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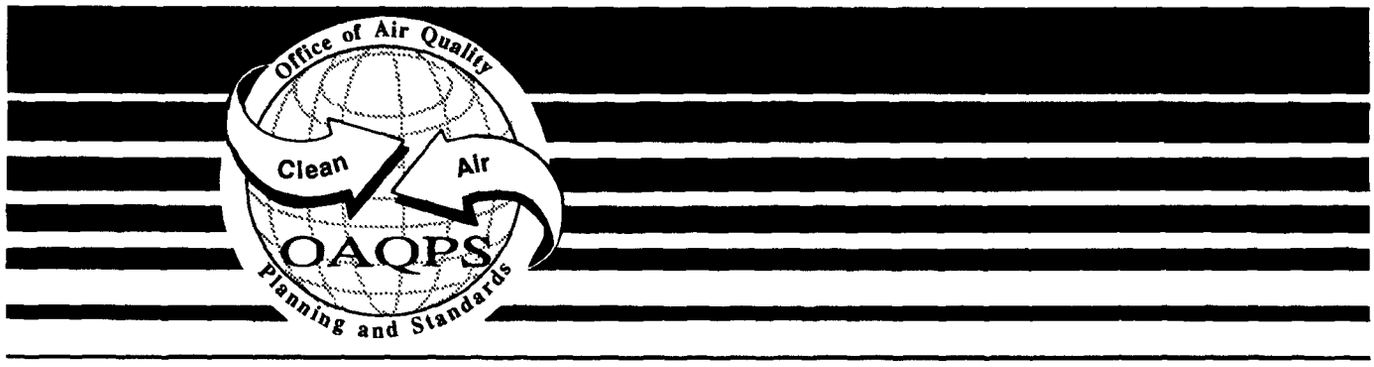
USER'S GUIDE FOR THE INDUSTRIAL SOURCE COMPLEX (ISC2) DISPERSION MODELS

VOLUME I - USER INSTRUCTIONS



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VOLUME I - USER INSTRUCTIONS

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U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
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PREFACE

This volume of the User's Guide for the Industrial Source Complex (ISC2) Dispersion Models (Version 2) provides user instructions for setting up and running the ISC2 models. The volume is organized to provide different levels of detail to meet the different needs of various types of users, from novice users to experienced modelers. The ISC2 User's Guide has been developed as part of a larger effort to restructure and reprogram the original ISC models, and to improve the "end-user" documentation for the models. Volume II of the ISC2 User's Guide provides a technical description of the dispersion algorithms utilized in the ISC2 models. Volume III provides a guide to programmers, including a description of the structure of the computer code and information about installing and maintaining the code on various computer systems.

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1.0 INTRODUCTION

The Industrial Source Complex (ISC2) dispersion models described in this document refer to restructured and reprogrammed versions of the original ISC models described in the ISC Dispersion Model User's Guide - Second Edition (Revised) (EPA, 1987a). The models were reprogrammed in order to improve the overall quality of the computer code, to improve the user interface, and to improve the end user documentation of the models.

This section provides an overall introduction to the ISC2 models and to the ISC2 User's Guide. It also serves specifically as an introduction to the user instructions contained in this volume for setting up and running the ISC2 models. Some suggestions are offered on how various users would best benefit from using the manuals. Also provided is an overview of the model's applicability, range of options, basic input data and hardware requirements, and a discussion of the relation of the ISC2 models to previous versions of ISC. The input file needed to run the ISC2 models is based on an approach that uses descriptive keywords and allows for a flexible structure and format. This is quite different from the earlier versions of the models which used a rigidly-formatted file with numeric option switches. Hence, this volume of the ISC2 Model User's Guide bears little resemblance to the previous ISC User's Guide.

1.1 HOW TO USE THE ISC2 MANUALS

The ISC2 Model User's Guide has been designed in an attempt to meet the needs of various types of users, depending on their level of experience with the models. This section describes briefly how different types of users would benefit most from their use of the manual.

1.1.1 Novice Users

Novice users are those whose exposure to or experience with the ISC2 models has been limited. They may be new to dispersion modeling applications in general, or new to the ISC2 models and therefore unfamiliar with the keyword/parameter approach utilized for the input file. These users should review the remainder of this Introduction to gain an overall perspective of the use of ISC2 models, particularly for regulatory modeling applications. They should then concentrate their review on Section 2, which provides a brief tutorial on setting up an input file that illustrates the most commonly used options of the ISC2 Short Term model. Section 2 provides a basic description of the input file structure and explains some of the advantages of the keyword/parameter approach to specifying modeling options and inputs. As the user becomes more familiar with the operation of the models and encounters the need to use more advanced features of the models, he/she will want to review the contents of Section 3, which provides a more detailed and complete reference of the various options for running the models.

1.1.2 Experienced Modelers

Experienced modelers will have had considerable experience in applying the ISC2 models in a variety of situations. They should have basic familiarity with the overall goals and purposes of regulatory modeling in general, and with the scope of options available in the ISC2 models in particular. Experienced modelers who are new to the ISC2 models will benefit from first reviewing the contents of Section 2 of this volume, which will give them a basic orientation to the structure, organization and philosophy of the keyword/parameter approach used for the input runstream file. Once they have a basic grasp of the input file structure and syntax rules, they will benefit most from using Section 3 of this volume as a

reference to learn the overall capabilities of the models, or to understand the mechanics for implementing particular options. The information in Section 3 has a functional organization with detailed descriptions of each of the individual keyword options by functional pathway. Once they are familiar with most or all of the keywords, they may find the functional keyword reference provided in Appendix B useful to quickly review the proper syntax and available options/parameters for a particular keyword. They may also find the Quick Reference Card pull-out available at the end of the user's guide sufficient as a simple reminder of the available keywords for each pathway and to ensure the proper order of parameters for each input image.

Modelers who have considerable experience with the previous versions of the ISC models should review the discussion at the end of this Introduction to understand the relation of the current version to previous versions of the models.

Experienced modelers may also have occasion to peruse the contents of Volume II, which describes the technical details of the dispersion modeling algorithms utilized in the ISC2 models. They may also have an interest in or need to review the contents of Volume III to learn about the structure and organization of the computer code, particularly if they are involved with installing the code on another computer system, or with compiling the code to meet the memory storage requirements for a particular application.

1.1.3 Management/Decision Makers

Those involved in a management or decision-making role for dispersion modeling applications will be especially interested in the remainder of this section, which provides an overview of the models, including their role in various regulatory

programs, a brief description of the range of available options, and basic input data and computer hardware requirements needed to run the models. From this information they should understand the basic capabilities of the ISC2 models well enough to judge the suitability of the models for particular applications. They may also want to review the brief tutorial provided in Section 2 to learn about the nature and structure of the input runstream file, in order to better be able to review the modeling results.

1.1.4 Programmers/Systems Analysts

Programmers and systems analysts, specifically those involved with installing the ISC2 code on other computer systems or charged with maintaining the code, should review the contents of Volume III. This will acquaint them with the structure and organization of the computer code, give specific details on compiling and linking the code for various situations, and explain in detail the memory storage requirements and control of input and output (I/O). They may also wish to review the remainder of this Introduction and the brief tutorial in Section 2 of this volume in order to have a basic understanding of the nature and overall capabilities of the models, and to understand the basic input runstream file structure and organization.

1.2 OVERVIEW OF THE ISC2 MODELS

This section provides an overview of the ISC2 models, including a discussion of the regulatory applicability of the models, a description of the basic options available for running the models, and an explanation of the basic input data and hardware requirements needed for executing the models.

1.2.1 Regulatory Applicability

The U.S. Environmental Protection Agency (EPA) maintains a Guideline on Air Quality Models which provides the agency's guidance on regulatory applicability of air quality dispersion models in general. Any regulatory application of the ISC2 models should conform to the guidance set forth in the Guideline on Air Quality Models (Revised) (EPA, 1987b), including the most recent Supplements to the guideline. Any non-guideline application of the models should meet the requirements of the applicable reviewing agency, such as an EPA Regional Office, a State or a local air pollution control agency. In general, regulatory modeling applications should be carried out in accordance with a modeling protocol that is reviewed and approved by the appropriate agency prior to conducting the modeling. The modeling protocol should identify the specific model, modeling options and input data to be used for a particular application.

1.2.2 Basic Input Data Requirements

There are two basic types of inputs that are needed to run the ISC2 models. One of the inputs is the runstream setup file which contains the selected modeling options, as well as source location and parameter data, receptor locations, meteorological data file specifications, and output options. The second basic type of input data needed to run the model is the meteorological data. There are various options for meteorological data file formats available with the ISC2 models. These are described briefly later in this section, and in more detail in Sections 2 and 3.

1.2.3 Computer Hardware Requirements

1.2.3.1 PC Hardware Requirements.

Given the rapid increase in speed and capacity of personal computers (PCs) available for modeling in recent years, and their relative ease of use and access, the PC has become the most popular environment for performing dispersion modeling applications within the modeling community (Bauman and Dehart, 1988; Rorex, 1990). This trend can be expected to continue in the future. The current versions of the ISC2 models were developed on an IBM-compatible PC using the Microsoft FORTRAN Optimizing Compiler (Version 5.1), and have been designed to run on such machines with a minimum of 640K bytes of RAM and MS-DOS Version 3.2 or higher. In order to handle the input data files (runstream setup and meteorology) and the output files, it is highly recommended that the system have a hard disk drive. The amount of storage space required on the hard disk for a particular application will depend greatly on the output options selected. Some of the optional output files of concentration data can be rather large. More information on output file products is provided in Sections 2 and 3.

While a math coprocessor chip is optional for execution of the ISC2 models on a PC, it is highly recommended, especially for the Short Term model, due to the large increase in execution speed that will be experienced. The model may be expected to run about five to ten times faster with a math coprocessor than without one.

For particularly large applications, involving a large number of sources, source groups, receptors and averaging periods, the user may find that the 640K RAM limit available with DOS is not enough. In addition to the DOS executable versions of the models, extended memory versions are available for use on 80386 and 80486 PCs with at least 4 MB of RAM.

Section 4.2.2 of this volume and Volume III of the ISC2 User's Guide contain information on increasing the capacity of the model and setting it up to run on systems (with 80386 processors and higher) that make use of extended memory beyond the 640K limit of DOS. There are special requirements for the operating system and Fortran language compiler needed to utilize the extended memory on these machines.

1.2.3.2 DEC VAX Requirements.

The models have also been uploaded and tested on a DEC VAX minicomputer. As with the IBM 3090, the VAX has some advantages of speed and greater memory capacity over the PC environment. There are no particular hardware requirements for running the models on the VAX. The user must be familiar with the operating system and Fortran language compiler being utilized on the VAX in order to properly setup and run the model and control the input and output files. Instructions for setting up and running the models on the DEC VAX are included in this volume and in more detail in Volume III of the User's Guide.

1.2.3.3 IBM 3090 Requirements.

While the models were developed on the PC, they have been uploaded and tested on EPA's IBM 3090 mainframe computer. The mainframe has advantages of speed and greater memory capacity over the PC environment. There are no particular hardware requirements for running the models on the IBM 3090. However, the user must be familiar with the IBM Job Control Language (JCL) and the VS FORTRAN Version 2.0 compiler in order to properly setup and run the models and control the input and output files in the mainframe environment. Instructions for setting up and running the models on the IBM 3090 are included in this volume and in Volume III of the User's Guide.

1.2.4 Overview of Available Modeling Options

The ISC2 models include a wide range of options for modeling air quality impacts of pollution sources, making them popular choices among the modeling community for a variety of applications. The following sections provide a brief overview of the options available in the ISC2 models.

1.2.4.1 Dispersion Options.

Since the ISC2 models are especially designed to support the EPA's regulatory modeling programs, the regulatory modeling options, as specified in the Guideline on Air Quality Models (Revised), are the default mode of operation for the models. These options include the use of stack-tip downwash, buoyancy-induced dispersion, final plume rise (except for sources with building downwash), a routine for processing averages when calm winds occur, default values for wind profile exponents and for the vertical potential temperature gradients, and the use of upper bound estimates for super-squat buildings having an influence on the lateral dispersion of the plume. The user can easily ensure the use of the regulatory default options by selecting a single keyword on the modeling option input card. To maintain the flexibility of the model, the non-regulatory default options have been retained, and by using descriptive keywords to specify these options it is evident at a glance from the input or output file which options have been employed for a particular application.

As with the earlier version of the ISC models, the user may select either rural or urban dispersion parameters (although the non-regulatory options of Urban Mode 1 and Urban Mode 2 have been eliminated), depending on the characteristics of the source location. The user also has the option of calculating either concentration values or deposition values for a particular run. The user can specify several short term

averages to be calculated in a single run of the ISC2 Short Term model, as well as requesting the overall period (e.g. annual) averages.

1.2.4.2 Source Options.

The model is capable of handling multiple sources, including point, volume and area source types. Line sources may also be modeled as a string of volume sources. Several source groups may be specified in a single run, with the source contributions combined for each group. This is particularly useful for PSD applications where combined impacts may be needed for a subset of the modeled background sources that consume increment, while the combined impacts from all background sources (and the permitted source) are needed to demonstrate compliance with the National Ambient Air Quality Standards (NAAQS). As with earlier versions of ISC, the models contain algorithms for modeling the effects of aerodynamic downwash due to nearby buildings on point source emissions, and algorithms for modeling the effects of settling and removal (through dry deposition) of large particulates. As noted above, for applications involving large particulates, the user can select either concentration or deposition values to be calculated. Once a run has been setup for either concentration or deposition, then a trivial change of one keyword is all that is needed to switch the model to calculate the other.

Source emission rates can be treated as constant throughout the modeling period, or may be varied by month, season, hour-of-day, or other optional periods of variation. These variable emission rate factors may be specified for a single source or for a group of sources.

