Z2

[a]Asterisks (*) indicate stations that are automatically outputted.

Table G-4. (Continued)

Station name	Station No.	Symbol	Agency	County	Elevation (m)	UTMN-north	UTME-east	Zone
PIGEON POINT	46	MPP	CG	SM	12	4115.0	553.9	Z1
PILLAR POINT	47	MPI	CG	SM	60	4150.0	544.4	Z1
POINT BONITA	48	MPB	CG	MA	24	4185.3	541.5	Z4
SONOMA-1ST ST WEST	49	DSO	BA	SN	29	4238.6	547.5	Z4
MT JACKSON	50	FMJ	FO	SN	500	4265.5	503.5	Z4
BERRYESSA LO	51	FBL	FO	NA	930	4279.6	570.5	Z3
ALLEN LO	52	FAL	FO	SM	710	4137.9	562.5	Z1
LOMA PRIETA	53	FLP	FO	SC	1160	4107.6	602.8	Z1
EAGLE ROCK	54	FEA	FO	SZ	760	4111.3	571.6	Z1
MOUNT OSO	55	FMO	FO	ST	976	4152.2	639.5	Z2
PLEASANT HILL	56	DPH	BA	CC	26	4197.9	581.1	Z2
*SAN LEANDRO	57	DSL	BA	AL	14	4174.7	573.9	Z1
LOS GATOS	58	DLG	BA	SC	116	4120.3	590.6	Z1
FAIRFIELD	59	DFA	BA	SL	5	4233.3	582.6	Z3
MORGAN HILL ARPT	60	NMH	MS	SC	193	4111.8	619.9	Z1
*SHELL,MARTINEZ	61	ISH	CM	CC	30	4208.0	577.1	Z2
SMITH ARPT,S RAFAEL	62	NSR	MS	MA	3	4208.4	542.4	Z4
*PHILLIPS,MARTINEZ	63	IPH	CM	CC	4	4208.6	582.4	Z2
ANTIOCH ARPT	64	NAN	MS	CC	93	4202.7	605.4	Z2
PG & E,PITTSBURG	65	EGP	PG	CC	2	4210.2	596.7	Z2
UNION,OLEUM	66	IUN	CM	CC	14	4210.7	567.1	Z2
STD OIL,GARDEN TRACT	67	IGT	CM	CC	2	4202.1	554.8	Z4
STD OIL,GERTRUDE ST	68	IGS	CM	CC	3	4200.7	554.7	Z4
ALLIED,RICHMOND	69	IAC	CM	CC	2	4199.2	554.9	Z4
PG & E MOSS LANDING	70	EGL	PG	MR	1	4074.1	608.7	Z1
CSUSJ	71	USJ	DM	SC	27	4132.2	599.1	Z1
HAYWARD ST COLLEGE	72	UHW	MS	AL	137	4167.7	583.6	Z1
U. C. BERKELEY	73	UCB	MS	AL	94	4191.7	565.3	Z1
LLL. WEST TOWER	74	LLT	LL	AL	177	4172.3	613.8	Z2
LLL. SITE 300	75	LLH	LL	SJ	360	4168.2	630.4	Z2
SAN JOSE EMSU	76	GEM	DM	SC	32	4131.0	600.3	Z1
OAKLAND RADIOSONDE	77	GOA	NW	AL	2	4177.4	568.3	Z1
SAN FRANCISCO BEACH	78	NSB	MS	SF	0	4176.1	543.6	Z1
MT SUTRO TOWER	79	UMS	DM	SF	277	4178.9	547.9	Z1
S. J. CIVIL DEFENSE	80	GSD	MS	SC	20	4134.0	597.2	Z1
MT TAMALPAIS	81	TAM	FO	MA	785	4197.8	537.2	Z4
MT DIABLO	82	DIA	FO	CC	1175	4193.1	595.6	Z2
SUNOL FORESTRY	83	FSU	FO	AL	73	4161.2	598.6	Z2
OAKLAND SEWAGE PLANT	84	OSW	MS	AL	3	4186.5	562.1	Z1
AL CHEM,PORT CHICAGO	85	IAP	CM	CC	1	4211.3	589.0	Z2
CHABOT REGIONAL PARK	86	PCP	DM	AL	122	4175.3	581.1	Z2
MODESTO ARPT	87	AMO	FA	ST	28	4166.2	679.6	Z2
*HAYWARD	88	DHW	BA	AL	259	4167.8	585.2	Z1
SUNNYVALE	89	DSY	BA	SC	31	4136.7	585.9	Z1
GILROY	90	DGL	BA	SC	60	4096.8	627.2	Z1
EAST SAN JOSE	91	DEJ	BA	SC	64	4138.8	602.5	Z1
BUCHANAN FIELD	92	PBF	BA	CC	6	4204.5	583.0	Z2
EAST SAN FRANCISCO	93	DFC	BA	SF	5	4178.7	553.9	Z1
OCEANICS CONCORD	94	VCO	NO	CC	6	4204.5	583.0	Z2
OCEANICS OAKLAND	95	VOK	NO	AL	1	4172.7	569.3	Z1
OCEANICS GNOSS FIELD	96	VGF	NO	MA	2	4221.6	539.8	Z4

Table G-4. (Continued)

Station name	Station No.	Symbol	Agency	County	Elevation (m)	UTMN-north	UTME-east	Zone
OCEANICS NILES CANY.	97	VNC	NO	AL	73	4160.7	597.9	Z2
SAN RAFAEL, 4TH ST	98	DRA	BA	MA	6	4202.6	542.5	Z4
RICHMOND, NEVIN AVE	99	DRH	BA	CC	9	4198.8	556.7	Z4
FREMONT, UNION ST	100	DFM	BA	AL	15	4154.4	592.1	Z1
SAN JOSE, ALMA AVE	101	DJO	BA	SC	33	4130.1	599.6	Z1
BURLINGAME, BAYSHORE	102	DBG	BA	SM	2	4161.1	556.1	Z1
OAKLAND, JACKSON ST	103	OAK	RB	AL	11	4183.7	564.7	Z1
NAPA, 1ST ST	104	DNP	BA	NA	5	4238.8	562.5	Z3
SANTA ROSA, 4TH ST	105	DSS	BA	SN	49	4254.5	525.0	Z4
VALLEJO TRAILER	106	DVT	BA	SL	5	4217.3	566.9	Z3
POINT MONTARA	107	MPM	CG	SM	17	4154.3	542.6	Z1
SAN CARLOS	108	VSC	MS	SM	2	4149.7	567.6	Z1
MARTINEZ	109	VMA	MS	CC	2	4208.4	575.4	Z2
ANTIOCH	110	VAT	MS	CC	0	4208.2	605.1	Z2
RIO VISTA	111	VRV	MS	SL	23	4224.6	613.9	Z2
TRACY	112	VTY	MS	SJ	20	4176.6	637.6	Z2
ALTAMONT PASS	113	VAP	MS	AL	174	4175.4	614.8	Z2
DUBLIN	114	VDU	MS	AL	99	4173.6	595.1	Z2
WALNUT CREEK	115	VWC	MS	CC	50	4194.2	582.9	Z2
WINTERS	116	VWT	MS	YO	38	4264.0	590.6	Z3
DIXON	117	VDX	MS	SL	17	4256.0	604.1	Z3
CACHE	118	VCH	MS	SL	0	4232.3	613.3	Z3
BENICIA	119	VBE	MS	SL	5	4214.2	576.1	Z2
VALLEJO	120	VVA	MS	SL	36	4219.6	567.6	Z3
NAPA	121	VNA	MS	NA	10	4239.1	561.8	Z3
BODEGA BAY	122	VBO	MS	SN	0	4238.0	496.4	Z4
SANTA ROSA	123	VSA	MS	SN	52	4253.5	526.4	Z4
SONOMA	124	VSN	MS	SN	24	4238.8	545.6	Z4
RICHMOND HARBOR	125	VRD	MS	CC	0	4195.2	557.6	Z4
BOLINAS BAY	126	VBY	MS	MA	0	4193.2	527.4	Z4
PETALUMA	127	VPE	MS	SN	17	4233.9	533.8	Z4
SAN RAFAEL	128	VSR	MS	MA	9	4201.8	542.3	Z4
*NILES CANYON	129	PNC	DM	AL	73	4160.7	597.9	Z2
DUMBARTON BRIDGE	130	RDB	DM	SM	3	4150.7	577.5	Z1
CSUSJ	131	RSJ	DM	SC	32	4131.0	600.4	Z1
RIO VISTA	132	RRV	DM	SL	0	4222.3	614.6	Z2
TRAVIS AFB	133	RTR	DM	SL	17	4235.5	592.7	Z3
SANTA ROSA	134	RSA	DM	SN	41	4253.6	523.3	Z4
FRESNO ARPT	135	VFA	RB	FR	100	4074.7	793.1	Z7
SALINAS ARPT	136	VSS	RB	MR	23	4058.4	624.6	Z7
SACRAMENTO ARPT	137	VSM	RB	SA	5	4284.6	622.2	Z7
OCEANICS SAN JOSE	138	VSJ	NO	SC	14	4135.4	595.1	Z1
OCEANICS LIVERMORE	139	VLV	NO	AL	122	4172.5	604.5	Z2
HAYWARD	140	PHW	DM	AL	76	4172.1	584.3	Z1
GILROY	141	PGY	DM	SC	58	4095.4	627.9	Z1
TRACY	142	PTY	DM	SJ	14	4177.9	638.1	Z2
*PLEASANTON	143	PPS	DM	AL	95	4168.2	597.8	Z2
MARE ISLAND	144	PMI	DM	SL	6	4216.0	563.9	Z3
DAVIS	145	PDV	DM	YO	13	4266.4	609.4	Z3
PETALUMA	146	PPE	DM	SN	3	4231.9	532.0	Z4

6. Example: UTME = 500. UTMN = 4150.

7. Remarks: A maximum of five UTM locations will be accepted, each on a separate line. To terminate this part, enter "UTME = 0. $". Caution: Do not add special UTM coordinates that are exactly on the northernmost or easternmost boundary of your subregion. The model considers these locations to be part of the adjacent zones outside your grid. All zones are referred to by their lower left corner coordinates.

(Part 3)

1. Description: Specification of LBL library tape number on which the output files and QREST (if LIRAQ-2) will be written
2. Variable: RESTPE
3. Mode: Integer
4. Value limits: LBL tape number
5. Units: None
6. Example: 12325
7. Remarks: These files are written to tape every run of the model, so if they are to be saved, you must use a different tape number for each run. The tape is written as a 9-track tape.

(Part 4)

1. Description: Specification of form of output
2. Variable: CODE
3. Mode: Integer
4. Value limits: An integer between one and three
5. Units: None
6. Example: CODE = 2

7. Remarks: The type of output from the model is determined by CODE according to the table:

CODE	Tabular output	Graphical output
1	Hardcopy	Microfiche
2	Microfiche	Microfiche
3	Both microfiche and hardcopy	Microfiche

Section L

(Part 1)

1. Description: Specification of computer time limit
2. Variable: CUS
3. Mode: Integer
4. Value limits: 300 - 99999
5. Units: Compute unit seconds
6. Example: CUS = 5000
7. Remarks: For LIRAQ-1 on a 5-km grid, limited experience indicates that each model hour takes about 50 CUS.

   For LIRAQ-2 on a 5-km grid, experience indicates that each model hour takes about 500 CUS unless an hour contains a sunrise/sunset, a meteorological update, or is the first hour, in which case, allow 1500 CUS for each of those hours.

   Caution: Because the LBL operating system does not provide options for restarting if inadequate time is allowed for completion of the run, it is important that an adequate margin of safety be allowed to assure the model completes its run. With smaller grid sizes, more time is needed because time varies inversely with grid size. Because the meteorology varies, the time to run different conditions can vary substantially.

(Part 2)

1.	Description:	Specification of priority
2.	Variable:	PRIOR
3.	Mode:	Integer
4.	Value limits:	See below
5.	Units:	None
6.	Examples:	PRIOR = 3
7.	Remarks:	Priorities: 3 - deferred 5 - standard 10 - rush

(Part 3)

1.	Description:	Account number
2.	Variable:	ACCNT
3.	Mode:	Integer
4.	Value limits:	Valid account number
5.	Units:	None
6.	Examples:	ACCNT = 621531
7.	Remarks:	Must be a valid LBL account number.

(Part 4)

1.	Description:	User's name
2.	Variable:	UNAM
3.	Mode:	Text
4.	Value limits:	$\leq$10 characters
5.	Units:	None
6.	Examples:	UNAM = #L.ROBINSON#
7.	Remarks:	Identifies person submitting job

(Part 5)

1. Description:	Routing information
2. Variable:	ROUT
3. Mode:	Text
4. Value limits:	$\leq$50 characters
5. Units:	None
6. Example:	#SEND TO EXPEDITER SERVICES#
7. Remarks:	This information is printed on all output and can be used for routing instructions.

(Part 6)

1. Description:	Program Storage System (PSS) subset names for the problem (PRBLM), control (CNTL), and staging (STAGE) files that will be used in storing the files on the IBM Data Cell.
2. Variable:	Not named
3. Mode:	Text
4. Value limits:	$\leq$7 characters, starting with an alphabetic character
5. Units:	None
6. Example:	#PWJL2T1#
7. Remarks:	Three unique subset names are to be entered, as requested, to identify the PRBLM, CNTL, and STAGE files, which are discussed in Appendix H.

FINAL REMARKS

After Sections A through L have been completed, you have the option of "playing back" at the terminal both the instruction file PRBLM and the control file CNTL that have been created. You should enter "#YES#" or "#NO#" to these questions. After the files are displayed, make minor corrections to them by using any standard text editor, provided you do not alter the basic file format.

Finally, by following the instructions outputted at the end of LIRPRB, write the files created by this problem-formulation run to the IBM Data Cell subsets specified in Section L, Part (6). If an error occurs during the LIBRITE operation, one can rewind the file affected by the error (e.g., REWIND <filename>) and then repeat the LIBRITE command.

Appendix H
Execution of the LIRAQ Model

W. E. Johnston
T. W. Stullich

BACKGROUND

The LIRAQ codes as described in this document have been designed to run on the Lawrence Berkeley Laboratory (LBL) computer system. To understand how this takes place, it is necessary to describe, briefly, the structure of that system, shown diagramically in Fig. H-1.

The essential point to note is that all information is staged to and from the CDC 7600 computer, on which the LIRAQ models actually run, via a CDC 6000 series computer. The 7600 has no direct link to any of the I/O devices, including the timesharing system. When a 7600 job requires information from tape, IBM Data Cell, etc., it initiates a job (called a STAGE job) on one of the 6000 computers, which reads information from the desired I/O device and places it on the 817 disks where it is accessible to the 7600.

PREPARATION FOR MODEL EXECUTION

As indicated in Appendix G, to relieve the user of the responsibility of putting together a lengthy control deck and having to manipulate a large data library (some 30 tapes) each time the LIRAQ model is to be run, the problem formulation program was written to interactively query the user as to the specific nature of the problem that he wishes to run. This program then uses the information that is provided interactively to do the following tasks:

- Construct a file (PRBLM) containing the formal description of the problem, including requests to modify the QSOR file and sufficient information to construct the parameter file (QSRUN) for the model.

- Construct a control card deck (CNTL) that will direct the data gathering and problem flow while on the 7600.

- Construct a deck (STAGE) to serve as input to the 6000 stage job. This job assembles the required data files from the tape library and then make these files available to the 7600 at the proper time.

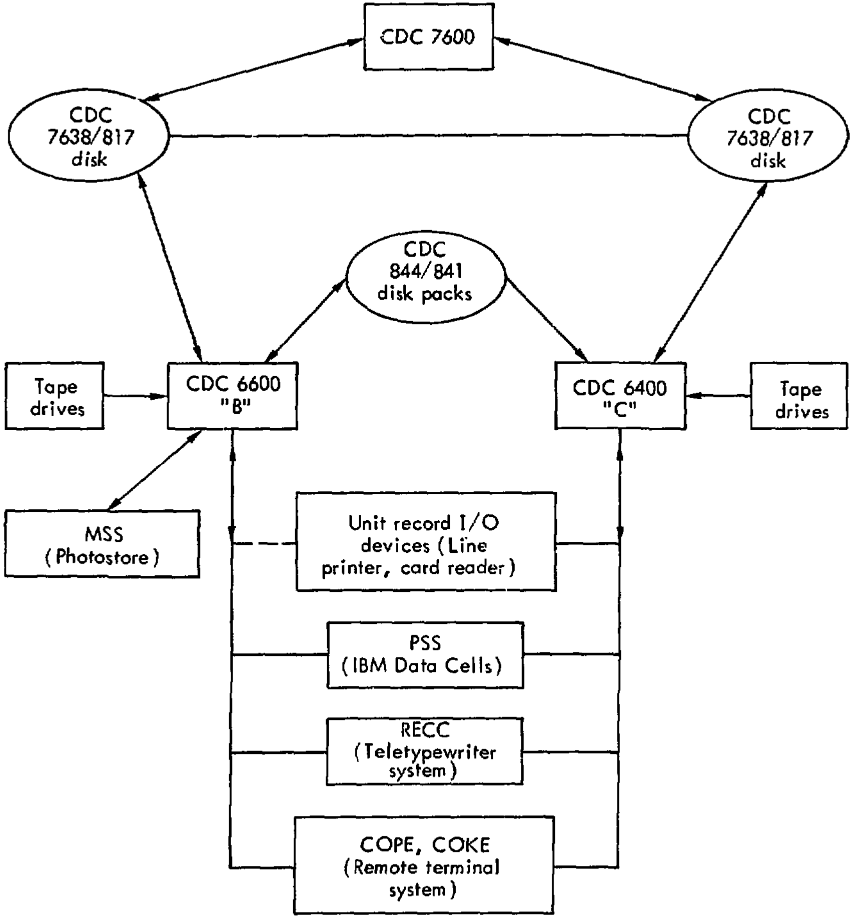


Fig. H-1. Flowchart of Lawrence Berkeley Laboratory (LBL) computer system.

EXECUTION OF LIRAQ

To run a problem perform the following steps:

(1) Interact with the problem formulation program to define the specific problem and to construct the control and stage decks. The sequence of events that then occurs is shown in Fig. H-2.

(2) Submit the control deck to the 7600 for execution.

Specifically the following steps must be carried out at the teletypewriter. (The user must have some minimal familiarity with the LBL timesharing system; to this end it is suggested that the LBL documentation entitled TTY and SESAME be read, CCARD is also a useful reference.)

(1) Log into SESAME, example:
>LOG, TEST, 16, 100.
<account>, <name>
where <name> is the name that will appear on LIRAQ output, and <account> is the LBL account number.

(2) Execute the following command to get the small control deck for the problem formulation program:
↑LOAD, PRBCNTL, LIRQLIB.

(3) Type ↑RUN to commence with the problem formulation. The interaction with this program is described in Appendix G.

(4) When the problem formulation program terminates, the files PRBLM, CNTL, and STAGE must be written to the IBM Data Cell using the subset names that were given during interaction with the problem formulation program. This is done by inputting the following commands:

a) ↑CC, SESAME.

b) LIBRITE, LIRQLIB, PRBLM, <subset name no.1>, 239, W = BAAPCD.
(Wait for the system response: "SESAME.")

c) LIBRITE, LIRQLIB, CNTL, <subset name no.2>, 239, W = BAAPCD.
(Wait for response)

d) LIBRITE, LIRQLIB, STAGE, <subset name no.3>, 239, W = BAAPCD.
(Wait for response)

(5) You may now submit the control deck to the 7600 for execution by typing:

DISPOSE, CNTL = IN.

