Technical Report Documentation Page

1. REPORT No.
CA-DOT-TL-7169-4-76-38

2. GOVERNMENT ACCESSION No.

3. RECIPIENT'S CATALOG No.

4. TITLE AND SUBTITLE
Transportation Systems And Regional Air Quality- An Approach And Computer Program For Wind Flow Field Analysis

5. REPORT DATE
May 1976

6. PERFORMING ORGANIZATION

7. AUTHOR(S)
James A. Racin and Andrew J. Ranzieri

8. PERFORMING ORGANIZATION REPORT No.
19701-657169

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Office of Transportation Laboratory
California Department of Transportation
Sacramento, California 95819

10. WORK UNIT No.

11. CONTRACT OR GRANT No.
A-8-27 19-603116

13. TYPE OF REPORT & PERIOD COVERED
Interim

12. SPONSORING AGENCY NAME AND ADDRESS
California Department of Transportation
Sacramento, California 95807

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
This work was accomplished in cooperation with the United States Department of Transportation.

16. ABSTRACT
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17. KEYWORDS
Regional air quality, photochemical models, interdisciplinary team, wind vector plots, monitoring, wind flow field, stations, computer program

18. No. OF PAGES:
48

19. DRI WEBSITE LINK
http://www.dot.ca.gov/hq/research/researchreports/1976-1977/76-38.pdf

20. FILE NAME
76-38.pdf

This page was created to provide searchable keywords and abstract text for older scanned research reports.
November 2005, Division of Research and Innovation

DIVISION OF STRUCTURES AND ENGINEERING SERVICES

TRANSPORTATION LABORATORY

RESEARCH REPORT

Transportation Systems And Regional Air Quality

AN APPROACH AND COMPUTER PROGRAM FOR WIND FLOW FIELD ANALYSIS

INTERIM REPORT

CA-DOT-TL-7169-4-76-38

MAY 1976

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Prepared in Cooperation with the U.S. Department of Transportation,

Federal Highway Administration

Caltrans

CALIFORNIA DEPARTMENT OF TRANSPORTATION

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TECHNICAL REPORT STANDARD TITLE PAGE

1 REPORT NO.	2. GOVERNMENT ACCESSION NO.	3 RECIPIENT'S CATALOG NO
CA-DOT-TL-7169-4-76-38		

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TRANSPORTATION SYSTEMS AND REGIONAL AIR QUALITY - An approach and Computer Program for Wind Flow Field Analysis	May 1976
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17 KEY WORDS	18. DISTRIBUTION STATEMENT
Regional air quality, photochemical models, interdisciplinary team, wind vector plots, monitoring, wind flow field, stations, computer program.	No restrictions. This publication is available to the public through the National Technical Information Service, Springfield, VA 22161.

19 SECURITY CLASSIF (OF THIS REPORT)	20 SECURITY CLASSIF (OF THIS PAGE)	21 NO. OF PAGES	22. PRICE
Unclassified	Unclassified	48	

DH - TL 1242 (Rev. 3-74)

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STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF STRUCTURES & ENGINEERING SERVICES
OFFICE OF TRANSPORTATION LABORATORY

May 1976

FHWA No. A-8-27
TL No. 657169

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this interim research project report titled:

AN APPROACH AND COMPUTER PROGRAM FOR WIND FLOW FIELD ANALYSIS

Study made by . . . . . Enviro-Chemical Branch

Under the Supervision of . . . . . E. C. Shirley, P.E.

Principal Investigator . . . . . A. J. Ranzieri, P.E.

Report Prepared by . . . . . James A. Racin

Assisted by . . . . . Ora Hogan
Andrew J. Ranzieri, P.E.

Very truly yours,

George A. Hill

GEORGE A. HILL
Chief, Transportation Laboratory

Attachment

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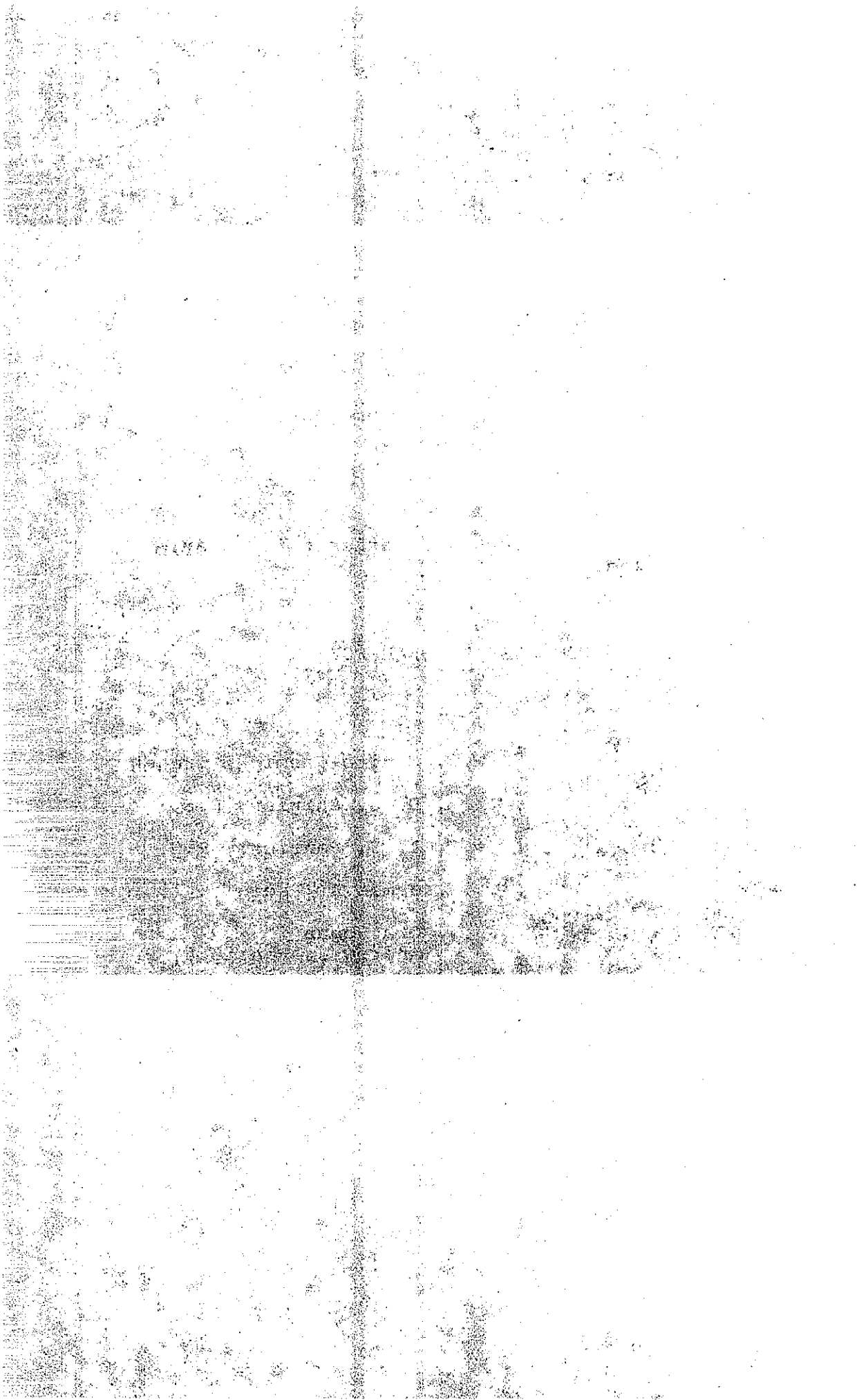

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ACKNOWLEDGEMENTS

This report was written by James A. Racin and Andrew J. Ranzieri of the California Department of Transportation, Transportation Laboratory (Translab) under the supervision of Earl C. Shirley. The computer program for plotting wind vectors was initially developed at Systems Applications, Incorporated (SAI). However, several modifications were installed by Translab to generalize the program for statewide use of the Teale Data Center's computing and plotting facilities. The authors express their thanks to the Caltrans Office of Computer Systems, especially Ora Louise Hogan and William A. DeWayne for their efforts in program development and in the design of input documents. Acknowledgements are also due to Timothy J. Woody of Translab for programming assistance.

The contents of this report reflect the views of the Transportation Laboratory which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

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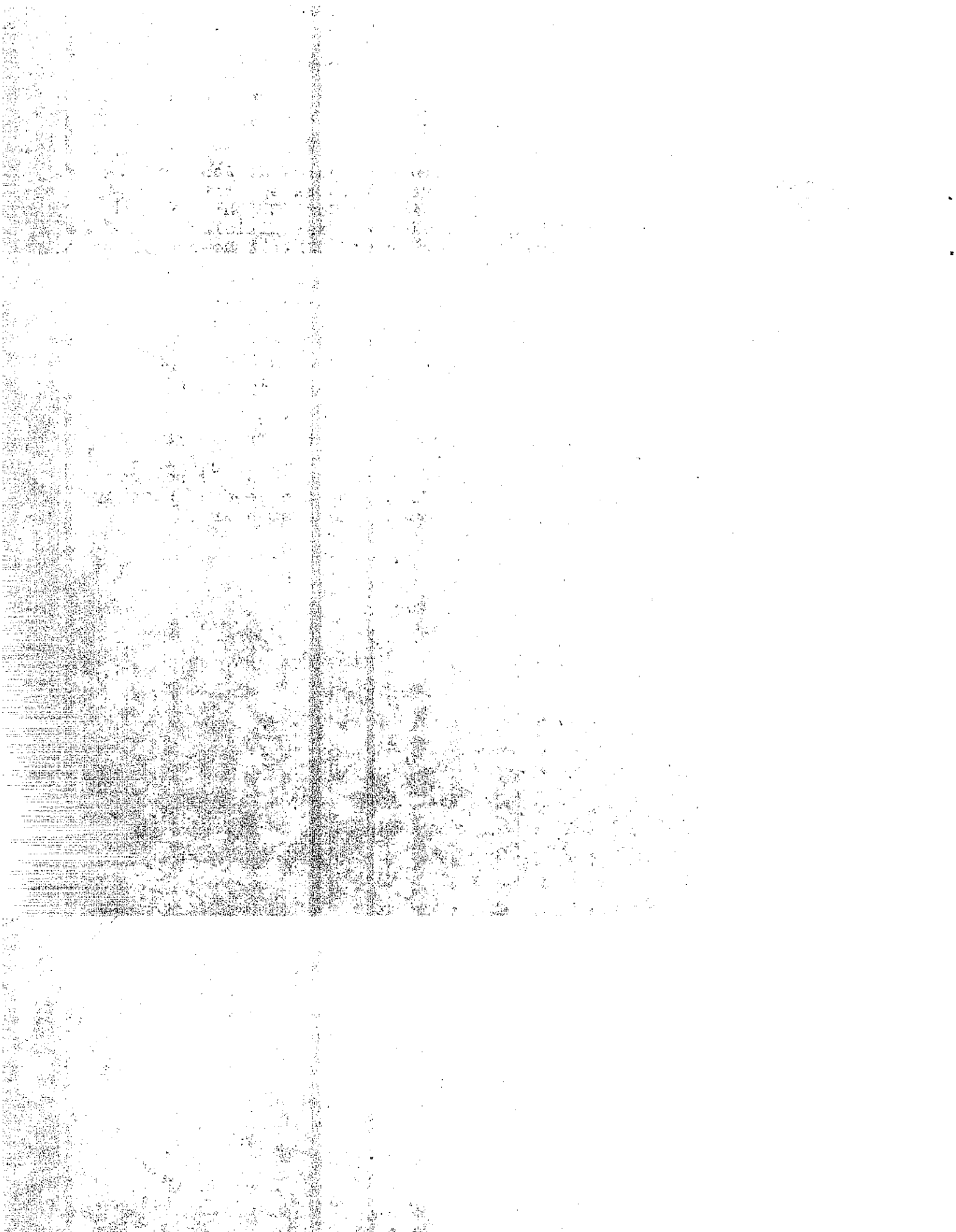

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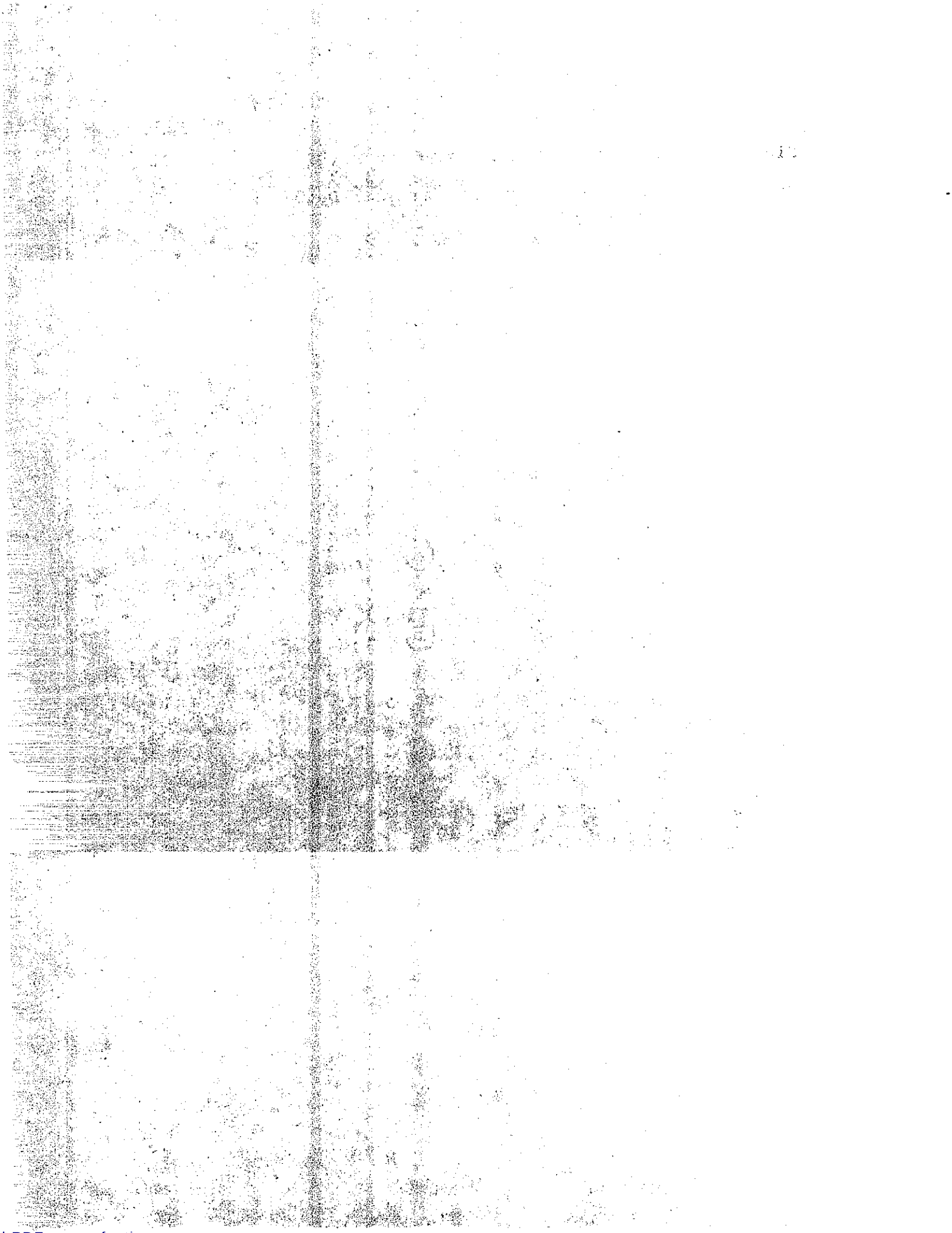

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I. INTRODUCTION

This research work was funded by the Federal Highway Administration (FHWA). Due to the nature of the project, several reports will be prepared covering individual aspects of the project. A technique for using the skills of an interdisciplinary team and a computer program for the analysis and characterization of regional wind flow patterns are included in this report.