1.2.4.3 Receptor Options.

The ISC2 models have added flexibility in the specification of receptor locations compared to the previous versions of the model. The user now has the capability of specifying multiple receptor networks in a single run, and may also mix Cartesian grid receptor networks and polar grid receptor networks in the same run. This is useful for applications where the user may need a coarse grid over the whole modeling domain, but a denser grid in the area of maximum expected impacts. There is also greater flexibility in specifying the location of the origin for polar receptors than in the earlier models, which assumed that all polar receptors were referenced to an origin at (0,0) in x,y, coordinates.

As with the earlier version of the ISC models, the user can input elevated receptor heights in order to model the effects of terrain above (or below) stack base, and may also specify receptor elevations above ground level to model flagpole receptors. Any terrain heights input above the release height for a particular source are "chopped-off" at the release height for that source's calculations. The ISC2 models do not include algorithms to model the impacts of sources on complex terrain, i.e., terrain above the release height.

1.2.4.4 Meteorology Options.

The ISC2 Short Term (ISCST2) model can utilize the unformatted, sequential files of meteorological data generated by the RAMMET and the MPRM preprocessors, provided the data file was generated by the same Fortran compiler as was used for the model. The user also has considerable flexibility to utilize formatted ASCII files that contain sequential hourly records of meteorological variables. For these hourly ASCII files, the user may use a default ASCII format, may specify the ASCII read format, or may select free-formatted reads for

inputting the meteorological data. A utility program called BINTOASC is provided with the ISC2 models to convert unformatted meteorological data files of several types to the default ASCII format used by ISCST2 and ISCEV2. This greatly improves the portability of applications to different computer systems. The BINTOASC program is described in Appendix C.

The previous version of the ISCST model allowed the user to specify hourly meteorological data in a "card image" format within the input option file. Applications of the earlier ISCST model using card image meteorological data can easily be duplicated using the ASCII file options available in the ISCST2 model. The model will process all available meteorological data in the specified input file by default, but the user can easily specify selected days or ranges of days to process.

The ISC2 Long Term (ISCLT2) model uses joint frequency distributions of wind speed class, by wind direction sector, by stability category, known as STAR summaries (for STability ARray). These STAR summaries are available from the National Climatic Data Center in Asheville, North Carolina. They may also be generated from sequential data files using the STAR utility program available on EPA's SCRAM Bulletin Board System or by the MPRM meteorological processor for on-site data. The meteorological data for ISCLT2 are read in from a separate data file rather than being included in the input option file, as was done in the earlier versions of ISCLT.

1.2.4.5 Output Options.

The ISC2 models retain options for all of the basic types of outputs available with the previous versions, and also include some new output options. The basic types of printed output available with ISCST2 are:

- Summaries of high values (highest, second highest, etc.) by receptor for each averaging period and source group combination;

- Summaries of overall maximum values (e.g., the maximum 50) for each averaging period and source group combination; and

- Tables of concurrent values summarized by receptor for each averaging period and source group combination for each day of data processed. These "raw" concentration values may also be output to unformatted (binary) files, as described below.

For the Long Term model, the user can also select output tables of values for each receptor, and/or tables of overall maximum values. The tables by receptor and maximum value tables can be output for the source group values or for the individual source values, or both. In addition, when maximum values for individual sources are output, the user has the option of specifying whether the maximum source values are to be the maximum values for each source independently, or the contribution of each source to the maximum group values, or both.

In addition to the tabular printed output products described above, the new models provide options for several types of file output products. One of these options for ISCST2 corresponds to the option for an unformatted ("binary") file of all concentration values available with the previous versions of ISCST. These files are often used for special postprocessing of the data. In addition to the unformatted concentration files, ISCST2 provides options for two additional types of file outputs. One option is to generate a file of (X,Y) coordinates and design values (e.g., the second highest values at each receptor for a particular averaging period and source group combination) that can be easily imported into many graphics plotting packages to generate contour plots of the concentration values. Separate files can be specified for all

of the averaging period and source group combinations of interest to the user.

Another output file option of the ISCST2 model is to generate a file of all occurrences when a concentration value equals or exceeds a user-specified threshold. Again, separate files are generated for only those combinations of averaging period and source group that are of interest to the user. These files include the date on which the threshold violation occurred, the receptor location, and the concentration value.

In addition to the availability of these new options for output products from ISCST2, the user has more flexibility to select only the output desired for a particular application. As an example, the option in the old ISCST model to generate an unformatted ("binary") file of concentration values for postprocessing combined the results for each receptor, source group and averaging period combination into a single file. This file of raw concentration values could be very large for even routine size runs, and the structure of the file made it cumbersome to work with. Often the user may be interested in postprocessing a single averaging period and source group of interest that is a small subset of the file for a full application. For the original ISCST model, a separate run may have been set up to generate the concentration file for only that combination. In ISCST2, the unformatted concentration files are separated for each averaging period and source group combination, and the user can specify that files be generated for only those combinations that are of interest for postprocessing. Similar flexibility is available with all of the output options for the new model.

1.2.4.6 Source Contribution Analyses.

In air quality dispersion modeling applications, the user may have a need to know the contribution that a particular source makes to an overall concentration value for a group of sources. This section provides a brief introduction to how these types of source contribution (sometimes referred to as source culpability) analyses are performed using the ISC2 models. More detailed information about exercising these options is provided in Section 3.

In the previous version of the ISCLT model, the user had an option (controlled by option switch ISW(11)) to have the highest 10 values for each source and source group reported independently, or to have the 10 highest values from the combined source group and the contributions from the individual sources to those highest group values. This option is retained in the ISCLT2 model, as mentioned briefly in the previous section.

The previous version of the ISCST model provided the option of specifying source groups for which the model calculates high values independently. However, there was no easy mechanism for obtaining the same kind of source contribution information that was provided by the ISCLT model. Users would often have to run the model a second time selecting only specific days where the high values occurred, and setting up each source in its own source group in order to obtain source contribution results.

Recognizing that source contribution information is also important to many short term modeling analyses, the ISCST2 model has been designed to make it much easier for users to perform this type of analysis. This is accomplished with the introduction of an additional model, referred to as the ISC2 Short Term - EVENT model (ISCEV2). The ISCST2 model treats

source groups independently, in the same manner as the old ISCST model. The ISCEV2 (EVENT) model is set up specifically to provide the contributions from individual sources to the concentration values for particular events. These events may be the design concentrations (e.g., the high-second-high 24-hour average concentration for a particular group of sources) that were generated from an execution of the ISCST2 model. Other events of interest might be occurrences of violations of a particular standard, for which it is necessary to determine whether the source being permitted contributes above a significance level. The models are set up in such a way that both of these types of events can be passed directly from an execution of the ISCST2 model to an input file for the EVENT model. The user is thus able to run the models in a batch mode to obtain the overall design value results from ISCST2 and the source contribution information from ISCEV2 in a single step. The EVENT model can also be run separately and accepts user-specified events for source contribution processing.

1.3 RELATION TO PREVIOUS VERSIONS OF ISC

1.3.1 Brief Background of Restructuring Effort

The ISC2 models came about as a result of a major effort to restructure and reprogram the models that began in April 1989, and was completed in January 1992. The effort was largely motivated by the need to improve the quality, reliability, and maintainability of the code when numerous "bugs" were discovered after the implementation of the revised downwash algorithms for shorter stacks. It became widely recognized that the code, originally developed in the 1970's and modified numerous times since, had become impossible to reliably modify, debug or maintain. However, the goals of the reprogramming effort also included improving the user interface by modifying the input file structure and the output products,

and to provide better "end user" documentation for the revised models. The ISC2 models were developed as replacements for and not updates to the previous versions of the models. The purpose of the reprogramming effort was **NOT** to modify any of the ISC model algorithms.

1.3.2 Differences Between the Original ISC and the ISC2 Models

During the course of reprogramming and testing the models, several discrepancies with the older versions of the models were discovered. These discrepancies were resolved, and corrections were incorporated into the ISC2 models prior to their release. Because of the nature of some of these bugs in the earlier versions, it was not practical to "fix" the previous versions prior to releasing the new models. However, for most applications, the design values estimated by the ISC2 models will not differ significantly from the design values estimated by the original models. The most significant discrepancies are likely to occur for sources whose plume rise is dominated by momentum rather than buoyancy, and for certain source situations involving the building downwash algorithms. Impacts for area sources for the ISCST2 model will be about 11.4 percent lower than previous versions of ISCST due to the correction of an error in the derivation of the area source equation for a finite line segment. There was also an error in the original ISCLT model in the treatment of lateral virtual distances that effects area sources, volume sources and point sources with building downwash. The largest differences due to this error are likely to be for receptors located relatively close to the source.

The only technical change between ISC2 and old versions of ISC, not involving correction of an error, is the extension of the direction-specific treatment of building downwash influences from the Schulman-Scire algorithm for shorter stacks

to the Huber-Snyder algorithm for stacks up to the Good Engineering Practice (GEP) stack height.

1.3.3 Suggestions for Converting Previous Input Files

In order to make the transition from the old models to ISC2 as easy as possible, a file conversion utility (STOLDNEW) has been developed that converts input files for the old ISCST model to the format required to run the ISCST2 model. Since there is considerable flexibility in structuring and formatting the input file for the ISCST2 model, and there are options available in ISCST2 that weren't available in the old model, the file generated by the conversion program may not always be in a form that will best meet the user's needs relative to ISCST2. However, user's will be able to make use of old input files and easily setup previous applications to run with the ISCST2 model. The file conversion utility is described in more detail in Appendix C. Due to similarities between the ISCST2 and ISCLT2 inputs, it is now much easier to setup an ISCLT2 run from an ISCST2 input file.

2.0 GETTING STARTED - A BRIEF TUTORIAL

This section provides a brief tutorial for setting up a simple application problem with the ISC2 Short Term model, which serves as an introduction for novice users to the ISC2 models. The example illustrates the usage of the most commonly used options in the ISC2 models for regulatory applications. A more complete description of the available options for setting up the ISC2 models is provided in Section 3.

The example problem presented in this section is a simple application of the ISCST2 model to a single point source. The source is a hypothetical stack at a small isolated facility in a rural setting. Since the stack is below the Good Engineering Practice (GEP) stack height, the emissions from the source are subject to the influence of aerodynamic downwash due to the presence of nearby buildings. The tutorial leads the user through selection and specification of modeling options, specification of source parameters, definition of receptor locations, specification of the input meteorological data, and selection of output options. Since this discussion is aimed at novice users of the ISC2 models, a general description of the input file keyword/parameter approach is provided first.

2.1 DESCRIPTION OF KEYWORD/PARAMETER APPROACH

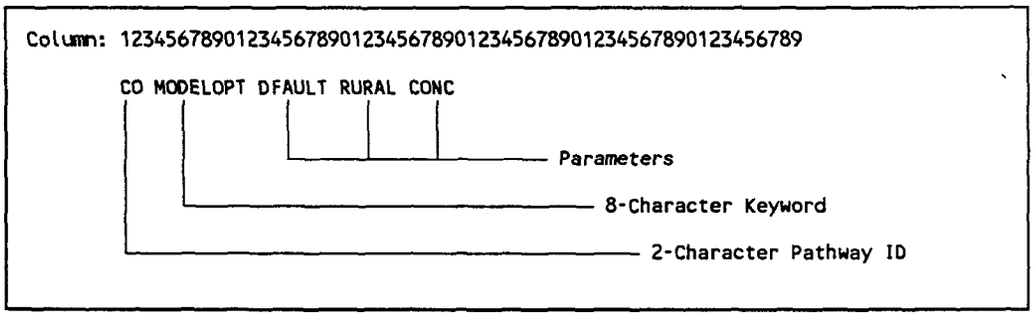
The input file for the ISC2 models makes use of a keyword/parameter approach to specifying the options and input data for running the models. The descriptive keywords and parameters that make up this input runstream file may be thought of as a command language through which the user communicates with the model what he/she wishes to accomplish for a particular model run. The keywords specify the type of option or input data being entered on each line of the input file, and the parameters following the keyword define the specific options selected or the actual input data. Some of

the parameters are also input as descriptive secondary keywords.

The runstream file is divided into five functional "pathways." These pathways are identified by a two-character pathway ID placed at the beginning of each runstream image. The pathways and the order in which they are input to the model are as follows:

CO - for specifying overall job **CO**ntrol options;
SO - for specifying **SO**urce information;
RE - for specifying **RE**ceptor information;
ME - for specifying **ME**teorology information; and
OU - for specifying **OU**tput options.

Each line of the input runstream file consists of a pathway ID, an 8-character keyword, and a parameter list. An example of a line of input from a runstream file, with its various parts identified, is shown below:



The following sections describe the rules for structuring the input runstream file, and explain some of the advantages of the keyword/parameter approach.

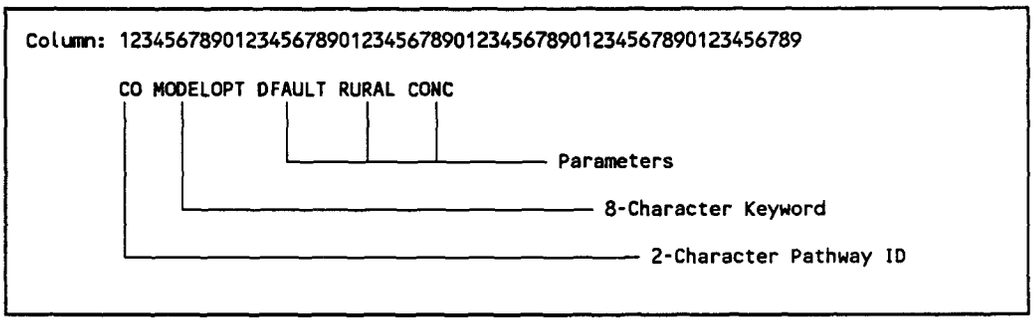
2.1.1 Basic Rules for Structuring Input Runstream Files

While the input runstream file has been designed to provide the user with considerable flexibility in structuring the input file, there are some basic syntax rules that need to be followed. These rules serve to maintain some consistency between input files generated by different users, to simplify the job of error handling performed by the models on the input data, and to provide information to the model in the appropriate order wherever order is critical to the interpretation of the inputs. These basic rules and the various elements of the input runstream file are described in the paragraphs that follow.