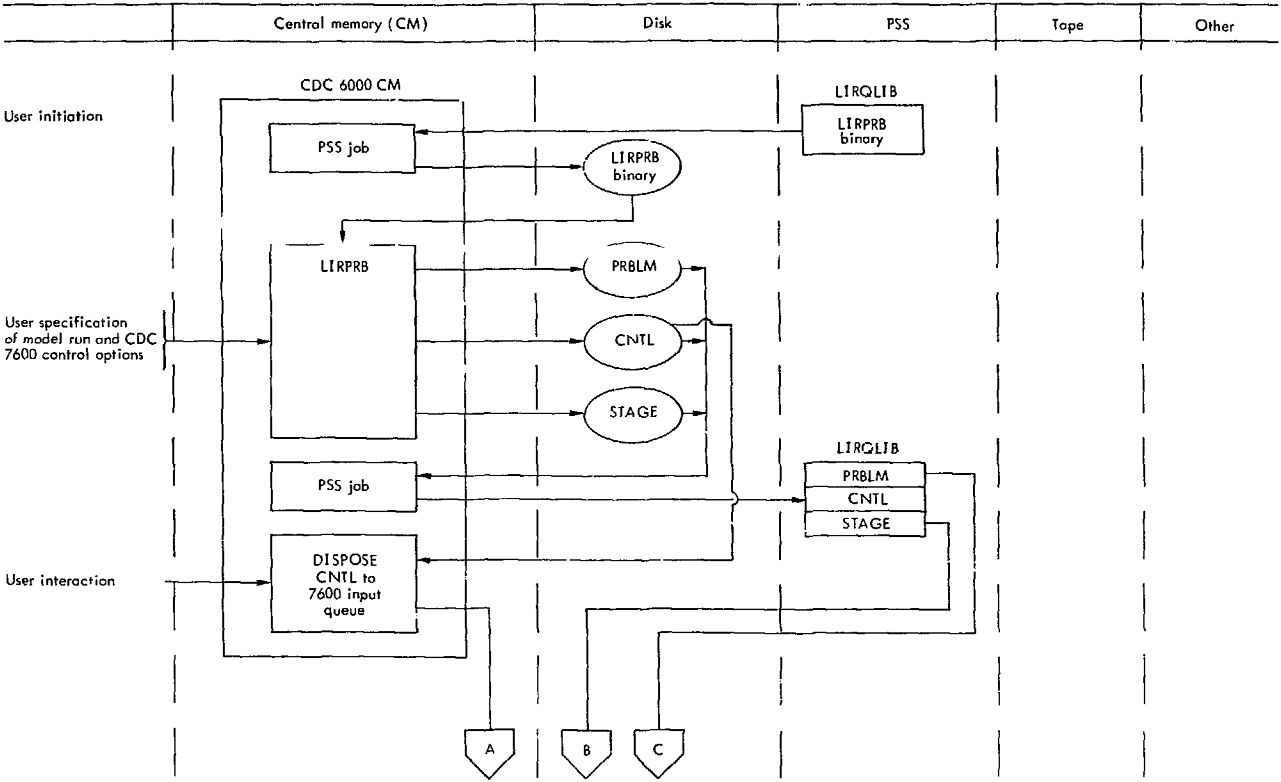


Fig. H-2. Flow of control when running the LIRAQ models at LBL using the problem formulation program (LIRPRB) interactively and using the 7600 control deck produced by LIRPRB.

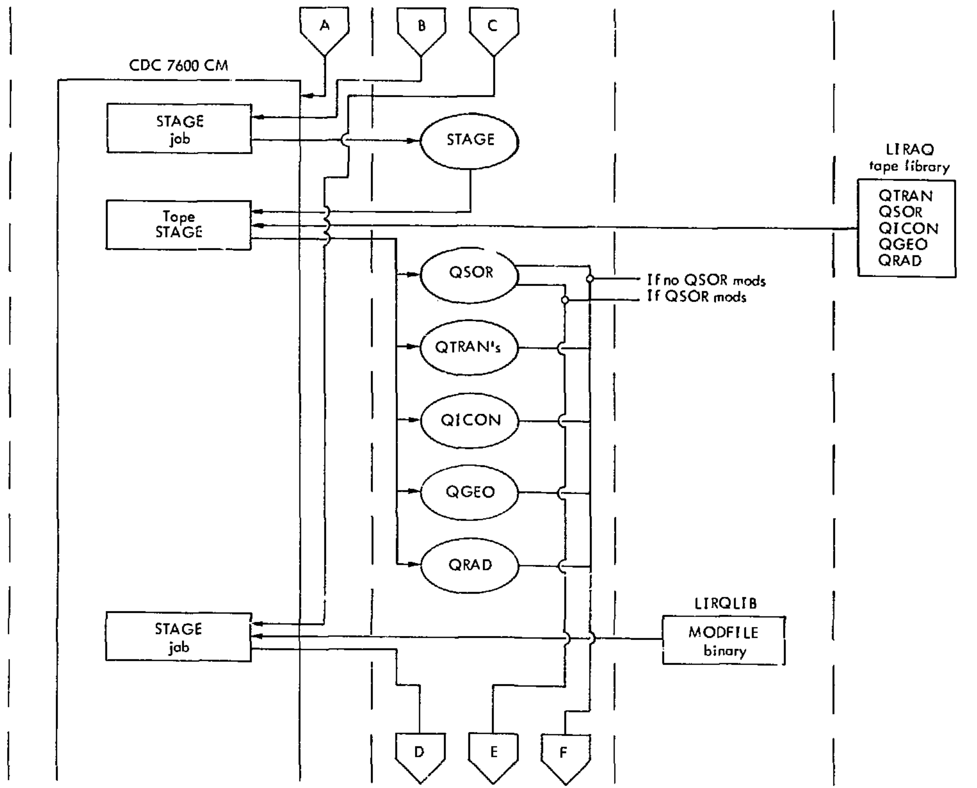


Fig. H-2. (Continued)

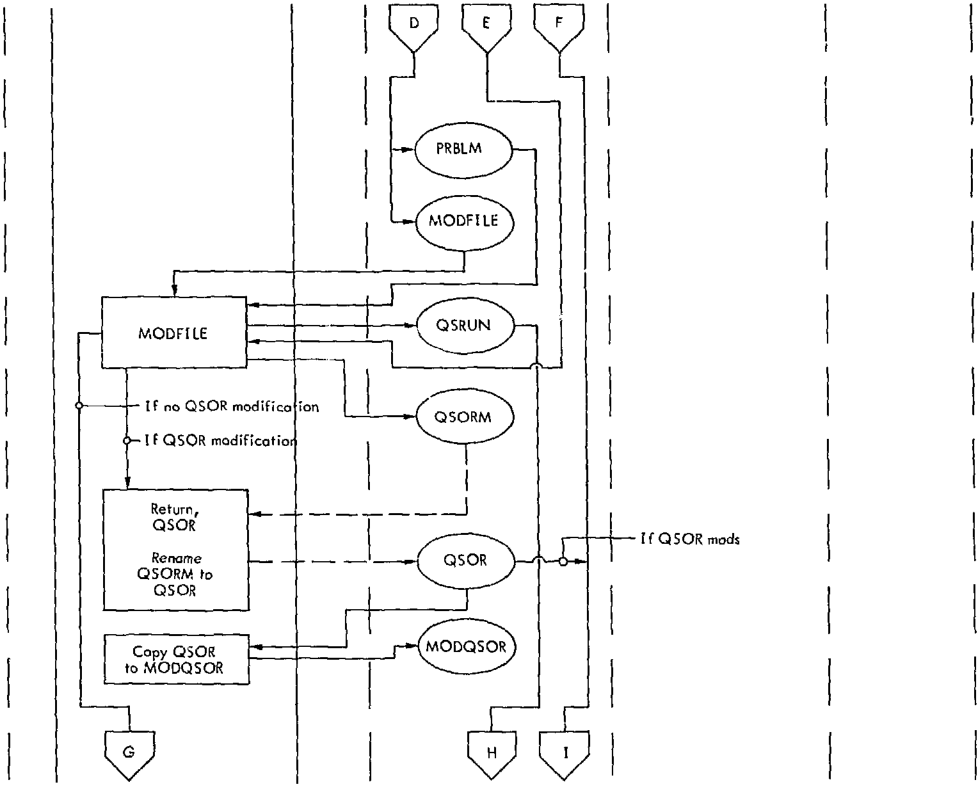


Fig. H-2. (Continued)

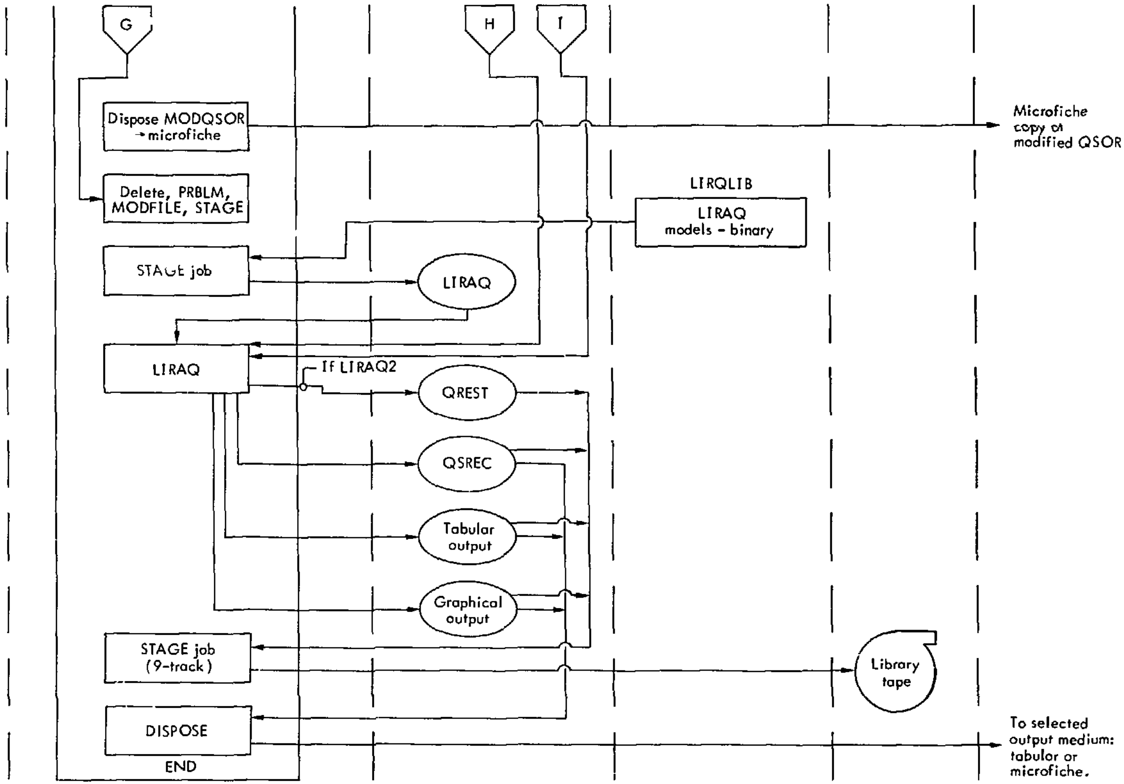


Fig. H-2. (Continued)

This step may be done at some future time (e. g., after you have logged out and then logged back in again) by doing the following:

a) LIBCOPY, LIRQLIB, CNTL, <subset name no.2>.

b) DISPOSE, CNTL = IN.

Step (5) will initiate execution of the problem on the 7600, thereby removing it from the influence of the user until the execution is complete.

Note: In the above steps replace the constructs <- - -> with the appropriate information when the command is actually entered on the teletypewriter.

LIRQLIB AND THE IBM DATA CELL AT LBL

The executable binary files for all of the programs associated with the LIRAQ model problem formulation and execution, and the files created during problem formulation are kept on the PSS (Program Storage System) at LBL. PSS is a software system for storing and retrieving information from the several IBM Data Cells at LBL. The information is organized into "libraries" and "subsets" (of those libraries). For the purpose of executing the LIRAQ codes at LBL, there is one library (LIBQLIB) and several subsets in the PSS.

There are several programs used for storing and retrieving information in the PSS. Two of these are used while running the LIRAQ model, and these perform the following functions:

(1) Information Storage

LIBRITE, <lib name>, <disk file>, <subset name>, <PSS group no.>, W = <PSS group name>.

where <lib name> is to be replaced with the library name;

<disk file> is the disk file where the information resides;

<subset name> is the library subset name;

<PSS group no.> is 239 for the BAAPCD;

<PSS group name> is BAAPCD for the LIRQLIB.

As an example, the command LIBRITE, LIRQLIB, CNTL, CNTLA, 239, W = BAAPCD.

would write the information in the disk file CNTL into the PSS subset CNTLA of the LIRQLIB library.

(2) Information Retrieval

LIBCOPY, <lib name>, <disk file>, <subset name>.

The first three parameters have the same function as for LIBRITE. For example, to retrieve the information written to the IBM Data Cell by the above example, enter:

LIBCOPY, LIRQLIB, FILEA, CNTLA.

FILEA will now contain the same information as CNTL, above. Note that on the 6000's the disk files are not rewound before or after the LIBRITE or LIBCOPY.

When carrying out problem formulation, the three files generated by LIRPRB must be written to the IBM Data Cell when LIRPRB ends so that the model will then have access to that information when it executes. There are several things to take note of in this regard.

- If you are going to formulate several runs at a time, it is necessary to give the LIRPRB files (PRBLM, CNTL and STAGE) unique subset names when you write them to the IBM Data Cell. The following format for the names (with a maximum of seven characters starting with an alphabetic character) offers one possible organizational system:

  Pnnxxxx

  Snnxxxx

  Cnnxxxx

  where P, S, or C is used to identify the file PRBLB, STAGE or CNTL, "nn" is replaced by the user's initials, and "xxxx" are characters to identify the particular model run.
  Thus, some examples would be:

  1 { PWJL2T1, SWJL2T1, CWJL2T1 }

  2 { PWJL2T2, SWJL2T2, CWJL2T2 }

  .
  .
  .

- Once created, the subsets may be overwritten but do not go away by themselves. This may present a "housecleaning" problem. Without some care, the PSS library might become cluttered with the subsets of old problem formulations. There are several solutions; one being to overwrite old subsets with new information, another to use the COPYPSS program to do the housecleaning (see LBL documentation for subsets STORAGE and PSS for use of the "DESTROY SUBSET" directive of COPYPSS).

- You may determine the current status of all of the PSS subsets by running the following program.

```
Job card
*6, PSS, NOTAPES
DSTLIST, GN = 239, G = BAAPCD,
  PW = PC, F = LF.
PSSLIST, LF.
(eoj)
```

There is a limited amount of storage space available for the LIRQLIB library on the IBM Data Cell, so the size of that space should be periodically monitored.

THE LIRAQ TAPE LIBRARY AT LBL

Modeling regional air quality requires assemblage of a great deal of data, which must be stored and available. At LBL, this is done by setting up a data tape library. Table H-1 gives the structure of this library. The structure of this library is rigid to the extent that any additions or modification to this structure must be reflected in the subroutine STRUCT of the LIRPRB program. Specifically, to add source emission, meteorological, or initial condition data files, the following procedures should be followed:

(1) To add a new source emission file:

(a) Change the "IF" statement at line 498 of LIRPRB to include the new year to be considered.

(b) Establish the following table in a DATA statement of LIRPRB, defining the array IEMTAB.

Subscript	Contents (IEMTAB)
1	<YEAR1>
2	<YEAR2>
3	<YEAR3>
4	<YEAR4>
	.
	.
	.
	.
	.
20	<YEAR20>

Table H-1. LIRAQ tape library structure at LBL.

File description	Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
QSOR							
1973, Season 3, Region 1	QSOR	19626 (11135)	4	14100	1	1	(351346B, 119526D)
Region 2	QSOR	01328 (23182)	1	14100	1	2	(1037143B 278115D)
Region 3	QSOR	01328 (23182)	2	14100	1	3	(1174124B, 325716D)
Region 4	QSOR	01328 (23182)	3	14100	1	4	(1036071B, 277561D)
Region 5	QSOR	01328 (23182)	4	14100	1	5	(614700B, 203200D)
Region 6	QSOR	01328 (23182)	5	14100	1	6	(1054613B, 285067D)
Region 7	QSOR	01389 (23110)	1	14100	1	7	(1175733B, 326619D)
Region 8	QSOR	01389 (23110)	2	14100	1	8	(1145310B, 314056D)
Region 9	QSOR	01389 (23110)	3	14100	1	9	(1012011B, 267273D)
Region 10	QSOR	01389 (23110)	4	14100	1	10	(554050B, 186408D)
Region 11	QSOR	01389 (23110)	5	14100	1	11	(543411B, 182025D)
QTRAN							24 hr
July 26-27, 1973 Region 1	QTRAN0		1	14360	4	1	(240332B, 82138D)
	QTRAN1		2	14360	4	2	(245110B, 84552D)
	QTRAN2		3	14360	4	3	(241221B, 82580D)
	QTRAN3		4	14360	4	4	(236160B, 81008D)

Table H-1. (Continued)

File description	Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
July 26-27, 1973 Region 2	QTRAN0	39020 (22902)	1	14360	4	5	(717000B, 237056D)
	QTRAN1	39020 (22902)	2	14360	4	6	(745562B, 246130D)
	QTRAN2	39020 (22902)	3	14360	4	7	(724614B, 240012D)
	QTRAN3	39020 (22902)	4	14360	4	8	(714756B, 236014D)
July 26-27, 1973 Region 3	QTRAN0	07481 (23154)	1	14360	4	9	(721470B, 238392D)
	QTRAN1	07481 (23154)	2	14360	4	10	(737560B, 245616D)
	QTRAN2	07481 (23154)	3	14360	4	11	(730272B, 241850D)
	QTRAN3	07481 (23154)	4	14360	4	12	(721310B, 238280D)
July 26-27, 1973 Region 4	QTRAN0	39024 (23153)	1	14917	5	1	(727166B, 241270D)
	QTRAN1	39024 (23153)	2	14917	5	2	(742166B, 246902D)
	QTRAN2	39024 (23153)	3	14917	5	3	(733624B, 243604D)
	QTRAN3	39024 (23153)	4	14917	5	4	(721664B, 238516D)
July 26-27, 1973 Region 5	QTRAN0	39025 (23153)	1	14917	5	5	(717762B, 237554D)
	QTRAN1	39025 (23153)	2	14917	5	6	(740722B, 246226D)
	QTRAN2	39025 (23153)	3	14917	5	7	(722604B, 238980D)
	QTRAN3	39025 (23153)	4	14917	5	8	(715420B, 236304D)

Table H-1. (Continued)