The evaluation of the interrelationships of land use, transportation, and air quality requires the use of regional photochemical models. The inputs to these models, references (1) and (2), require information on the temporal and spatial distributions of:

1) Emissions from mobile and stationary sources.

2) Meteorological Parameters

   - wind speed and direction both at the surface and aloft
   - temperature as a function of height above ground
   - turbulent diffusion
   - insolation

3) Pollutants

   - hydrocarbons, reactive and nonreactive
   - oxides of nitrogen
   - carbon monoxide
   - ozone

The adequacy of regional data bases varies among urban areas with regard to:

1) the number of ground monitoring stations for both air pollutant and meteorological data within the study region,

2) the distance between stations, and

3) the frequency of temperature measurements, and the frequency of measurements of the vertical temperature profile.

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Generally, in order to apply a regional photochemical model in an urban area, a field monitoring program is required to develop the air quality and meteorological input for the models. It is recommended that models be validated for a particular urban area by obtaining field measurements and comparing the model results to the observations. To do this use must be made of the existing surface wind monitoring network and of the historical data available from air pollution control districts, airports, etc. Part of the task at hand is to determine if the data are representative of the region where the models are to be applied. In most cases additional measurements must be made to describe the surface wind flow field.

Figure 1 presents a generalized flow diagram of a regional air quality modeling process. Any data which are to be included in regional data bases for modeling purposes should be screened for temporal and spatial representativeness. This report focuses on the analysis of the regional wind flow field.

The purpose of this study was to develop an approach and an operational computer program to plot wind vectors as an aid for the characterization and analysis of a wind flow field. The approach which is presented in Section IV suggests utilizing the skills of an interdisciplinary team. The format of the input data for the wind vector plot program is compatible with the input format for the grid model developed by Systems Applications, Incorporated, (SAI) (3) and the trajectory model developed by General Research Corporation (GRC). (4)

In Section II the conclusions are presented, and in Section III the implementation of the findings and recommendations are discussed.

Details of the wind vector plot program output, input requirements, and job control language (JCL) are discussed in Sections V, VI, and VII, respectively. The Appendices provide supplementary information which includes:

1) an explanation of the grid unit coordinate system used to locate wind stations with an example showing the conversion from the Universal Transverse Mercator (UTM) coordinate system to grid units,

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REGIONAL MODELING PROCESS

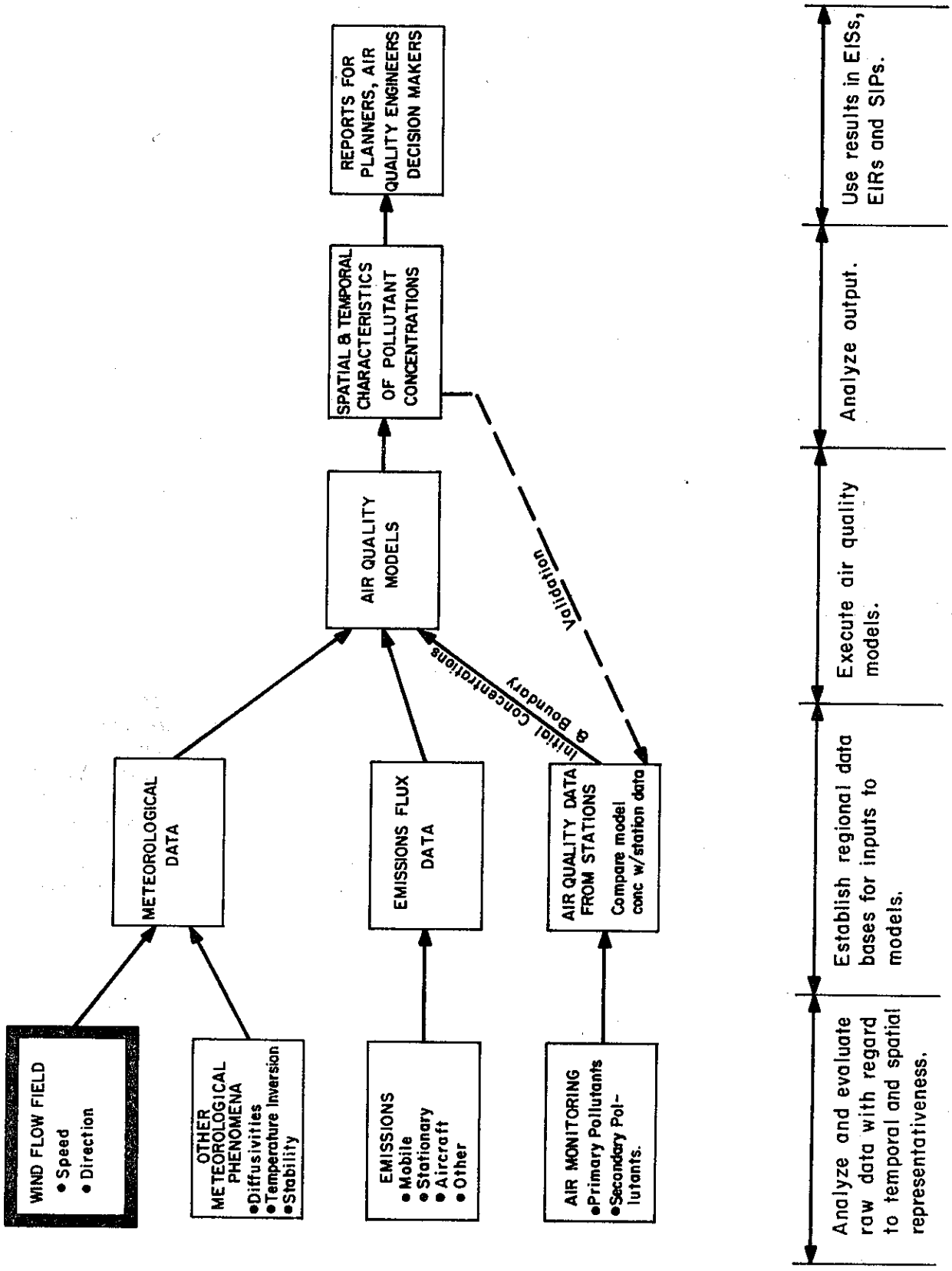

Figure 1

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2) a table of wind directional reporting systems for converting from 36 point or whole degree systems to a 16 point system,

3) a listing of a typical input data file for the wind vector plot program,

4) a listing of the wind vector plot program in Fortran IV,

5) input forms and examples.

II. CONCLUSIONS

A comprehensive study of regional air quality requires an analysis of the wind flow field. An interdisciplinary team can utilize the approach and computer program developed in this research to design an efficient, high quality, and economically feasible surface wind monitoring network. This network will provide representative input data necessary for regional air quality models.

III. IMPLEMENTATION AND RECOMMENDATIONS

In general any agency involved in regional air quality impact analysis and having access to the computer facilities at the Stephen P. Teale Consolidated Data Center in Sacramento, California, can execute the wind vector plot program. Other agencies may modify the program listed in Appendix D to operate on their facility. Air quality engineers, transportation planners, and environmental planners will use the methodology and computer program to develop high quality wind data inputs for regional air quality models. The regional models will be used to assess the impact of alternative transportation systems on the air environment.

The approach and the wind vector plot program for wind flow field analysis has been tested and is currently used in the ongoing regional air quality impact studies in the Los Angeles, San Diego, and Sacramento areas. Primary guidance in applying the methodology and program was given by the staff of the air quality section of the Transportation Laboratory in Sacramento.

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The majority of the wind data collection was accomplished by the respective Transportation Districts. In addition to Laboratory and Transportation District interaction, there were varying degrees of involvement with the local air pollution control districts and regional planning commissions. Based on experience in San Diego, it is recommended that members of an interdisciplinary team be chosen from several of the affected agencies in the study region. With broad interagency involvement a more credible, comprehensive wind flow field analysis is developed. Also the cooperation of private land owners can be encouraged for locating temporary wind monitoring equipment, when it is not possible to find public property which meets siting requirements.

IV. THE APPROACH

Overview

The initial step in the application of regional air quality models is to perform a wind flow field analysis. The analysis entails the elimination and relocation of redundant or non-representative wind stations. It may be decided that additional wind stations must be established to provide an adequate description of the wind flow patterns in the region. A well defined network of wind monitoring stations is a key element in the design of a cost effective study. Only high quality data from representative wind stations are used as inputs to regional models.

Figure 2 is a flow diagram of the tasks that comprise the approach for the wind flow field analysis. The subheadings in the following discussion are keyed to Figure 2.

Organize Interdisciplinary Team

To analyze a wind flow field an interdisciplinary team of experts and practitioners is necessary. Among the members there should be:

1) a meteorologist familiar with the study region and air pollution phenomena,

2) an air quality simulation modeler versed in computer applications,

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AN APPROACH FOR WIND FLOW FIELD ANALYSIS

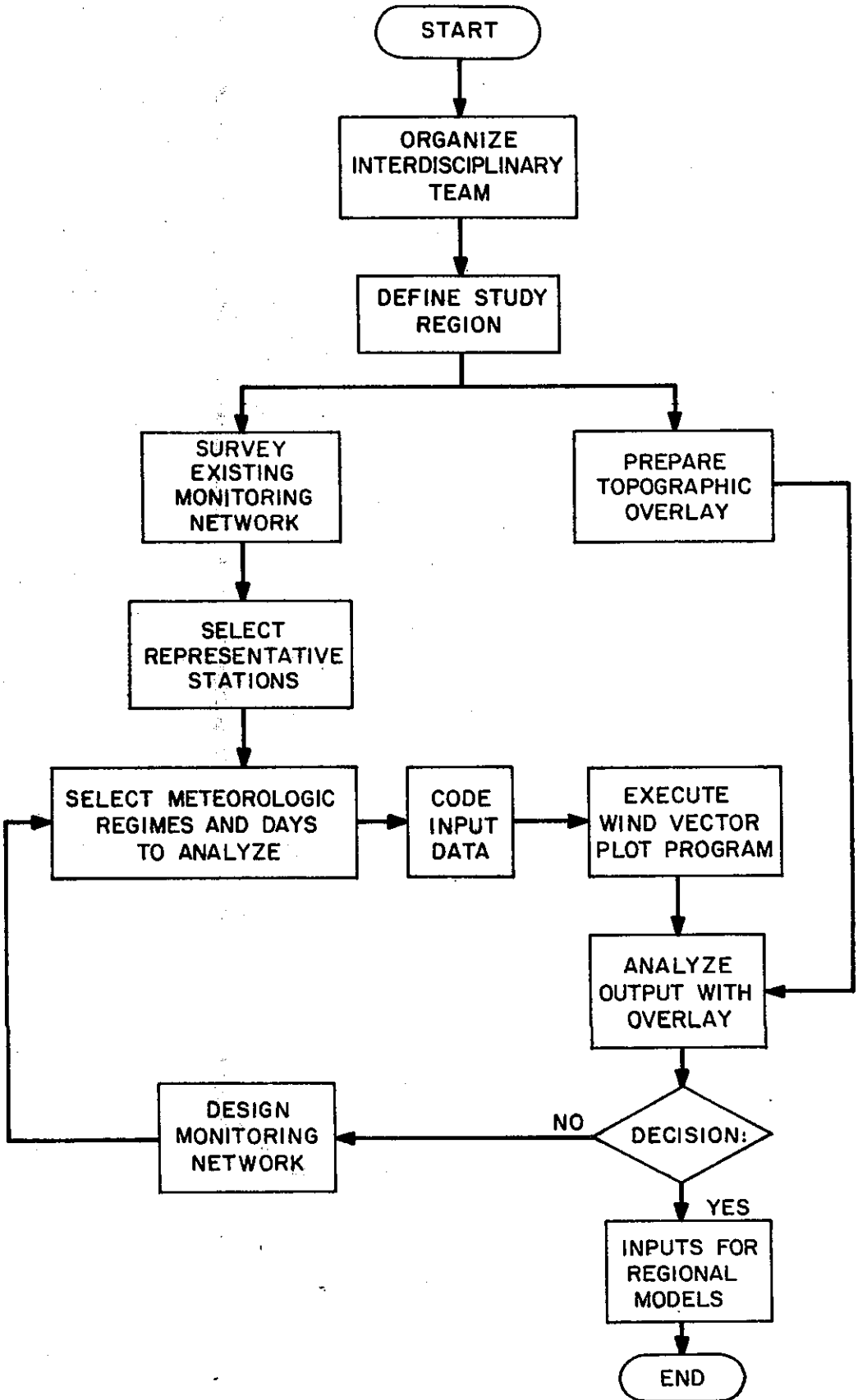

Figure 2

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3) an air quality engineer with field instrumentation experience,

4) an environmental planner with knowledge of land use, demography, economics, and potential growth of the region.