One of the most basic rules is that all inputs for a particular pathway must be contiguous, i.e., all inputs for the CO pathway must come first, followed by the inputs for the SO pathway, and so on. The beginning of each pathway is identified with a "STARTING" keyword, and the ending of the pathway with the "FINISHED" keyword. Thus the first functional record of each input file must be "CO STARTING" and the last record of each input file must be "OU FINISHED." The rest of the input images will define the options and input data for a particular run.

Each record in the input runstream file is referred to as a runstream "image." These records are initially read into the model as 80-character images. The information on each input image consists of a "pathway," a "keyword," and one or more "parameters." Each of these "fields" on the runstream image must be separated from other fields by at least one blank space. To simplify the interpretation of the runstream image by the model, the runstream file must be structured with the two-character pathway in columns 1 and 2, the eight-character keyword in columns 4 through 11, followed by the parameters in columns 13 through 80, as necessary. (For reasons that are

explained in Section 2.4.8, the models will accept input files where all inputs are shifted by up to three columns to the right.) For most keywords, the order of parameters following the keyword is important -- the exact spacing of the parameters is not important, as long as they are separated from each other by at least one blank space and do not extend beyond the 80 character limit. The example of a runstream image from the CO pathway shown above is repeated here:



Alphabetical characters can be input as either lower case or upper case letters. The models convert all character input to upper case letters internally, with the exception of the title fields and file names to be discussed later. Throughout this document, the convention of using upper case letters is followed. For numeric input data, it should be noted that all data are assumed to be in metric units, i.e., length units of meters, speed units of meters per second, temperature units of degrees Kelvin, and emission units of grams per second. In a few instances, the user has the option of specifying units of feet for length and the model will perform the conversion to meters. These exceptions are the input of receptor heights for elevated terrain and the specification of anemometer height, since these values are often more readily available in feet than in meters.

Certain keywords are mandatory and must be present in every runstream file, such as the MODELOPT keyword shown in the

example above which identifies the modeling options. Other keywords are optional and are only needed to exercise particular options, such as the option to allow for the input of flagpole receptor heights. Some of the keywords are repeatable, such as the keywords to specify source parameters, while other keywords may only appear once. The keyword references in Section 3, Appendices A and B and the Quick Reference Card at the end of this volume identify each keyword as to its type, either mandatory or optional, and either repeatable or non-repeatable.

With a few exceptions that are described below, the order of keywords within each pathway is not critical. For the CO pathway, an exception is that the MODELOPT and POLLUTID keywords must be specified before the DCAYCOEF or HALFLIFE keyword because of the link between the urban default option and the decay coefficient for SO_2. For the SO pathway, the LOCATION keyword must be specified before other keywords for a particular source, and the SRCGROUP keyword must be the last keyword before SO FINISHED. For keywords on the SO pathway that accept a range of source IDs, the source parameters specified by those keywords will only be applied to the sources already defined, and will exclude any sources that are specified latter in the input file.

2.1.2 Advantages of the Keyword Approach

The keyword approach provides some advantages over the type of input file used by the earlier versions of ISC. One advantage is that the keywords are descriptive of the options and inputs being used for a particular run, making it easier for a reviewer to ascertain what was accomplished in a particular run by reviewing the input file. Another advantage is that the user has considerable flexibility in structuring the inputs to improve their readability and understandability, as long as they adhere to the few basic rules described above.

Some special provisions have been made to increase the flexibility to the user in structuring the input files. One provision is to allow for blank records in the input file. This allows the user to separate the pathways from each other, or to separate a group of images, such as source locations, from the other images. Another provision is for the use of "comment cards," identified by a "**" in the pathway field. Any input image that has "**" for the pathway ID will be ignored by the model. This is especially useful for labeling the columns in the source parameter input images, as illustrated in the example problem later in this section. It may also be used to "comment out" certain options for a particular run without deleting the options and associated data (e.g., elevated terrain heights) completely from the input file. Because of the descriptive nature of the keyword options and the flexibility of the inputs it is generally much easier to make modifications to an existing input runstream file to obtain the desired result.

Another reason for improved "user-friendliness" of the new models over the previous versions of the models is that much more detailed error-handling has been built into the models. The new model provides descriptions of the location and nature of all of the errors encountered for a particular run. Rather than stopping execution at each occurrence of an input error, the new model will read through and attempt to process all input records and report all errors encountered. If a fatal error occurs, then the model will not attempt to execute the model calculations.

2.2 REGULATORY DEFAULT OPTION

The regulatory default option is controlled from the MODELOPT keyword on the CO pathway. As its name implies, this keyword controls the selection of modeling options. It is a mandatory, non-repeatable keyword, and it is an especially

important keyword for understanding and controlling the operation of the ISC2 models. As noted in Section 1, the regulatory default options, as specified in the Guideline on Air Quality Models, are truly the default options for the ISC2 models. That is to say that, unless specified otherwise through the available keyword options, the ISC2 models implement the following regulatory options:

- Use stack-tip downwash (except for Schulman-Scire downwash);
- Use buoyancy-induced dispersion (except for Schulman-Scire downwash);
- Do not use gradual plume rise (except for building downwash);
- Use the calms processing routines;
- Use upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings;
- Use default wind profile exponents; and
- Use default vertical potential temperature gradients.

Rather than specifying options with numeric switches as in the earlier version of the ISC model, the parameters for the MODELOPT keyword are character strings, called "secondary keywords," that are descriptive of the option being selected. For example, to ensure that the regulatory default options be used for a particular run, the user would include the secondary keyword "DFAULT" on the MODELOPT input. The presence of this secondary keyword tells the model to override any attempt to use a non-regulatory default option. The model will warn the user if a non-regulatory option is selected along with the DFAULT option, but will not halt processing. For regulatory modeling applications, it is strongly suggested that the DFAULT switch be set, even though the model defaults to the regulatory options without it.

For any application in which a non-regulatory option is to be selected, the DFAULT switch must not be set, since it would otherwise override the non-regulatory option. The non-regulatory options are also specified by descriptive secondary keywords, such as "NOBID" to specify the option not to use buoyancy-induced dispersion. (A programmer note: these modeling option keywords also correspond to the Fortran logical variable names used to control the options in the ISC2 computer code. This is one reason why they are limited to six characters, .e.g., DFAULT instead of DEFAULT, since the standard Fortran language (ANSI, 1978) only allows variable names up to six characters in length).

The MODELOPT keyword, which is also used to specify the selection of rural or urban dispersion parameters, and concentration or deposition values, is described in more detail in the Section 3.2.2.

2.3 MODEL STORAGE LIMITS

The ISC2 models have been designed using a static storage allocation approach, where the model results are stored in data arrays, and the array limits are controlled by PARAMETER statements in the Fortran computer code. These array limits also correspond to the limits on the number of sources, receptors, source groups and averaging periods that the model can accept for a given run. Depending on the amount of memory available on the particular computer system being used, and the needs for a particular modeling application, the storage limits can easily be changed by modifying the PARAMETER statements and recompiling the model. Section 4.2.2 of this volume and Volume III of the User's Guide provide more information about modifying the storage limits of the models.

The limits on the number of receptors, sources, source groups, averaging periods, and events (for ISCEV2 model) are

initially set as follows for the three models for the DOS and extended memory (EM) versions on the PC:

PARAMETER Name	Limit Controlled	ISCST2	ISCEV2	ISCLT2
NREC	Number of Receptors	600 (DOS) 1200 (EM)	-	500 (DOS) 1200 (EM)
NSRC	Number of Sources	100 (DOS) 300 (EM)	100 (DOS) 500 (EM)	100 (DOS) 300 (EM)
NGRP	Number of Source Groups	2 (DOS) 5 (EM)	25 (DOS) 50 (EM)	3 (DOS) 5 (EM)
NAVE	Number of Short Term Averages	2 (DOS) 4 (EM)	4 (DOS) 4 (EM)	-
NEVE	Number of Events	-	2500 (DOS) 5000 (EM)	-

Fortran PARAMETER statements are also used to specify the array limits for the number of high short term values by receptor to store for the ISCST2 model (NVAL, initially set to 6), and the number of overall maximum values to store (NMAX, initially set to 50 for ISCST2 and to 10 for Long Term). The NMAX limits correspond to the limits available in the previous versions of the model, but can also be modified by the user and the model recompiled in order to meet particular needs.

In addition to the parameters mentioned above, parameters are used to specify the number of gridded receptor networks in a particular run (NNET), and the number of x-coordinate (or distance) and y-coordinate (or direction) values (IXM and IYM) for each receptor network. Initially, the models allow up to 5 receptor networks (of any type), and up to 50 x-coordinates (or distances) and up to 50 y-coordinates (or directions). The source arrays also include limits on the number of variable emission rate factors per source (NQF, initially set to 96 for SEASHR in Short Term and to 36 for the DOS version of Long Term

and 144 for the EM version of Long Term), the number of sectors for direction-specific building dimensions (NSEC, initially set to 36 for Short Term and 16 for Long Term), and the number of settling and removal categories (NVSMAX, initially set to 20).

2.4 SETTING UP A SIMPLE RUNSTREAM FILE

This section goes through a step-by-step description of setting up a simple application problem, illustrating the most commonly used options of the ISCST2 model. The example problem is based on the test example file provided with the previous version of the ISCST model. The input files for the previous version of the ISCST model and the new version are shown together in Figure 2-1. The remainder of this section explains the various parts of the input file for the ISCST2 model, and also illustrates some of the flexibility in structuring the input file.

```
TEST RUNSTREAM - RURAL DOWNWASH TEST  -  35M STACK, "TALL" BUILDING
 1 4 1 0 0 1 0 0 1 0 0 0 0 1 1 0 1 1 1 0 1 1 0 1 2 1 1 1 1 2
     1     5    36
      100.      200.      300.      500.     1000.
       10.       10.
       6.1
1111111111111111111111111111111111111111111111111111111111111111111111111111111111
1111111111111111111111111111111111111111111111111111111111111111111111111111111111
1111111111111111111111111111111111111111111111111111111111111111111111111111111111
1111111111111111111111111111111111111111111111111111111111111111111111111111111111
1111111111111111111111111111111111111111111111
 94823    64 94823    64
    1          1.0                        35.  432. 11.70   2.4 -34. 33.33   15.
  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0 34.0  34.0
  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0 34.0  34.0
  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0  34.0 34.0  34.0
 35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56 15.00 20.56 25.50 29.66
 32.92 35.18 36.37 36.45 35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
 25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45 35.43 33.33
```

```
CO STARTING
CO TITLEONE A Simple Example Problem for the ISCST2 Model
CO MODELOPT  DFAULT  RURAL  CONC
CO AVERTIME  3  24  PERIOD
CO POLLUTID  SO2
CO RUNORNOT  RUN
CO FINISHED

SO STARTING
SO LOCATION  STACK1 POINT  0.0   0.0    0.0
SO SRCPARAM  STACK1 1.00  35.0  432.0  11.7  2.4
SO BUILDHGT  STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT  STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT  STACK1 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDWID  STACK1 35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56
SO BUILDWID  STACK1 15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45
SO BUILDWID  STACK1 35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
SO BUILDWID  STACK1 25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18
SO BUILDWID  STACK1 36.37 36.45 35.43 33.33
SO SRCGROUP  ALL
SO FINISHED

RE STARTING
RE GRIDPOLR  POL1  STA
RE GRIDPOLR  POL1  ORIG  0.0   0.0
RE GRIDPOLR  POL1  DIST  100.  200.  300.  500.  1000.
RE GRIDPOLR  POL1  GDIR  36    10.   10.
RE GRIDPOLR  POL1  END
RE FINISHED

ME STARTING
ME INPUTFIL  PREPIT.BIN  UNFORM
ME ANEMHGHT  20 FEET
ME SURFDATA  94823  1964  PITTSBURGH
ME UAIRDATA  94823  1964  PITTSBURGH
ME FINISHED

OU STARTING
OU RECTABLE  ALLAVE  FIRST  SECOND
OU MAXTABLE  ALLAVE  50
OU FINISHED
```

FIGURE 2-1. EXAMPLE INPUT FILES FOR ISCST (top) AND ISCST2 (bottom) MODELS FOR SAMPLE PROBLEM

2.4.1 A Simple Industrial Source Application

For this simple tutorial, an application is selected involving a single point source of SO_2 that is subject to the influences of building downwash. The source consists of a 35-meter stack with a buoyant release that is adjacent to a building. We will assume that the stack is situated in a rural setting with relatively flat terrain within 50 kilometers of the plant. A polar receptor network will be placed around the stack location to identify areas of maximum impact.

2.4.2 Selecting Modeling Options - CO Pathway

The modeling options are input to the model on the COntrol pathway. The mandatory keywords for the CO pathway are listed below. A complete listing of all keywords is provided in Appendix B.

STARTING - Indicates the beginning of inputs for the pathway; this keyword is mandatory on each of the pathways.

TITLEONE - A user-specified title line (up to 68 characters) that will appear on each page of the printed output file (an optional second title line is also available with the keyword TITLETWO).

MODELOPT - Controls the modeling options selected for a particular run through a series of secondary keywords.

AVERTIME - Identifies the averaging periods to be calculated for a particular run.

POLLUTID - Identifies the type of pollutant being modeled. At the present time, this option only influences the results if SO_2 is modeled with urban dispersion in the regulatory default mode, when a half-life of 4 hours is used to model exponential decay.