File description	Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
July 26-27, 1973 Region 6	QTRAN0	39026 (23153)	1	14917	5	9	(711742B, 234466D)
	QTRAN1	39026 (23153)	2	14917	5	10	(724714B, 240076D)
	QTRAN2	39026 (23153)	3	14917	5	11	(714574B, 234900D)
	QTRAN3	39026 (23153)	4	14917	5	12	(711014B, 233996D)
July 26-27, 1973 Region 7	QTRAN0	07410 (23156)	1	14934	6	1	(723634B, 239516D)
	QTRAN1	07410 (23156)	2	14934	6	2	(741252B, 246442D)
	QTRAN2	07410 (23156)	3	14934	6	3	(737332B, 245466D)
	QTRAN3	07410 (23156)	4	14934	6	4	(715402B, 236290D)
July 26-27, 1973 Region 8	QTRAN0	07437 (23173)	1	14934	6	5	(714612B, 235914D)
	QTRAN1	07437 (23173)	2	14934	6	6	(727332B, 241370D)
	QTRAN2	07437 (23173)	3	14934	6	7	(741470B, 246584D)
	QTRAN3	07437 (23173)	4	14934	6	8	(731400B, 242432D)
July 26-27, 1973 Region 9	QTRAN0	07504 (23179)	1	14934	6	9	(726234B, 240796D)
	QTRAN1	07504 (23179)	2	14934	6	10	(740100B, 245824D)
	QTRAN2	07504 (23179)	3	14934	6	11	(742710B, 247240D)
	QTRAN3	07504 (23179)	4	14934	6	12	(737462B, 245554D)

Table H-1. (Continued)

File description	Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
July 26-27, 1973 Region 10	QTRAN0	07549 (23191)	1	15004	7	1	(727416B, 241422D)
	QTRAN1	07549 (23191)	2	15004	7	2	(741446B, 246566D)
	QTRAN2	07549 (23191)	3	15004	7	3	(716420B, 236816D)
	QTRAN3	07549 (23191)	4	15004	7	4	(705560B, 232304D)
July 26-27, 1973 Region 11	QTRAN0	07405 (23194)	1	15004	7	5	(721542B, 238434D)
	QTRAN1	07405 (23194)	2	15004	7	6	(733222B, 243346D)
	QTRAN2	07405 (23194)	3	15004	7	7	(712340B, 234720D)
	QTRAN3	07405 (23194)	4	15004	7	8	(704574B, 231804D)
QTRAN							13 hr
August 20, 1973 Region 1	QTRAN0	39439 (04012)	1	15041	8	1	(243224B, 83604D)
	QTRAN1	39439 (04012)	2	15041	8	2	(243034B, 83484D)
	QTRAN2	39439 (04012)	3	15041	8	3	(243250B, 83624D)
August 20, 1973 Region 2	QTRAN0	06920 (23212)	1	15041	8	4	(732202B, 242818D)
	QTRAN1	06920 (23212)	2	15041	8	5	(735066B, 244278D)
	QTRAN2	06920 (23212)	3	15041	8	6	(732524B, 243028D)
August 20, 1973 Region 3	QTRAN0	07028 (04277)	1	15041	8	7	(735364B, 244468D)
	QTRAN1	07028 (04277)	2	15041	8	8	(740422B, 246034D)
	QTRAN2	07028 (04277)	3	15041	8	9	(741654B, 246700D)

Table H-1. (Continued)

File description	Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
August 20, 1973 Region 4	QTRAN0	07056 (05202)	1	15079	9	1	(734046B, 243750D)
	QTRAN1	07056 (05202)	2	15079	9	2	(731060B, 242224D)
	QTRAN2	07056 (05202)	3	15079	9	3	(731704B, 242626D)
August 20, 1973 Region 6	QTRAN0	06990 (05316)	1	15079	9	4	(716444B, 236836D)
	QTRAN1	06990 (05316)	2	15079	9	5	(716150B, 236648D)
	QTRAN2	06990 (05316)	3	15079	9	6	(720544B, 237924D)
QTRAN							48 hr
September 26-28, 1974 Region 1	QTRAN0	07131 (23197)	1	15485	10	1	(236554B, 81260D)
	QTRAN1	07131 (23197)	2	15485	10	2	(244362B, 84210D)
	QTRAN2	07131 (23197)	3	15485	10	3	(233506B, 79686D)
	QTRAN3	07131 (23197)	4	15485	10	4	(236014B, 80908D)
	QTRAN4	07145 (23199)	1	15485	10	5	(240362B, 82162D)
	QTRAN5	07145 (23199)	2	15485	10	6	(244444B, 84260D)
	QTRAN6	07145 (23199)	3	15485	10	7	(235266B, 80566D)
	QTRAN7	07145 (23199)	4	15485	10	8	(234024B, 79892D)

Table H-1. (Continued)

File description		Filename (as used) by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
September 26-28, 1973	Region 2	QTRAN0	07144 (23200)	1	15485	10	9	(717360B, 237464D)
		QTRAN1	07144 (23200)	2	15485	10	10	(740576B, 246142D)
		QTRAN2	07144 (23200)	3	15485	10	11	(711454B, 234284D)
		QTRAN3	07144 (23200)	4	15485	10	12	(717012B, 237066D)
		QTRAN4	07404 (23202)	1	15485	10	13	(722446B, 238886D)
		QTRAN5	07404 (23202)	2	15485	10	14	(741444B, 246564D)
		QTRAN6	07404 (23202)	3	15485	10	15	(715164B, 236148D)
		QTRAN7	07404 (23202)	4	15485	10	16	(710060B, 233520D)
September 26-28, 1973	Region 3	QTRAN0	39028 (03093)	1	15536	11	1	(714406B, 235782D)
		QTRAN1	39028 (03093)	2	15536	11	2	(740252B, 245930D)
		QTRAN2	39028 (03093)	3	15536	11	3	(710000B, 233472D)
		QTRAN3	39028 (03093)	4	15536	11	4	(715770B, 236536D)
		QTRAN4	39406 (03983)	1	15536	11	5	(721040B, 238112D)
		QTRAN5	39406 (03983)	2	15536	11	6	(742170B, 246904D)
		QTRAN6	39406 (03983)	3	15536	11	7	(717556B, 237422D)
		QTRAN7	39406 (03983)	4	15536	11	8	(707536B, 233310D)

Table H-1. (Continued)

File description		Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
September 26-28, 1973	Region 4	QTRAN0	39029 (03141)	1	15537	12	1	(715742B, 236514D)
		QTRAN1	39029 (03141)	2	15537	12	2	(737462B, 245554D)
		QTRAN2	39029 (03141)	3	15537	12	3	(705052B, 231978D)
		QTRAN3	39029 (03141)	4	15537	12	4	(713566B, 235382D)
		QTRAN4	06956 (23213)	1	15537	12	5	(723610B, 239496D)
		QTRAN5	06956 (23213)	2	15537	12	6	(746336B, 245982D)
		QTRAN6	06956 (23213)	3	15537	12	7	(712266B, 234678D)
		QTRAN7	06956 (23213)	3	15537	12	8	(711074B, 234044D)
September 26-28, 1973	Region 6	QTRAN0	39027 (05769)	1	15541	13	1	(721544B, 238436D)
		QTRAN1	39027 (05769)	[illegible]	15541	13	2	(735616B, 244622D)
		QTRAN2	39027 (05769)	3	15541	13	3	(705036B, 231966D)
		QTRAN3	39027 (05769)	4	15541	13	4	(714306B, 235718D)
		QTRAN4	06994 (05754)	1	15541	13	5	(725654B, 240556D)
		QTRAN5	06994 (05754)	2	15541	13	6	(741354B, 246508D)
		QTRAN6	06994 (05754)	3	15541	13	7	(711042B, 234018D)
		QTRAN7	06994 (05754)	4	15541	13	8	(707330B, 233176D)

Table H-I. (Continued)

File description	Filename (as used by LIRAQ)	Original tape no. (working copy, 7-track)	File no. on original tape	Library tape no.	Library tape (9-track) sequence no.	File no. on library tape	Other information (B=octal, D=decimal)
QICON							
July 26-27, 1973	QICON	19626 (11135)	2	15784	14	1	(33555B, 14189D)
August 20, 1973	QICON	19626 (11135)	2	15784	14	2	(22451B, 9513D)
September 26-28, 1973	QICON	19626 (11135)	2	15784	14	3	(63741B, 26593D)
QRAD	QRAD	19626 (11135)	3	15784	14	4	(1221B, 657D)
QGEO	QGEO	19626 (11135)	1	15784	14	5	(112116B, 37966D)

A specific example might be

```
IEMTAB(1) = 1973
IEMTAB(2) = 1980
IEMTAB(3) = 1985
IEMTAB(4) = 1990
        .
        .
        .
IEMTAB(20)
```

(c) Replace the statement at line 1310 (i.e., SYEAR = EMISS - 1972) by the statements

```
    DO 95 I = 1, 20
    IF (EMISS. EQ. IEMTAB (I))
   XSYEAR = I
95 CONTINUE
```

(2) To add a new meterological data set:

(a) Change the "4" in lines 687 and 689 of LIRPRB to be a number that is one greater than the total number of meteorological data sets.

(b) Redefine the table in Appendix G, Section G, Part (1) to be consistent with (a) above.

In addition, several changes must be made in subroutine STRUCT of LIRPRB to reflect the changes in the tape library. Instructions for these changes are explained in the COMMENT cards of that subroutine. The existing coding may be used as a guide in making additions to the tape tables. Care should be taken not to overflow the tables in the COMMON block /LIBARY/. The entries for the source file should be in the order defined in the EMTAB table described above.

Another function of the tape library is to store output data. Thus, certain information is written on tape at the end of each run. Generally this information includes all model output and, in the case of LIRAQ2, the restart file. This restart file is written after the fourth end-of-file mark, by convention. The tape number for this purpose is requested during problem formulation. It is recommended that the user use a different tape each time a model run is made in order to keep a complete history of the runs. When output from model runs is no longer needed, the tapes may be overwritten. The output tape is written as a 9-track binary tape.

FILE CREATION AND MODIFICATION

During the execution stage, in addition to assembling needed data files from the tape library, the control system carries out two additional file operations in a program called MODFILE. A microfiche listing of this code is included in the attachment to this User's Guide.

The functions carried out by MODFILE are:

- Using as input the information in the PRBLM file, a QSRUN file is generated that controls operation of the LIRAQ codes. The structure and content of this file are described in Appendixes A and B in association with the description of the LIRAQ-1 and LIRAQ-2 models, respectively;

- Based on instructions in the PRBLM file, which are reflected in the control deck only if modification is to take place, the QSOR source emissions file is modified so it reflects the modifications expressed by the user at input.

EXAMPLE OF CONTROL SYSTEM OPERATION

Examples of the control and stage decks for model runs have been shown in Appendixes A and B. Initiation of the control program produces, in addition to model output, a record of the control and staging operations and a table of the amount of time used for the calculation. Figure H-3 shows a listing of the output containing the record of control operations and the timing information from a typical run.

```
11.53.11. LIRQ202 . 75/11/27  7600  BKY15F  5   LIRQ2   DFRD
11.53.11. INPUT 6200C 11.53.28. 27 NOV 75  VIA L2TESOO
11.53.11.LIRQ2,P2,T2000.679656,JOHNSTON,W
11.53.11.COMMENT.  (NONE
11.53.11.COMMENT.  *PSS
11.53.11.DISKHOG, 20000.
11.53.11.SCP,A=  1800.
11.53.11.LIBCOPY,LIFOLIB    ,STAGE      ,SL2MT2     .
11.53.11. TAPEPAC  DISK 1
11.53.20. *STAGING COMPLETE   11.53.20.         2 CUS.
11.53.20.TAPE,DUMMY,X,NT,R, 14100,I=STAGE.
11.53.20. OUTPUT   DISK 1
11.53.20. TAPEPAC  DISK 1
11.54.50. *STAGING COMPLETE   11.54.49.         2 CLS.
11.54.50. 11.55.09 **BKY61K*C 27 NOV 75
11.54.50. REQUEST DUMMY,NT,14100.
11.54.50. DUMMY    NT 32 C 14100
11.54.50. REQUEST QSOR,WC.
11.54.50.  119526W    1R     1F TRANSMITTED
11.54.50. NT32,9C  0003539 0000RP  000000W 0000WP
11.54.50.
11.54.50.TAPE,DUMMY,X,NT,R, 14360,I=STAGE.
11.54.51. TAPEPAC  DISK 1
11.57.16. *STAGING COMPLETE   11.57.16.         4 CUS.
11.57.16. 11.57.35 **BKY61K*C 27 NOV 75
11.57.16. REQUEST DUMMY,NT,14360.
11.57.16. DUMMY    NT 33 D 14360
11.57.16. REQUEST QTRAN0,WC.
11.57.16. REQUEST QTRAN1,WC.
11.57.16. REQUEST QTRAN2,WC.
11.57.16. REQUEST QTRAN3,WC.
11.57.16.  330278W    4R     4F TRANSMITTED
11.57.16. NT33,9D  001214R 0016RP  000000W 0000WP
11.57.16.
11.57.16.TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
11.57.16. TAPEPAC  DISK 1
11.58.53. *STAGING COMPLETE   11.58.52.       . 2 CLS.
11.58.53. 11.59.12 **BKY61K*C 27 NOV 75
11.58.53. REQUEST DUMMY,NT,15784.
11.58.53. DUMMY    NT 32 C 15784
11.58.53. REQUEST CICON,WC.
11.58.53.   14189W    1R     1F TRANSMITTED
11.58.53. NT32,9C  000035R 0000RP  000000W 0000WP
11.58.53.
11.58.53.TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
11.58.53. TAPEPAC  DISK 1
```

Fig. H-3. Dayfile from a typical LIRAQ run (indicates the sequence of operations directed by a typical control deck).

```
12.00.55. *STAGING COMPLETE   12.00.19.        2 CUS.
12.00.55. 12.00.39 **BKY61K*C 27 NOV 75
12.00.55. REQUEST DUMMY,NT,15784.
12.00.55. DUMMY   NT 32 C 15784
12.00.55. REQUEST QPAD,WC.
12.00.55.     657W     13    1F TRANSMITTED
12.00.55. NT32,9C  000151P 0000RP  000000W 0000WF
12.00.55.
12.00.55.TAPE,DUMMY,X,NT,R, 15784,I=STAGE.
12.00.55. TAPEPAC  DISK 1
12.02.08. *STAGING COMPLETE   12.02.08.        2 CUS.
12.02.08. 12.02.28 **BKY61K*C 27 NOV 75
12.02.08. REQUEST DUMMY,NT,15784.
12.02.08. DUMMY   NT 32 C 15784
12.02.08. REQUEST QGEO,WC.
12.02.08.   37566W     13    1F TRANSMITTED
12.02.08. NT32,9C  000265P 0000RP  000000W 0000WP
12.02.08.
12.02.08.CXIT.
12.02.08. SKIP TO FIN. CARD
12.02.08.FIN.
12.02.08.LIBCOPY,LIBQLIB    ,MODFILE    ,MODFILE   .
12.02.08.LIBCOPY,LIBQLIB    ,PRBLM      ,PL2MT2    .
12.02.08. TAPEPAC  DISK 1
12.02.26. *STAGING COMPLETE   12.02.26.        2 CUS.
12.02.26.LINK,F=MODFILE,LC=BERX,X.
12.02.26. FLS=124K  FLL=0000K  LCM BUFFERS=0134K  TOTAL LCM=0260K
12.02.26. FLS=134K  FLL=0000K  LCM BUFFERS=0134K  TOTAL LCM=0270K
12.02.29. FLS=144K  FLL=0000K  LCM BUFFERS=0174K  TOTAL LCM=0340K
12.02.30. DBGMAP   DISK 1
12.02.30.  MODFILE LCM BUFFER UNLOADED
12.02.30. LOAD COMPLETE, LINK 78.
12.02.30.   TIME---         77 MSEC.
12.02.30.   MEMORY-      LOAD     136700,  EXECUTE    126000.
12.02.30. FLS=126K  FLL=0000K  LCM BUFFERS=0074K  TOTAL LCM=0222K
12.02.30. FTN4.4 FORTRAN LIBRARY PSR401BKY 01 (10/10 12.45.54 ).
12.02.30. QSRUN    DISK 1
12.02.30. QSORM    DISK 1
12.02.41.  EXIT    MODFILE
12.02.41.     9.509 CP SECONDS EXECUTION TIME
12.02.41.RETURN,QSOR.
12.02.41.RENAME,QSOR=QSORM.
12.02.41. QSOR     - NEW NAME FOR QSORM
12.02.41.COPY,QSOR       /RR,MODQSOR    /RR.
12.02.42. MODQSOR  DISK 1
12.02.43.DISPOSE,MODQSOR    =MF,T=(LIBAQ      /MODQSOR    ).
12.02.43. TAPEPAC  DISK 1
12.02.54. * MODQSOR QUEUED MF 1875
12.02.54.EXIT.
12.02.54. SKIP TO FIN. CARD
12.02.54.FIN.
12.02.54.LIBCOPY,LIBQLIB    ,BINARY     ,LIBC2BN   .
12.02.55. TAPEPAC  DISK 1
12.03.25. *STAGING COMPLETE   12.03.08.        3 CUS.
12.03.25.REWIND,BINARY     .
12.03.25.CXIT.
12.03.25. SKIP TO FIN. CARD
12.03.25.FIN.
12.03.25.GET,BINARY,MAIN.REL/LIBAQ2
12.03.25. MAIN     DISK 1
12.03.25. EDITING COMPLETE.
12.03.25.REWIND,BINARY     .
12.03.25.REWIND,MAIN       .
12.03.25.WRITEF,TAPE3      .
```

Fig. H-3. (Continued)

```
12.03.25. TAPE3    DISK 1
12.03.25.WRITEF,TAPE12     .
12.03.25. TAPE12   DISK 1
12.03.25.WRITEF,QSTEP      .
12.03.25. QSTEP    DISK 1
12.03.25.REWIND,TAPE3      .
12.03.25.REWIND,TAPE12     .
12.03.25.REWIND,QSTEP      .
12.03.25.FREEZE,QSRUN=4,QFAO=4,QICON=34.
12.03.25.RFL,    141000,    667000.
12.03.25. FLS=141K  FLL=0000K  LCM BUFFERS=0134K  TOTAL LCM=0275K
12.03.25. FLS=141K  FLL=0667K  LCM BUFFERS=0134K  TOTAL LCM=1164K
12.03.25.TIM.
12.03.25.     9.610 SECONDS,        47 BF LOADS,     81.724 CUS USED.
12.03.25.LINK,F=MAIN,F=BINARY,LO=BERX,X.
15.12.00.           2 LOAD ERROR(S), SEE MAP.
15.12.00. FLS=151K  FLL=0667K  LCM BUFFERS=0334K  TOTAL LCM=1374K
15.12.00.  MAIN    LCM BUFFER UNLOADED
15.12.00.  BINARY  LCM BUFFER UNLOADED
15.12.00. LOAD COMPLETE, LINK 7B.
15.12.00.   TIME---        132 MSEC.
15.12.00.   MEMORY-      LOAD    142100,  EXECUTE    125000,      LCM     667000
15.12.00. FLS=125K  FLL=0667K  LCM BUFFERS=0134K  TOTAL LCM=1150K
15.12.00. FTN4.4 FORTRAN LIBRARY PSR401BKY 01 (10/10 12.45.54 ).
15.12.10.             0000000000000000
15.12.10.-------------------------------------- 0000000000000000
15.12.10.MODEL TIME =           2.1599999999999  E+004
15.12.10.ELAPSED CP TIME,MILLISECONDS=   0000000000018520
15.12.10.BUFFER LOADS =          0000000000000073
15.12.10.COMPUTE UNITS REMAINING =       0000000001655945
15.12.10.FIELD LENGTH (FLL,FLS) =       0241342802340352
15.12.10.DISK TRACKS ASSIGNED =          0000000000002440
15.12.10.ELAPSED MILLI-CUS SINCE LAST CALL=       0000000000144055
15.12.10.PRIORITY =              0000000000000001
15.12.10.             0000000000000000
15.12.10.             0000000000000000
15.12.10. QREST    DISK 1
15.12.10.             0000000000000000
15.12.10.-------------------------------------- 0000000000000000
15.12.10.MODEL TIME =           2.1599999999999  E+004
15.12.10.ELAPSED CP TIME,MILLISECONDS=   0000000000018523
15.12.10.BUFFER LOADS =          0000000000000074
15.12.10.COMPUTE UNITS REMAINING =       0000000001655107
15.12.10.FIELD LENGTH (FLL,FLS) =       0241342802340352
15.12.10.DISK TRACKS ASSIGNED =          0000000000002480
15.12.10.ELAPSED MILLI-CUS SINCE LAST CALL=       0000000000000838
15.12.10.PRIORITY =              0000000000000001
15.12.10.             0000000000000000
15.12.10.             0000000000000000
15.16.02.             0000000000000000
15.16.02.-------------------------------------- 0000000000000000
15.16.02.MODEL TIME =           2.3359999999998  E+004
15.16.02.ELAPSED CP TIME,MILLISECONDS=   0000000000244237
15.16.02.BUFFER LOADS =          0000000000000075
15.16.02.COMPUTE UNITS REMAINING =       0000000000556220
15.16.02.FIELD LENGTH (FLL,FLS) =       0241342802340352
15.16.02.DISK TRACKS ASSIGNED =          0000000000002520
15.16.02.ELAPSED MILLI-CUS SINCE LAST CALL=       0000000001098887
15.16.02.PRIORITY =              0000000000000001
15.16.02.             0000000000000000
15.16.02.             0000000000000000
15.16.32.             0000000000000000
15.16.32.-------------------------------------- 0000000000000000
```