The team may decide to consult with various other disciplines, depending on the nature and complexity of the study. Expertise may be found among personnel in public agencies and the private sector. After selecting a leader and determining the composition of the basic team, the task of region definition can begin.

Define Study Region

The task of study region definition is not trivial, since it is here that the success, economy, and adequacy of subsequent aspects of the modeling study are determined. Redefinition may be necessary at some future date, but the ability to maintain quality and control of the whole program is dependent upon the effort exerted at the outset. As evidenced by experience, boundary redefinition can upset emission inventories, sampling studies, and computer simulations. Such changes are costly in terms of time, money, and human resources.

The air quality modeling regions are either rectangular or square with the origin at the southwest corner. Locations within the region are specified by the northerly and easterly displacements from the origin. The region is subdivided into square grid cells. Table 1 in Section VI presents some typical areas in California with the region limits in terms of the number of grid cells and the lengths of each side of the grid cell. Further information on location and ground coordinate systems is presented under "Survey Existing Monitoring Network" and Appendix A.

Among the factors that determine the adequate definition of a study region are:

1) spatial and temporal characteristics of sources of air pollutant emissions- both present and future

2) land use, population, and economics- both present and future growth patterns

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3) significant topographic features

4) major bodies of water and unique meteorological phenomena

The following constraints are based on considerations in the SAI photochemical airshed model. It is not necessary to encompass "extra-regional" sources of air pollution within the boundaries of the study region. Influxes of air pollution can be handled in the airshed model by defining boundary concentrations, i.e. near the edges of the region. (5) Region size is controlled by the number and size of grid cells. The minimum grid cell size is 2 kilometers by 2 kilometers. (7) The current maximum number of cells used in the airshed model is 3,200. (6) In Los Angeles the cells are arranged thus: 40 north-south and 80 east-west with a grid cell size of 3.2 kilometers by 3.2 kilometers.

Prepare Topographic Overlay

Since the wind vector plot program does not plot elevation contours, a topographic map must be prepared for analyzing the wind vector plots. Selection of a contour interval appropriate for the study region is necessary. For example, in the Sacramento region which is relatively flat, a contour interval of 50 feet (15.2 meters) should provide more than adequate information, while in San Diego, which has prominent terrain effects, an appropriate contour interval would be 500 feet (152.4 meters). Flexibility in establishing an appropriate contour interval will permit variation in the complexity of the flow field definition. The map scale is controlled by the region size definition and plot size.* See Table 1 in Section VI.

Survey Existing Monitoring Stations

All wind monitoring stations within the study region should be surveyed. A Wind Instrumentation Survey sheet, shown in Figure 3, serves as a means to evaluate the quality of data monitored at each location in terms of instrument exposure, type of instrumentation, and other factors at each location. It is also an important aspect in documenting the wind flow field analysis, the subsequent validation studies, and simulations. Assure

*In this plot program, the scale in kilometers per inch can be determined if one divides the number of grid cells in the east-west direction by the east-west length, and then multiplies the quotient by the length of the grid cell side in kilometers.

$$\frac{\text{No of Grid Cells (E-W)}}{\text{East-West Length}} \times \text{Grid cell side (kilometers)} = \text{Scale (km/in.)}$$

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that the instrument systems have been calibrated recently; for example, a portable mechanical weather station can be calibrated in a wind tunnel. Also note any discrepancies in directional orientation of the instruments at their respective locations, and inquire about directional orientation checks and procedures. It is recommended that photographs and a current survey sheet be maintained for ALL sources of wind data within the study region. Photographs of instrument exposure and written documentation are needed to support findings and to establish a complete record.

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WIND INSTRUMENTATION SURVEY

LOCATION: BY: DATE:

1. A. MANUFACTURER:

   B. MODEL NO.: C. NAME:

2. A. PARAMETER B. THRESHOLD C. ACCURACY

   1) WIND SPEED :

   2) WIND DIRECTION:

3. MAINTENANCE SCHEDULE :

4. CALIBRATION SCHEDULE :

5. RECORDING INSTRUMENTS

   A. POWER SOURCE :

   B. AVERAGING TIMES :

   C. RECORDING METHOD :

   D. DATA HANDLING :

   E. PARAMETER/UNIT REPORTED

   F. CHART SPEED :

   G. SCALES :

   H. YEARS OF CONTINUOUS RECORD FOR INSTR. AT SAME LOCATION

6. EXPOSURE : A. OBSTRUCTIONS : B. TERRAIN :

   C. HEIGHT OF INSTRUMENTS :

7. PHOTOS : PANORAMICS AND 'CLOSE-UPS'

8. COMMENTARY : BY OF PHONE

Figure 3

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Select Representative Stations

Based on the findings of the Wind Instrumentation Survey, representative stations can be selected. The major factors that determine station representativeness are instrument exposure and averaging times for the readings of wind speed and directions. Stations with poor exposure and those at which wind data are "instantaneous" readings should not be used in the wind vector plot program or the subsequent analysis. Also, stations which report wind directions for less than 16 points should not be included. Stations for which hourly averaged data can be obtained should be included in the program and analysis.

SELECT METEOROLOGICAL REGIMES AND DAYS TO ANALYZE

In regional air quality modeling, for either validation studies or predictions, the emphasis is on determining conditions that produce high concentrations. Modelers will provide results for analysis and comparison to the National or the California Ambient Air Quality Standards. One of the difficulties in applying regional air quality models to predict low concentrations is inherent in the accuracy of the monitoring equipment. For example, carbon monixide can be measured to an accuracy of ± 0.5 parts per million (PPM) with a long path non-dispersive infrared analyzer. There would be a high degree of uncertainty between observed and predicted values in the range of one or two PPM. The wind flow field analysis will assist the team in determining which sets of meteorological conditions would produce the higher pollutant concentrations. For example, for carbon monoxide these meteorological conditions are calm or light winds and a ground based temperature inversion. For photochemical oxidant the conditions are clear skies and an elevated inversion.

Selecting days for validation studies can begin with an examination of pollutant measurements. A wind flow field analysis should be performed for days on which historical air quality data indicate that:

1) pollutant concentrations exceeded the air quality standards or

2) the concentrations approached the standards.

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The practice of studying pollutant and meteorological histories will enable the team to determine which conditions are representative for use in scenarios for future air quality. The costs to be incurred later in the modeling process can be reduced by selecting fewer days for simulations.

Code Input Data

The data to be used as input to the wind vector plot program must be presented in the formats discussed in Section VI and as indicated in Appendix E. The units of wind speed should be the same among all the stations, and the units of the directions must be coded in the 16 point reporting system, where 1 is north. Appendix B presents a table for conversion of directional data from the 36 point and whole degree systems to the 16 point system. The wind vector plot program will not perform the conversions.

Execute Wind Vector Plot Program

When the data are properly formatted, converted to the appropriate units, and in a form suitable for acceptance by the computer, e.g. cards or magnetic tape, the wind vector plot program can be executed. File composition and job control language are discussed in Sections VI and VII, respectively.

Analyze Output With Overlay

The hourly plots of wind data can now be analyzed with the topographic overlay. Redundant stations can be identified. Areas with limited or no coverage can be noted, as well as "sensitive" areas; e.g. schools, hospitals, and potentially high pollutant locations.

Decision:

At this point the team can decide whether or not the existing wind monitoring network adequately describes the wind flow field for the "worst" meteorological regimes. "Worst" regimes are those which produce the highest pollutant concentrations.

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NO: Design Monitoring Network

If the decision is that the wind flow field needs further description, the team can utilize the plots to relocate redundant stations or site additional stations in areas with little or no information.

The scheduling and duration of data collection for designing a monitoring program to describe a representative wind flow field will vary according to the amount and quality of existing data, the significant meteorological regimes, and the amount of additional data required. The schedule to monitor wind data should coincide with monitoring for the primary and secondary pollutants, generally winter and summer, respectively. References (8) and (9) provide further information regarding pollutant seasons and wind data collection schedules.

After a sufficient amount of wind monitoring has been completed, the process can be iterated with the re-entry point in Figure 2 being "Select Meteorological Regimes and Days to Analyze." When the team members are satisfied that the wind flow field is adequately described, they can proceed with the final task of the wind flow field analysis.

YES: Inputs for Regional Models

If the wind flow field is adequately described, the team can submit the station data (Type 2 and Type 3 cards as described in Section VI) for use in regional air quality models.

At this point the wind flow field analysis for the time period in question is completed.

V. OUTPUT FROM WIND VECTOR PROGRAM

Output from the wind vector plot program consists of a plot tape and instructions to the CALCOMP plotter operator at the California Teale Data Center (TDC). The user receives his own copy of the instructions in addition

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to listings of his job control language, and device utilization reports. An example plotter instruction sheet is shown in Figure 4. Only the plots of the hourly averaged wind vectors, and not the magnetic tape, are received by the user via the normal output routing process from TDC.

A plot consists of:

1) a frame, either a square or rectangle, which represents the boundaries of the study region, oriented with the top of the page as true north.

2) hourly wind vectors at each station within the frame, with the magnitude of wind speed plotted above a square station symbol.

3) the date (year, month, day) and time (military) within the lower left corner of the frame.

A wind vector originates at the center of the small square station symbol and extends in the direction from which the wind blew a length commensurate to the magnitude of the wind speed. A barb is added to the head of the vector pointing in the direction to which the wind blew.

As many as 24 frames can be plotted, one for each hour of the day. As pointed out in the description of the control cards in Section VI, the user may select which hours to plot. After the final frame is plotted, the 6 digit volume serial number of the plot tape is plotted. Figure 5 shows a reduced plot of a final frame.

VI. INPUT TO WIND VECTOR PROGRAM

The input file for the wind vector plot program is organized as follows:

First, 2 control cards (records) which provide routing, labor cost, starting and stopping hours to plot, and other information. Cards are identified as "Control 1" and "Control 2" in Appendix E.

Second, a collection of cards (99 maximum) with station name, number and (X,Y) grid unit coordinates. See Appendix A, Explanation of Grid Units. Cards are identified as "Type 2 cards" in Appendix E.

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SAMPLE PLOTTER INSTRUCTION SHEET

JOB EXECUTED ON DECEMBER 08, 1975

PLOTTER INSTRUCTIONS FOR TAPE NO. = 011255

ATTACH THIS NOTE TO PLOTTER TAPE

****
USE 11 INCH WIDE WHITE PAPER
START PEN AT LEFT EDGE OF PLOTTER
USE NO. 3 PEN
****

292 INCHES OF PAPER REQUIRED

24 PLOTS ON THIS TAPE -- LAST BLOCK ADDRESS = 999

SEND OUTPUT TO TRANSLAB 5900 FOLSOM RACIN 9-444-4846

LABOR COST V981 JOBNAME IS TMENVWP3
****

Figure 4

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SAMPLE PLOT OF A FRAME

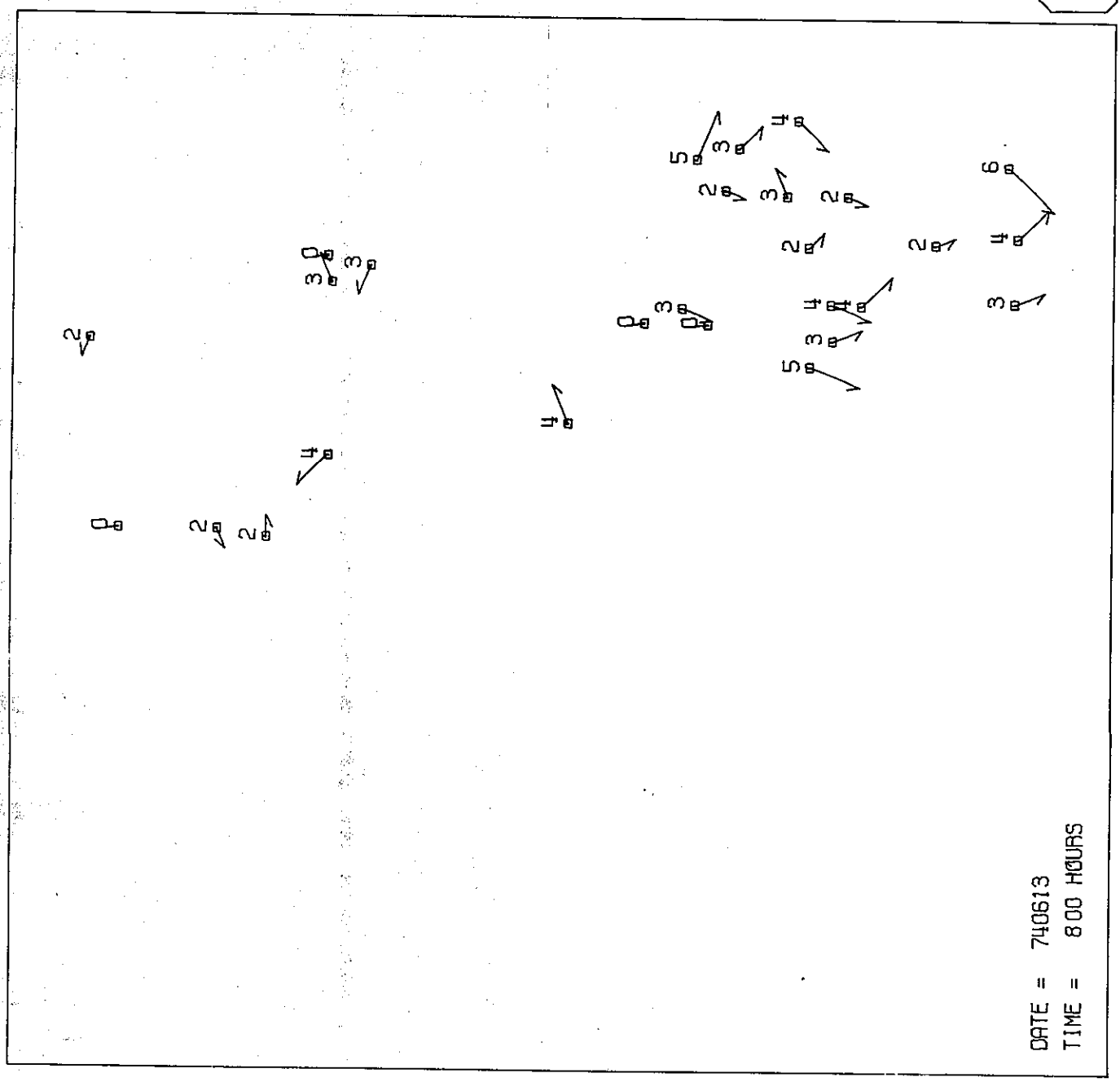

Figure 5

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and Third, pairs of cards for each station (99 pairs maximum) with provision for recording 24 hourly values per card. The first card of a pair has wind direction values based on the 16 point system where 1 is North. The second card of a pair has wind speeds. Cards are identified as "Type 3 cards" in Appendix E. All the control and data cards must be 80 column records.