RUNORNOT - A special keyword that tells the model whether to run the full model executions or not. If

the user selects not to run, then the runstream setup file will be processed and any input errors reported, but no dispersion calculations will be made.

FINISHED - Indicates that the user is finished with the inputs for this pathway; this keyword is also mandatory on each of the other pathways.

The first two keywords are fairly self-explanatory. As discussed above in Section 2.2, the MODELOPT keyword on the CO pathway is pivotal to controlling the modeling options used for a particular run. For this example, we intend to use the regulatory default options, so we will include the "DFAULT" keyword on our MODELOPT input image. We also need to identify whether the source being modeled is in a rural or an urban environment (see Section 8.2.8 of the Guideline on Air Quality Models for a discussion of rural/urban determinations). For this example we are assuming that the facility is in a rural setting. We also need to identify on this input image whether we want the model to calculate concentration values or deposition values. For this example, we are calculating concentration values. After the first three input records our input file will look something like this:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the ISCST2 Model
CO MODELOPT  DFAULT  RURAL  CONC
```

Note that the title parameter field does not need to be in quotations, even though it represents a single parameter. The model simply reads whatever appears in columns 13 through 80 of the TITLEONE card as the title field, without changing the lower case to upper case letters. Leading blanks are therefore significant if the user wishes to center the title within the field. Note also that the spacing and order of the secondary

keywords on the MODELOPT card are not significant. A MODELOPT card that looked like this:

```
CO MODELOPT   RURAL   CONC                DFAULT
```

would have an identical result as the example above. It is suggested that the user adopt a style that is consistent and easy to read. A complete description of the available modeling options that can be specified on the MODELOPT keyword is provided in Section 3.

Since the pollutant in this example is SO_2, we will probably need to calculate average values for 3-hour and 24-hour time periods, and we also need to calculate averages for the full annual time period. Our runstream file might therefore look something like this after adding two more keywords:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the ISCST2 Model
CO MODELOPT  DFAULT  RURAL  CONC
CO AVERTIME  3  24  PERIOD
CO POLLUTID  SO2
```

Note again that the order of the parameters on the AVERTIME keyword is not critical, although the order of the short term averages given on the AVERTIME keyword will also be the order in which the results are presented in the output file. The order of the keywords within each pathway is also not critical in most cases, although the intent of the input runstream file may be easier to decipher if a consistent and logical order is followed. It is suggested that users follow the order in which the keywords are presented in Section 3, in Appendix B, and in the Quick Reference Card, unless there is a clear advantage to doing otherwise.

The only remaining mandatory keywords for the CO pathway are RUNORNOT and FINISHED. We will set the RUNORNOT switch to RUN for this example. If a user is unsure about the operation of certain options, or is setting up a complex runstream file to run for the first time, it may be desirable to set the model NOT to run, but simply to read and analyze the input file and report any errors or warning messages that are generated. Once the input file has been debugged using these descriptive error/warning messages, then the RUNORNOT switch can be set to RUN, avoiding a possible costly waste of resources generating erroneous results. Even if the model is set NOT to run, all of the inputs are summarized in the output file for the user to review.

Our complete runstream file for the CO pathway may look something like this:

```
CO STARTING
CO TITLEONE A Simple Example Problem for the ISCST2 Model
CO MODELOPT  DFAULT  RURAL  CONC
CO AVERTIME  3  24  PERIOD
CO POLLUTID  SO2
CO RUNORNOT  RUN
CO FINISHED
```

The following set of runstream images has a more structured look, but it is equivalent to the example above:

```
CO STARTING
   TITLEONE A Simple Example Problem for the ISCST2 Model
   MODELOPT  DFAULT  RURAL  CONC
   AVERTIME  3  24  PERIOD
   POLLUTID  SO2
   RUNORNOT  RUN
CO FINISHED
```

Since the pathway ID is required to begin in column 1 (see Section 2.4.8 for a discussion of this restriction), the model will assume that the previous pathway is in effect if the

pathway field is left blank. The model will do the same for blank keyword fields, which will be illustrated in the next section.

In addition to these mandatory keywords on the CO pathway, the user may select optional keywords to specify that elevated terrain heights will be used (the default is flat terrain), to allow the use of receptor heights above ground-level for flagpole receptors, to specify a decay coefficient or a half-life for exponential decay, and to generate an input file containing events for processing with the EVENT model. The user also has the option of having the model periodically save the results to a file for later re-starting in the event of a power failure or other interruption of the model's execution. These options are described in more detail in Section 3 of this volume.

2.4.3 Specifying Source Inputs - SO Pathway

Besides the STARTING and FINISHED keywords that are mandatory for all pathways, the SOurce pathway has the following mandatory keywords:

LOCATION - Identifies a particular source ID and specifies the source type and location of that source.

SRCPARAM - Specifies the source parameters for a particular source ID identified by a previous LOCATION card.

SRCGROUP - Specifies how sources will be grouped for calculational purposes. There is always at least one group, even though it may be the group of ALL sources and even if there is only one source.

Since the hypothetical source in our example problem is influenced by a nearby building, we also need to include the optional keywords BUILDHGT and BUILDWID in our input file.

The input file for the SO pathway for this example will look something like this:

```
SO STARTING
SO LOCATION  STACK1  POINT  0.0   0.0   0.0
SO SRCPARAM  STACK1  1.00  35.0  432.0  11.7  2.4
SO BUILDHGT  STACK1  34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT  STACK1  34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT  STACK1  34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDWID  STACK1  35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56
SO BUILDWID  STACK1  15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45
SO BUILDWID  STACK1  35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
SO BUILDWID  STACK1  25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18
SO BUILDWID  STACK1  36.37 36.45 35.43 33.33
SO SRCGROUP  ALL
SO FINISHED
```

There are a few things to note about these inputs. Firstly, the source ID (STACK1 in this example) is an alphanumeric parameter (up to eight characters) that identifies the inputs for different keywords with a particular source. It is crucial that the source be identified with a LOCATION card before any other keyword makes reference to that source, since this identifies the source type (POINT in this case), and therefore which parameters the model will allow. Besides POINT sources, the current versions of the ISC2 models also allow VOLUME and AREA sources to be specified.

Another thing to note is that since the new versions of the models use direction-specific building dimensions for all sources with downwash, there are 36 building heights and 36 building widths entered on the appropriate keywords, one value for each 10 degree sector beginning with the 10 degree flow vector (direction <u>toward</u> which the wind is blowing), and continuing clockwise. Since the user could not fit all 36 values on a single record, the pathway, keyword and source ID were repeated as many times as were necessary. In this case there were 12 values given on each of three lines for the building heights, and eight values on each of four lines plus a line of four values for building widths. There could have been fewer or more lines as long as exactly 36 values were entered

before starting with a new keyword. Since all of the building heights were the same across the sectors (fairly realistic for the height but not for widths, unless the structure was circular), there is a short cut available for specifying numeric input in the runstream files for the new models. The user can specify "repeat values" by entering a field such as "36*34.0" as a parameter for the BUILDHGT keyword. The model will interpret this as "36 separate entries, each with a value of 34.0," and store the values in the appropriate arrays within the model. Since the model must identify this as a single parameter field, there must not be any spaces between the repeat-value and the value to be repeated.

The final keyword before finishing the SO pathway must be the SRCGROUP keyword. In this example, since there is only one source, we have taken advantage of a short cut provided by the model by specifying a source group ID (which may be up to eight characters) of ALL. Whenever this card appears in an input file, it will generate a source group with a source-group ID of ALL, consisting of all sources defined for that run. The sources do not have to be explicitly identified. In a run involving multiple sources, the user may specify multiple source groups by repeating the SRCGROUP keyword. The use of the SRCGROUP card is explained in more detail in Section 3.

Using some of the formatting options discussed above, the SO pathway for our example may look like this, with the same result as above:

```
SO STARTING
   LOCATION  STACK1  POINT  0.0   0.0   0.0

** Point Source       QS    HS    TS    VS   DS
** Parameters:       ----  ----  ----  ----  ---
   SRCPARAM  STACK1  1.00  35.0  432.  11.7  2.4

   BUILDHGT  STACK1  36*34.
   BUILDWID  STACK1  35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56
             STACK1  15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45
             STACK1  35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
             STACK1  25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18
             STACK1  36.37 36.45 35.43 33.33
   SRCGROUP  ALL
SO FINISHED
```

This version of the SO pathway inputs illustrates the use of the comment card to label the stack parameters on the SRCPARAM card, i.e., QS for emission rate (g/s), HS for stack height (m), TS for stack exit temperature (K), VS for exit velocity (m/s), and DS for stack diameter (m). A complete description of the source parameter card, with a list of parameters for each source type, is provided in Section 3.3 and in Appendix B.

Other optional inputs that may be entered on the SO pathway include specifying variable emission rate factors for sources whose emissions vary as a function of month, season, hour-of-day, STAR category, or season and hour-of-day (see Section 3.3.4 for more details). The number of factors entered depends on the option selected, and factors may be input for single sources or for a range of sources. Other keywords allow the user to specify settling velocity categories, mass fractions, and reflection coefficients for sources of large particulates that experience settling and removal of the pollutant as it is dispersed and transported downwind. This option is also explained in more detail in Section 3.

2.4.4 Specifying a Receptor Network - RE Pathway

As mentioned above, this example will illustrate the use of a single polar receptor network centered on the stack location. Other options available on the REceptor pathway include specifying a Cartesian grid receptor network, specifying discrete receptor locations in either a polar or a Cartesian system, and specifying the location of receptors along the boundary around a particular source. These other options are described in more detail in Section 3.4.

For this example we will specify a polar network with receptors located at five downwind distances for every 10-degree flow vector around the plant. There will be a total of 180 receptors. The RE pathway for this example will look something like this:

```
RE STARTING
   GRIDPOLR  POL1  STA
             POL1  ORIG  0.0  0.0
             POL1  DIST  100.  200.  300.  500.  1000.
             POL1  GDIR  36    10.   10.
             POL1  END
RE FINISHED
```

The first thing to note about these inputs is that there is a new set of keywords, including something that looks like a STArting and ENDing. In fact the GRIDPOLR keyword can be thought of as a "sub-pathway," in that all of the information for a particular polar network must be in contiguous records, and that the starting and ending of the sub-pathway are identified. The order of secondary keywords within the sub-pathway is not critical, similar to the main pathways. Each card must be identified with a network ID (up to four alphanumeric characters), in this case it is "POL1." Multiple networks may be specified in a single model run. The model waits until the END secondary keyword is encountered to set the

variables, which may include terrain heights for receptors on elevated terrain or flagpole receptor heights if those options are being exercised by the user. The use of these optional secondary keywords is described in detail in Section 3.4.

For this example, the ORIG secondary keyword specifies the location of the origin, in (X,Y) coordinates, for the polar network being defined. This network is centered at the same (X,Y) location as the source specified above. The ORIG keyword is optional, and the model will default to an origin of (0.0, 0.0) if it is omitted. The DIST keyword identifies the distances along each direction radial at which the receptors will be located. In this case there are five distances. More could be added by adding values to that input card or by including a continuation card, if needed. The GDIR keyword specifies that the model will Generate DIRection radials for the network, in this case there will be 36 directions, beginning with the 10 degree flow vector and incrementing every 10 degrees clockwise. The user may elect to define Discrete DIRection radials instead by using the DDIR keyword in place of the GDIR keyword.

2.4.5 Specifying the Meteorological Input - ME Pathway

The MEteorolgy pathway has the following three mandatory keywords (besides STARTING and FINISHED, of course):

- INPUTFIL - Specifies the filename and format for the input meteorological data file.
- ANEMHGHT - Specifies the anemometer height for the wind data to be used for the modeling run.
- SURFDATA - Specifies information about the surface meteorological data which will be used in the modeling.
- UAIRDATA - Specifies information about the upper air meteorological data (i.e. mixing heights) which will be used in the modeling.

For the purposes of this example we will assume that the meteorological data file is an unformatted (sometimes called "binary") file that was generated by the RAMMET meteorological preprocessor program. The filename is PREPIT.BIN (the sample file that is provided on the SCRAM BBS with the RAMMET model), and it consists of one year of data for Pittsburgh, PA from 1964. The runstream images for the MEteorology pathway would look something like this:

```
ME STARTING
   INPUTFIL  PREPIT.BIN  UNFORM
   ANEMHGHT  20 FEET
   SURFDATA  94823  1964  PITTSBURGH
   UAIRDATA  94823  1964  PITTSBURGH
ME FINISHED
```

The first parameter on the INPUTFIL keyword is the filename, which can be entered as a full DOS pathname, including the drive specification and subdirectories, up to a total of 40 characters. The second parameter is the format of the meteorology data file. In this case the secondary keyword of UNFORM is used to specify that the meteorological data file is of the UNFORMatted type generated by RAMMET (or MPRM). Another option to the user would be to leave the format parameter field blank, in which case the model will assume a default read format for an ASCII file of hourly records. The order of variables assumed for the ASCII file input is as follows: year, month, day, hour, flow vector, wind speed (m/s), temperature (K), stability category, rural mixing height (m), and urban mixing height (m). Other user options for specifying the format for ASCII meteorology files are described more fully in Section 3.5.1.

The ANEMHGHT keyword is important because the input wind speed data are adjusted from the anemometer height to the release height for model calculations, so that differences in anemometer height can significantly effect the modeled results.

For National Weather Service (NWS) data, the user should check records (e.g. the Local Climatological Data summary report) for the particular station to determine the correct anemometer height for the data period used in the modeling, since the anemometer location and height may change over time. The model will assume that the anemometer height is in meters, unless the secondary keyword "FEET" is included in the runstream image, as illustrated in this example. The model will convert inputs in feet to meters.