Fig. H-3. (Continued)

```
15.16.32.MODEL TIME =            2.5199999999999  E+C04
15.16.32.ELAPSED CP TIME,MILLISECONDS=   0000000000272941
15.16.32.BUFFER LOADS =          0000000000000C76
15.16.32.COMPUTE UNITS REMAINING =       CCCC0C0000416427
15.16.32.FIELD LENGTH (FLL,FLS) =        0241342802340352
15.16.32.DISK TRACKS ASSIGNED =          COCCCC0C00002520
15.16.32.ELAPSED MILLI-CUS SINCE LAST CALL=        CCC0000000139793
15.16.32.PRIORITY =              0000000000000001
15.16.32.              0000C00000000000
15.16.32.              0000000000000000
15.16.33.              CC00000000000000
15.16.33.----------------------------------------  0000000000000000
15.16.33.MODEL TIME =            2.51999999999999  E+004
15.16.33.ELAPSED CP TIME,MILLISECONDS=   000C0C0000273683
15.16.33.BUFFER LOADS =          000000000000C077
15.16.33.COMPUTE UNITS REMAINING =       CC0C000000412603
15.16.33.FIELD LENGTH (FLL,FLS) =        0241342802340352
15.16.33.DISK TRACKS ASSIGNED =          000CCC0000002600
15.16.33.ELAPSED MILLI-CUS SINCE LAST CALL=        0000000000003824
15.16.33.PRIORITY =              000000000CCC0001
15.16.33.              0000000000000000
15.16.33.              0000000000000000
15.16.33.  TAPE3   LCM BUFFER UNLOADED
15.16.33.  QRAD    LCM BUFFER UNLOADED
15.16.33.  QSCR    LCM BUFFER UNLOADED
15.16.33.  EXIT    LTRAQ2
15.16.33.   263.894 CP SECONDS EXECUTION TIME
15.16.33.SCP,A=0.
15.16.33.EXIT.
15.16.33. SKIP TO FIN. CARD
15.16.33.FIN.
15.16.33.RENAME,TSTAGE=STAGE.
15.16.33. TSTAGE  - NEW NAME FOR STAGE
15.16.33.COPY,TAPE3     /RR,OFXF,NULL,1F,TAPEQ     .
15.16.33.  QICON   LCM BUFFER UNLOADED
15.16.33. TAPEQ    DISK 1
15.16.33.COPY,QSTEP     /RR,OFXF,NULL,1F,TAPEQ     .
15.16.34.COPY,TAPE12    /RR,OFXF,NULL,1F,TAPEQ     .
15.16.34.COPY,QREST     /RR,TAPEQ     .
15.16.34.STAGE,TAPEQ      , 10509,NT,W.
15.16.35. TAPEPAC  DISK 1
15.36.39. *STAGING COMPLETE   15.33.44.        2 CUS.
15.36.39. * 15.34.13 **BKY61K*C 27 NOV 75
15.36.39. * TPSTAGE NT 31 B 10509
15.36.39. *
15.36.39. *
15.36.39. * STAGE OUT REEL 1, TAPEQ
15.36.39. * END REEL 1
15.36.39. *     FROM 7000*    18R      8F.
15.36.40. *       TO 6000*    18R      8F    75310W.
15.36.40. * NT31,99  0C0000R 0000RP  000245W 0000WP
15.36.40. *
15.36.40. *
15.36.40. * TOTAL STAGED TO 6000 - FILE TAPEQ
15.36.40. *    75310 WORDS,    18 RECORDS,     8 FILES.
15.36.40. *
15.36.40. *
15.36.40.EXIT
15.36.40.RENAME,STAGE=TSTAGE.
15.36.40. STAGE   - NEW NAME FOR TSTAGE
15.36.40.COPY,TAPE3     /RR,TAPE3A    /RR.
15.36.40. TAPE3A   DISK 1
15.36.40.DISPOSE,TAPE3     =LP,T=(LTRAQ2    /TAPE3     ).
```

Fig. H-3. (Continued)

```
15.36.40. TAPEPAC   DISK 1
15.36.56. * TAPE3    QUEUED PR 640
15.36.56.DISPOSE,TAPE3A      =MF,T=(LIRAQ2     /TAPE3A      ).
15.36.56. TAPEPAC   DISK 1
15.37.47. * TAPE3A   QUEUED MF 640
15.37.47.COPY,QSTEP        /RP,QSTEPA     /PR.
15.37.47. QSTEPA    DISK 1
15.37.48.DISPOSE,QSTEP       =LP,T=(LIRAQ2     /QSTEP       ).
15.37.48. TAPEPAC   DISK 1
15.38.01. * QSTEP    QUEUED PR 4
15.38.01.DISPOSE,QSTEPA      =MF,T=(LIRAQ2     /QSTEPA      ).
15.38.02. TAPEPAC   DISK 1
15.38.10. * QSTEPA   QUEUED MF 4
15.38.10.COPY,TAPE12       /RP,TAPE12A    /PR.
15.38.10. TAPE12A   DISK 1
15.38.10.DISPOSE,TAPE12      =LP,T=(LIRAQ2     /TAPE12      ).
15.38.10. TAPEPAC   DISK 1
15.38.20. * TAPE12   QUEUED PR 45
15.38.20.DISPOSE,TAPE12A     =MF,T=(LIRAQ2     /TAPE12A     ).
15.38.20. TAPEPAC   DISK 1
15.38.33. * TAPE12A QUEUED MF 45
15.38.33.EXIT.
15.38.33. SKIP TO FIN. CARD
15.38.33.FIN.
15.38.33.REWIND,STAGE      .
15.38.33.REWIND,INPUT      .
15.38.33.COPYSBF,INPUT,OUTPUT.
15.38.33.             1 FILE(S) COPIED.
15.38.33. COPY COMPLETE.
15.38.33.COPYSBF,STAGE,OUTPUT.
15.38.33.             1 FILE(S) COPIED.
15.38.33. COPY COMPLETE.
15.38.33- DISK USED       2840 SECTORS
15.38.33- LCM BLD.          96
15.38.33- IIO           523.115
15.38.33- CPU TIME      273.709 SECONDS.
15.38.33- STAGING           21 CUS.
15.38.33- 75/11/27.       1414 CUS.
15.38.33. $             79.883 EST.

15.39.16. LIRQ202.  OUTPUT  QUEUED PR 112
```

Fig. H-3. (Continued)

Appendix I
The Bay Area Model Data Base

T. W. Stullich

INTRODUCTION

To create a data base that would serve as a central repository for all observed meteorological and air quality data collected as part of the NSF Bay Area project, it was desirable to use a Data Management System (DMS) that was flexible enough to integrate data from a number of different sources with intrinsically different formats, while permitting rapid recall through efficient search algorithms. We selected a Lawrence Livermore Laboratory DMS, MASTER CONTROL (MC), to provide this function (Hampel and Wade, 1973). MASTER CONTROL has several desirable features which prompted our choice. It has been operational for several years and currently services many large and diverse data bases (Hampel and Wiley, 1975). MASTER CONTROL allows the user freedom of input format, operates with a telegraphic English command language, has macro expansion features, and can be run in either batch mode or interactively within a timesharing environment. Most importantly, it also allows the user to build input files for other processing codes and models in whatever format required.

To construct the MC data base tailored to the needs of this project, we developed a preprocessing code, PREPRO, and an interface code, BAMINT. After field collection agencies had specified their data types and formats, PREPRO was written incorporating these features so that an MC-compatible file structure could be created. PREPRO also provided the function of error-checking the data, where possible, as well as performing scaling changes and supplying invariant information that was to become an integral part of each record. Concurrently, BAMINT was constructed to supply the necessary link needed to manipulate the data base with MASTER CONTROL. BAMINT consists of a collection of array definitions, macro expansions for user convenience, and data format constructions that allow derived data to be displayed, digitized, or listed with constructions suitable to the user's needs.

This data base and its management system are local to the Lawrence Livermore Laboratory for the purpose of this project and at present are not portable, except to the Los Alamos

Scientific Laboratory computer facility. However, any or all data can be made available to the LIRAQ user on request.

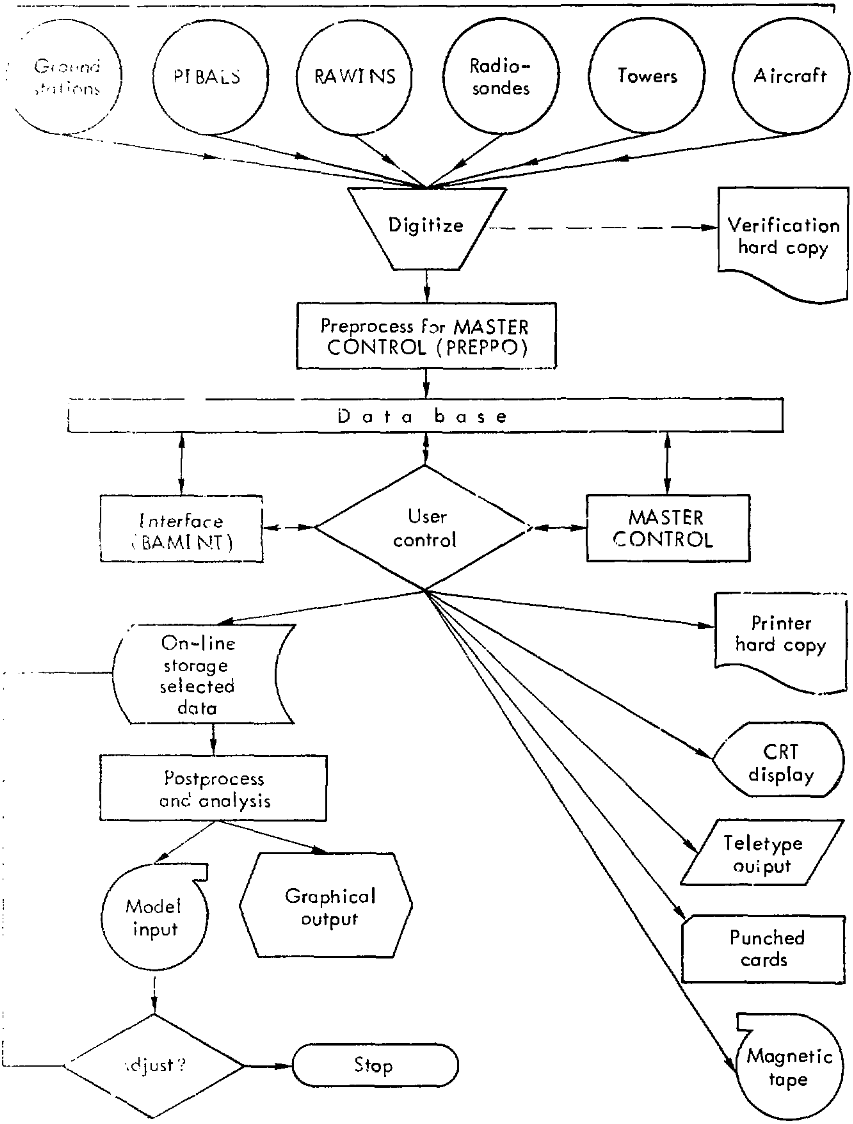
PROCEDURES USED TO COLLECT AND PROCESS THE DATA

Figure I-1 provides a schematic overview showing how incoming data over the 1973-1974 collection period were processed and subjected to analysis. Primary sources of data were the Bay Area Air Pollution Control District (BAAPCD), California State University/San Jose (CSUSJ), NASA Ames Research Laboratory (ARC), and the Lawrence Livermore Laboratory (LLL). The BAAPCD was responsible for obtaining all available meteorological and air quality data acquired from quasi-permanent fixed ground stations, within the area of interest (Fig. I-2). Agencies that provided data in this category were the National Weather Service, California State University/San Jose, Air Resources Board, Air Force, Navy, Coast Guard, Federal Aviation Agency, Pacific Gas and Electric, Department of Forestry, miscellaneous private industries, and the BAAPCD itself. Data were transcribed onto coding sheets and sent to LLL for keypunching.

CSUSJ coordinated the collection of vertical soundings of meteorological data (other than from aircraft and towers), which were obtained both from fixed locations as well as mobile pibal/radiosonde teams. This source of data was rather restricted because of limited availability and the lack of manpower and equipment for deployment in the field. CSUSJ took observed data and, using an interpolating routine, encoded the data at fixed levels from the surface through 1500 m. LLL again provided keypunching. Contributing agencies were the National Weather Service and CSUSJ.

NASA Ames was responsible for deploying a fixed wing aircraft (Cessna 401) instrumented for both meteorological and air quality data in order to obtain spatial distributions, particularly in the vertical. Their input to the data base consisted of a fixed-format magnetic tape that was processed by PREPRO. Finally, LLL collected data from a 135-ft tower at LLL and from a rawinsonde station at LLL's Site 300 about 18 km southeast of LLL. The meteorological data collected from these sites (i.e., temperature and wind) were reduced, codified, and keypunched by LLL personnel and entered into the data base via PREPRO.

As data were entered into the data base, copies were sent back to the collecting agency for further



. . 1-1. Schematic flow chart of data processing techniques for model usage.

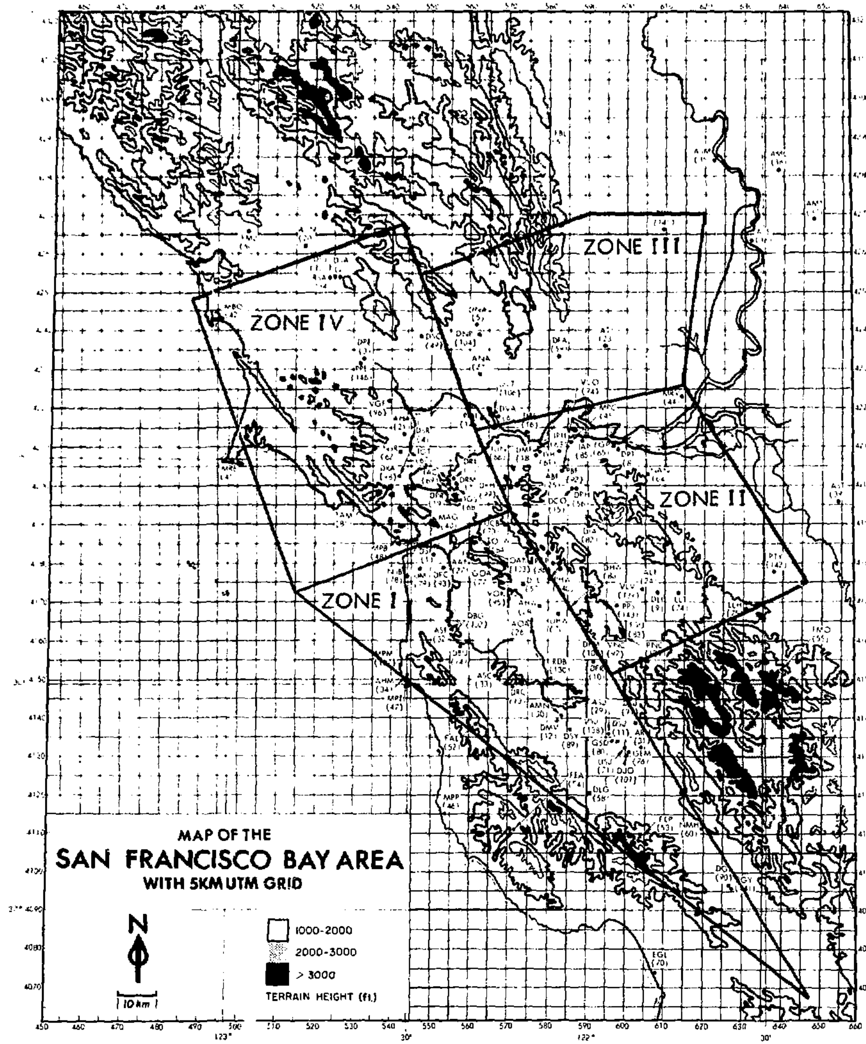


Fig. I-2. Bay Area observation network.

error checking (which had already been partially accomplished by the preprocessor) and verification. Additionally, LLL designed a number of graphical post-processing codes that displayed subsets of the data base, as identified by the user through MASTER CONTROL, in a variety of forms including 16mm time-lapse movies, horizontal map plots with shoreline and location identification, standard vertical profile plots, interactive television display plots,* and contour and streamline analyses. These computer tools assisted in the analysis of the data.

DESCRIPTION AND CHARACTERISTICS OF THE DATA BASE

Field data were collected in 1973 and 1974 during the summer and fall months (June-October), periods during which air pollution episodes are common in the San Francisco Bay Area. The area of interest ranged from the Santa Clara Valley in the south to as far north as Sacramento, and from the Pacific Ocean to the Sacramento River. Figure I-2 shows a detailed view of the area. For field study days, this area was subdivided into four primary zones. Surface observation sites are indicated in the figure and a detailed description of their location parameters is given in Table C-1. Since auxiliary observational capabilities, such as dedicated aircraft and mobile pibal and radiosonde units, were quite limited in number, a target zone for modeling purposes was selected in advance, and consequently, density of information within the data base is a strong function of date and zone. (See Chapter 6 of the Final Report for more detail concerning the operational planning for the data collection.)