Input formats for Type 2 and 3 cards are compatible with those of the data preparation programs for the Systems Applications, Incorporated, photochemical airshed model. (3) Type 3 cards are compatible with the wind data format for the DIFKIN trajectory photochemical smog model. (4)

Appendix B shows a table for converting a 36 sided or a whole degree wind directional reporting system to a 16 point system. There is no reason to store data with greater refinement than in the 16 point system because:

1) input files for regional analyses usually involve other information such as traffic and emissions data for which future predictions are of questionable accuracy.

2) wind data are normally an hourly average.

Appendix C shows a printout of a file that is set up to plot 16 frames.

Descriptions of the data fields, explanatory notes, examples, and forms for coding input are in Appendix E.

In an urban area there may be numerous meteorological sources that monitor surface winds. However, due to instrument malfunctions, maintenance and calibration schedules, etc., hourly data from stations may be missing. Similarly the number of reported calms within an urban area must be analyzed. Calms are a function of: 1) instrumentation response characteristics, 2) instrumentation calibration and maintenance, 3) instrument exposure, and 4) averaging time. To properly analyze those stations having instrument malfunctions or recorded calms, it is recommended that the procedures below be followed:

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1) Maintain a DAILY DIARY which shows:

- station name
- location coordinates (Universal Transverse Mercator and grid units)
- hours for which the data are:

  a) hourly averages
  b) instantaneous readings
  or c) MISSING or to be discarded because of instrument malfunction.

Such a diary enables the user to verify that the input file is set up correctly for CALMS and MISSING data. A printout of the file showing the Type 3 cards should be checked against your diary.

2) Code CALMS thus:

On the direction card show any valid nonzero directional value, and on the speed card show a zero or blank. The plot of a CALM shows the numeral zero above the square station symbol.

3) Code MISSING or data to be discarded thus:

On both the direction and speed card leave blanks. Nothing is plotted for a station reporting MISSING data during a particular hour.

You may submit data with a mixture of CALMS, MISSING and normal readings if that is what you have for a given day. However, since these files will ultimately be used in photochemical models to predict hourly concentrations of pollutants, it is recommended that the hourly rather than instantaneous readings be used.

Some typical sizes and orientations for modeling regions in California are shown in Table 1. Plot sizes may be varied to fit the overlay maps. The plot size for the North to South dimension should be less than or equal to the plot paper size.

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Region and Plot Sizes

Area in California	Side Lengths of square cell (Kilometers)	East to West		North to South		Plot Paper Size * Inches
		Plot Size Inches	No. of Grid Cells	Plot Size Inches	No. of Grid Cells	
Los Angeles	3.2	16	80	8	40	11
San Diego	2	8	40	16	80	30
Fresno, Sacramento, Stockton	2	10	25	10	25	11

*See Appendix E, Control Card No. 2

Table 1

Since the wind vector plot program does not convert units, it is the responsibility of the user to assure that wind speed units are consistent for the stations represented in the wind data. There is no provision for converting to daylight savings time. Therefore, code the wind direction and speed values in the appropriate columns on Type 3 cards for Pacific Standard Time.

Establish all the Type 2 cards for your region and include them in each execution of the plot program. This precludes repetitious modification of CONTROL CARD 2, field 1, (number of stations) when you are making plots for several days, some of which may not have pairs of Type 3 cards for each of the Type 2 cards. More simply stated, include all the Type 2 cards in execution, even though you cannot supply Type 3 cards. However, for each pair of Type 3 cards you must have a corresponding Type 2 card.

The Type 3 cards submitted for execution should include data from one date only.

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Since the wind vector plot program does not sort or edit the input, before an input file is submitted for execution, the following items should be checked:

1) Format - All data must be coded in correct positions (columns) on all records.

2) Sequence - Control Cards 1 and 2, Type 2 cards, then pairs of Type 3 cards, alternating direction and speed for each station.

3) Date - The dates on Type 3 cards should be the same. Plotting several days of data in one execution would not be very useful.

4) Number of Records

   a. 2 control cards
   + b. Type 2 cards, less than or equal to 99.
   + c. An even number of type 3 cards, but less than or equal to 198.

5) Syntax - Check for the following common errors in data entry:

   a) commas in place of decimal points

   b) "o" in place of "0" (zero)

   c) misspelled station names between Type 2 and Type 3 cards.

   d) decimals in integer fields

   e) alphabetic characters in numeric fields

VII. JOB CONTROL LANGUAGE (JCL)

A schematic of the JCL needed to execute the wind vector plot program at the California Teale Data Center is shown in Figure 6. The bold printed characters are required. Figure 7 is a JCL input document for Teale Data Center users. An explanation of the data definition (DD) statements follows.

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SCHEMATIC OF COMPLETE JOB DECK

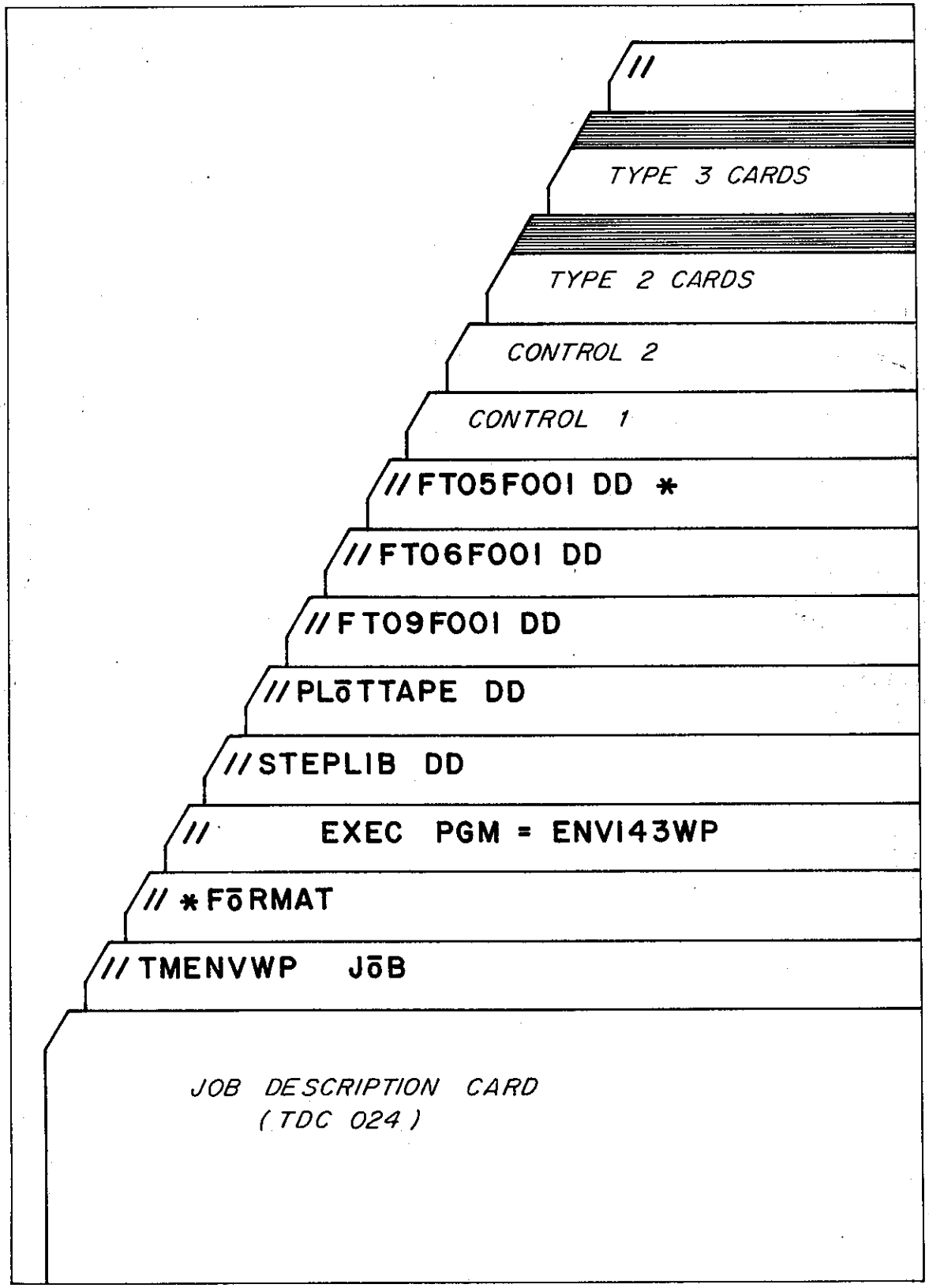

Figure 6

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JCL INPUT DOCUMENT FOR TEALE DATA CENTER USERS

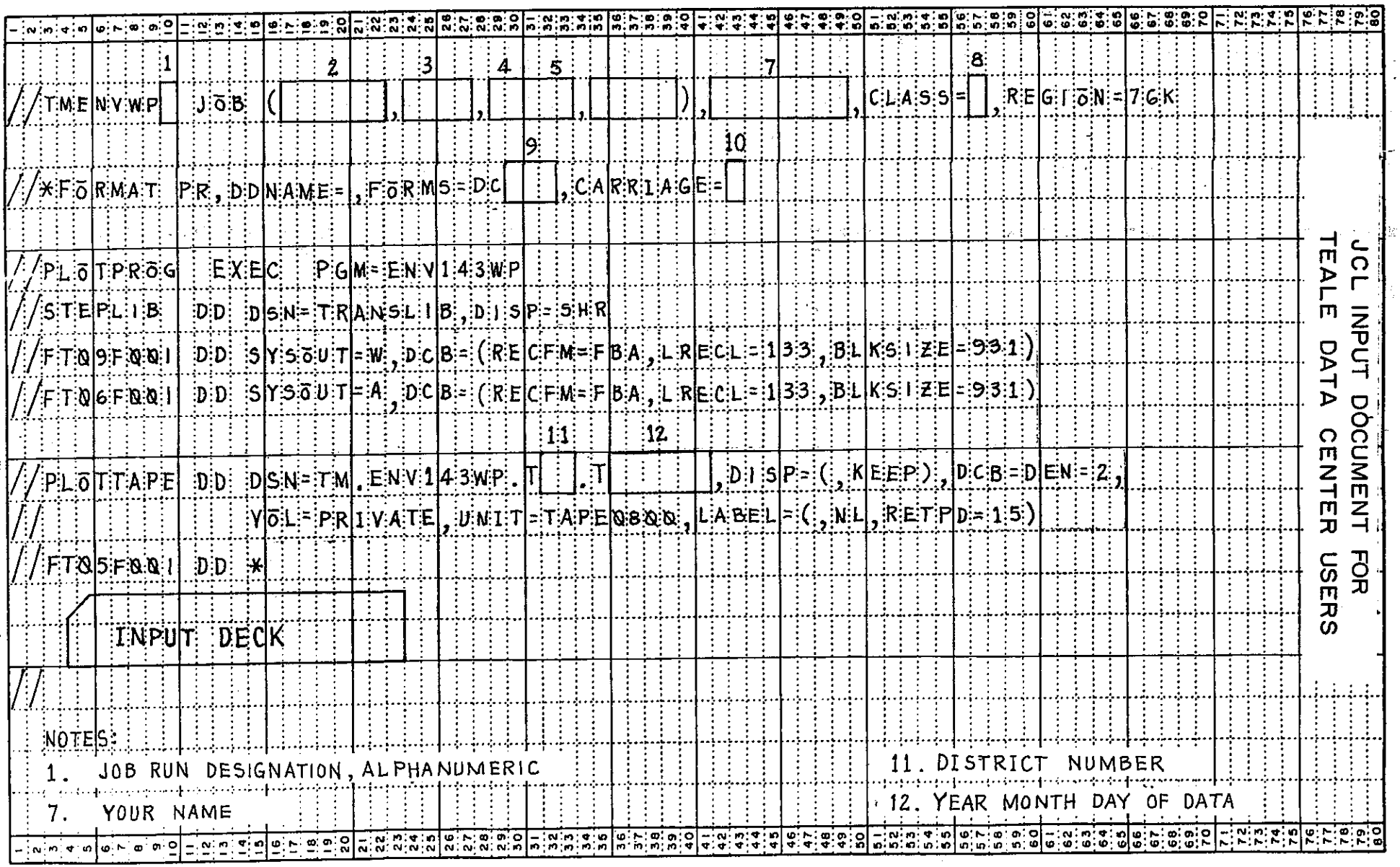

Figure 7
22

DAS-CS 90-062

Notes: See your local EDP shop for item 2 → 6 and 8 → 10.
Check computer systems' "Buzz Item" for JCL Updates.

DD Name	Explanation
STEPLIB	Name of library where executable program is stored.
PLOTTAPE	Nine track 800 bpi plot tape output which goes to plotter operator at Teale Data Center. Other forms of CALCOMP software may use FT08F001.
FT09F001	Printed output file sent directly to operator of plotter.
FT06F001	Printed output file routed to user (see Figure 4).
FT05F001	Input file, which in Figure 6 is a deck of 80 column punched cards.

For use at other computer installations the JCL may require some modifications. Similarly it is expected that the wind vector plot program itself will have to be modified for execution at other computer installations. For this reason a listing of the FORTRAN IV program is presented in Appendix D. A qualified computer programmer should have little difficulty making such modifications.

The plot subroutines belong to the CALCOMP software package currently in operation at the Teale Data Center. The wind plot program requires approximately 77,824 bytes (76K) of core for execution. It was compiled by using the FORTRAN G compiler and executes on the IBM 370/168 at Teale under VS2, release 1.7.

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(2) Whitney, David C., User's Guide and Description of the Data Preparation Programs, Appendix to Volume II, Report R73-27, EPA Contract 68-02-0339, Systems Applications, Inc., San Rafael, California, p. 9.

(3) Whitney, David C., Op. cit., pp.35-37.

(4) Martinez, J. R., Nordsieck, R. A., Hirschberg, M. A., User's Guide to Diffusion/Kinetics (DIFKIN) Code, Final Report, EPA Contract No. 68-02-0336, General Research Corporation, Santa Barbara, California, December, 1973, p. 11.