The final two mandatory inputs identify the location and data period of the input meteorological data. A separate keyword is used for the surface meteorological data and for the upper air (mixing height) data. The parameters on these cards are the station number (e.g. WBAN number for NWS stations), the data period (year), and a station name. It is important that these inputs be provided correctly since the model compares the station number and year from the runstream input file with values provided in the first record of the meteorology file. The user may also optionally input the (X,Y) coordinates for the location of the station(s), although these values are not currently used by the model.

Other optional keywords available on the ME pathway provide the user with options to specify selected days to process from the meteorological data file, a wind direction rotation correction term, and user-specified wind speed profile exponents and/or vertical potential temperature gradients. The wind profile exponents and potential temperature gradients are ignored (and a warning message generated) if the regulatory default option is selected. These optional inputs are described in more detail in Section 3.5.

2.4.6 Selecting Output Options - OU Pathway

All of the keywords on the OUtput pathway are optional, although the model will warn the user if no printed outputs are requested and will halt processing if no outputs (printed results or file outputs) are selected. The following three keywords correspond to the printed result output options available in the previous version of the ISCST model, although the user has greater flexibility to select only the outputs that are needed for a particular application. The printed table keywords are:

RECTABLE - Specifies the selection of high value by receptor table output options.

MAXTABLE - Specifies the selection of overall maximum value table output options.

DAYTABLE - Specifies the selection of printed results (by receptor) for each day of data processed (this option can produce very large files and such be used with care).

The RECTABLE keyword corresponds to the option for highest, second-highest and third-highest values by receptor available in the old ISCST model. The MAXTABLE keyword corresponds to the maximum 50 table option available in the old ISCST model. For both of these keywords, the user has additional flexibility to specify for which short term averaging periods the outputs are selected. For the MAXTABLE keyword the user can also specify the number of overall maximum values to summarize for each averaging period selected, up to a maximum number controlled by a parameter in the computer code. For this example problem we will select the highest and second-highest values by receptor, and the maximum 50 values

for all averaging periods. These OU pathway inputs will look something like this:

```
OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  ALLAVE  50
OU FINISHED
```

To simplify the input for users who request the same printed table output options for all averaging periods, these keywords recognize the secondary keyword "ALLAVE" as the first parameter for that purpose. In order to obtain the overall maximum 10 values for the 24-hour averages only, then the OU pathway images would look like this:

```
OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  24  10
OU FINISHED
```

It should also be noted that these output table options apply only to the short-term averaging periods, such as the 3-hour and 24-hour averages used in our example. If the user has selected that PERIOD averages be calculated (on the CO AVERTIME keyword), then the output file will automatically include a table of period averages summarized by receptor (the RECTABLE option does not apply since there is only one period value for each receptor). In addition, the printed output file will include tables summarizing the highest values for each averaging period and source group.

Other options on the OU pathway include several keywords to produce output files for specialized purposes, such as generating contour plots of high values, identifying occurrences of violations of a particular threshold value (e.g. a NAAQS), and for postprocessing of the raw concentration data. These options are described in detail in Section 3.6.

The complete input runstream file for this simple example is shown in Figure 2-2. Note that a consistent style has been used for formatting and structuring the file in order to improve its readability. This input file is comparable to the version shown earlier in Figure 2-1, which used a somewhat different style.

```
CO STARTING
   TITLEONE A Simple Example Problem for the ISCST2 Model
   MODELOPT  DFAULT  RURAL  CONC
   AVERTIME  3  24  PERIOD
   POLLUTID  SO2
   RUNORNOT  RUN
CO FINISHED

SO STARTING
   LOCATION  STACK1  POINT  0.0   0.0   0.0

** Point Source       QS    HS    TS    VS   DS
** Parameters:       ----  ----  ----  ----  ---
   SRCPARAM  STACK1  1.00  35.0  432.  11.7  2.4

   BUILDHGT  STACK1  36*34.
   BUILDWID  STACK1  35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56
             STACK1  15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45
             STACK1  35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
             STACK1  25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18
             STACK1  36.37 36.45 35.43 33.33
   SRCGROUP  ALL
SO FINISHED

RE STARTING
   GRIDPOLR  POL1  STA
             POL1  ORIG  0.0  0.0
             POL1  DIST  100.  200.  300.  500.  1000.
             POL1  GDIR  36    10.   10.
             POL1  END
RE FINISHED

ME STARTING
   INPUTFIL  PREPIT.BIN  UNFORM
   ANEMHGHT  20 FEET
   SURFDATA  94823  1964  PITTSBURGH
   UAIRDATA  94823  1964  PITTSBURGH
ME FINISHED

OU STARTING
   RECTABLE  ALLAVE  FIRST  SECOND
   MAXTABLE  ALLAVE  50
OU FINISHED
```

FIGURE 2-2. EXAMPLE INPUT RUNSTREAM FILE FOR SAMPLE PROBLEM

2.4.7 Using the Error Message File to Debug the Input Runstream File

The previous sections in this tutorial have lead through the step-by-step construction of a sample runstream input file for ISCST2. This simple example problem illustrated the usage of the most commonly used options of the ISCST2 model. However, many real-time applications of the model will be much more complex than this example, perhaps involving multiple sources

and source groups, multiple receptor networks, the addition of discrete receptor locations, and/or elevated terrain heights. Since humans are prone to make errors from time to time, an effort has been made to develop improved error handling capabilities for the ISC2 models.

The error handling capabilities of the ISC2 models are designed to accomplish two things for the user. First, the model should read through the complete input file and report all occurrences of errors or suspect entries before stopping, rather than stopping on the first instance (and every instance thereafter) of an error in the input file. Second, the model should provide error and warning messages that are detailed and descriptive enough that they will help the user in his/her effort to debug the input file. The remainder of this section provides of brief introduction to the use of the model's error handling capabilities. Appendix E of this volume provides more details about the error handling provided by the ISC2 models, including a listing and explanation of all error and other types of messages generated by the models.

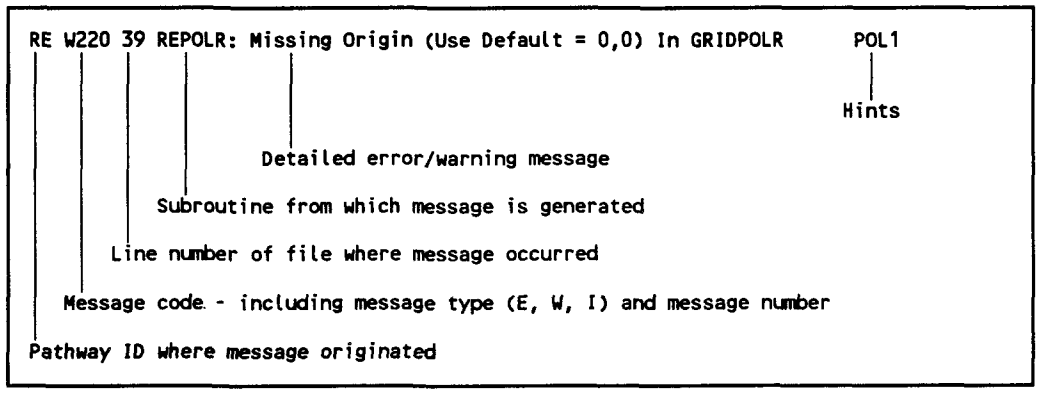
The ISC2 models generate messages during the processing of the input data and during the execution of model calculations. These messages inform the user about a range of possible conditions including:

- Errors that will halt any further processing, except to identify additional error conditions;
- Warnings that do not halt processing but indicate a possible errors or suspect conditions; and
- Informational messages that may be of interest to the user but have no direct bearing on the validity of the results.

As the model encounters a condition for which a message is generated, the model writes the message to a temporary storage file. At the completion of the setup processing for a run, and

at the completion of the model calculations, the model rereads the message file and generates a summary of the messages which is included in the main printed output file. If the processing of the model setup information indicates no errors or warnings, and the user has selected the option to RUN the model calculations on the CO RUNORNOT card, then the model will simply write a statement to the print file that the model setup was completed successfully. Otherwise, the model will report a summary of the messages encountered. The summary of model setup messages that would be generated for the example problem if the option NOT to run was chosen is shown in Figure 2-3. This summary table reports the total number of occurrences for each of the message types, and lists the detailed message for any fatal errors or warning messages that were generated. In this case, since there were no errors or suspicious conditions in the setup file, there are no error or warning messages listed.

An example of the warning message that would have been generated had we left out the card on the RE pathway that specifies the origin of the polar receptor network is shown below:



Since this is a warning message, it would have appeared at the end of the message summary table in the output file, but it would not have halted processing of the data. The last item on

the message line, "Hints," may include such information as the keyword or parameter name causing the error, the source ID, group ID or (as in this case) the network ID involved, or perhaps the date variable identifying when the message occurred during the processing of the meteorological data, such as an informational message identifying the occurrence of a calm wind.

For new users and for particularly complex applications, it is strongly recommended that the model first be run with the RUNORNOT keyword (on the CO pathway) set NOT to run. In this way, the user can determine if the model is being setup properly by the runstream file before committing the resources to perform a complete run. The user should make a point of examining any warning messages carefully to be sure that the model is operating as expected for their application, since these messages will not halt processing by the model. In most cases, the detailed messages will provide enough information for the user to determine the location and nature of any errors in the runstream setup file. If the intent of the message is not immediately clear, then the user should refer to the more detailed descriptions provided in Appendix E for the particular error code generated.

In deciphering the error and warning messages, the line number provided as part of the message may be particularly helpful in locating the error within the input file. However, if it is an error of omission that is caught by the error checking performed at the completion of inputs for a pathway, then the line number will correspond to the last record for that pathway. The user may need to examine all of the messages carefully before locating the error or errors, especially since a single occurrence of certain types of errors may lead to other error conditions being identified later in the input file which do not really constitute errors in themselves. An example of this is provided in Figure 2-4, which shows some

inputs for the SO pathway where the building dimension keywords have been typed incorrectly, and the associated list of error messages. Since continuation cards were being used for the building width inputs, and the keyword was entered incorrectly on the first line, the subsequent records were also taken by the model to be invalid keyword inputs. While the error messages are the same for these records, the message originates from a different part of the model (SUBROUTINE SOCARD) for the records with the blank keyword.

Since the detailed error and warning messages are listed in the output file as part of the message summary table, there will generally not be a need for the user to examine the contents of the detailed message file. For this reason, the default operation of the model is to write the messages that are generated by a particular run to a temporary file that is deleted when the run is completed. If the user wishes to examine the complete list of detailed messages (of all types), there is an optional keyword available on the CO pathway for that purpose. The ERRORFIL keyword, which is described in

detail in Section 3.2.7, allows the user to save the complete list of detailed messages to a user-specified filename.

```
  *** Message Summary For ISC2 Model Setup ***


  --------- Summary of Total Messages ---------

A Total of           0 Fatal Error Message(s)
A Total of           0 Warning Message(s)
A Total of           0 Information Message(s)


   ******** FATAL ERROR MESSAGES ********
               ***  NONE  ***


   ********   WARNING MESSAGES   ********
               ***  NONE  ***


   ************************************
   *** SETUP Finishes Successfully ***
   ************************************
```

FIGURE 2-3. EXAMPLE MESSAGE SUMMARY TABLE FOR RUNSTREAM SETUP

```
SO STARTING
   LOCATION  STACK1  POINT  0.0   0.0   0.0
** Point Source      QS    HS    TS     VS   DS
** Parameters:       ----  ----  ----   ----  ---
   SRCPARAM  STACK1  1.00  35.0  432.0  11.7  2.4
   BUILDHTS  STACK1  36*34.
   BUILDWTS  STACK1  35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56
             STACK1  15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45
             STACK1  35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
             STACK1  25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18
             STACK1  36.37 36.45 35.43 33.33
   SRCGROUP  ALL
SO FINISHED
```

```
 *** Message Summary For ISC2 Model Setup ***
 --------- Summary of Total Messages ---------
A Total of           6 Fatal Error Message(s)
A Total of           0 Warning Message(s)
A Total of           0 Information Message(s)

   ******** FATAL ERROR MESSAGES ********
SO E105   17 EXKEY : Invalid Keyword Specified. The Troubled Keyword is BUILDHTS
SO E105   18 EXKEY : Invalid Keyword Specified. The Troubled Keyword is BUILDWTS
SO E105   19 SOCARD: Invalid Keyword Specified. The Troubled Keyword is BUILDWTS
SO E105   20 SOCARD: Invalid Keyword Specified. The Troubled Keyword is BUILDWTS
SO E105   21 SOCARD: Invalid Keyword Specified. The Troubled Keyword is BUILDWTS
SO E105   22 SOCARD: Invalid Keyword Specified. The Troubled Keyword is BUILDWTS

   ********   WARNING MESSAGES   ********
              ***  NONE  ***

   ************************************
   *** SETUP Finishes UN-successfully ***
   ************************************
```

FIGURE 2-4. EXAMPLE OF KEYWORD ERROR AND ASSOCIATED MESSAGE SUMMARY TABLE

2.4.8 Running the Model and Reviewing the Results

Now that we have a complete and error-free runstream input file, we are ready to run the model and then review the results. Running the model on the PC is similar to running the previous version of the model on the PC, although we now have to specify the meteorology filename from the runstream file.

instead of on the command line. Also, the PC-executable files available on the SCRAM BBS open the runstream input and printed output files explicitly within the model, so there is no need to "redirect" the I/O on the command line using the DOS redirection symbols '<' and '>'. The command line to run the sample problem might look something like this on the PC:

```
C:\>ISCST2 TEST-ST.INP TEST-ST.OUT
```

The "c-prompt" of DOS has been represented by the characters "C:\>", but may appear different on different machines. The important points are that the ISCST2.EXE file either be in the directory from which you are attempting to run the model, or in a directory that is included on the DOS PATH command when the system is "booted-up." The runstream input filename must appear first (without any DOS "redirection" symbol), followed by the desired output filename (also without the DOS redirection symbol), and these files must also be located in the directory from which the model is being executed, unless a complete DOS pathname is provided on the command line.