It was desirable within the data base to further characterize a data record with a number of descriptors concerning the nature of the observation and its location. Therefore, descriptor codes (see Table I-1) were appended to each record to indicate details such as county, UTM coordinates, elevation, zone, mode of observation, and reporting agency. The first five numbers within the logical record number was used to indicate the date of the observation, with the last four numbers random to insure unique record numbers. There were never more than 9,999 records on a given day. The parameter codes indicate the different quantities which were measured, as well as their units and format. Obviously, not all

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*One such routine for this purpose was developed by Keller et al. (1975).

Table I-1. A collection of codes and tables for categorical [illegible] of data.

County codes	
Alameda	AL
Contra Costa	CC
Marin	MA
San Francisco	SF
Santa Clara	SC
San Mateo	SM
Napa	NA
Sonoma	SO
Solano	SL
Mendocino	ME
Stanislaus	ST
Yolo	YO
Sacramento	SA
San Joaquin	SJ
Fresno	FR
Monterey	MR
Santa Cruz	SZ

Zone codes (see Fig. I-2 for zone boundaries)	
Area I	Z1
Area II	Z2
Area III	Z3
Area IV	Z4
Area V	Z5 (Sawtooth over zones 1 through 4)
Area VI	Z6 (Special 24-hr intensive survey)
Area VII	Z7 (Outside of above zones)

Agency codes
NASA - Ames
Bay Area Air Pollution [illegible] District
National Weather Service
Lawrence Livermore Laboratory
California State University, San Jose
Air Resources Board, State of California
Air Force
Army
Navy
Coast Guard
Federal Aviation Agency
Pacific Gas and Electric
Forestry Department, State of California
Commercial
Miscellaneous

Mode codes
Aircraft
Tower
Radiosonde
Pibal
Rawin
Ground report
Ship report
Miscellaneous

Table I-1. (Continued)

Format codes	
Surface observations	1
Mandatory levels in the vertical	2
Continuation card for format 2	3
Significant levels in the vertical	4
Remarks card	5
Special vertical format	6

Card image format No. 1 (surface observations)

Columns	Field name	Description
1- 3	Station identification number	I.D. numbers reference a station list containing information on location (UTM-coordinates), elevation, county, station name, etc. See Fig. 2.
5- 6	Parameter	Code symbol from parameter list.
8	Mode	Code symbol from mode list.
10-11	Agency	Code symbol from agency list.
13	Format flag	Code symbol from format list.
15-20	Date	Code form: YYMMDD (year-month-day).
22-69	Hourly averaged parameter values	Two numeric characters for each hour, space delimited.
80	Special flag	blank = continuation follows. R = remark follows. E = end of record.

Table I-1. (Continued)

Card image format Nos. 2, 3, and 4 (vertical profiles)		
Columns	Field name	Description
1- 3	Station identification No.	Same as card image format No. 1.
5- 6	Parameter	Same as card image format No. 1.
8	Mode	Same as card image format No. 1.
10-11	Agency	Same as card image format No. 1.
13	Format flag	Same as card image format No. 1.
15-22	Date-time	Code form: YYMMDDHH (year-month-day-nearest whole hour).
24-77	Parameter values for mandatory levels	Code form: VVVV. Four numeric characters for each level, space-delimited. Mandatory and significant levels for different modes will be tabled within preprocessor.
80	Special flag	Same as card image format No. 1.

Card image format No. 5 (remarks card)		
Columns	Field name	Description
1- 3	Station identification No.	Same as card image format No. 1.
5- 6	Parameter	Same as card image format No. 1.

Table I-1. (Continued)

Card image format No. 5 (remarks card) (continued)		
Columns	Field name	Description
8	Mode	Same as card image format No. 1.
10-11	Agency	Same as card image format No. 1.
13	Format flag	Same as card image format No. 1.
15-20	Date	Same as card image format No. 1.
22-78	Text	Free-form alphanumeric textual remark (blanks are significant). Remark can be continued to another card by use of an R-flag and another remarks card.
80	Special flag	Same as card image format No. 1.

Card image format No. 6		
Columns	Field name	Description
1- 3	Station identification No.	Same as card image format No. 1.
5- 6	Parameter	Same as card image format No. 1.
8	Mode	Same as card image format No. 1.
10-11	Agency	Same as card image format No. 1.
13	Format flag	Same as card image format No. 1.

Table I-1. (Continued)

Card image format No. 6 (continued)		
Columns	Field name	Description
15-22	Date-time	Same as card image format Nos. 2, 3 and 4.
24-76	Altitude and parameter value	Code form: HHHHVVVV. Four numeric characters representing altitude (metres above the surface) and four numeric characters for the observed parameter value. Groups of eight characters space-delimited.
80	Special flag	Same as card image format No. 1.

Parameter codes

Meteorology	Code	Units	Surface format	Vertical format
Air temperature[a]	WT	(°C)	xx	
		(°C) x 10		xxx
Absolute humidity	WH	(g/m^3) x 10		xxx
Dewpoint	WW	(°C) x 10	xx	
		(°C) x 10		xxx
Wind speed	WS	(m/s)	xx	
		(m/s) x 10		xxx
Wind direction	WD	(tens of degrees-true)	xx	
		(whole degrees-true)		xxx
UV radiant energy flux	WU	($photons/cm^2/s$)		x.xxE±xx
Pressure[b]	WP	(mbar) x 10		xxxx

[a]Encode negative temperatures as: absolute value of actual + 50. (e.g., -5"="55; -5.1"="55.1). Scaling operation follows this conversion.

[b]Left-most digit is dropped when pressure exceeds 1000 mbar (e.g., 1012"="012; 1012.2"="0122).

Table I-1. (Continued)

Parameter codes (continued)

Meteorology	Code	Units	Surface format	Vertical format
S.F. Bay temperature	WB	(°C)		xx
Condensation nuclei	WC	(No./m^3)		x.xxE±xx
Turbulence	WR			xxx

Pollutants (concentrations)	Code	Aircraft tower units	Aircraft tower format	Ground station units	Ground station format
Carbon monoxide	CO	(ppmv)	xx.xx	(ppmv)	xx
Ozone	OZ	(pphmv)	xx.xx		
Oxidant (aircraft)	OA	(pphmv)	xxxx		
Oxidant (ground)	OG			(pphmv)	xx
Nitrogen oxide	NO	(pphmv)	xxxx	(pphmv)	xx
Nitrogen dioxide	N2	(pphmv)	xxxx	(pphmv)	xx
Sulfur dioxide	S2	(pphmv)	xxxx	(ppbv)	xx
Peroxyacetyl nitrate	PN	(ppbv)	xxx		
Acetylene	AC	(ppbv)	xxx		
Total hydrocarbons (less methane)	HC	(ppbv)	xxx		
Total hydrocarbons (with methane)	HM	(ppmv)	xxx	(ppmv)	xx
Oxides of nitrogen	TN	(pphmv)	xxxx	(pphmv)	xx

Mandatory levels — Levels (metres above surface)

Mode	Agency	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Aircraft	NASA	15	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Radiosonde	All	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Pibal	All	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Aircraft	ARB	0	152	305	457	610	762	914	1067	1219	1372	1524					
Tower	LLL	10	40														
Rawin (Site 300)	LLL	0	36	235	539	844	1149	1454									
Rawin	All others	0	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Significant levels																	
Radiosonde	All	50	150	250	350	450	550	650	750	850	950						

reporting stations were equipped to measure all parameters. Table I-2 shows the distribution of the availability of an observed parameter by location. With the array descriptors discussed above, it was possible to search the data base with MASTER CONTROL for any subset of characteristics. For example, it would be relatively simple to locate that subset of data that contained temperature reports within Alameda County in July of 1973. More complicated boolean sets can be defined and identified and made available to the requestor in digitized form in any format desired.

The NASA aircraft data were unique enough to set them apart in a data base of their own for ease of management. The data base was, however, preprocessed with the same code and interface as were other forms of data, and addressable by MASTER CONTROL in much the same manner. A detailed description of the observation and recording of the data by NASA is given in Appendix 7-1 of the Final Report.

Three general formats were developed within the interface to display the data: a surface data format, for a single near-ground level report from quasi-permanent stations as a function of time; a vertical data format, for multi-level vertical probes into the atmosphere (balloons, towers, etc.) as a function of altitude; and a NASA aircraft data format, which contains a number of observed parameter reports within a single record. Figure I-3 illustrates how typical records might appear within the data base under these formats. Note that values are scaled as indicated in the parameter code section in Fig. I-3, whereas fields filled with "nines" indicate missing data. Data within this data base are not tied to a particular format. The MASTER CONTROL user may construct any format desired and have the data displayed in that manner. Remarks that provide further clarification of the data are appended to logical records when available.

Table I-3 shows a breakdown by date of the more than 17 000 records collected during the survey period.

Table I-2. Distribution of observed parameters by station.

	Station Number	Temperature	Dew point	Wind direction	Wind speed	Carbon monoxide	Oxidant	Nitric oxide	Nitrogen dioxide	Sulfur dioxide	Hydrocarbons (with methane)	Total oxides of nitrogen	Remarks
San Francisco	0 0 1	0	0	⊠	⊠	⊠	⊠	⊠	⊠		⊠	⊠	
Santa Rosa	0 0 2	0	0	⊠	⊠	⊠	⊠	⊠	⊠		⊠	⊠	
Petaluma	0 0 3						⊠						
San Rafael	0 0 4	0	0	⊠	⊠	⊠	⊠	⊠	⊠		⊠	⊠	
Napa	0 0 5	0	0	⊠	⊠	⊠	⊠	⊠	⊠		⊠	⊠	
Vallejo	0 0 6	0	0	⊠	⊠	⊠	⊠	⊠	⊠	0	⊠	⊠	
Richmond - Jade St.	0 0 7									⊠			
Pittsburg	0 0 8	0	0	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	⊠	
Livermore	0 0 9	0	0	⊠	⊠	⊠	⊠	0	⊠		⊠	0	
Fremont	0 1 0	0	0	0	0	⊠	⊠				⊠		
San Jose	0 1 1	0	0	⊠	⊠	⊠	⊠	⊠	⊠		⊠	⊠	
Mountain View	0 1 2	0	0				⊠						
Redwood City	0 1 3	0	0	⊠	⊠	⊠	⊠	⊠	⊠		⊠	⊠	
Burlingame	0 1 4	0	0	0	0	⊠	⊠				⊠		
Concord - Treat Blvd.	0 1 5	0	0	0	0	⊠	⊠		⊠	⊠			
Benicia	0 1 6			0	0					⊠			
Richmond - 13th St.	0 1 7	0	0	⊠	⊠	⊠	⊠	0	⊠	⊠	⊠	0	
Martinez - Fire Station	0 1 8									⊠			
Point Richmond	0 1 9									⊠			
Sonoma Co. Arpt.	0 2 0	0	0	0	0								
Hamilton AFB	0 2 1	⊠	⊠	⊠	⊠								Q
Napa Co. Arpt.	0 2 2			⊠	⊠								
Travis AFB 1	0 2 3	⊠	⊠	⊠	⊠								
Livermore Arpt.	0 2 4			⊠	⊠								L
Buchanan Fld.	0 2 5			⊠	⊠								
Oakland Int. Arpt.	0 2 6	⊠	⊠	⊠	⊠								
Alameda NAS	0 2 7	⊠	⊠	⊠	⊠								
Hayward Arpt.	0 2 8			⊠	⊠								
San Jose Arpt.	0 2 9	⊠	⊠	⊠	⊠								
Moffett Fld. NAS	0 3 0	⊠	⊠	⊠	⊠								

Table I-2. Continued.

	Station Number	Temperature	Dew point	Wind direction	Wind speed	Carbon monoxide	Oxidant	Nitric oxide	Nitrogen dioxide	Sulfur dioxide	Hydrocarbons (with methane)	Total oxides of nitrogen	Remarks
Reid Hillview Arpt.	0 3 1			⊠	⊠								
San Francisco Arpt.	0 3 2	⊠	⊠	⊠	⊠								
San Carlos Arpt.	0 3 3			0	0								
Half Moon Bay Arpt.	0 3 4												N
Sacramento Metro. Arpt.	0 3 5	⊠	⊠	⊠	⊠								
Sacramento Exec. Arpt	0 3 6	⊠	⊠	⊠	⊠								
Mather AFB	0 3 7	⊠	⊠	⊠	⊠								
McClellan AFB	0 3 8	⊠	⊠	⊠	⊠								
Stockton Arpt.	0 3 9	⊠	⊠	⊠	⊠								
Angel Island	0 4 0			⊠	⊠								
Point Reyes	0 4 1			⊠	⊠								
Bodega Bay	0 4 2			⊠	⊠								
Point Arena	0 4 3			⊠	⊠								
Rio Vista	0 4 4			⊠	⊠								
Port Chicago	0 4 5				⊠								
Pigeon Point	0 4 6			⊠	⊠								
Pillar Point	0 4 7			0	0								
Point Bonita	0 4 8			⊠	⊠								
Sonoma - 1st St. West	0 4 9						0						
Mt. Jackson	0 5 0	⊠	⊠	⊠	⊠								
Berryessa	0 5 1	X	X	X	X								
Allen	0 5 2	⊠	⊠	⊠	⊠								
Loma Prieta	0 5 3	⊠	⊠	⊠	⊠								
Eagle Rock	0 5 4	⊠	⊠	⊠	⊠								
Mount Oso	0 5 5	⊠	⊠	⊠	⊠								
Pleasant Hill	0 5 6	0	0				⊠						
San Leandro	0 5 7						⊠						
Los Gatos	0 5 8	0	0				⊠						
Fairfield	0 5 9	0	0				⊠						
Morgan Hill Arpt.	0 6 0												N

Table I-2. (Continued)

	Station Number	Temperature	Dew point	Wind direction	Wind speed	Carbon monoxide	Oxidant	Nitric oxide	Nitrogen dioxide	Sulfur dioxide	Hydrocarbons (with methane)	Total oxides of nitrogen	Remarks
Shell, Martinez	0 6 1			⊠	⊠								
Smith Arpt., San Rafael	0 6 2												N
Phillips, Martinez	0 6 3			⊠	⊠								
Antioch Arpt.	0 6 4												N
PG&E, Pittsburgh	0 6 5	⊠	⊠	⊠	⊠								
Union, Oleum	0 6 6			⊠	⊠								
Std. Oil, Garden Tract	0 6 7			⊠	⊠								
Std. Oil, Gertrude St.	0 6 8			⊠	⊠								
Allied, Richmond	0 6 9			⊠	⊠								
PG&E, Moss Lndg.	0 7 0	⊠	⊠	⊠	⊠								
CSUSJ	0 7 1	⊠		⊠	⊠								P
Hayward State College	0 7 2	⊠		⊠	⊠								
UC Berkeley	0 7 3			⊠	⊠								
LLL - Tower	0 7 4	⊠		⊠	⊠								L
LLL - Hazard Cont.	0 7 5	⊠		⊠	⊠								L
San Jose EMSU	0 7 6												P
Oakland Radiosonde	0 7 7												R
San Francisco Beach	0 7 8												N
SJ Civil Defense	0 8 0	0		⊠	⊠								
Mt. Tamalpais	0 8 1	⊠	⊠	⊠	⊠								
Mt. Diablo	0 8 2			X	X								
Sunol	0 8 3	0	0	0	0								
Oakland Sewage	0 8 4			⊠	⊠								
Allied Chem. Port Chicago	0 8 5			⊠	⊠								
Chabot Regional Park	0 8 6			0	0								P
Modesto Arpt.	0 8 7	⊠	⊠	⊠	⊠								
Hayward	0 8 8						⊠						
Sunnyvale	0 8 9	0	0	⊠	⊠	⊠	⊠	⊠	⊠			⊠	
Gilroy	0 9 0	0	0	⊠	⊠	⊠	⊠	⊠	⊠			⊠	
E. San Jose	0 9 1						⊠						

Table I-2. (Continued)

	Station Number	Temperature	Dew point	Wind direction	Wind speed	Carbon monoxide	Oxidant	Nitric oxide	Nitrogen dioxide	Sulfur dioxide	Hydrocarbons (with methane)	Total oxides of nitrogen	Remarks
Buchanan Fld.	0 9 2			0	0								P
E. San Francisco	0 9 3			⊠	⊠								
Oceanics Concord	0 9 4	0											A
Oceanics Oakland	0 9 5	0											A
Oceanics Gnoss Field	0 9 6	0											A
Oceanics Niles Cany.	0 9 7	0											A
San Rafael, 4th St.	0 9 8			+	+		+	+	+		+	+	
Richmond, Nevin Ave.	0 9 9			+	+	+	+	+	+		+	+	
Fremont, Union St.	1 0 0			+	+	+	+				+		
San Jose, Alma Ave.	1 0 1			+	+	+	+	+	+		+	+	
Burlingame, Bayshore	1 0 2			+	+	+	+				+		
Oakland, Jackson St.	1 0 3					+	+	+	+		+	+	
Napa, 1st St.	1 0 4					+							
Santa Rosa, 4th St.	1 0 5					+	+	+	+		+	+	
Vallejo Trailer	1 0 6					+	+	+	+		+	+	
Point Montara	1 0 7			+	+								
Niles Canyon	1 2 9			⊠	⊠								P
Rio Vista	1 3 2	X	X	X	X								R
Fresno Arpt.	1 3 5	⊠											A
Salinas Arpt.	1 3 6	⊠											A
Sacramento Arpt.	1 3 7	⊠											A
Oceanics San Jose	1 3 8	0											A
Oceanics Livermore	1 3 9	0											A
Hayward	1 4 0			X	X								P
Gilroy	1 4 1			⊠	⊠								P
Tracy	1 4 2			X	X								P
Pleasanton	1 4 3			X	X								P

Table I-2. (Continued)

Legend

X - 1973 encoded data
O - 1974 encoded data
⊗ - 1973 and 1974 encoded data
+ - 1970 encoded data (special validation study)

Remarks

A - Aircraft sounding
L - Lawrence Livermore Laboratory encoded data
N - Nomogram location (used for deriving inversion heights)
P - Pibal station
Q - Pibal and surface station
R - Radiosonde station

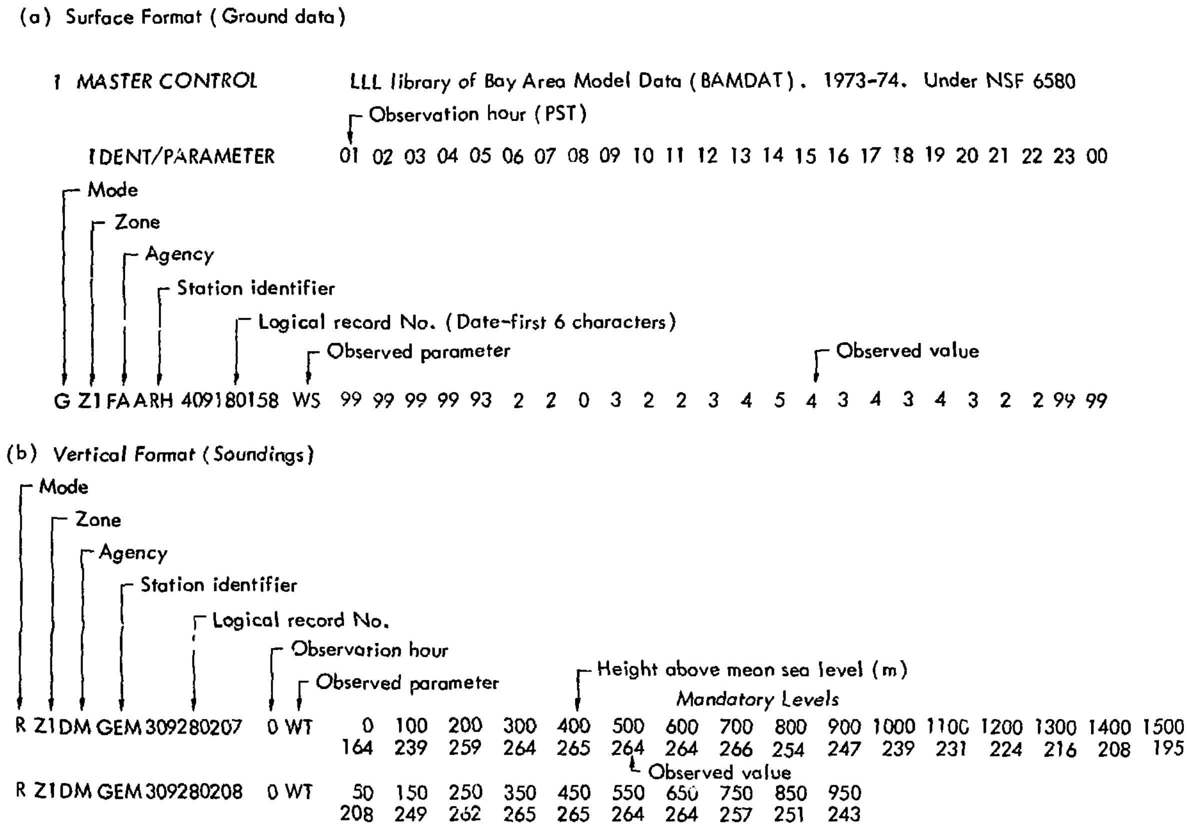

Fig. I-3. Typical records within the data base.