(5) Whitney, David C., Op. cit., p. 20.

(6) Personal communication from Dr. David C. Whitney of Systems Applications, Inc., Director of Computer Services, on December 24, 1975.

(7) Reynolds, Steven D., Roth, Phillip M., and Seinfeld, John H., Atmospheric Environment, Vol. 7, Pergamon Press, Great Britain, 1973, "Mathematical Modeling of Photochemical Air Pollution - I", p. 1039.

(8) Beaton, John L., Ranzieri, Andrew J., Skog, John B., Meteorology and Its Influence on the Dispersion of Pollutants from Highway Line Sources, Air Quality Manual - Vol. I, California Department of Transportation, Report No. CA-HWY-MR6570825(1)-72-11, Sacramento, California, April, 1972, pp. 66, 67.

(9) Bemis, Gerald R., Ranzieri, Andrew J., et al, Applications of Statistics in Analyzing Aerometric Data for Transportation Systems, California Department of Transportation, Report No. CA-DOT-TL-7082-9-74-38, October, 1974, pp. 68-106.

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APPENDIX A

Explanation of Grid Units

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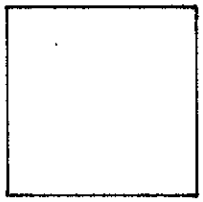
Explanation of Grid Units

Measurement of distances in grid units is relative to the southwesterly corner of the study region (origin) and is specified by X (easterly) and Y (northerly) displacements therefrom.

Stations are usually located on United States Coast and Geodetic Survey (U.S. C.G.S.) 7 1/2 minute quad sheets by utilizing the Universal Transverse Mercator (UTM) metric coordinate system. Grid cell size is usually in kilometers, thus it is advantageous to determine station coordinates in the UTM system to simplify the conversion to GRID UNITS, as demonstrated in the following example.

2000 meters
1 Grid Unit



2000 meters
1 Grid Unit

1 GRID CELL

for Sacramento Regional Study

UTM origin is:
X_o(East) = 616,000 meters
Y_o(North) = 4,245,000 meters

UTM coordinates for Wind Station at Roseville Fairgrounds:
X_R(East) = 648,250
Y_R(North) = 4,291,050 meters

Convert from UTM to GRID UNITS:

$$X_{G.U.} = \frac{1}{2000}(648,250-616,000) = \underline{16.12}$$

$$Y_{G.U.} = \frac{1}{2000}(4,291,050-4,245,000) = \underline{23.02}$$

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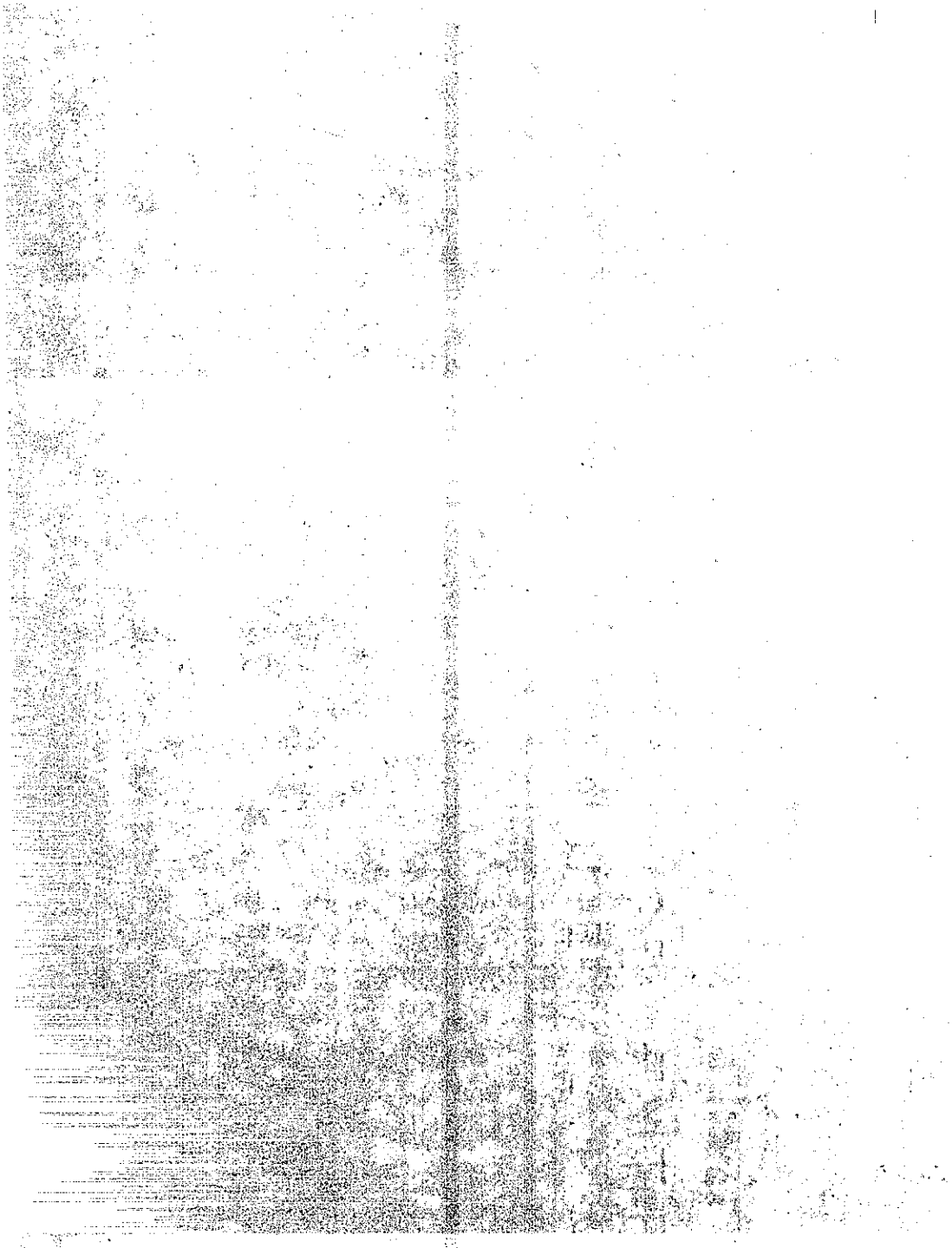

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APPENDIX B

Wind Direction Conversion Table

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The conversion of a 36 sided or whole degree directional reporting system to a 16 point directional reporting system is done using the following table extracted in part from the U.S. Weather Bureau Tape Reference Manual, TDF14:

Directional Reporting System

	16 point	36 sided	Whole Degrees
1	North	35-36-01	349-11 (Clockwise)
2	North-Northeast	02-03	12-33
3	Northeast	04-05	34-56
4	East-Northeast	06-07	57-78
5	East	08-09-10	79-101
6	East-Southeast	11-12	102-123
7	Southeast	13-14	124-146
8	South-Southeast	15-16	147-168
9	South	17-18-19	169-191
10	South-Southwest	20-21	192-213
11	Southwest	22-23	214-236
12	West-Southwest	24-25	237-258
13	West	26-27-28	259-281
14	West-Northwest	29-30	282-303
15	Northwest	31-32	304-326
16	North-Northwest	33-34	327-348

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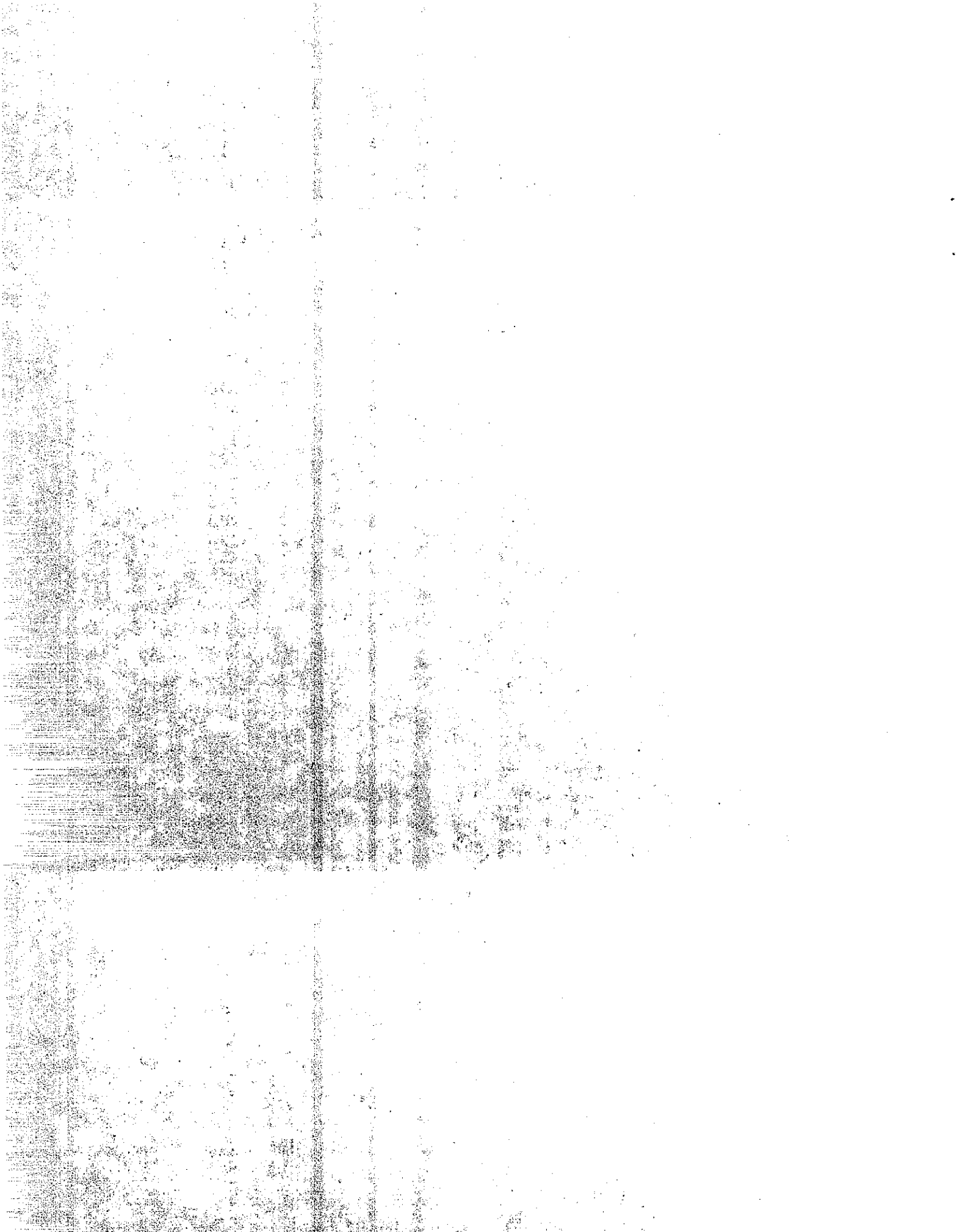