As mentioned above, the SCRAM PC-executable files for ISC2 open the input and output files explicitly. One reason for this is to allow for the models to write an update on the status of processing to the PC terminal screen. For the ISCST2 model, the model first indicates that setup information is being processed and then gives the Julian day currently being processed. If no status message is seen then the model did not load into memory properly. If the model stops after completing the setup processing, then either the RUNORNOT option was set NOT to run, or a fatal error was encountered during the setup processing. Another reason for not sending the printed output to the default output device (i.e., to the screen or redirected to a file), is so that any DOS error messages will be visible on the screen and not be written to the printed file. One such message might be that there is insufficient memory available to

run the program. Handling of DOS error messages may require some knowledge of DOS, unless the meaning of the message is obvious.

The order of contents and organization of the main output file for the ISC2 models is presented in Figure 2-5.

```
Echo of Input Runstream Images

Summary of Runstream Setup Messages

Summary of Inputs
     Summary of Modeling Options
     Summary of Source Data
     Summary of Receptor Data
     Summary of Meteorology Data

Model Results

     Daily Results for Each Averaging Period Selected for
         Each Day Processed (If Applicable)
         - DAYTABLE Keyword

     Period Results for Each Source Group (If Applicable)
         - PERIOD Parameter on AVERTIME Keyword

     Short Term Average Results (High, Second High, etc.)
         by Receptor for Each Source Group (If Applicable)
         - RECTABLE Keyword

     Overall Maximum Short Term Average Results for Each
         Source Group (If Applicable)
         - MAXTABLE Keyword

Summary Tables of High Values for Each Averaging Period and
     Source Group (Always provided if PERIOD averages or the
     RECTABLE keyword are used)

Summary of Complete Model Execution Messages
```

FIGURE 2-5. ORGANIZATION OF ISCST2 MODEL OUTPUT FILE

Each page of the output file, except for the echo of the input file images, is labeled with the model name and version number, user-specified title(s), page number, and, for the PC version of the model, the date and time of the particular run. Also

included as part of the header information for each page is a one-line summary of the modeling options used for that particular run. The modeling options are listed as the secondary keywords used to control the options, such as URBAN or RURAL, CONC or DEPOS, DFAULT, NOCALM, etc. (Details about the date/time routines used on the PC version and how these non-standard routines are bypassed on other systems are provided in Volume III.)

Since the complete input file is normally echoed back as part of the output file, and since processing of the inputs stops when the OU FINISHED card is reached, the run can be duplicated by simply specifying the output filename as the input runstream file. Alternatively, the input records could be "cut and pasted" from the output file to a separate file using a text editor. Since the outputs are not being printed to the default output device by the DOS PC version, the input records in the printed output file will all be shifted by one column to the right (the first column is normally used for Fortran carriage control, and is left blank in case the model is ported to a system where the default output device is used). The model will still run properly with these inputs, since it has been written to allow a shift of up to three columns to the right, as long as each input record is shifted by the same amount. However, each successive run of the model will shift the inputs one more column, and there will be the risk that parts of the record beyond column 80 will be lost, possibly resulting in an error message or invalid results.

By default, the models will echo each line of the input runstream file to the printed output file. This provides a convenient record of the inputs as originally read into the model, without any rounding of numerical values that may appear in the input summary tables. As noted above, it also means that the output file can be used as an input file to the model to reproduce a particular application. However, for some

applications, the length of the input runstream file may be too cumbersome to include the entire set of inputs at the beginning of each output file. This may happen, for example, if a large number of sources are being defined or if a large number of discrete receptor locations are used. For this reason, the user is provided with the option to "turn off" the echoing of the input file at any point within the runstream file. This is accomplished by entering the keywords "NO ECHO" in the first two fields anywhere within the runstream file. In other words, place NO in the pathway field, followed by a space and then ECHO. None of the input runstream images after the NO ECHO will be echoed to the output file. Thus, a user may choose to place NO ECHO after the COntrol pathway in order to keep the control options echoed, but suppress echoing the rest of the input file.

The details of the message summary tables were discussed in the previous section. An example of the summary of modeling option inputs is shown in Figure 2-6 for the simple example described in this section. For the new model, the summary of source parameter input data includes separate tables for each source type, rather than combining all sources onto a single table. In this way the column headings are specific to the source type, and avoid the confusion of the earlier model.

Figure 2-7 presents an example of the results output for the second highest values by receptor for our sample problem. These values are the second highest 24-hour averages at each receptor location. Note that several of the numbers are followed by a 'c.' This flag indicates that the average included at least one calm hour during the averaging period. The number in parentheses following each concentration value is the date corresponding to each value. The date is given as an eight digit integer variable that includes the year (2-digits), month, day, and hour corresponding to the end of the averaging period. Since these are 24-hour averages and are based on

block (end-to-end) rather than running averages, all of the dates end on hour 24.

For each of the different types of model result tables, the controlling keyword is identified above at the end of the description. All of the outputs of the same type, e.g. high values by receptor, are printed together, and the order of tables loops through all source groups for a particular averaging period, and then loops through all averaging periods. The summary tables of high values at the end of the model results follow the same order of loops. An example of the summary tables for our sample problem is shown in Figure 2-8. The summaries for all averaging periods have been combined onto a single figure, but would appear on separate pages of the actual output file.

```
*** ISCST2 - VERSION 92062 ***    *** A Simple Example Problem for the ISCST2 Model          ***      03/02/92
                                  ***                                                       ***      12:00:00
                                                                                                     PAGE   1

*** MODELING OPTIONS USED:  CONC   RURAL  FLAT DFAULT

                                        ***     MODEL SETUP OPTIONS SUMMARY       ***
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

**Model Is Setup For Calculation of Average CONCentration Values.

**Model Uses RURAL Dispersion.

**Model Uses Regulatory DEFAULT Options:
          1. Final Plume Rise.
          2. Stack-tip Downwash.
          3. Buoyancy-induced Dispersion.
          4. Use Calms Processing Routine.
          5. Not Use Missing Data Processing Routine.
          6. Default Wind Profile Exponents.
          7. Default Vertical Potential Temperature Gradients.
          8. "Upper Bound" Values for Supersquat Buildings.
          9. No Exponential Decay for Rural Mode

**Model Assumes Receptors on FLAT Terrain.

**Model Assumes No FLAGPOLE Receptor Heights.

**Model Calculates  2 Short Term Average(s) of:   3-HR  24-HR
    and Calculates PERIOD Averages

**There Are    1 Source(s);      1 Source Group(s); and    180 Receptor(s)

**The Model Assumes A Pollutant Type of:  SO2

**Model Set To Continue RUNning After the Setup Testing.

**Output Options Selected:
        Model Outputs Tables of PERIOD Averages by Receptor
        Model Outputs Tables of Highest Short Term Values by Receptor (RECTABLE Keyword)
        Model Outputs Tables of Overall Maximum Short Term Values (MAXTABLE Keyword)

**NOTE:  The Following Flags May Appear Following CONC Values: c for Calm Hours
                                                               m for Missing Hours
                                                               b for Both Calm and Missing Hours

**Misc. Inputs:  Anem. Hgt. (m) =     6.10 ;    Decay Coef. = .0000     ;    Rot. Angle =      .0
                 Emission Units = GRAMS/SEC ;  Emission Rate Unit Factor =    .10000E+07
                 Output Units   = MICROGRAMS/M**3
```

FIGURE 2-6. EXAMPLE MODEL OPTION SUMMARY TABLE FROM AN ISC2 MODEL OUTPUT FILE

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE 2ND HIGHEST 24-HR AVERAGE CONCENTRATION VALUES FOR SOURCE GROUP: ALL ***
INCLUDING SOURCE(S): STACK1 ,

*** NETWORK ID: POL1 ; NETWORK TYPE: GRIDPOLR ***
** CONC OF SO2 IN MICROGRAMS/M**3 **

DIRECTION (DEGREES)	DISTANCE (METERS) 100.00	200.00	300.00	500.00	1000.00
10.0	2.71554c(64090324)	6.67232c(64062324)	4.42707c(64062324)	2.18815 (64082824)	1.19711 (64082824)
20.0	.44236c(64052124)	10.28463c(64022324)	6.96574c(64022324)	3.18978 (64082224)	1.63925c(64022324)
30.0	.17184 (64030124)	9.85105 (64111124)	6.59831 (64082324)	3.23402 (64082324)	1.64196 (64111124)
40.0	4.05090 (64050724)	11.01469 (64111224)	7.89729 (64111224)	4.16514 (64011524)	2.11710 (64011524)
50.0	19.16218 (64010224)	14.96328 (64010224)	10.82979 (64010224)	5.54154 (64011624)	2.73929 (64011624)
60.0	12.35331 (64112224)	8.77614c(64090424)	6.28799 (64041024)	2.98714 (64012524)	1.63003 (64121424)
70.0	9.02535 (64092424)	7.99603 (64092424)	5.89014 (64092424)	2.88788 (64010424)	1.65078 (64092424)
80.0	5.06520 (64112124)	6.40739 (64112124)	4.74408 (64112124)	2.55844 (64011024)	1.49710c(64032724)
90.0	1.68559 (64112124)	2.19678 (64112124)	1.66265 (64112124)	1.07166 (64032624)	.69802 (64010424)
100.0	2.66341 (64040924)	3.13590 (64040824)	2.22915 (64121824)	1.09655 (64051024)	.71595 (64051024)
110.0	6.83261 (64121824)	5.79770 (64121824)	4.27077 (64121824)	2.00392 (64121824)	1.09398 (64121824)
120.0	11.71061 (64031824)	8.50432 (64031824)	6.11431 (64031824)	3.12291 (64031824)	1.64605 (64031824)
130.0	16.05277c(64081924)	9.89747c(64090524)	6.88463c(64090524)	3.72998c(64081924)	2.10878c(64081924)
140.0	3.29226 (64101024)	9.15877c(64052524)	6.15151c(64052524)	3.15633c(64052524)	1.52434c(64052524)
150.0	.18564c(64041524)	8.50791 (64021624)	6.00712 (64021624)	3.31153 (64021624)	1.56689c(64052524)
160.0	.17527 (64011324)	8.83049c(64061624)	5.99124 (64072924)	3.08596c(64061624)	1.65611c(64061624)
170.0	3.47711 (64052824)	7.43029 (64113024)	5.01844 (64113024)	2.48778 (64113024)	1.18052 (64113024)
180.0	17.47922 (64060124)	11.12898 (64060124)	7.42250 (64060124)	3.85228c(64091124)	1.91279c(64091124)
190.0	3.16602 (64090124)	12.75750c(64021124)	8.45298c(64021124)	4.01492c(64021124)	1.99520c(64021124)
200.0	.16059c(64073024)	10.86819c(64080624)	7.51403c(64080624)	4.03296c(64080624)	2.02005 (64122724)
210.0	.10566 (64053024)	2.03903c(64091524)	1.17021c(64091524)	.52926c(64091524)	.39925 (64093024)
220.0	1.89370c(64021824)	6.55822 (64073124)	4.36206 (64073124)	2.94145c(64101424)	1.66903c(64101424)
230.0	12.19118c(64021824)	7.74898c(64021824)	5.06357c(64021824)	2.32321 (64040524)	1.25836 (64040524)
240.0	10.58376 (64042524)	7.25489 (64042524)	5.63061c(64103124)	2.96244 (64011224)	1.52340 (64101624)
250.0	5.38213 (64050124)	4.53138 (64050124)	3.31738 (64050124)	1.58103 (64050124)	1.08642 (64050124)
260.0	2.14076 (64050124)	2.30836 (64050124)	1.69570 (64050124)	.92923 (64011224)	.58775 (64112524)
270.0	.36025 (64112524)	.45349 (64080324)	.30214 (64080324)	.21800c(64080624)	.28354c(64080624)
280.0	1.76597 (64042924)	1.64920 (64042924)	1.01601 (64042924)	.40989 (64042624)	.42157 (64042924)
290.0	6.83110 (64042924)	5.53660 (64042924)	3.84305 (64042924)	1.52813 (64042924)	1.06812 (64042924)
300.0	12.90372 (64050224)	9.50182 (64050224)	6.93072 (64050224)	2.99970 (64010824)	1.73656 (64050224)
310.0	17.10543 (64042624)	10.94597c(64031324)	7.28243 (64100124)	3.86108 (64100124)	1.97803 (64042624)
320.0	3.65464 (64041324)	8.17806 (64092024)	5.15071 (64092024)	2.48078 (64100124)	1.41601 (64012224)
330.0	.15640 (64050624)	5.17366 (64030624)	3.37007 (64030624)	1.64493c(64092624)	.94371 (64030624)
340.0	.19178c(64061824)	8.41811c(64041624)	5.46671c(64041624)	2.71718 (64122424)	1.42183 (64122424)
350.0	2.32522 (64081124)	9.89359 (64122324)	6.08236 (64122324)	2.81776c(64102124)	1.48921c(64102124)
360.0	10.60564c(64042024)	7.24821 (64100824)	4.68091c(64092624)	2.34005 (64041324)	1.25130 (64100824)

FIGURE 2-7. EXAMPLE OUTPUT TABLE OF HIGH VALUES BY RECEPTOR

*** MODELING OPTIONS USED: CONC RURAL FLAT DFAULT

*** THE SUMMARY OF MAXIMUM PERIOD (240 HRS) RESULTS ***
** CONC OF SO2 IN MICROGRAMS/M**3 **

NETWORK GROUP ID	AVERAGE CONC	RECEPTOR (XR, YR, ZELEV, ZFLAG)	OF TYPE	GRID-ID
ALL	1ST HIGHEST VALUE IS 2.17785	AT (76.60, 64.28, .00, .00)	GP	POL1
	2ND HIGHEST VALUE IS 1.92925	AT (86.60, 50.00, .00, .00)	GP	POL1
	3RD HIGHEST VALUE IS 1.64972	AT (76.60, -64.28, .00, .00)	GP	POL1
	4TH HIGHEST VALUE IS 1.55566	AT (153.21, 128.56, .00, .00)	GP	POL1
	5TH HIGHEST VALUE IS 1.39265	AT (-76.60, 64.28, .00, .00)	GP	POL1
	6TH HIGHEST VALUE IS 1.30548	AT (173.21, 100.00, .00, .00)	GP	POL1