(c) NASA Aircraft Format

- Mode
- Mission identification
- Zone
- Logical record No.
- Time (hr/min/s)
- UTM north location
- UTM east location
- Height above mean sea level (m)

A MISSION 13 Z1 406291383 19:29.35 4131.8 604.8 1478

METDAT	WT	WH	WP	WD	WS	WR	WB		WC	MJ	Parameter types and observed values
	264	35	9999	999	999	0	99		9.99E+99	9.99E+99	
POLDAT	CO	OZ	OA	NO	N2	TN	S2	PN	AC	HC	
	1.11	3.94	0000	0	1	1	9999	999	000	999	

Fig. I-3. (Continued)

Table I-3. Distribution of MASTER CONTROL data base records by date.

Record frequency by year

	1973	1974	Total
NASA	2 877	7 328	10 205
Other	3 852	3 595	7 447
Total	6 729	10 923	17 652

Record frequency by day

Sampling Date		Data Type: NASA	Data Type: Other
1973			
April	24	407	
July	22		6
	23		308
	24		333
	25		8
	26	482	426
	27	491	265
August	19		8
	20	519	406
	21	506	445
	22		12
September	9		8
	10	130	299
	11	342	300
	12		14
	25		8
	26		314
	27		334
	28		268
	29		18
1974			
June	28		6
	29	1 570	398
	30		6
July	23		6
	24	719	285
	25		12
	26	635	368
	27		6

Table I-3. (Continued)

Record frequency by day			
Sampling Date		Data Type	
		NASA	Other
August	20		6
	21	605	321
	22	612	377
	23	599	340
	24		6
	26		2
	27		6
	28	186	324
	29		6
September	5		6
	6		362
	7		6
	17		6
	18	443	321
	19	1 047	306
	20		6
	24		6
	25	912	95
	26		6

Appendix J
Programs Developed by BAAPCD

M. Kim

H. Harawitz

INTRODUCTION

In addition to the programs developed by LLL that relate to the LIRAQ model, staff of the BAAPCD were responsible for development of two programs to be used in the initial generation of source emission data used by the processor codes described in Appendix D. The primary effort focused on working with consultant James Fennessey on development of a mobile source emission inventory as described in detail in Chapter 6 of the Final Report. The program flow-charts and a description of the input data needed to operate the various codes are presented in detail in this Appendix. A listing of these codes is included in the microfiche attachment. Copies of the data files used by the programs are available from the BAAPCD.

The second program is much shorter. It takes information from a population tape, which is based on census tract information (and made available to this project by the Association of Bay Area Governments), and distributes the source emissions attributed to population into grid squares based on their population. A listing of these codes is included with the text here.

CODES FOR MOBILE SOURCE INVENTORY

This section contains a description of the computer programs that interface with files generated by DCO/TRANPLAN, the transportation modeling software utilized by the Metropolitan Transportation Commission (MTC).

The basic model flow chart is depicted in Figure J-1. The following subsections describe in more detail the various programs shown in the figure. Travel pattern models for both 1973 and 1980 were executed on the LBL CDC 6600 computer system. Emission models, including AIRMOD and other subroutines, were run on the CDC 6600 computer system maintained at the CDC offices in Palo Alto. The codes that develop the highway traffic loading used in determining the mobile source emission inventory (i.e., the sequence of operations leading finally to file LODHIST in Fig. J-1) are proprietary codes of Control Data Corporation and part of the DCO/TRANPLAN program. The BAAPCD has formulated the control cards

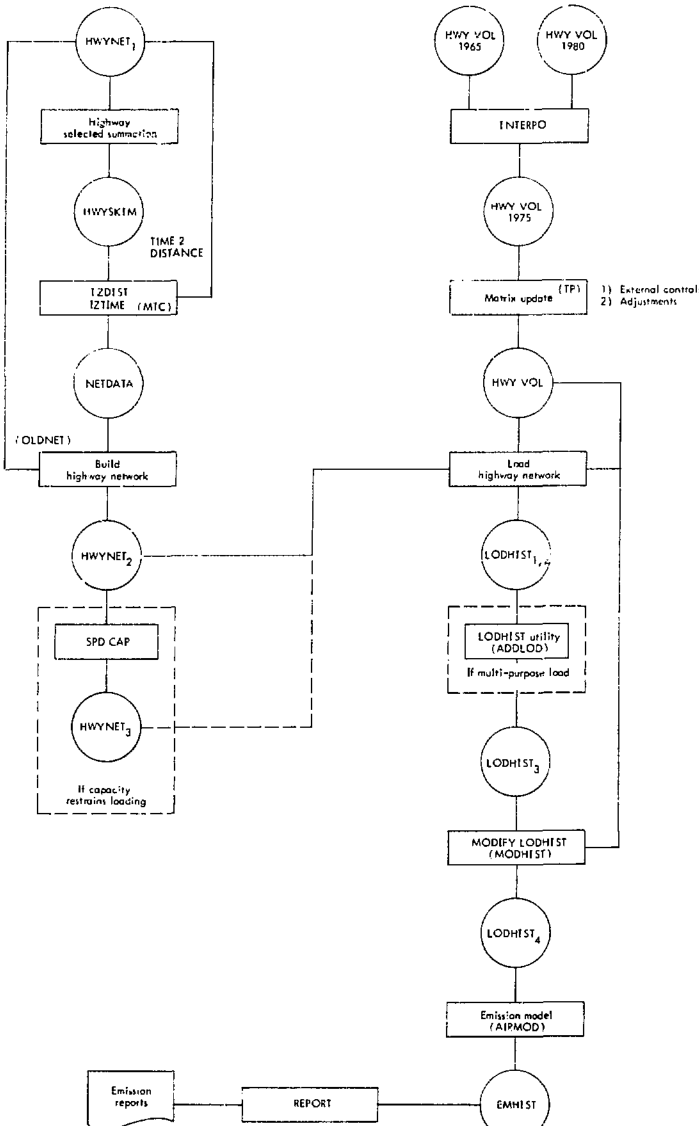

Fig. J-1. Schematic flow chart of program sequence used in developing mobile source inventory.

described in this appendix for their particular problem of interest, and the potential user should contact CDC for access to the system and for complete documentation.

The two remaining codes shown in Fig. J-1 (i.e., AIRMOD and REPORT) develop an emissions inventory from the network loading. These codes were developed as part of this project for use on the LBL computer system. Listings of these codes are included on the microfiche, and access to the codes is available through contact with the BAAPCD.

Program AIRMOD

The AIRMOD program produces an emission history file for mobile sources based upon data output from models of the MTC. Emission rates are applied to the traffic assignment data, given on the loaded highway network history file LODHIST. There is no practical limit to the number of emission types that can be input to the program. Emission rates are input for speeds ranging from 5-100 mph in 5-mph increments; they may also be input as variable for each link type 0-9 as used by MTC. Daily distribution of traffic by link type is permitted for up to 24 periods of the day. The AIRMOD program also contains a subroutine for a standard rotation and translation procedure to convert the State Plane Grid Coordinate system to Universal Transverse Mercator (UTM) coordinates.

The output file EMHIST contains an emission history record set for each input emission type and for each UTM grid square in the BAAPCD.

A number of control and data cards are required for operation of the AIRMOD program, as summarized in Table J-1. A detailed description of the options available using the control cards is given in Table J-2. Table J-3 gives the format of the Type 1 data cards, which are required in order to specify the hourly (or period) volume distribution throughout the day for each link type. All

Table J-1. Summary of control and data cards needed for the AIRMOD program.

```
Three header cards
b$OPTIONS PEAK (i) = m*.FALSE.,
                     n*.TRUE.$
b$PARAMS NUMEN     = ne,
         NUMHRS    = nh,
         PKTIME    = 2,
         SELPUR    = sp,
         NUMLNK    = nl,
         NUMX      = nx,
         NUMY      = ny,
         YEAR      = y $

Data cards:
     Type 1 - daily volume distri-
              bution by link type
     Type 2 - emission rates by
              link type
```

Table J-2. Detailed description of control cards required for the AIRMOD program.

Three header cards	Header cards are required; any may be blank but <u>three</u> must be input. These identify the output emission history file for future reference during reporting.
b$OPTIONS PEAK (1) = 7*.FALSE.,	12:01 AM to 7:00 AM
2*.TRUE.,	7:01 AM to 9:00 AM PEAK
7*.FALSE.,	9:01 AM to 4:00 PM
2*.TRUE.,	4:01 PM to 6:00 PM PEAK
6*.FALSE. $	6:01 PM to 12:00 AM
	Specifies the peak hours (periods) that will use the peak time field. This specification is ignored if incremental loading capacity restraint is used. (Default: 24*.FALSE.)
b$PARAMS NUMEN = ne	Specifies the number of emission types to be analyzed in the run. (Default is one.)
NUMHRS = nh	Specifies the number of time periods, usually hours of the day, to be analyzed. (Default is 24.)
PKTIME = 2	Specifies, for non-capacity restrained loading, that the peak period time is in field 2. (Default is field 1.)
SELPUR = sp	Specifies the trip purpose to be analyzed. (Default is purpose one.)
NUMLNK = nl	Specifies the number of link types to be analyzed. The link types key on the assignment group codes. (The default value assumes only one link type, that is assignment group code 0.)
NUMX = nx	Specifies the number of grid elements horizontally across the network. (The default value is 100.)
NUMY = ny	Specifies the number of grid elements vertically in the network. (The default value is 100.)
YEAR = y	Specifies the year for which the data applies.

Table J-3. Format specification for Type 1 data cards input to the AIRMOD program.

Card column	Contents
4	Link type code
7-8	First pointer (p) for first hour or period on this card. (Card 1 for a link type would contain a 1 in this field; card 2, 11; card 3, 21.)
11-17	Hour (period) factor for hour p (xx.xxxx)
18-24	Hour (period) factor for hour p+1
.	.
.	.
.	.
	...
74-80	Hour (period) factor for hour p+9

fields are assumed to be right-justified.

Table J-4 gives the format of the Type 2 data cards, which specify emission characteristics and are required for each emission type.

Figure J-2 gives a sample file constructed for the CYBERNET SCOPE operating system. The program controls are for 4-hr values for the year 1980 and use carbon monoxide emission rates.

Program IZDIST

This program is a postprocessor to the programs shown on Fig. J-1. Its function is to augment the emissions inventory on the specified links by distributing the intrazonal (representing local) travel to the UTM grids designated for each MTC traffic analysis zone. The traffic on the "dummy" intrazonal links are prorated according to the vehicle miles of travel allocated to the grid square specified for each MTC zone and according to the hourly distribution within each grid square. The program then produces two files: a total emission history file containing the intrazonal and the interzonal traffic and an intrazonal only emission history file. This sequence is shown schematically in Fig. J-3. Table J-5 gives a detailed description of the program control cards and Fig. J-4 shows an example of the resulting file, showing only a few of the data cards for an actual 1973 run.

Program INTEREM

This program is also a postprocessor of files generated by the sequence shown in Fig. J-1. By

Table J-4. Card description and format for Type 2 data cards input to the AIRMOD program.

Column	Description
Title card	Each emission set has a title card that describes the set. This information is placed on the emission history file.
Link type cards	For each link type, two cards are required in the following format to describe the emission/speed relationships.
3-4	Emission type number (ranges from 1 to NUMEM)
7-8	Link type code (based on assignment group code)
10	A "1" or a "2" describing the first or second card in each link type set.
11-17	Specifies the emission rate at 5 mph for card 1, or 55 mph for card 2. (xxx.xxx)
18-24	10 mph or 60 mph
.	.
.	.
.	.
74-80	50 mph or 100 mph

Note: Speed values below 5 mph use the 5-mph emission rate; above 100 mph use the 100-mph rate. All other values are interpolated between the two bracketing speeds.

performing a linear interpolation (or extrapolation) in time between two emission history files from different years, this program permits an estimate of emission activity in a year without the more costly network modeling technique. However, it lacks network and land use sensitivity and should be used for preliminary analyses only. The two input emission history files must have the same emission types and number of time periods. An option is also included to add two emission history files is included - this permits the analysis of the combination of two selected areas.

Figure J-5 shows a schematic of the input/output requirements of program INTEREM, with a detailed description of the control cards given in Table J-6. Figure J-6 shows an example including SCOPE system and program controls, which illustrates the creation of a 1973 emission history file by interpolation between 1965 and 1980 emission history files.

```
$CHARGE,XXXXXYY-ZZZ,JOBIDENT.
AIRMOD(CM5000,CL300000,T500,MT2,P2)
LABEL,LODHIST,R,L=80LOADTOTAL,VSN=PA4587.
LABEL,EMHIST,W,L=1980TOTVOL4BASEHR,X=SV.  (PR)
ATTACH(AIRMOD,JWFAIRMODEL,PW=JWF)
RFL,50000.
REDUCE.
AIRMOD(LODHIST)
0000000000000000000000
     4 BASE HOURS -- NIGHT, AM PEAK PERIOD, MID DAY, PM PEAK PERIOD -- 1980
                              EMISSION NO. 1 ONLY -- CARBON MONOXIDE
  SF BAY AREA AIR POLLUTION MODEL - NSF (RANN) 1973 MOBILE SOURCE INVENTORY
 $OPTIONS PEAK(1)=.FALSE.,.TRUE.,.FALSE.,.TRUE. $
 $PARAMS NUMEM=1, NUMHRS=4, NUMLNK=10, NUMX=220, NUMY=220, YEAR=1980,
          BASEX=4085, BASEY=445 $
   0    1    0.0160 0.0500 0.0230 0.0710
   1    1    0.0160 0.0500 0.0230 0.0710
   2    1    0.0160 0.0500 0.0230 0.0710
   3    1    0.0160 0.0500 0.0230 0.0710
   4    1    0.0160 0.0500 0.0230 0.0710
   5    1    0.0160 0.0500 0.0230 0.0710
   6    1    0.0160 0.0500 0.0230 0.0710
   7    1    0.0160 0.0500 0.0230 0.0710
   8    1    0.0160 0.0500 0.0230 0.0710
   9    1    0.0160 0.0500 0.0230 0.0710
CARBON MONOXIDE
   1    0 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    0 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    1 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    1 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    2 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    2 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    3 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    3 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    4 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    4 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    5 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    5 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    6 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    6 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    7 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    7 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    8 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    8 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
   1    9 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
   1    9 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
0000000000000000000000
```

Fig. J-2. Example of control and input cards for program AIRMOD.

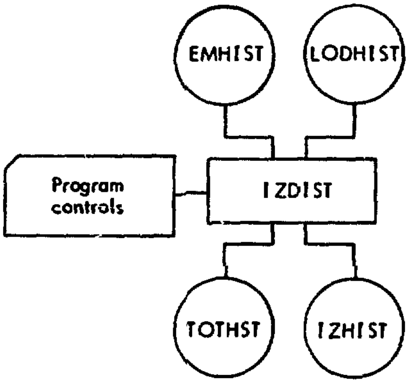

Fig. J-3. File process chart for program IZDIST.

Program INTERPO

As shown in Fig. J-1, this program generates a trip table by means of extrapolation/interpolation between two given trip tables. The output trip table is assigned to an appropriate highway network. An adjustment (or scaling) capability to factor the output trip table is optionally permitted.

Figure J-7 shows a flow chart of files needed and produced by INTERPO. A detailed description of the control cards needed is given in Table J-7. An example of a file so constructed is given in Fig. J-8, which illustrates the generation of a 1973 trip table by interpolation between 1965 and 1980 trip tables.

Program REPORT

As shown in Fig. J-1, this program outputs the emission history files, EMHIST, in a report format. It is structured to selectively report on emission types, periods (hours) of the day and up to 10 rectangular geographical locations within the study area. The user should be aware that without judicious use of the select options the program may generate voluminous detailed output which would be difficult to assimilate.

Table J-8 provides a detailed description of the program controls for this program, which include three header cards followed by NAMELIST, OPTIONS and PARAMS cards. If any subareas are specified a descriptive title card for each subarea follows. Figure J-9 gives an example of the necessary CYBERNET SCOPE operating system and program controls, which will lead to issuance of a report of emission types 1, 2 and 4 on an emission history file. Only the first 12 hr are to be reported and for three subareas.

Program ADDLOD

As shown in Fig. J-1, this program combines two similar (the same number of purpose/iteration loading combinations) loaded highway network history files (LODHIST and LODHIST2)

Table J-5. Detailed description of program control cards for program IZDIST.

Three header cards	No options or parameter are inputted to IZDIST. Header cards are required; any may be blank but three must be input. These identify the output emission history files for future reference during reporting.
Zone-grid equivalence cards	Two types of cards are permitted to identify the pertinent UTM grid squares in each MTC zone.
1) Range cards	These cards permit the definition of a rectangle of grid squares.

Column	Description
1-6	"RANGES"
7-10	Not used
11-15	Right-justified MTC zone number
16-20	Range 1: Lower y-value
21-25	Range 1: Upper y-value
26-30	Range 1: Lower x-value
31-35	Range 1: Upper x-value
36-40	Range 2: Lower y-value
41-45	Range 2: Upper y-value
46-50	Range 2: Lower x-value
51-55	Range 2: Upper x-value
56-60	Range 3: Lower y-value
61-65	Range 3: Upper y-value
66-70	Range 3: Lower x-value
71-75	Range 3: Upper x-value

2) Specific cards	These cards permit the definition of specific grids to zones.