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APPENDIX C

Sample Listing of Wind Vector Input Data File

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```
TRANSLAB 5900 FOLSOM,(916)444-4878 RACIN       VOCC       TMENVWPI
   14   05   20   30    3                10.  10.  50.
318MTHO    24.4214.85
319WABA    24.3513.47
320JAMA    33.1616.40
321ERRE    29.5114.13
322RAIN    22.5048.45
323FELI    26.1035.73
331CHUV    27.2610.12
332ELCA    31.8417.07
333OSID    13.2540.37
334SAND    22.6914.76
335CHOL    27.1015.88
336ESCO    26.5037.68
337SANY    28.67 5.32
338KNYM    24.1721.61
740614320JAMAJAMACHASDCO WD 16PT07010102151304141305101109111310111111111101302
740614320JAMAJAMACHASDCO WS MPH 030304040404030403030608100609111007070705030201
740614321ERREERRECA SD COWD 16PT04130204020204040402151515151515011510140101090 9
740614321ERREERRECA SD COWS MPH 020203030503030404030406090708080605060503020303
740614322RAINRAINBOW SDCOWD 16PT15111201020407091010101011111212121211110050404
740614322RAINRAINBOW SDCOWS MPH 020402020302020204060711131213121112080803010203
740614323FELIFELICITASDCOWD 16PT07151415150909100513131114121315151514131215141 4
740614323FELIFELICITASDCOWS MPH 020202030201020203030407080606070806040302010102
740614331CHUVCHULAVISTA   WD 16PT16021615010202021513131313151313131313131416160 2
740614331CHUVCHULAVISTA   WS MPH 010102020202040404040708100909070607050402000002
740614332ELCAEL CAJON     WD 16PT16020202010101040401141414141414141616131313131307
740614332ELCAEL CAJON     WS MPH 020203040302020202020306070808060505030302010000
740614333OSIDOCEANSIDE    WD 16PT12161616161614131313131313131313131313131314140104
740614333OSIDOCEANSIDE    WS MPH 010303020303040203051010121212121008060605020102
740614334SANDSAN DIEGO    WD 16PT15161601010116011513131313131314141414141616160 1
740614334SANDSAN DIEGO    WS MPH 010404040403030203071010101010070808080604040302
740614335CHOLCHOLLAS      WD 16PT15141401010101161616161414141414141414141415151 6
740614335CHOLCHOLLAS      WS MPH 010303030302030302020207070806060705040705040203
740614336ESCOESCONDIDO    WD 16PT14151616161616051212131313131313131213131313131 3
740614336ESCOESCONDIDO    WS MPH 000601010100000101010202030404030303020201000000
740614337SANYSANYSIDRO    WD 16PT                    1414141414141413131313120905 5
740614337SANYSANYSIDRO    WS MPH                     0305101010100908080807040201 4
740614338KNYMKEARNY MESA  WD 16PT13151516161616161615141415151515151313151616 6
740614338KNYMKEARNY MESA  WS MPH 020304040403030304040612131313101009080909040302
```


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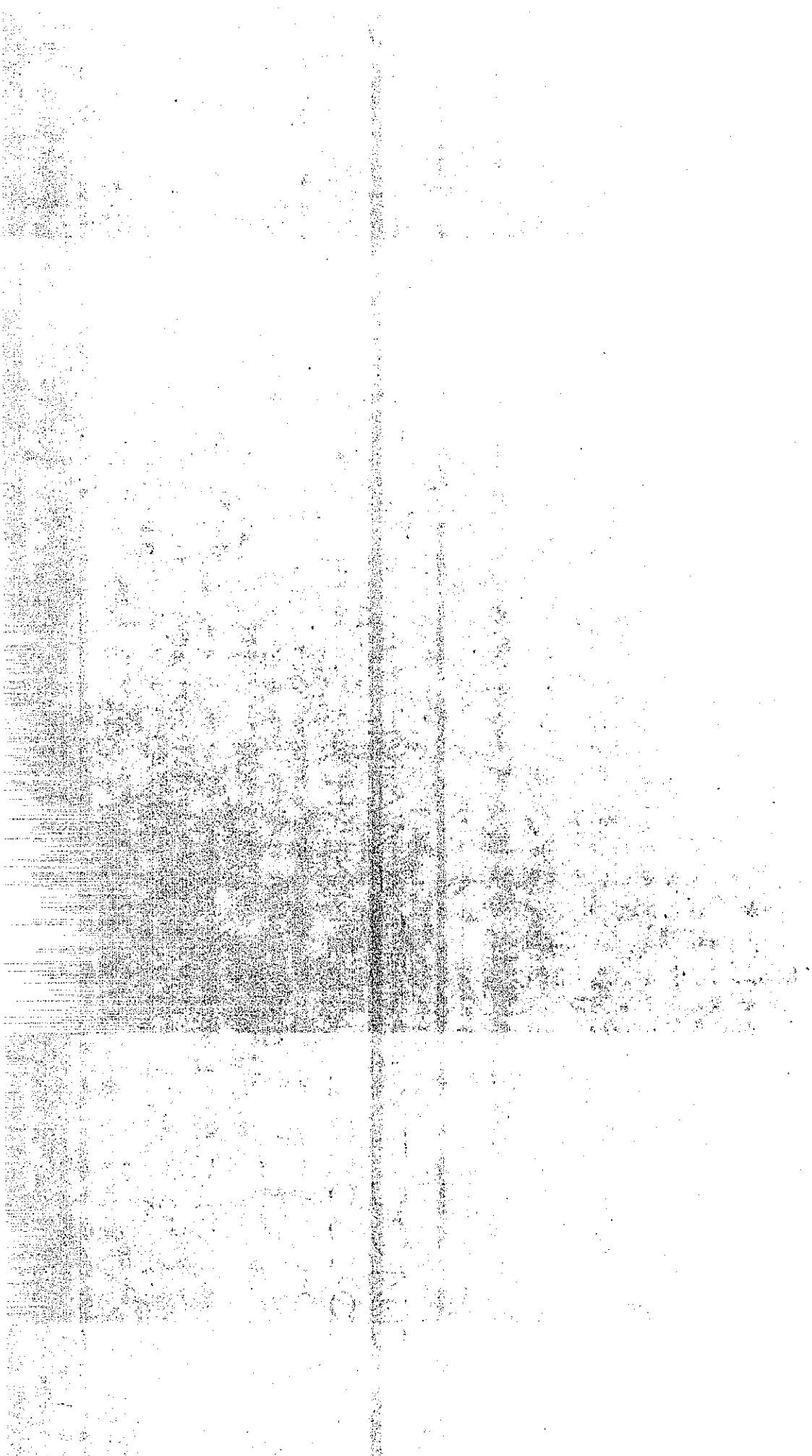

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APPENDIX D

List of Wind Vector Plot Program in Fortran IV

NOTE: This software is designed to operate at the Teale Data Center of the State of California on the IBM 370 computer. Minor modifications may be necessary to make the program operational at other installations.

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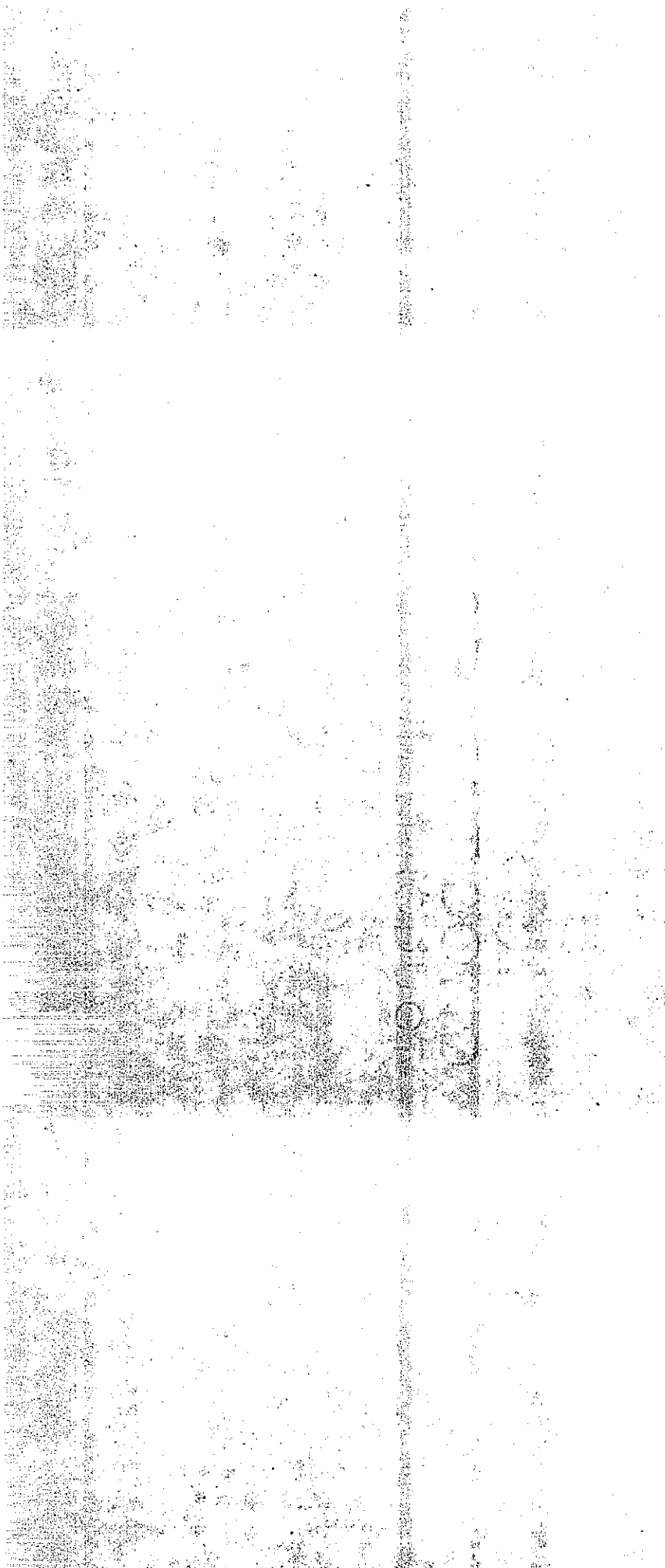

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```
C MAIN PROGRAM : READ CONTROLS + DATA... CALL STAPLT & PLTMSG                    00001
C   GENERALIZED (SOMEWHAT) BY JIM RACIN    6  MARCH  '75                        00002
C PLOT WIND DATA                                  12/20/74  D WHITNEY            00003
C MODIFIED BY J.RACIN,24 JAN 75. NO COORDINATE TRANSFORMS. ALL OF THE            00004
C WIND DATA (FORMAT 3) IS PLOTTED, REGARDLESS OF AVERAGING TIME.                 00005
      DIMENSION STAX(99),STAY(99),JPOINT(24),JPSTA(24,99)                        00006
      DIMENSION STASP(24,99),NAMSTA(99),IDEST(10),JOBN(2)                        00007
      DATA IWS/'WS '/,IWD/'WD '/                                                 00008
      READ (5,4) IDEST,LCC,JOBN                                                  00009
4     FORMAT (10A4,6X,A4,6X,2A4)                                                 00010
      READ (5,1) NSTA,JSTRT,JSTOP,IWIDE,IPEN,XMAX,YMAX,XGRID                     00011
1     FORMAT (5(3X,I2),10X,3F5.0)                                                00012
      DO 10 J=1,NSTA                                                             00013
      READ (5,2) NAMSTA(J),STAX(J),STAY(J)                                       00014
      DO 5 K = 1,24                                                              00015
      STASP(K,J) = 0.0                                                           00016
      JPSTA(K,J) = 0                                                             00017
    5 CONTINUE                                                                   00018
   10  CONTINUE                                                                  00019
2     FORMAT (3X,A4,3X,2F5.0)                                                    00020
   20 READ (5,3,END=100) JDATE,KSTA,KVAR,JPOINT                                  00021
3     FORMAT (I6,3X,A4,12X,A3,4X,24I2)                                           00022
      DO 30 J=1,NSTA                                                             00023
      IF (KSTA.EQ.NAMSTA(J)) GO TO 40                                            00024
   30 CONTINUE                                                                   00025
      GO TO 20                                                                   00026
   40 JSTA=J                                                                     00027
      IF (KVAR.EQ.IWS  ) GO TO 60                                                00028
      IF (KVAR.NE.IWD  ) GO TO 20                                                00029
      DO 50 J=1,24                                                               00030
      JPSTA(J,JSTA)=JPOINT(J)                                                    00031
   50  CONTINUE                                                                  00032
      GO TO 20                                                                   00033
   60  DO 70 J=1,24                                                              00034
      STASP(J,JSTA)=JPOINT(J)                                                    00035
   70  CONTINUE                                                                  00036
      GO TO 20                                                                   00037
  100 CALL STAPLT (JSTRT,JSTOP,NSTA,STAX,STAY,STASP,JPSTA,JDATE,                 00038
     $XMAX,YMAX,XGRID)                                                           00039
      NPLOT=JSTOP-JSTRT+1                                                        00040
      IXMAX=XMAX                                                                 00041
C PAPER LENGTH CALC- '2'=SPACE BETWEEN FRAMES, '4'=LENGTH OF VOLSER #            00042
      ILONG = NPLOT * ( 2 + IXMAX ) + 4                                          00043
      CALL PLTMSG (NPLOT,IPEN,IWIDE,ILONG,9,LCC,IDEST,JOBN)                      00044
      STOP                                                                       00045
      END                                                                        00046


      SUBROUTINE STAPLT (JSTRT,JSTOP,NSTA,STAX,STAY,STAS,JSTP,JDATE,             00047
     $XMAX,YMAX,XGRID)                                                           00048
C                     PLOTS A WIND VELOCITY VECTOR AND PRINTS                    00049
C                     MAGNITUDE AT EACH STATION FROM JSTRT THRU                  00050
C                     JSTOP HOURS                                                00051
```


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```
C                                GW LUNDBERG  SYSTEMS APPLICATIONS INC
C
C                                JSTRT    = STARTING HOUR
C                                JSTOP    = FINAL HOUR
C                                NSTA     = NUMBER OF STATIONS
C                                STAX     = X COORDINATE OF STATION
C                                STAY     = Y COORDINATE OF STATION
C                                STAS     = STATION WIND SPEED/MPH
C                                JSTP     = STATION WIND ANGLE IN POINTS
C MODIFIED BY J. RACIN 6 MAR '75---PROGRAM CORRECTED SO THAT NORTH DATA
C IS PLOTTED PARALLEL TO DIRECTION OF PEN MOVEMENT, I.E. Y DIRECTION.
C  THE DATE IS NOW PLOTTED IN ADDITION TO THE TIME.  ALSO THE START
C AND STOP HOURS MAY BE SELECTED BY THE USER.
      DIMENSION STAX(NSTA), STAY(NSTA), STAS(24,NSTA), JSTP(24,NSTA),
     $     MAG(31), JBUF(1000)
C                        HOLLERITH ARRAY OF WIND SPEEDS AND HOURS
      DATA MAG /2H 0, 2H 1, 2H 2, 2H 3, 2H 4, 2H 5, 2H 6, 2H 7, 2H 8,
     $     2H 9, 2H10, 2H11, 2H12, 2H13, 2H14, 2H15, 2H16, 2H17, 2H18,
     $     2H19, 2H20, 2H21, 2H22, 2H23, 2H24, 2H25, 2H26, 2H27, 2H28,
     $     2H29, 2H30/
      DATA XSPACE/2.0/,BRBSZ/0.12/,
     $     SCALE /0.10/, YUP, YDWN /0.5, -11.0/, LDEV /06/, SZLT /0.14/,
     $     TWOPI /6.28318531/, PIOVR2 /1.57079633/,
     $     PIOVR6 /0.52359878/, PIOVR8 /0.39269908/,
     $     BOXSZ /0.07/
C                        INITIALIZE PLOT -- VARIES FROM MACHINE TO
C                        MACHINE
      CALL PLOTS (JBUF, 1000, LDEV)
C                        DETERMINE UNIT SIZE
      UNITSZ=XMAX/XGRID
C
      JBEG = JSTRT + 1
      JEND = JSTOP + 1
C                        OUTER LOOP FOR EACH HOUR STARTING AT JSTRT AND
C                        RUNNING THRU JSTOP
      DO 200 J=JBEG,JEND
C                      MOVE PEN OVER 'XSPACE' INCHES AND RESET ORIGIN.
C                        DRAW FRAME FOR THIS HOUR
      CALL PLOT (XSPACE, 0.0, -3)
      CALL PLOT (0.0, YDWN, -3)
      CALL PLOT (0.0, YUP, -3)
      CALL PLOT (0.0, YMAX, 2)
      CALL PLOT (XMAX, YMAX, 2)
      CALL PLOT (XMAX, 0.0, 2)
      CALL PLOT (0.0, 0.0, 2)
C                        PRINT TIME & 'YYMMDD' DATE IN LOWER LEFT CORNER
      X = 0.25
      Y = 0.25
      CALL SYMBOL (X, Y, SZLT, 6HTIME =, 0.0, 6)
      X = X + 7.0 * SZLT
      JTIME = MAG(J)
      CALL SYMBOL (X, Y, SZLT, JTIME, 0.0, 2)
      X = X + 2.0 * SZLT
```


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```
      CALL SYMBOL (X, Y, SZLT, 8HOO HOURS, 0.0, 8)                      00105
      X=0.25                                                            00106
      Y=0.55                                                            00107
      CALL SYMBOL (X,Y,SZLT,7HDATE = ,0.0,7)                            00108
      X = X + 7.0 * SZLT                                                00109
       DATE=FLOAT(JDATE)                                                00110
       CALL NUMBER (X,Y,SZLT,DATE,0.0,-1)                               00111
C                     LOOP FOR PLOTTING WIND VELOCITIES FOR EACH        00112
C                     STATION                                           00113
      DO 100 K=1,NSTA                                                   00114
C                     IF WIND DIRECTION IS ZERO SKIP THIS STATION       00115
      IF (JSTP(J,K) .EQ. 0) GO TO 100                                   00116
C                     PLOT A SMALL SQUARE AT STATION LOCATION           00117
C                     UNLESS COORDINATES ARE TABOO                      00118
      XO = STAX(K) * UNITSZ                                             00119
      YO = STAY(K) * UNITSZ                                             00120
      IF (XO .GT. XMAX) GO TO 100                                       00121
      IF (XO .LT. 0.0) GO TO 100                                        00122
      IF (YO .GT. YMAX) GO TO 100                                       00123
      IF (YO .LT. 0.0) GO TO 100                                        00124
      CALL SYMBOL (XO, YO, BOXSZ, 0, 0.0, -1)                           00125
C                     CONVERT TO CONVENTIONAL POLAR COORDINATES         00126
C                     WITH POLE LINE RUNNING NORTH = Y                  00127
      THETA = JSTP(J,K)                                                 00128
      RHO = STAS(J,K)                                                   00129
      THETA = AMOD ((THETA+7.) * PIOVR8, TWOPI)                         00130
      THETA = TWOPI - THETA                                             00131
C                     TRANSFORM THETA SO THAT POLE LINE RUNS EAST = X   00132
      PHI   = AMOD (THETA+PIOVR2, TWOPI)                                00133
C                     CALCULATE SCALED X AND Y COORDINATES OF THE       00134
C                     VELOCITY -- U AND V                               00135
      SIGMA = SCALE * RHO                                               00136
      U = SIGMA * COS (PHI)                                             00137
      V = SIGMA * SIN (PHI)                                             00138
C                     MOVE VECTOR TO STATION                            00139
      X1 = XO + U                                                       00140
      Y1 = YO + V                                                       00141
C                     AND DRAW VECTOR, BUT MAKE SURE IT STAYS WITHIN    00142
C                     BOUNDARY (FORGIVE THE REDUNDANT CODING)           00143
      NOBRB = 0                                                         00144
      IF (X1 .GT. XMAX .OR. X1 .LT. 0.0) NOBRB = 1                      00145
      IF (X1 .GT. XMAX) X1 = XMAX                                       00146
      IF (X1 .LT. 0.) X1 = 0.0                                          00147
      IF (Y1 .GT. YMAX .OR. Y1 .LT. 0.0) NOBRB = 1                      00148
      IF (Y1 .GT. YMAX) Y1 = YMAX                                       00149
      IF (Y1 .LT. 0.) Y1 = 0.0                                          00150
      CALL PLOT (XO, YO, 3)                                             00151
      CALL PLOT (X1, Y1, 2)                                             00152
C                     ADD THE BARB UNLESS VECTOR HAS BUMPED BOUNDARY    00153
      IF (NOBRB .EQ. 1) GO TO 10                                        00154
      CHI = PHI + PIOVR6                                                00155
      X2 = BRBSZ * COS (CHI)                                            00156
      Y2 = BRBSZ * SIN (CHI)                                            00157
```