*** THE SUMMARY OF HIGHEST 3-HR RESULTS ***

** CONC OF SO2 IN MICROGRAMS/M**3 **

GROUP ID	AVERAGE CONC	DATE (YYMMDDHH)	RECEPTOR (XR, YR, ZELEV, ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL HIGH 1ST HIGH VALUE IS	81.64407	ON 64031321: AT (-76.60, 64.28, .00, .00)	GP	POL1
HIGH 2ND HIGH VALUE IS	61.58743	ON 64022721: AT (-76.60, 64.28, .00, .00)	GP	POL1

*** THE SUMMARY OF HIGHEST 24-HR RESULTS ***

** CONC OF SO2 IN MICROGRAMS/M**3 **

GROUP ID	AVERAGE CONC	DATE (YYMMDDHH)	RECEPTOR (XR, YR, ZELEV, ZFLAG)	OF TYPE	NETWORK GRID-ID
ALL HIGH 1ST HIGH VALUE IS	24.60251	ON 64011624: AT (76.60, 64.28, .00, .00)	GP	POL1
HIGH 2ND HIGH VALUE IS	19.16218	ON 64010224: AT (76.60, 64.28, .00, .00)	GP	POL1

*** RECEPTOR TYPES: GC = GRIDCART
GP = GRIDPOLR
DC = DISCCART
DP = DISCPOLR
BD = BOUNDARY

FIGURE 2-8. EXAMPLE OF RESULT SUMMARY TABLES FOR THE ISC2 SHORT TERM MODEL

2.5 MODIFYING AN EXISTING RUNSTREAM FILE

As noted earlier, one of the advantages of the keyword/parameter approach and the flexible format adopted for the input runstream file is that it will be easier for the user to make modifications to the runstream file and obtain the desired result. This section briefly illustrates some examples of how a runstream file can be modified. It is assumed that the reader is familiar with the operation of and basic editing commands for a text editor (i.e., a program that edits ASCII files), and is familiar with the previous sections of this tutorial.

2.5.1 Modifying Modeling Options

Depending on the type of analysis being performed, the user may need to modify the modeling options and run the model again. Because of the descriptive nature of the keywords and the secondary keywords used to control the modeling options, this can easily be done with the new runstream file, and usually without having to refer back to the user's guide each time a modification is attempted.

One example where a modeling option would need to be changed is if a modeler wanted to obtain both concentration estimates and estimates of dry deposition for a source or sources of large particulates. The only change needed to accomplish this is to replace the secondary keyword of CONC (for CONCentration) with the secondary keyword of DEPOS (for DEPOSition) on the MODELOPT input card. None of the source information needs to be changed since the model automatically converts the emission rates to the proper units for deposition calculations. It is equally easy to modify a run to use urban dispersion instead of rural dispersion (or vice versa) by replacing the RURAL secondary keyword with URBAN on the

MODELOPT card. As noted earlier, the order and exact spacing of the secondary keywords on the MODELOPT card is not important.

Another modeling option change that will be discussed here is switching between flat and elevated terrain modeling. As noted earlier, the model assumes flat terrain, i.e., all receptors are assumed to be at the same elevation as the base elevation for the source as the default mode of operation. If the user wishes to model receptors on elevated terrain, then the TERRHGTS keyword must be included on the CO pathway. This keyword, which is described in more detail in Section 3.2.3, accepts one of two possible secondary keywords, either FLAT or ELEV. Their meaning should be obvious. Note that the input runstream image:

```
CO TERRHGTS   FLAT
```

has the same effect as having no TERRHGTS keyword at all. One difference between ISC2 and the older version of ISC is that if the user elects to perform FLAT terrain modeling for a particular application, the model will ignore any elevated terrain height information given on the RE pathway. Processing will continue as flat terrain, and warning messages will be generated to warn the user that elevated terrain heights were present in the file, but ignored for processing. The advantage of this approach is that if an application is setup for elevated terrain modeling, a simple change of the secondary keyword on the TERRHGTS card from ELEV to FLAT is all that is needed to run the model in flat terrain mode. The terrain height information does not need to be removed from the input file as in the previous versions of the model.

2.5.2 Adding or Modifying a Source or Source Group

Modifying the input file to add a source or a source group, or to add a source to a source group, is as simple as just adding it. There is no need to specify the total number of sources in the run, which would then have to be changed if more sources were added. The same applies to the number of groups, or the number of sources per group. If the user attempts to input more than the total number of sources or groups allowed for a particular run, an error message will be generated to that effect. Also, modifying a source group to delete a source is as easy as just deleting it from the input card, without having to change any other inputs.

Another way of "deleting" a source or a group from an input file is to place a "**" in the pathway field of the card or cards which define the source or group to "comment out" those inputs. This approach, which was discussed above in Section 2.1.2, has the advantage of leaving the input data for the source or group in the input file for possible later use. It doesn't matter whether the "**" is entered with the text editor in "insert" mode, in which case the other inputs of that line are moved over, or if it is in "overtype" mode, which would replace the pathway ID that was already there.

2.5.3 Adding or Modifying a Receptor Network

As with source data, adding to or modifying the receptor information in the ISC2 MODELS is relatively straight forward. The problem of having to make several changes to accomplish one small modification, such as adding a distance to a polar receptor network, has been avoided in the new model. All that the user needs to do is to add the new distance on the appropriate input card, which is easily identifiable because of the use of descriptive keywords. The model checks to ensure that the user does not attempt to specify more than the maximum

number of receptors for a particular run, and generates an appropriate message if too many are input.

2.5.4 Modifying Output Options

Modifying the output options involves many of the same principles that are described above. In addition, all of the output options are structured in a way that allows the user to select options for specific averaging periods, so that the user may find it useful to copy a record or group of records set up for one averaging period and simply change the averaging period parameter. The other important short cut that is available for the printed table output options is to use the secondary keyword ALLAVE to indicate that the option applies to all averaging periods that are calculated. In this way, there will be no need to change the output options if a new averaging period is added to a run or if one is deleted.

3.0 DETAILED KEYWORD REFERENCE

This section of the ISC2 User's Guide provides a detailed reference for all of the input keyword options for the ISC2 Short Term and Long Term models. The information provided in this section is more complete and detailed than the information provided in the Brief Tutorial in Section 2. Since this section is intended to meet the needs of experienced modelers who may need to understand completely how particular options are implemented in the model, the information for each keyword should stand on its own. This section assumes that the reader has a basic understanding of the keyword/parameter approach used by the new models for specification of input options and data. Novice users should first review the contents of Section 2 in order to obtain that understanding.

The information in this section is organized by function, i.e., the keywords are grouped by pathway, and are in a logical order based on their function within the model. The order of keywords presented here is the same as the order used in the functional keyword reference in Appendix B, and the Quick Reference Card pull-out at the end of the volume. The syntax for each keyword is provided, and the keyword type is specified - either mandatory or optional and either repeatable or non-repeatable. Unless noted otherwise, there are no special requirements for the order of keywords within each pathway, although the order in which the keywords are presented here and in Appendix B is recommended. Any keyword which has special requirements for its order within the pathway is so noted following the syntax and type description.

The syntax descriptions in the following sections use certain conventions. Parameters that are in all capital letters and underlined in the syntax description are secondary keywords that are to be entered as indicated for that keyword. Other parameters are given descriptive names to convey the

meaning of the parameter, and are listed with an initial capital letter. Many of the parameter names used correspond to variable names used in the computer code of the models. Parentheses around a parameter indicate that the parameter is optional for that keyword. The default that is taken when an optional parameter is left blank is explained in the discussion for that keyword.

3.1 AN OVERVIEW OF SHORT TERM VS. LONG TERM MODEL INPUTS

One of the goals of the reprogramming effort was to make the inputs for the new Short Term and Long Term models as consistent as possible. As a result, the majority of keywords are the same for both models. Because of this similarity, and because the Short Term model is the more widely used of the two, the discussions in the following sections are oriented toward the Short Term model. Any differences in the parameters for a keyword for the Long Term model are highlighted so that they are easily distinguishable. Also, any keyword that applies to only one of the models includes a note to that effect. There is no separate reference for the Long Term model inputs as there was in the user's guide for the previous versions of the models.

Also, unless otherwise noted, the input keywords described below apply to both the ISCST2 and the ISCEV2 (EVENT) Short Term models. In addition to the isolated keywords noted that apply to only one or the other model, the entire REceptor pathway applies only to ISCST2, and the EVent pathway applies only to the ISCEV2 model.

3.2 CONTROL PATHWAY INPUTS AND OPTIONS

The COntrol pathway contains the keywords that provide the overall control of the model run. These include the dispersion options, averaging time options, terrain height options, and

others that are described below. The CO pathway must be the first pathway in the runstream input file.

3.2.1 Title Information

There are two keywords that allow the user to specify up to two lines of title information that will appear on each page of the main output file from the model. The first keyword, TITLEONE, is mandatory, while the second keyword, TITLETWO, is optional. The syntax and type for the keywords are summarized below:

Syntax:	CO TITLEONE Title1 CO TITLETWO Title2
Type:	TITLEONE - Mandatory, Non-repeatable TITLETWO - Optional, Non-repeatable

The parameters Title1 and Title2 are character parameters of length 68, which are read as a single field from columns 13 to 80 of the input record. The title information is taken as it appears in the runstream file without any conversion of lower case to upper case letters. If the TITLETWO keyword is not included in the runstream file, then the second line of the title in the output file will appear blank.

3.2.2 Dispersion Options

The dispersion options are controlled by the MODELOPT keyword on the CO pathway. The syntax, type, and order of the MODELOPT keyword are summarized below:

Syntax:	CO MODELOPT	DFAULT	CONC or DEPOS	RURAL or URBAN	GRDRIS	NOSTD	NOBID	NOCALM	MSGPRO
Type:	Mandatory, Non-repeatable								
Order:	Must precede POLLUTID, HALFLIFE and DCAYCOEF								

where the secondary keyword parameters are described below (the order and spacing of the parameters is not critical):

DFAULT - Specifies that the regulatory default options will be used;

CONC - Specifies that CONCentration values will be calculated;

DEPOS - Specifies that dry DEPOSition values will be calculated;

RURAL - Specifies that RURAL dispersion parameters will be used;

URBAN - Specifies that URBAN dispersion parameters will be used;

GRDRIS - Specifies that the non-default option of gradual plume rise will be used;

NOSTD - Specifies that the non-default option of no stack-tip downwash will be used;

NOBID - Specifies that the non-default option of no buoyancy-induced dispersion will be used;

NOCALM - Specifies that the non-default option to bypass the calms processing routine will be used (Short Term only); and

MSGPRO - Specifies that the non-default option of the missing data processing routine will be used (Short Term only).

If the DFAULT secondary keyword is included among the parameter fields, then any non-default option will be overridden. This includes the non-default options that may be specified on the MODELOPT keyword, and also any attempt to enter non-default values of the wind profile exponents (see keyword WINDPROF on the ME pathway) or vertical potential temperature gradients (see keyword DTHETADZ on the ME pathway). If the DFAULT parameter is not specified, then the regulatory default options will still be used unless a non-default option is specified in the input runstream. The model will also assume RURAL dispersion if neither the RURAL or URBAN keywords

are present, and will assume CONCentration calculations if neither the CONC or DEPOS keywords are used. Non-fatal warning messages are generated in either case.

The regulatory default options are identified in Appendix A of the Guideline on Air Quality Models (Revised) (EPA, 1987b), and include the following:

- Use stack-tip downwash (except for Schulman-Scire downwash);
- Use buoyancy-induced dispersion (except for Schulman-Scire downwash);
- Do not use gradual plume rise (except for building downwash);
- Use the calms processing routines;
- Use upper-bound concentration estimates for sources influenced by building downwash from super-squat buildings;
- Use default wind speed profile exponents; and
- Use default vertical potential temperature gradients.

The default wind profile exponents and vertical potential temperature gradients are provided below:

Pasquill Stability Category	Rural Wind Profile Exponent	Urban Wind Profile Exponent	Rural Temperature Gradient (K/m)	Urban Temperature Gradient (K/m)
A	0.07	0.15	0.0	0.0
B	0.07	0.15	0.0	0.0
C	0.10	0.20	0.0	0.0
D	0.15	0.25	0.0	0.0
E	0.35	0.30	0.020	0.020
F	0.55	0.30	0.035	0.035

The missing data processing routines, that are included in the ISC2 Short Term model as a non-regulatory option, allow the model to handle missing meteorological data in the processing of short term averages. With this option selected, the model treats missing meteorological data in the same way as the calms processing routine, i.e., it sets the concentration (or deposition) values to zero for that hour, and calculates the short term averages according to EPA's calms policy. Calms and missing values are tracked separately for the purpose of flagging the short term averages. An average that includes a calm hour is flagged with a 'c', an average that includes a missing hour is flagged with an 'm', and an average that includes both calm and missing hours is flagged with a 'b'. If missing meteorological data are encountered without the missing data processing option, then the model will continue to read through and check the meteorological data, but will not perform any dispersion calculations.

3.2.3 Averaging Time Options

The averaging periods for both the Short Term and Long Term models are selected using the AVERTIME keyword. Since the averaging period options are different between the Short Term and Long Term models, the syntax for the AVERTIME keyword is somewhat different.