Column	Description
1-8	"SPECIFIC"
9-10	Not used
11-15	Right-justified MTC zone number
16-20	Grid 1: y-value
21-25	Grid 1: x-value
26-30	Grid 2: y-value
31-35	Grid 2: x-value
36-40	Grid 3: y-value
41-45	Grid 3: x-value
46-50	Grid 4: y-value
51-55	Grid 4: x-value
56-60	Grid 5: y-value
61-65	Grid 5: x-value

```
$CHARGE,XXXXXYY-ZZ7,JOBIDENT.
IZDIST(CM5000,CL50000,MT2,T40,P2)
LABEL,A,R,L=LODHISTSTACK,VSN=PA6364.
COPYBF(A,LODHST)
REWIND(LODHST)
UNLOAD(A)
LABEL,B,L=1973EMHIST,VSN=PA1234.
COPYBF(B,EMHIST)
REWIND(EMHIST)
UNLOAD(B)
ATTACH(IZDIST,JWFIZDIST,PW=JWF)
RFL,50000.
REDUCE.
IZDIST.
RFL,5000.
LABEL,STACK,W,L=1973TOTHISTIZHIST,X=SV.
COPYBF(TOTHST,STACK)
COPYBF(IZHIST,STACK)
000000000000000000000
                         TOTAL EMHIST FILE -- TOTHIST AND IZHIST
                            EMISSION NO. 1 ONLY -- CARBON MONOXIDE
   SF BAY AREA AIR POLLUTION MODEL - NSF LIRAQ1 1973 MOBILE SOURCE INVENTORY
 $PARAMS $
RANGES        055 4190 4191  541  543
 .  .     .   . .  .  .  .   . .  .    .   .   .
RANGES        026 4183 4184  548  549
END
    1     0 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     0 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     1 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     1 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     2 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     2 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     3 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     3 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     4 1 95.380 95.380 62.750 48.480 40 160 34.140 30.620 27.610 25.100 23.090
    1     4 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     5 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     5 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     6 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     6 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     7 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     7 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     8 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     8 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
    1     9 1 95.380 95.380 62.750 48.480 40.160 34.140 30.620 27.610 25.100 23.090
    1     9 2 21.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080 20.080
000000000000000000000
```

Fig. J-4. Example of program control cards required for program IZDIST.

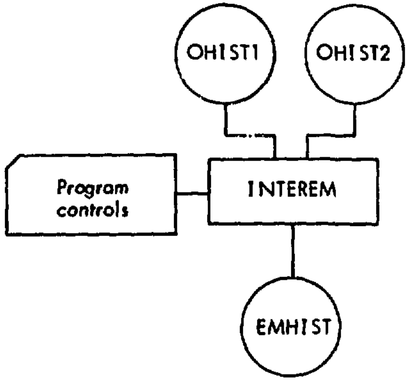

Fig. J-5. File process diagram for program INTEREM.

```
$CHARGE,XXXXXYY-ZZZ,JOBIDENT.
INTEREM(CM5000,CL50000,T200,MT3,P4)
LABEL,OHIST1,R,L=1965EMHIST,VSN=PA1235.
LABEL,OHIST2,R,L=1980EMHIST,VSN=PA8214.
LABEL,EMHIST,W,L=1973EMHIST,X=SV.  (PR)
ATTACH(INTEREM,JWFINTEREM,PW=JWF)
REDUCE.
INTEREM.
0000000000000000000000
    1973 EMISSION HISTORY -- INTERPOLATED BETWEEN 1965 AND 1980 EMHIST FILES
   SF BAY AREA AIR POLLUTION MODEL - NSF LIRAQ1 1973 MOBILE SOURCE INVENTORY

 $OPTIONS $
 $PARAMS YEAR = 1973 $
0000000000000000000000
```

Fig. J-6. Example of control cards needed as input to program INTEREM.

Table J-6. Detailed description of control cards required for program INTEREM.

Three header cards	Header cards are required; any may be blank but three must be input. These identify the output emission history file for future reference during reporting.
b$OPTIONS ADD = .TRUE.$	Specifies that the output emission history file is to be the addition of the two input emission history files. The two input files must be for the number of emission types and the daily time periods must be coincident.
b$PARAMS YEAR = y $	Specifies the "target" year for interpolation (or extrapolation). The control years are taken from the header records of the two input files.

Table J-7. Detailed description of program cards required by program INTERPO.

Three header cards	Header cards are required; any may be blank but three must be input. These identify the output trip table for future reference during reporting.
b$PARAMS BASEYR = b,	Specifies the year corresponding to the trip table on file, INVOL1. This integer parameter is required.
FUTYR = f,	Specifies the year corresponding to the trip table on file, INVOL2. This integer parameter is required.
TARGYR = t,	Specifies the "target" year for the extrapolated/interpolated trip table to be generated on file, VOLUME. This integer parameter is required.
ADJFAC = fac $	Specifies an adjustment or scaling factor by which the output trip is multiplied. This parameter is entered as a floating-point value; the default value is 1.0.

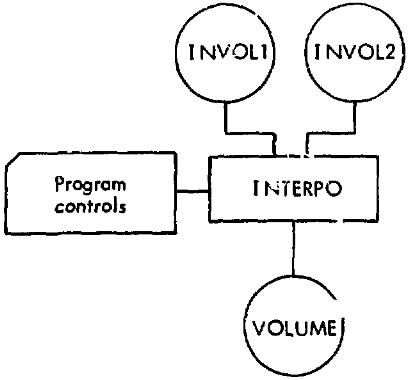

Fig. J-7. File process chart for program INTERPO.

```
$CHARGE,XXXXXYY-ZZZ,JOBIDENT.
INTERPO(CM10000,CL50000,T50,P2,MT1)
ATTACH(INTERPO,JWFINTERPO)
RFL,5000.
LABEL,ONE,R,L=TOTAUTODR65-311,VSN=PA4508.
COPYBF(ONE,INVOL1)
REWIND(INVOL1)
LABEL,TWO,R,L=TOTAUTODR80-311,VSN=PA771.
COPYBF(TWO,INVOL2)
REWIND(INVOL2)
UNLOAD(TWO)
LABEL,VOLUME,W,L=TOTAUTODR73-311,X=SV.  (PR)
RFL,50000.
REDUCE.
INTERPO.
RFL,5000.
COPYBF(VOLUME,RTABIN)
ATTACH(TRNPLN,DCOTRANPLAN)
RFL,20000.
TRNPLN.
000000000000000000000
1973 TRIP TABLES AFTER INTERPOLATION
T1 = VEH-WORK+ VEH-NON WORK
T1 = VEH/
T1 = VEH-WORK + VEH-NON WORK, T2 = VEH-WORK, T3 = VEH-NON WORK
   SF BAY AREA AIR POLLUTION MODEL - NSF LIRAQ1 1973 MOBILE SOURCE INVENTORY
 $PARAMS FUTRY=1980, BASEYR=1965, TARGYR=1973 $
000000000000000000000
$REPORT MATRIX
$FILE
   INPUT FILE = RTABIN
$OPTIONS
   PRINT TRIP ENDS
$PARAMETERS
   SELECTED PURPOSES = 1-3
$END TP FUNCTION
000000000000000000000
```

Fig. J-8. Example of control card input file for program INTERPO.

Table J-8. Detailed description of control cards needed for program REPORT.

Three header cards	Header cards are required; any may be blank but three must be input. These identify the output reports.
bSOPTIONS SELEM(i) = .TRUE.$	Specifies that all emissions, i, will be reported. If this option is not specified, no report will be produced.
bSPARAMS MINY(i) = iy, MAXY(i) = ay, MINX(i) = ix, MAXX(i) = ax,	Specifies the boundaries of up to 10 (i up to 10) rectangular subareas to be reported. If no coordinates are selected, then the total area is to be reported.
SELTIM(i) = list $	Specifies the time periods (hours) throughout the day to be reported. If this parameter is not specified, then all 24 hr are to be reported.
Subarea descriptive title cards	For each subarea specified a descriptive header card is required. (It may be blank.)

```
$CHARGE,XXXXXYY-ZZZ,JOBIDENT.
REPORT(CM5000,CL50000,T100,MT1,F2)
LABEL,EMHIST,R,L=1973EMHIST24HRS,VSN=PA5541.
ATTACH(REPORT,JWFREPORT,PW=JWF)
REDUCE.
REPORT.
0000000000000000000000
          SUBAREA 1 = SAN FRANCISCO(APPROX), SUBAREA 2 = OAKLAND(APPROX)
          SUBAREA 3 = SAN JOSE(APPROX) -- TIMES REPORTED 12 MIDNIGHT TO NOON
   SF BAY AREA AIR POLLUTION MODEL - NSF LIRAQ1 1973 MOBILE SOURCE INVENTORY
 $OPTIONS SELEM(1)=.TRUE., SELEM(2)=.TRUE., SELEM(4)=.TRUE. $
 $PARAMS MINY(1) = 1000, MINX(1) = 300, MAXY(1) = 1200, MAXX(1) = 450,
         MINY(2) =  950, MINX(2) = 400, MAXY(2) = 1250, MAXX(2) = 425,
         MINY(3) = 975, MINX(3) = 100, MAXY(3) = 100, MAXX(3) = 275 ,
         SELTIM(1) = 1,2,3,4,5,6,7,8,9,10,11,12 $
SAN FRANCISCO
OAKLAND
SAN JOSE


NOTE -- MINS AND MAXS ARE EXAMPLES ONLY -- NOT THE REAL X AND Y VALUES
0000000000000000000000
```

Fig. J-9. Example of control card deck for program REPORT.

to produce an "added" file, LODHIST. Currently MTC, via the RTTPP modeling task, is loading work trips on peak-hour travel times and other trips on off-peak. This technique is an expedient method to approximate the effect of congestion in trip assignment. The ADDLOD program adds the two-loaded highway networks so produced.

The only program control cards that must be inputted are three header cards. No options or parameters are inputted to ADDLOD. The header cards are required; any may be blank but three must be input. These identify the output loaded highway network history file for future reference during reporting.

The SCOPE system and program controls, shown in Fig. J-10, illustrate the generation of a "total-purpose" loaded highway network history file from two "single-purpose" (work on the peak and non-work on the off-peak network) files.

Program MODHIST

This program modifies a loaded highway network history file OLDLOD (shown as $LODHIST_3$ in Fig. J-1) in two ways:

1) It inserts intrazonal trips on dummy centroid connectors as an approximation of local traffic.

```
$CHARGE,XXXXXYY-ZZZ,JOBIDENT.
LOAD1(CM5000,CL150000,P4,MT1,T100)
ATTACH(ADDLOD,DCOADDLOD,PW=DCO)
LABEL,A,R,L=73LOD2WORKPKST,VSN=PA2324.
COPYBF(A,LDHST1)
UNLOAD(A)
REWIND(LDHST1)
LABEL,B,R,L=73LOD2NONWORKOFFS,VSN=PA3626.
COPYBF(B,LDHST2)
REWIND(LDHST2)
UNLOAD(B)
LABEL,LODHIST,W,L=73STOCHLODADDED,X=SV.  (PR)
RFL,50000.
REDUCE.
ADDLOD(LDHST1,LDHST2,LODHIST)
ATTATCH(TRNPLN,DCOTRANPLAN)
RFL,20000.
TRNPLN.
000000000000000000000
1973 ADDED STOCH LOADING -- WORK ON PEAK AND NON-WORK ON OFF-PEAK (NO TRKS OR IZ
TRIP TABLE ADJUSTED FOR EXTERNALS AND GOLDEN GATE BRIDGE VOLUMES
   SF BAY AREA AIR POLLUTION MODEL - NSF LIRAQ1 1973 MOBILE SOURCE INVENTORY
000000000000000000000
$REPORT HIGHWAY LOAD
$FILE
   INPUT FILE = LODHIST
$PARAMETERS
   SELECTED OR NODES = 1-10,2580,2396,2395,2579,2640,2340,2265,2313,2244,2461
$END TP FUNCTION
000000000000000000000
```

Fig. J-10. Sample program card input to the program ADDLOD.

2) It applies truck-loading factors (measured percentages of truck traffic) by facility type and, where specific truck factors vary from the norm, applies truck loading factors to individual links. No practical limit for specific link truck factors exists. A new file, NEWLOD, which becomes $LODHIST_4$ as input to AIRMOD, is outputted. This is shown schematically in Fig. J-11.

Table J-9 gives detailed description of the program controls for this program. Three header cards are followed by a NAMELIST PARAMS card and specific link truck factor data cards; no options are input. Table J-10 is the format of the data cards necessary to override the link type factors to account for local or geographical truck loading variation. These cards are grouped in sets that define the links having the same truck-loading ratio. All the data cards are fixed-field format. Figure J-12 illustrates the SCOPE system and program controls needed in order to provide for the creation of the final adjusted 1973 loaded highway network history file. A default of 0.02 trucks on non-freeway and a specified 0.07 on freeway link types was inputted together with a series of specific link truck ratios ranging from 0.03 to 0.25.

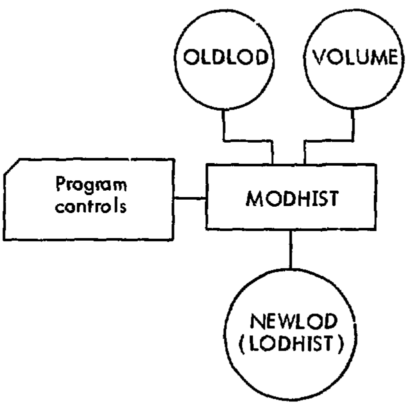

Fig. J-11. File process chart for program MODHIST.

Additional Files

A number of additional files are also required as input during the processing of the mobile source inventory. These are given in parts (a) through (e) of Table J-11.

POPULATION DISTRIBUTED SOURCES

BAAPCD developed a special program to apportion by population distribution the pollutant source emissions that could not be attributed to mobile, airport, or major point sources. Thus, this program takes pollutant emissions and distributes them geographically by population. The input to the program EMITS consists of nine control cards, one for each Bay Area county, and a

Table J-9. Detailed description of program controls to be inputted to MODHIST.

Three header cards	Header cards are required; any may be blank but three must be input. These identify the output-loaded highway network history file for future reference during reporting.
b$PARAMS TRUCKF(i) = fac $	Specifies the truck ratio by up to the 10 link types (Assignment Group Codes) used by MTC. A code of zero is represented by i = 10. The values are floating-point ratios; i.e., 10% trucks would be input at 0.10. The default value for all link types is 0.02.

Table J-10. Detailed format of data cards to set local or geographical truck-loading variation.

Column		Description
Set card	1-10	Integer, right-justified value, specifying the number of links in the set.
	11-20	Floating-point value defining the truck ratios to be applied to each link in the set, and a series of link identifier cards.
Link cards		
	1-5	The A-node of a link; integer right-justified.
	6-10	The B-node of the link; integer right-justified.
	11-20 21-30 31-40 41-50	These fields are similar to columns 1-10. One-way or two-way links are described in like manner; two-way links should not be entered A-B and B-A. Five links are permitted on a card; no gaps are permitted.

population tape. Each card contains the county code, county, population, and emissions in tons per day for that county of particulates, organics, NO_x, SO_x, and CO. Table J-12 shows the input deck used for the year 1973 in the Bay Area. The input tape contains population data and centroid locations for census block groups in the nine Bay Area counties. The output consists of a file (Tape 10) listing emissions of each contaminant in grams per second by grid squares. A print file with page headings and proper spacing for printing in 8-1/2 by 11 inch format is also created (Tape 6).

Figure J-13 gives a listing of this program.

```
$CHARGE,F3412UE-051,LOAD1.
LOAD1(CM5000,CL110000,P2,MT1,T100)
LABEL,A,R,L=VOLUMESTACK,VSN=PA21.
COPYBF(A,VOLUME)
UNLOAD(A)
REWIND(VOLUME)
LABEL,B,R,L=80LODADDEDIZDATA,VSN=PA3912.
COPYBF(B,OLDLOD)
UNLOAD(B)
REWIND(OLDLOD)
LABEL,LODHIST,W,L=80FREELODADDTR+IZ,X=SV.   (PR)
ATTACH(MODHIST,JWFIZTRUCK,PW=JWF)
RFL,50000.
REDUCE.
MODHIST(OLDLOD,LODHIST)
ATTACH(TRNPLN,DCOTRANPLAN)
RFL,20000.
TRNPLN.
0000000000000000000000
1980 ADDED FREE LOADING -- WORK ON PEAK AND NON-WORK ON OFF-PEAK TRUCKS + INTRAS
TRIP TABLE ADJUSTED FOR GOLDEN GATE (1973 ADJUSTMENT) NO EXTERNAL ADJUSTMENT
   SF BAY AREA AIR POLLUTION MODEL - NSF LIRAQ1 1973 MOBILE SOURCE INVENTORY
$REPORT HIGHWAY LOAD
$FILE
   INPUT FILE = LODHIST
$PARAMETERS
   SELECTED OR NODES = 1-10,2580,2396,2395,2579,2460,2340,2265,2313,2244,2461,
                  2711,2366,10458,3366,10394,5050,5488,5271
$END TP FUNCTION
```

Fig. J-12. Example of program control cards necessary as input to MODHIST.

Table J-11. Description of file structure and format of input data needed to complete input for mobile source inventory processing.

(a) <u>Emission History File</u>

Record 1 - 50 words

READ (LUN) (HEAD (I), I=1,50)

Words 1-24	-- Title information
25	-- Date
26	-- Time
27	-- Study year
28	-- Number of emissions
29	-- Number of hours
30	-- Number of X grids
31	-- Number of Y grids
32	-- Base x-value
33	-- Base y-value
34-50	-- Not used

The following records are repeated for each emission type on the file:

Record 2 READ (LUN) N,(IO(I), I=1,N)

where: N = 9

IO(1) = 8HEMISSION

IO(2-9) = emission title

A set of records for each y-grid; each record is for a grid square with nonzero vehicle-miles.

READ (LUN) N, (IO(I), I=1, N)

where: N = 1 -- end of y-grid set

or

N = number of hours + 4

IO(1) = x-grid value - base x-value (integer)

IO(2) = y-grid value - base y-value (integer)

IO(3) = vehicle - miles

IO(4) = vehicle - hours

IO(5) = emission value for hour 1

IO(6) = emission value for hour 2

. . .