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```
      X2 = X1 - X2                                                      00158
      Y2 = Y1 - Y2                                                      00159
      CALL PLOT (X2, Y2, 2)                                             00160
C                         DETERMINE INDEX INTO HOLLERITH ARRAY MAG      00161
   10 JRHO = IFIX (RHO + 0.1) + 1                                       00162
      IF (JRHO .GT. 31) JRHO = 31                                       00163
C                         NOW PRINT SPEED ABOVE LITTLE SQUARE           00164
      CALL SYMBOL (XO-SZLT, YO+0.10, SZLT, MAG(JRHO), 0.0, 2)           00165
  100 CONTINUE                                                          00166
C                         ALL DONE WITH STATIONS FOR THIS HOUR          00167
C                         MOVE ORIGIN TO LOWER RIGHT CORNER OF FRAME    00168
      CALL PLOT (XMAX, 0.0, -3)                                         00169
  200 CONTINUE                                                          00170
C                         ALL DONE -- CLOSE PLOT FILE                   00171
      RETURN                                                            00172
      END                                                               00173
```


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```
      SUBROUTINE PLTMSG (NPLOT,IPEN,IWIDE,ILONG,IUNIT,LCC,IDEST,JOBN)
C     MODIFIED BY JIM RACIN  6  MARCH  '75
C        SENDS MESSAGE TO PLOTTER OPERATOR        8/2/74        D HOGAN
C*************************************************************************
C     NPLOT = NUMBER OF PLOTS OUTPUT                          (INTEGER*4)
C     IPEN = PEN TIP NUMBER - I.E. LINE WIDTH                 (INTEGER*4)
C     IWIDE = 11 INCHES, OR 30 INCHES = WIDTH OF PLOTS        (INTEGER*4)
C     ILONG = THE TOTAL LENGTH OF PAPER NEEDED FOR PLOTTING (INT*4)
C     ITAPE = VOLUME SERIAL NUMBER OF THE PLOT TAPE     (INT*4)
C     IDEST = DESTINATION-ROUTING INFORMATION                 (40 ALPHAS)
C       LCC = LABOR COST USED ON JOB CARD                     (4 ALPHAS)
C      JOBN = JOBNAME USED ON JOB CARD                        (8 ALPHAS)
C
C     IUNIT NUMBER 9 IS USED FOR PLOT MESSAGE TO OPERATOR AT TEALE.
C   //FT09F001  DD  SYSOUT=W,DCB=(RECFM=FBA,LRECL=133,BLKSIZE=931)
C
C     CONTROL CARD INPUTS THAT ARE READ IN MAIN- IDEST,LCC,JOBN,IWIDE,IPEN
C
C     NPLOT AND ILONG ARE CALCULATED IN MAIN.
C*************************************************************************
      DIMENSION IDAY(5),ITAPE(2),IDEST(10),JOBN(2)
      CALL DHDATE(4,IDAY)
      CALL SERIAL(ITAPE,IERR)
      IF (IERR.NE.0) GO TO 40
      WRITE (IUNIT,101) IDAY,ITAPE,IWIDE,IPEN,ILONG,NPLOT,IDEST,LCC,JOBN
      WRITE      (6,101) IDAY,ITAPE,IWIDE,IPEN,ILONG,NPLOT,IDEST,LCC,JOBN
      CALL SYMBOL (0.1,0.0,0.7,ITAPE,0.0,6)
      CALL PLOT (0.0,0.0,999)
      GO TO 100
   40 WRITE (6,102)
  100 RETURN
  101 FORMAT ('1',T15,'JOB EXECUTED ON ',4A4,A2///
     1 T15,'PLOTTER INSTRUCTIONS FOR TAPE NO. = ',A4,A2//
     2 T15,'ATTACH THIS NOTE TO PLOTTER TAPE'///
     3 T10,14(4H****)/
     4 T10,'USE ',I2,' INCH WIDE     WHITE PAPER'/
     6 T10,'START PEN AT LEFT EDGE OF PLOTTER'/
     7 T10,'USE NO. ',I2,' PEN'/
     8 T10,14(4H****)///
     9 T15,I4,' INCHES OF PAPER REQUIRED'///
     A T15,I4,' PLOTS ON THIS TAPE -- LAST BLOCK ADDRESS = 999'/////
     B T10,'SEND OUTPUT TO ',10A4///
     C T10,'LABOR COST  ',A4,'        JOBNAME IS  ',2A4/
     D T10,14(4H****)///)
  102 FORMAT ('ERROR IN PLOT TAPE VOLUME ASSIGNMENT')
      END
```


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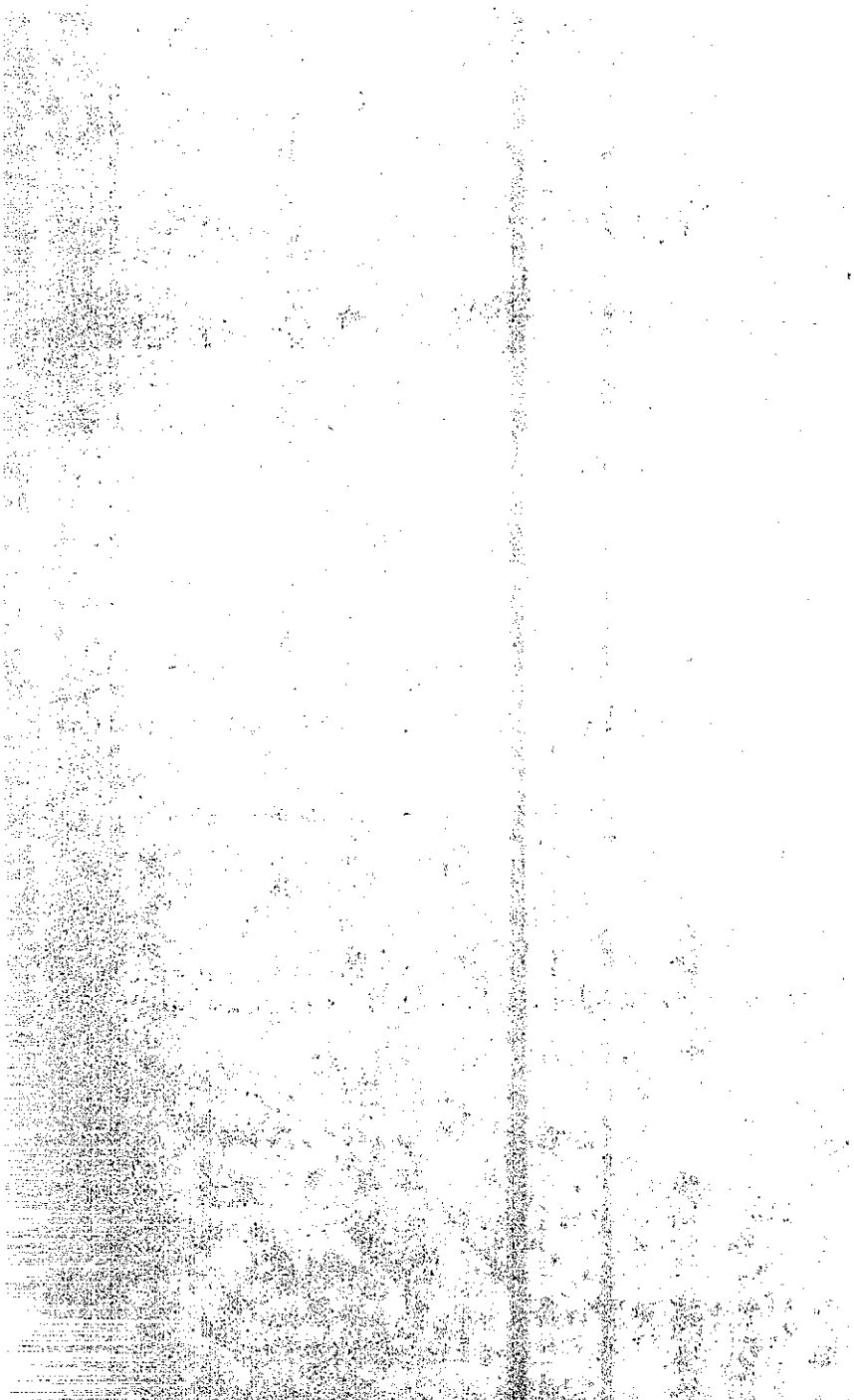

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APPENDIX E

Input Forms, Explanatory Notes, and Examples

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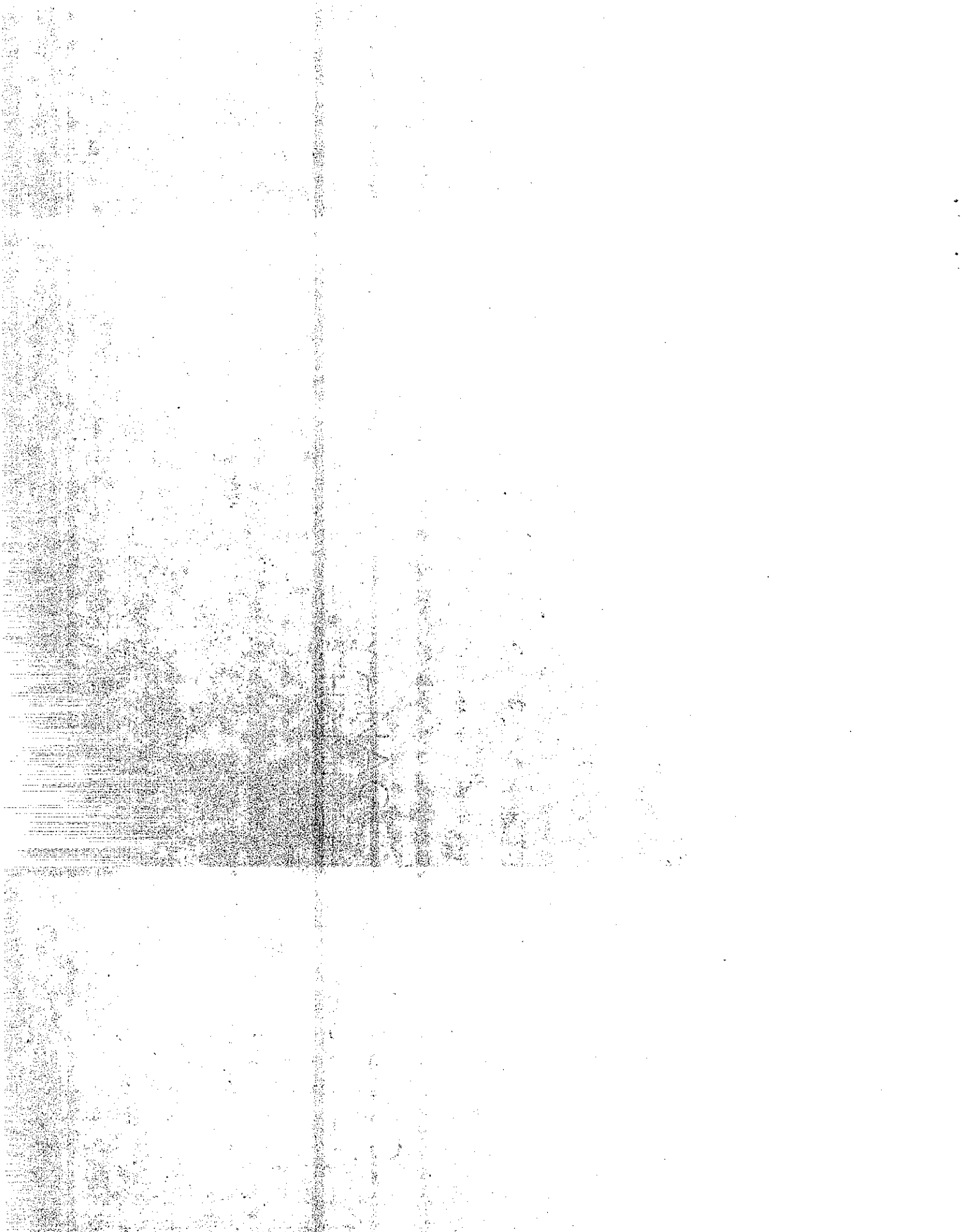

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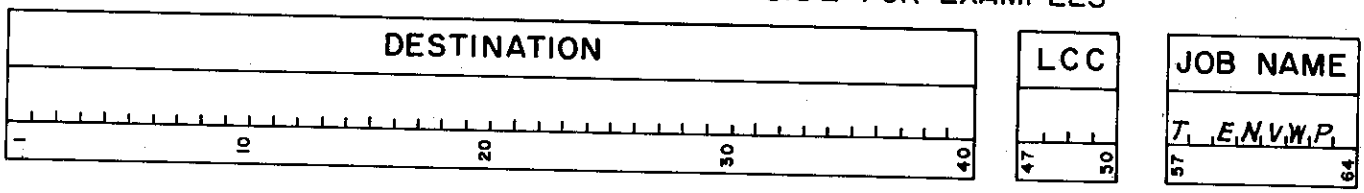
WIND PLOT CONTROL CARDS

CONTROL 1

SEE REVERSE SIDE FOR EXAMPLES

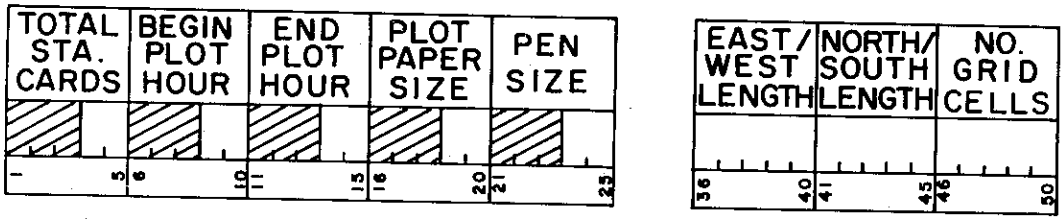


DESTINATION - Routing information: it is recommended that you include information appropriate for courier from TDC to your installation.

LCC - Labor Cost Code: Same as on the "JOB" card.

JOBNAME - Same as on the "JOB" card.

CONTROL 2



TOTAL STATION CARDS - Total number of Type 2 cards; 99 is maximum.

BEGIN PLOT HOUR - Begin plotting at this hour. (00 for midnight)

END PLOT HOUR - End plotting after this hour.

PLOT PAPER SIZE - See table I, section VI

PEN SIZE - Use a 2 or 3 (2 = smallest recommended ink pen size).

} Integer values, right justify.

EAST/WEST LENGTH - Length of region in inches in east/west direction.

NORTH/SOUTH LENGTH - Length of region in inches in north/south direction. *

NUMBER GRID CELLS - No. of grid cells along east/west. See table I, section VI

} Decimal values, include the decimal point in a separate column.

*Do not exceed "Plot Paper Size" for N/S length.

BY: _____ SOURCE: _____

CHECK: _____ E/A: _____

VERIFY

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WIND PLOT CONTROL CARDS

CONTROL 1

INSTRUCTIONS AND EXAMPLES

DESTINATION	LCC	JOB NAME
TRANSLAB 5900 FOLSOM, RAC/N 9-444-4846	V888	TMENVWPI
1–40	47–50	57–64

DESTINATION - Routing information: it is recommended that you include information appropriate for courier from TDC to your installation.

LCC - Labor Cost Code: Same as on the "JOB" card.

JOBNAME - Same as on the "JOB" card.

CONTROL 2

TOTAL STA. CARDS	BEGIN PLOT HOUR	END PLOT HOUR	PLOT PAPER SIZE	PEN SIZE
31	4	20	11	2
1–5	6–10	11–15	16–20	21–25

EAST/WEST LENGTH	NORTH/SOUTH LENGTH	NO. GRID CELLS
20.0	10.0	100.0
36–40	41–45	46–50

TOTAL STATION CARDS - Total number of Type 2 cards; 99 is maximum.

BEGIN PLOT HOUR - Begin plotting at this hour. (00 for midnight)

END PLOT HOUR - End plotting after this hour.

PLOT PAPER SIZE - See table I, section VI

PEN SIZE - Use a 2 or 3 (2 = smallest recommended ink pen size).

} Integer values, right justify.

EAST/WEST LENGTH - Length of region in inches in east/west direction.

NORTH/SOUTH LENGTH - Length of region in inches in north/south direction.*

NUMBER GRID CELLS - No. of grid cells along east/west. See table I, section VI

} Decimal values include the decimal point in a separate column.

*Do not exceed "Plot Paper Size" for N/S length.

BY: _____ SOURCE: _____

CHECK: _____ E/A: _____

VERIFY

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WIND STATION COORDINATES

TYPE 2 CARDS

FOR INSTRUCTIONS SEE REVERSE SIDE

STA NO	STA NAME		X COOR	Y COOR
1 3	4 7		11 15	16 20

STA NO	STA NAME		X COOR	Y COOR
1 3	4 7		11 15	16 20

BY: ______________________

CHECK: ______________________

SOURCE: ______________________

E/A: ______________________

VERIFY

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WIND STATION COORDINATES

TYPE 2 CARDS

INSTRUCTIONS AND EXAMPLES

STA NO	STA NAME		X COOR	Y COOR
1 3	4 7		11 15	16 20
101	CHPA		15.7	20.3
91	MATH		30.2	26.5
194	EXEC		15.9	23.5
186	MCCL		24.2	19.86

STA NO	STA NAME		X COOR	Y COOR
1 3	4 7		11 15	16 20
157	ROS3		24.6	24.9
169	NGAT		19.76	19.76
215	ARC1		20.25	24.10
101	HULK		20.01	20.01

STATION NUMBER - Must be same as on corresponding Type 3 cards; integer data only; right justify.

STATION NAME - Must be same as on corresponding Type 3 cards; can be abbreviation or acronym of the station name; alphanumeric data; left justify.

X COORDINATES - Decimal point must be inserted in one column; numeric data and one decimal point only. See appendix A for explanation of grid units.

Y COORDINATES - Decimal point must be inserted in one column; numeric data and one decimal point only.

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WIND PLOT DIRECTION AND SPEED DATA

TYPE 3 CARDS

FOR INSTRUCTIONS SEE REVERSE SIDE

DATE			STATION NUMBER	STATION NAME	USERS COMMENTS	PARAMETER		HOURLY VALUES																								
YEAR	MONTH	DAY				INPUT	UNITS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	3	5	7 9	10 13	14 25	26 28	29 32	33 35	37 39	41 43	45 47	49 51	53 55	57 59	61 63	65 67	69 71	73 75	77 79													
						W,D,	1,6,P,T																									
						W,S,																									
						W,D,	1,6,P,T																									
						W,S,																									
						W,D,	1,6,P,T																									
						W,S,																									
						W,D,	1,6,P,T																									
						W,S,																									
						W,D,	1,6,P,T																									
						W,S,																									
						W,D,	1,6,P,T																									
						W,S,																									
						W,D,	1,6,P,T																									
						W,S,																									

E-5

BY: _____

CHECK: _____

DATE: _____

REMARKS:

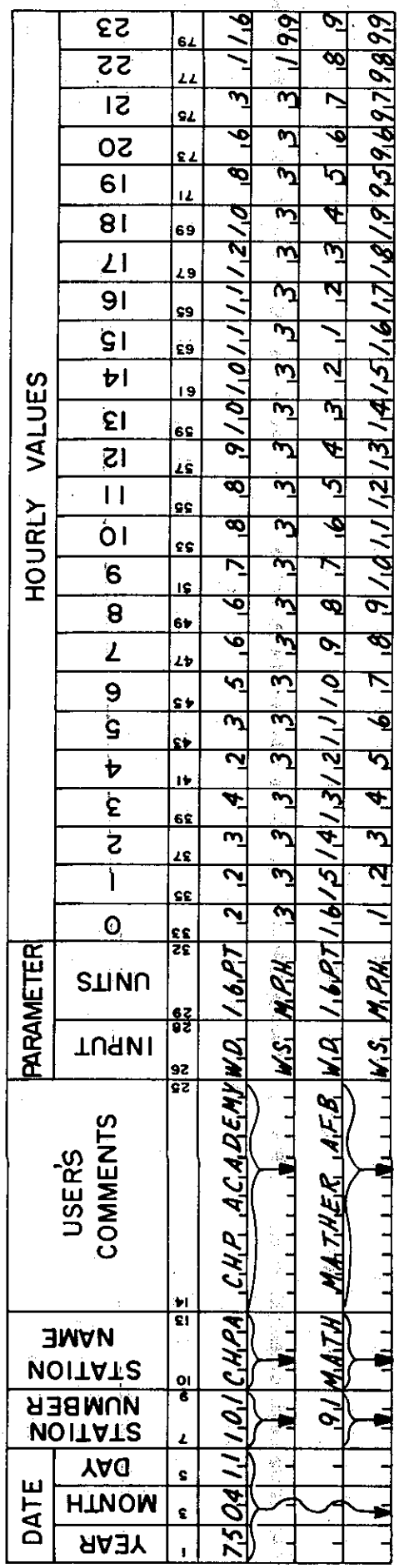
_____ NAME: _____

_____ DATE: _____

VERIFY

WIND PLOT DIRECTION AND SPEED DATA

TYPE 3 CARD



INSTRUCTIONS AND EXAMPLES

DATE - Date wind data was obtained; integer.

STATION NUMBER - Must be same as on corresponding Type 2 cards; integer; right justify

STATION NAME - Must be same as on corresponding Type 2 cards; can be an abbreviation or acronym of the station name; alphanumeric data; left justify.

USER'S COMMENTS - Can be any comments or can be used for further clarify station names. Alphanumeric.

INPUT PARAMETER - WD for wind direction and WS for wind speed; proper sequence is wind direction then wind speed; alphanumeric. Column 28 is blank.

UNITS PARAMETER - Use 16 point wind directions (where 1 is north), see appendix B; alphanumeric indicator for units of wind speed; left justify.

HOURLY VALUES - Whole integers only; right justify. No decimals.

Special Notes:

There has to be an equal number of wind direction cards and wind speed cards.

There is a maximum of 99 pairs of Type 3 cards per submittal.

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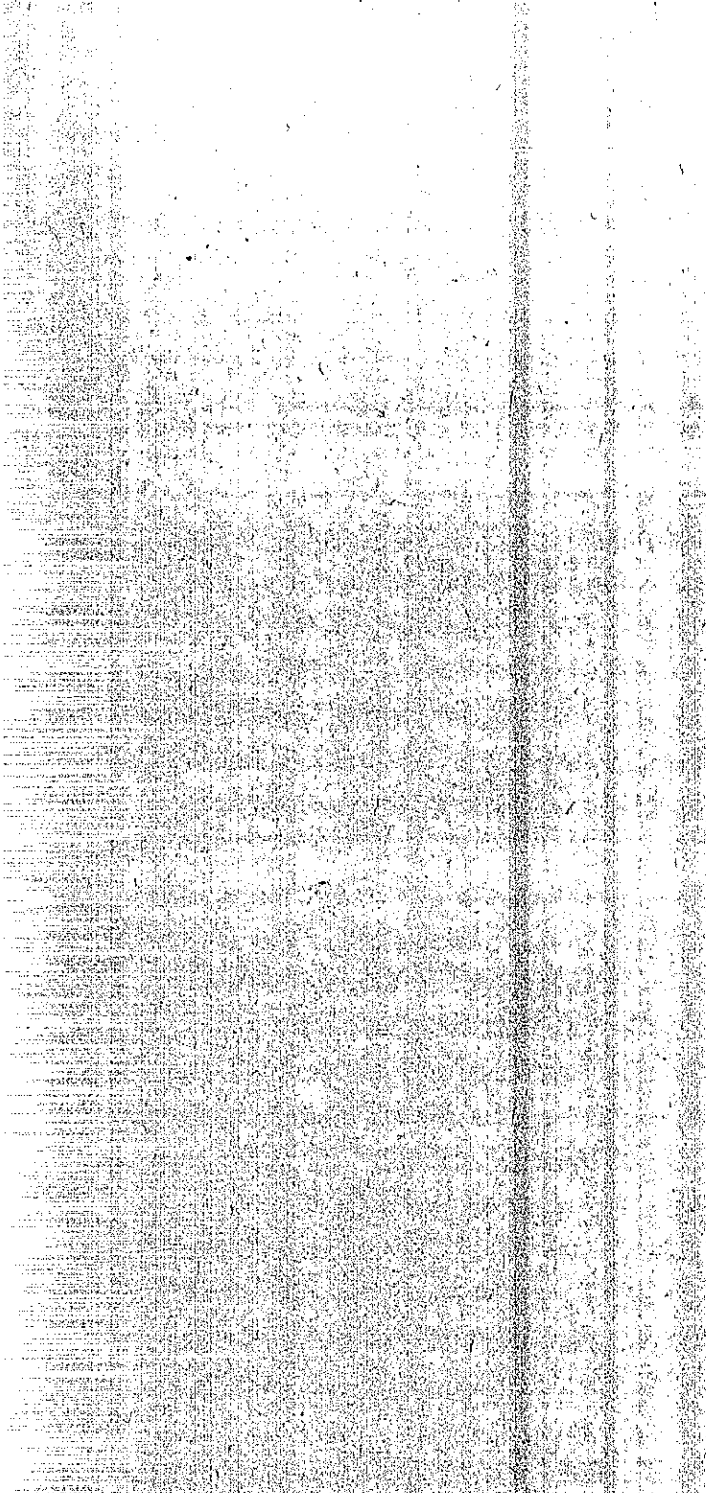

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