IO(N) = emission value for hour N-4

Table J-11. (Continued)

(b) Loaded Highway Network History File

Header set 1

Variable name		Card Nos.
FNAME	IOHTRANPLAN	1
	CALL FINDVID(GLHWY	2
	NET,NDVM)	3
	User identification	4
GDATE	dd mmm yy	5
GTIME	hh.mm.ss.	6
FUNCT	BUILD HIGH	7
		8
		9
FTYPE	HWYNETWORK	10
GNAME	HWYNET	11
TITLE		12
	3 header cards	13
		14
		15
PTITLE	PURPOSE 1	16
	PURPOSE 2	17
	.	.
	.	.
	.	.
	PURPOSE n	80
		81-85 (not used)

Header set 2

Variable name		Card No.
MAXZON	MAXIMUM ZONE	1
NUMPUR	NUMBER OF TABLES	2
		3
MAXNEX	MAXNODE EXTERNAL	4
MAXNI	MAXNODE INTERNAL	5
NLINK	NUMBER OF LINKS	6
LCOST	COST NETWORK FLAG	7
LUSER	USER NETWORK FLAG	8
LTPCN	MAXIMUM TURN PEN CODE	9
LINKGP	MAXIMUM LINK GP1 CODE	10
	MAXIMUM LINK GP2 CODE	11
	MAXIMUM LINE GP3 CODE	12
CAPAC	MAXIMUM CAPACITY	13
VOLUMS	MAXIMUM VOLUME	14
		15
ASSGRP	MAXIMUM ASSIGN GROUP	16
NODATA	NUMBER OF COORD NODES	17
NUMPRO	NUMBER OF PROHIBITORS	18
TESSUM	TRIP END SUMMARY FLAG	19
TABLES	TABLE POINTERS	20
LODPCT	LOAD PERCENT ITER=1	21
	LOAD PERCENT ITER=2	22
	LOAD PERCENT ITER=3	23
	LOAD PERCENT ITER=4	24
	LOAD PERCENT ITER=5	25
	LOAD PERCENT ITER=6	26
	LOAD PERCENT ITER=7	27
	LOAD PERCENT ITER=8	28
	LOAD PERCENT ITER=9	29
	LOAD PERCENT ITER=10	30
NUMITR	NUMBER OF ITERATIONS	31
LODPUR	NUMBER OF LOADED PURPOSES	32
NUMSELK	NUMBER OF SELECTED LINKS	33
NUMTURN	NUMBER OF SAVED TURNS	34
NUMWEAV	NUMBER OF WEAVE LINKS	35
NUMLINE	NUMBER OF TRANSIT LINES	36
MINMAXX	MINIMUM/MAXIMUMX	37
MINMAXY	MINIMUM/MAXIMUMY	38
VINEB	TRUE IF VINE BUILDER	39
		40-50 (not used)

Table J-11. (Continued)

(c) Coordinate Records

READ (LUN) N, (IO(I), I = 1, N)   1 N 501

IO(1) = 5H NODES

IO(I) -- bits	0-17	node number
bits	18-35	y coordinate (biased + 10000)
bits	36-53	x coordinate (biased + 10000)

(d) Turn Prohibitor Records

READ (LUN) N, (IO(I), I = 1, N)   1 N 501

IO(1) = 5H TURNS

IO(I) -- bits	46-59	from node
bits	32-45	through node
bits	18-31	to node

(e) Link Records

READ (LUN) N, (IO(I), I = 1, N).   1 N 501

IO(1) = 5H LINKS

IO(I) -- bits	0-16	A-node	(I=2, 6, 10, etc.)
	17-33	B-node	
	34-47	distance	
	48-51	direction code - 1	
	52-55	assignment group code	
IO(I+1) -- bits	0-14	user impedance	
	15-29	cost impedance	
	30-44	time 2 impedance	
	45-59	time 1 impedance	
IO(I+2) -- bits	0-18	capacity 2	
	19-37	capacity	
	38-44	link group 3 code	
	45-51	link group 2 code	
	52-58	link group 1 code	
	59	twoway flag (1=twoway 0=oneway)	
IO(I+3) -- bits	0-47	link load	
	48-59	link impedance	

Table J-12. Input deck indicating how pollutant emissions should be distributed by population. A card is entered for each county (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma, respectively).

County code	County population	Emissions				
001	1073184	160	1200	213	124	402
013	558389	78	661	07	00	204
041	206038	43	170	38	05	79
055	79140	55	130	28	01	233
075	715674	151	755	141	75	214
081	556234	118	655	104	21	251
085	1064714	128	1170	306	54	380
095	132801	39	115	10	10	93
097	176722	64	180	34	06	180

```
      PROGRAM EMITS (INPUT,OUTPUT,TAPE7,TAPE8=OUTPUT,TAPE6,TAPE10)
      DIMENSION CPOP(9),CHOUSE(9),TOTF(9)
      DIMENSION IDATA(8),FDATA(6)
      DIMENSION COUNTY (7,9)
      DIMENSION ICOUNTY(7,9)
      EQUIVALENCE(COUNTY,ICOUNTY)
C*****FACTOR TO CONVERT TONS/DAY TO GRAMS/SECOND.
      CFACTOR=10.5
C*****READ INPUT DATA CARDS
      READ 100,((COUNTY(I,J),I=1,7),J=1,9)
      PRINT 110
C*****ECHO-CHECK ON INPUT DATA
      PRINT 101,((COUNTY(I,J),I=1,7),J=1,9)
C*****LOOP TO CONVERT INPUT EMISSIONS
      DO 10 I=3,7
      DO 10 J=1,9
   10 COUNTY(I,J)=COUNTY(I,J)*CFACTOR
      PRINT 201
      PRINT 600
      PRINT 500
C*****PRINT CONVERTED EMISSIONS
      PRINT 102,((COUNTY(I,J),I=1,7),J=1,9)
      WRITE(6,1500)
C
C*****INITIALIZE COUNTY POPULATION,HOUSING AND FRACTION VARIABLES
      DO 15 I=1,9
      CPOP(I)=0.
      CHOUSE(I)=0.
      TOTF(I)=0.
```

Fig. J-13. Listing of the code developed to distribute area sources by population.

```
   15 CONTINUE
C
C
C***** INITIALIZE CHECKING VARIABLE ON FIRST GRID SQUARE TO BE LISTED
      LX=622
      LY=4090
C*****INITIALIZE VARIABLES
      PART=ORG=FNOX=SOX=CO=0.
      TPART=TORG=TFNOX=TSOX=TCO=0.
      IPGT6=0
      LINEST6=0
      PRINT 201
C*****READ A RECORD FROM INPUT TAPE
   60 READ(7,700)IDATA,FDATA
C*****ECHO-CHECK ON DATA FROM INPUT TAPE
      WRITE(8,710)IDATA,FDATA
      IF(EOF,7)9000,61
C*****CHECK FOR A CENTROID ON INPUT TAPE. IF NONE, GO TO NEXT RECORD
   61 IF((FDATA(5).EQ.0.).OR.(FDATA(6).EQ.0.))GO TO 60
C*****SET UTM COORDINATES EQUAL TO IAN INTEGER VALUE IN ORDER TO
C     ESTABLISH A GRID SQUARE.
      IY=FDATA(5)
      IX=FDATA(6)
C*****IF CURRENT VALUES OF UTMX AND UTMY ARE NOT THE SAME AS THE LAST
C     THEN GO TO THE PRINTING SEQUENCE. IF THEY ARE THE SAME THEN CONTINUE.
      IF((IY.NE.LY).OR.(IX.NE.LX))GO TO 311
   65 CONTINUE
C ROUTINE TO EVALUATE CONTAMINANTS
      DO 200 J=1,9
      IF(IDATA(1).NE.ICOUNTY(1,J))GO TO 200
      J1=J
      GO TO 300
  200 CONTINUE
  300 CONTINUE
C*****FRACTION IS SET TO POP ASSIGNED TO CENTROID DIVIDED BY COUNTY POP.
C     EMISSIONS ARE COMPUTED FOR EACH CONTAMINANT AND ADDED TO PREVIOUS
C     TOTAL FOR THAT GRID SQUARE.  A GRAND TOTAL FOR EACH CONTAMINANT
C     IS ALSO COMPUTED.
      F=FDATA(2)/COUNTY(2,J1)
C
C*****          SEQUENCE FOR CHECKING INPUT TAPE POPULATION FIGURES,ETC.
      TOTF(J1)=TOTF(J1)+F
      CPOP(J1)=CPOP(J1)+FDATA(2)
      CHOUSE(J1)=CHOUSE(J1)+FDATA(1)
C
C
      PART=F*COUNTY(3,J1)+PART
      ORG =F*COUNTY(4,J1)+ORG
      FNOX=F*COUNTY(5,J1)+FNOX
      SOX =F*COUNTY(6,J1)+SOX
      CO  =F*COUNTY(7,J1)+CO
      GO TO 60
  311 CONTINUE
C*****ROUTINE PRINTS VVALUES OF CONTAMINANTS ONTO PRINT FILE(TAPE6)
C     AND ALSO STORES VALUES ON TAPE10.
 1300 IF(LINEST6.EQ.0)GO TO 1400
      IF(LINEST6/IPGT6-48.EQ.0)GO TO 1400
      GO TO 1410
```

Fig. J-13. (Continued)

```
 1400 IPGT6=IPGT6+1
      WRITE(6,1340)IPGT6
      WRITE(6,1320)
 1410 WRITE(6,1310)LY,LX,PART,ORG,FNOX,SOX,CO
      WRITE(10,1330)LY,LX,PART,ORG,FNOX,SOX,CO
      TPART=TPART+PART
      TORG=TORG+ORG
      TFNOX=TFNOX+FNOX
      TSOX=TSOX+SOX
      TCO=TCO+CO
      PART=ORG=FNOX=SOX=CO=0.
      LINEST6=LINEST6+1
      LX=IX
      LY=IY
      GO TO 65
 9000 CONTINUE
      WRITE(6,1350)TPART,TORG,TFNOX,TSOX,TCO
C*******      CALL SUBROUTINE TO LIST INPUT TAPE CHECKING VARIABLES
      H=10HPOPULATION
      CALL CHEKER(CPOP,H)
      H=7HHOUSING
      CALL CHEKER(CHOUSE,H)
      H=9HFRACTIONS
      CALL CHEKER(TOTF,H)
      END FILE 6
      END FILE 8
      END FILE 10
  100 FORMAT(I10,F10.0,5F10.1)
 101  FORMAT(1X,  I3,1X,F7.0,1X,F4.1,1X,F5.1,1X,F4.1,1X,F3.1,1X,F4.1)
 102  FORMAT(1X,  I3,1X,F7.0,1X,5F12.3)
 110  FORMAT(1X,*MATRIX OF INPUT COUNTY EMISSIONS*/)
  201 FORMAT(1H1)
 500  FORMAT(1H0)
 600  FORMAT(1X,*MATRIX OF CONVERTED COUNTY EMISSIONS*/)
  700 FORMAT(I3,A4,3A10,A4,A2,A1,F7.0,F8.0,F8.4,F7.4,2F10.3)
  710 FORMAT(1X,I3,1X,A4,1X,3A10,1X,A4,1X,A2,1X,A1,1X,F7,1X,F8,1X,F9.4,
     *1X,F8.4,1X,2F11.3)
 1310 FORMAT(1X,4X,I4,4X,I3,3X,5E11.2)
 1320 FORMAT(1X,3X,*UTM-Y*2X,*UTM-X*6X,*PART*8X,*ORG*8X,*NOX*8X,*SOX*8X,
     **CO*/)
 1330 FORMAT(I4,I3,5E9.2)
 1340 FORMAT(1H1,//65X,I9//)
 1350 FORMAT(1X,6X,*TOTALS-*5X,5E11.2)
 1500 FORMAT(1H1,16(/)20X,*POPULATION DISTRIBUTED EMISSIONS*//13X,*STATI
     *ONARY SOURCES - MAJOR SOURCES EXCLUDED*////22X,   *EMISSIONS IN GR
     *AMS PER SECOND*10(/)22X,*(CORRECTED FOR OUT-OF-DISTRICT PORTIONS*
     */22X,*OF SOLANO AND SONOMA COUNTIES.)*8(/)8X,*BASED ON- 1970 POPUL
     *ATION, 1973 BAAPCD SOURCE INVENTORY*)
       STOP
       END
C*****         SUBROUTINE TO LIST TAPE CHECKING VARIABLES
      SUBROUTINE CHEKER(A,H)
      DIMENSION A(9)
      WRITE(6,15)H
      DO 10 N=1,9
      WRITE(6,20) A(N)
   10 CONTINUE
   15 FORMAT(1H1,1H0,10X,1A10,/)
   20 FORMAT(1X,10X,E20.6)
      RETURN
      END
```

Fig. J-13. (Continued)

```
SMOG73,P3,T250,CM70000.658056,HARAWITZ,H
RUN76(S)
ATTSKIP(TAPE7,BAAPCD)
STAGE,TAPE7,38436.
CATALOG(TAPE7,BAAPCD)
ENDSKIP.
REWIND(TAPE7)
LINK,B,P=BKY10.
LGOB(LC=99999)
CXIT.
EXIT.
FIN.
STAGE,TAPE6,W,08263.
STAGE,TAPE10,W,08196.
STAGE,TAPE10,W,38439/C.
REWIND,TAPE6.
COPY,TAPE6,OUTPUT.
DISPOSE,TAPE10=MF,T2=LT08196.
COPY,TAPE6/RBR,TAPE15.
REWIND(INPUT)
COPY,INPUT,PUNCH.
REWIND(INPUT)
COPYSBF(INPUT,TAPE12)
REWIND,INPUT.
COPYSBF,INPUT,OUTPUT.
DISPOSE,TAPE6=PR,PA=1F.
DISPOSE,TAPE12=PR,PA=1F.
DISPOSE,TAPE15=PR,PA=1F.
EXIT.
```

Fig. J-13. (Continued)

Appendix K
LIRAQ Input and Output Data File Libraries

In carrying out the NSF-sponsored project to develop a regional air quality model for the San Francisco Bay Area (MacCracken and Sauter, 1975), a number of simulation runs were carried out using the LIRAQ-1 and LIRAQ-2 models. Because the input files and results of these runs were important in assessing model performance and because they may be of use in future studies by the Bay Area Air Pollution Control District, two sets of microfiche have been prepared to serve as a history of model studies at LLL and LBL with LIRAQ. These sets of microfiche are maintained by the BAAPCD.

Input data files that have been used in LIRAQ simulations have been assembled into an indexed set described in Table K-1. These files that apply to all problem runs are those specifying topography and solar intensity. For each of three meteorological periods in 1973, input files specifying meteorological, cloud, and pollutant concentration conditions have also been prepared. Also included in this set of files are the QTRAN files that have been processed by the MASCON program and are thus ready for input to LIRAQ. Where no three-letter run designation is given, the run was not carried out.

The results which are normally available for each model run (for some of the runs some parts of the output could not be permanently saved) include direct tabular and graphical output from the LIRAQ model and graphical output from a special post-processor code which compared the observed data to the calculated concentrations. Table K-2 shows the annotated table of contents that provides a framework for accessing particular model results.

Table K-1. Library of microfiche listings of input data files for LIRAQ model.

Table of Contents

Table K-1. (Continued)

6A FICHE for August 20, 1973, Meteorology
B Region 6 - ICE-tabular
C Region 6 - ICE-graphical
D
E Region 7 - tabular
F Region 7 - graphical
G
H Region 8 - tabular
I Region 8 - graphical
J
K Region 9 - tabular
L Region 9 - graphical
M
N Region 10 - tabular
O Region 10 - graphical
P
Q Region 11 - tabular
R Region 11 - graphical
S
T

7A FICHE for September 26-28, 1973 Meteor.
B QMET
C QCLD
D QICON3
E
F Region 1 - CJD-tabular
G Region 1 - CJD-graphical
H
I Region 2 - MJP-tabular
J Region 2 - MJP-graphical
K
L Region 3 - IMF-tabular
M Region 3 - IMF-graphical
N
O Region 4 - CFE-tabular
P Region 4 - CFE-graphical
Q
R Region 5 - tabular
S Region 5 - graphical
T

8A FICHE for September 26-28, 1973, Meteor.
B Region 6 - LCE-tabular
C Region 6 - LCE-graphical
D
E Region 7 - tabular
F Region 7 - graphical
G
H Region 8 - tabular
I Region 8 - graphical
J
K Region 9 - tabular
L Region 9 - graphical
M
N Region 10 - tabular
O Region 10 - graphical
P
Q Region 11 - tabular
R Region 11 - graphical
S
T

9A FICHE of QSOR files for summer, 1973
B Region 1 QSOR373 01
C Region 2 QSOR373 02
D Region 3 QSOR373 03
E Region 4 QSOR373 04
F Region 5 QSOR373 05
G Region 6 QSOR373 06
H Region 7 QSOR373 07
I Region 8 QSOR373 08
J Region 9 QSOR373 09
K Region 10 QSOR373 10
L Region 11 QSOR373 11
M
N
O
P
Q
R
S
T

10A
B
C
D
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F
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K
L
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N
O
P
Q
R
S
T

Table K-2. Annotated table of contents for simulation runs at LLL and LBL.

LIRAQ-1 simulations at LLL

Run MNL	0400 July 26 - 0400 July 27, 1973, 5-km simulation of Region 1 CO concentrations.
Run FOO	0400 July 26 - 0400 July 27, 1973, 2-km simulation of Region 3 CO concentrations.
Run KNI	0400 July 26 - 2200 July 26, 1973, 1-km simulation of Region 6 CO concentrations.
Run MCL	0400 July 26 - 2200 July 26, 1973, 5-km simulation of Region 6 CO concentrations.
Run OML	0400 July 26 - 2200 July 26, 1973, 2-km simulation of Region 3 CO concentrations with Livermore Valley emissions set to zero.
Run BEH	0400 August 20 - 2200 August 20, 1973, 5-km simulation of Region 1 CO concentrations.
Run PBN	0400 September 26 - 0400 September 28, 1973, 5-km simulation of Region 1 CO concentrations.
Run CCJ	0400 September 26 - 0400 September 28, 1973, 5-km simulation of Region 1 CO concentrations with east, north, and top boundary concentrations set to 2 ppm.

LIRAQ-2 simulations at LLL

Run PJP	0400 July 26 - 1900 July 26, 1973, 5-km simulation of Central Bay Area. Referred to as run J_1.
Run PKM	0400 July 26 - 1900 July 26, 1973, 5-km simulation of Central Bay Area. Referred to as run J_2.
Run CHK	0400 July 26 - 1900 July 26, 1973, 5-km simulation of Central Bay Area. Referred to as run J_3.
Run DFF	0400 July 26 - 1800 July 26, 1973, 2-km simulation of Region 3 subarea around Martinez. All microfiche files were lost.
Run KPB	0400 July 26 - 1800 July 26, 1973; 2-km simulation of Region 3 subarea around Martinez (same as DFF) with refinery perturbation.
Run EAN	0400 July 26 - 1900 July 26, 1973; 5-km simulation of Central Bay Area with all emissions in the Livermore Valley set to zero.
Run IDI	0400 July 26 - 1800 July 26, 1973; 5-km simulation of Central Bay Area with nitric oxide surface source emissions multiplied by 1.4.
Run JMC	0400 August 20 - 1900 August 20, 1973; 5-km simulation of Central Bay Area. Referred to as Run A_1.

Table K-2. (Continued)

LIRAQ-2 simulations at LLL (cont)	
Run MKA	0400 August 20 - 1800 August 20, 1973; 5-km simulation of Central Bay Area. Referred to as Run A_2.
Run LIC	0400 August 20 - 1900 August 20, 1973; 5-km simulation of Central Bay Area. Referred to as Run A_3.
Run COI	0400 September 26 - 1900 September 27, 1973; 5-km simulation of Central Bay Area. The first 24 hours are also referred to as Run S_1 and the last 19 hours as Run S_2.
Run AEA	0400 September 27 - 1800 September 27, 1973; 5-km simulation of Central Bay Area. Referred to as Run S_3.
Run KCK	0700 September 27 - 1800 September 27, 1973; 5-km simulation of Central Bay Area. Referred to as Run S_4.
Simulations made at LBL	
Run 220	0600 July 26 - 1800 July 26, 1973; 5-km LIRAQ-1 simulation of Region 1 with surface CO emissions in San Francisco multiplied by 0.5.
Run 168	0600 July 26 - 0700 July 26, 1973; 5-km LIRAQ-2 simulation of Central Bay Area with surface emissions of all pollutants reduced by a factor of 10 outside the Livermore Valley.
Run 059	0700 July 26 - 1800 July 26, 1973; 5-km LIRAQ-2 simulation continuing Run 168.

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