3.2.3.1 Short Term Model Options.

The syntax and type of the Short Term AVERTIME keyword are summarized below:

Syntax:	CO AVERTIME Time1 Time2 Time3 Time4 MONTH PERIOD
Type:	Mandatory, Non-repeatable

where the parameters Time1 . . . Time4 refer to the user-specified short term averaging periods of 1, 2, 3, 4, 6, 8, 12, or 24 hours, the secondary keyword MONTH refers to monthly averages (for calendar months), and the secondary keyword PERIOD refers to the average for the entire data period. Any of the short term averaging periods listed above may be selected for a given run, up to the maximum number of short term averages set in the computer code by the parameter NAVE. The initial values for NAVE are given in Sections 2.3 and 4.2.2. The monthly averages are treated as short term averages, and selection of the MONTH average counts toward the limit of NAVE. Since the monthly averages are treated as short term averages, the user can select appropriate output options, such as the second highest values by receptor, on the OUtput pathway. The PERIOD keyword may be used to calculate the annual average for a full year of meteorological data, or to calculate the period average for a period other than a year.

The location of the PERIOD keyword in the parameter list is not critical. The order of the short term averaging periods (including MONTH) is also not critical, although it does control the order of the averaging period result tables in the main output file. Generally, it is recommended that the short term averaging periods be input in increasing order, unless there is a clear advantage in doing otherwise.

3.2.3.2 Long Term Model Options.

The syntax and type of the Long Term AVERTIME keyword are summarized below:

Syntax:	CO AVERTIME	JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC WINTER SPRING SUMMER FALL QUART1 QUART2 QUART3 QUART4 MONTH SEASON QUARTR ANNUAL PERIOD
Type:	Mandatory, Non-repeatable	

where all of the parameters are secondary keywords that relate to an averaging period or periods associated with a single STAR data summary or a group of STAR summaries. The keywords for individual months, seasons and quarters are fairly self-explanatory. If the secondary keyword of SEASON is used, then it is assumed that all four seasons are present in the STAR data file, and averages are calculated for each season. Similarly, if the keyword MONTH or QUARTR is used, then the model assumes that all twelve months or all four quarters are present in the STAR data file, and averages are calculated for each averaging period. The MONTH and SEASON keywords or the MONTH and QUARTR keywords can also be used together in the same run. However, seasonal STAR summaries and quarterly STAR summaries cannot be used together in the same run, since the seasons and quarters occupy the same locations in data storage. It is assumed that the STAR summaries for the individual seasons, months or quarters are in the order listed in above. Thus, the following two cards produce the same result:

```
CO AVERTIME  WINTER  SPRING  SUMMER  FALL
```

and

```
CO AVERTIME  SEASON
```

The ANNUAL secondary keyword indicates that averages are to be calculated for an annual STAR summary. This differs from the PERIOD secondary keyword, which refers to an average calculated for all STAR summaries included in the data file. The PERIOD keyword may be used to calculate the annual average from a data file consisting of STAR summaries for each of the four seasons or for each of the twelve months. Thus, the ANNUAL and PERIOD keywords cannot both be present on the AVERTIME card. The PERIOD average cannot be used when monthly

STARs are included with seasonal or quarterly STARs in the same data file.

The following card can be used to calculate the averages for each of the four seasons and for the annual period from a data file consisting of five STAR summaries, one for each season and one for the annual period:

```
CO AVERTIME  SEASON  ANNUAL
```

whereas the following card will calculate the averages for each of the four seasons, and will then rewind the meteorology file and calculate the averages for the annual period from the four seasonal STAR summaries:

```
CO AVERTIME  SEASON  PERIOD
```

The AVERTIME keyword works in conjunction with the STARDATA keyword on the ME pathway to control which averaging periods are calculated. Both of these keywords recognize the same set of secondary keywords. The CO AVERTIME card defines which averaging periods are to be calculated, and is a mandatory keyword. The ME STARDATA card defines which STAR summaries are included in the data file. The STARDATA keyword is optional, unless the AVERTIME card includes only the PERIOD average, in which case the STARDATA keyword is mandatory in order to define which STAR summaries are included in the period average. If the ME STARDATA keyword is omitted, then the ISCLT2 model assumes that the meteorological data file contains only the STAR summaries identified on the CO AVERTIME card.

3.2.4 Specifying the Pollutant Type

The POLLUTID keyword is used to identify the type of pollutant being modeled for a particular run. The syntax, type, and order of the POLLUTID keyword are summarized below:

Syntax:	CO POLLUTID Pollut
Type:	Mandatory, Non-repeatable
Order:	Must follow MODELOPT and precede HALFLIFE and DCAYCOEF

where the Pollut parameter may be name of up to eight characters. Examples include SO2, NOX, CO, PM10, TSP, and OTHER. The only choices that currently have any impact on the results are the selection of SO2 in conjunction with URBAN dispersion and the regulatory default option, and the selection of PM10 (or PM-10) with the multi-year option for generating the high-sixth-high in five years. For the urban SO_2 default case, the model uses a half life of 4 hours for exponential decay of the SO2.

3.2.5 Modeling With Exponential Decay

The models provide the option to use exponential decay of the pollutant being modeled. Two keywords are available for this purpose, the HALFLIFE and DCAYCOEF keywords. The syntax, type, and order of these keywords are summarized below:

Syntax:	CO HALFLIFE Haflif CO DCAYCOEF Decay
Type:	Optional, Non-repeatable
Order:	Must follow MODELOPT and POLLUTID

where the Haflif parameter is used to specify the half life for exponential decay in seconds, and the parameter Decay is used to specify the decay coefficient in units of s^{-1}. The relationship between these parameters is DECAY = 0.693/HAFLIF.

Only one of these keywords may be specified in a given run. If more than one is encountered, a non-fatal warning message is generated and the first specification is used in the modeling. Also, since the regulatory default option includes a half life of 4 hours for exponential decay of SO_2 in urban settings, any HALFLIFE or DCAYCOEF input conflicting with that option will be overridden if the DFAULT option is selected on the CO MODELOPT card.

3.2.6 Options for Elevated Terrain Heights

Two optional keywords are available on the COntrol pathway to control the receptor options for modeling elevated terrain heights - the TERRHGTS and ELEVUNIT keywords.

The TERRHGTS keyword controls whether the model assumes flat terrain or allows for the input of receptor heights on elevated terrain. The syntax and type of the TERRHGTS keyword are summarized below:

Syntax:	CO TERRHGTS FLAT or ELEV
Type:	Optional, Non-repeatable

where the FLAT secondary keyword forces flat terrain calculations to be used throughout, regardless of the input of terrain heights on the REceptor pathway. Any terrain heights that are entered on the REceptor pathway are ignored if FLAT terrain is specified, and a non-fatal warning message is generated. The ELEV secondary keyword specifies that receptor heights on elevated terrain are allowed on the REceptor pathway. If elevated terrain is assumed and a receptor height is not specified, then it is assumed to have a value of 0.0 meters. For terrain heights above the release height, the models automatically truncate ("chop off") the terrain heights at the physical release heights for modeling impacts at those

receptors. The models assume flat terrain as the default if no TERRHGTS keyword is present in the input runstream.

The ELEVUNIT keyword allows the user to specify the input units for receptor elevation data included in the RE pathway. The syntax and type of the ELEVUNIT keyword are summarized below:

Syntax:	CO ELEVUNIT METERS or FEET
Type:	Optional, Non-repeatable

The default units for all receptor terrain height inputs to the model is meters. Since terrain data are frequently available more easily in feet, the presence of this keyword with the FEET parameter instructs the model to convert all receptor elevations from feet to meters. No other variables are effected by this keyword.

3.2.7 Flagpole Receptor Height Option

The FLAGPOLE keyword specifies that receptor heights above local ground level (i.e. flagpole receptors) are allowed on the REceptor pathway. The FLAGPOLE keyword may also be used to specify a default flagpole receptor height other than 0.0 meters. The syntax and type of the FLAGPOLE keyword are summarized below:

Syntax:	CO FLAGPOLE (Flagdf)
Type:	Optional, Non-repeatable

where Flagdf is an optional parameter to specify a default flagpole receptor height. If no parameter is provided, then a default flagpole receptor height of 0.0 meters is used. Any flagpole receptor heights that are entered on the REceptor pathway are ignored if the FLAGPOLE keyword is not present on

the COntrol pathway, and a non-fatal warning message is generated.

3.2.8 To Run or Not to Run - That is the Question

Because of the improved error handling and the "defensive programming" that has been employed in the design of the ISC2 model, it is intended that the model will read through all of the inputs in the runstream file regardless of any errors or warnings that may be encountered. If a fatal error occurs in processing of the runstream information, then further model calculations will be aborted. Otherwise, the model will attempt to run. Because of the great many options available in the ISC2 models, and the potential for wasted resources if a large run is performed with some incorrect input data, the RUNORNOT keyword has been included on the COntrol pathway to allow the user to specify whether to RUN the model and perform all of the calculations, or NOT to run and only process the input runstream data and summarize the setup information. The syntax and type of the RUNORNOT keyword are summarized below:

Syntax:	CO RUNORNOT RUN or NOT
Type:	Mandatory, Non-repeatable

3.2.9 Generating an Input File for the Short Term EVENT Model (ISCEV2)

The Short Term model consists of two executable files - one is used for routine processing (ISCST2) and the other is used for EVENT processing (ISCEV2). The EVENTFIL keyword controls whether or not the ISCST2 model will generate an input file for use with the EVENT model, and applies only to the ISCST2 model. The syntax and type of the EVENTFIL keyword are summarized below:

Syntax:	CO EVENTFIL (Evfile) (Evopt)
Type:	Optional, Non-repeatable

where the optional Evfile parameter specifies the name of the EVENT input file to be generated (up to 40 characters), and the optional parameter, Evopt, specifies the level of detail to be used in the EVENT output file. Valid inputs for the Evopt parameter are the secondary keywords of SOCONT and DETAIL (see the EVENTOUT keyword on the OUtput pathway, Section 3.7.2). The default filename used if no parameters are specified is PASSTWO.INP, and the default for the level of detail is DETAIL. If only one parameter is present, then it is taken to be the Evfile, and the default will be used for Evopt.

The primary difference between routine ISCST2 and EVENT processing is in the treatment of source group contributions. The ISCST2 model treats the source groups independently, corresponding to the way source groups are treated in the previous version of the ISCST model. The EVENT model is designed to provide source contributions to particular events, such as the design concentrations determined from ISCST2, or user specified events. The user may specify the "events" to process using the EVent pathway, which lists specific combinations of receptor location, source group, and averaging period. By specifying the EVENTFIL keyword, an input runstream file will be generated that can be used directly with the EVENT model. The events included in the generated EVENT model input file are the design concentrations defined by the RECTABLE keyword and the threshold violations identified by the MAXIFILE keyword on the OU pathway.

3.2.10 The Model Re-start Capability

The ISCST2 model has an optional capability to store intermediate results into an unformatted file, so that the model run can be continued later in case of a power failure or

a user interrupt. This re-start option is controlled by the SAVEFILE and INITFILE keywords on the CO pathway. The syntax and type of these keywords are summarized below:

Syntax:	CO SAVEFILE (Savfil) (Dayinc) (Savfl2) CO INITFILE (Inifil)
Type:	Optional, Non-repeatable

The SAVEFILE keyword instructs the model to save the intermediate results to a file, and controls the save options. All three parameters for this keyword are optional. If the user specifies only the Savfil parameter, then the intermediate results are saved to the same file (and overwritten) each time. If the user specifies both the Savfil and the Savfl2 parameters, then the model alternates between the two files for storing intermediate results. The latter approach requires additional disk space to handle two storage files. However, selecting two files avoids the potential problem that the power failure or interrupt might occur while the temporary file is open and the intermediate results are being copied to it. In such a case, the temporary results file would be lost.

The optional Dayinc parameter allows the user to specify the number of days between successive dumps. The default is to dump values at the end of each day, i.e., Dayinc = 1. For larger modeling runs, where the SAVEFILE option is most useful, the additional execution time required to implement this option is very small compared to the total runtime. To be most effective, it is recommended that results be saved at least every 5 days.

If no parameters are specified for the SAVEFILE keyword, then the model will store intermediate results at the end of each day using a default filename of TMP.FIL.

The INITFILE keyword works in conjunction with the SAVEFILE keyword, and instructs the model to initialize the results arrays from a previously saved file. The optional parameter, Inifil, identifies the unformatted file of intermediate results to use for initializing the model. If no Inifil parameter is specified, then the model assumes the default filename of TMP.FIL. If the file doesn't exist or if there are any errors encountered in opening the file, then a fatal error message is generated and processing is halted.

Note: It is important to note that if both the SAVEFILE and INITFILE keywords are used in a the same model run, then different filenames must be specified for the Savfil and Inifil parameters. Otherwise, the model will encounter an error in opening the files, and further processing will be halted.

3.2.11 Performing Multiple Year Analyses for PM-10

The MULTYEAR keyword on the CO pathway provides an option for the user to perform a multiple year analysis such as would be needed to determine the "high-sixth-high in five years" design value for determining PM-10 impacts. In the past, such modeling would require extensive postprocessing of ISCST binary concentration files. Since the multiple year option makes use of the model re-start capabilities described in the previous section, the MULTYEAR keyword is not compatible with the SAVEFILE or INITFILE keywords. The model will generate a fatal error message if the user attempts to exercise both options in a single run. The syntax and type of this keyword is summarized below:

Syntax:	CO MULTYEAR Savfil (Inifil)
Type:	Optional, Non-repeatable

where the Savfil parameter specifies the filename for saving the results arrays at the end of each year of processing, and

the Inifil parameter specifies the filename to use for initializing the results arrays at the beginning of the current year. The Inifil parameter is optional, and should be left blank for the first year in the multi-year series of runs.

The MULTYEAR option works by accumulating the high short term average results from year to year through the mechanism of the re-start save file. The model may be setup to run in a batch file with several years of meteorological data, and at the end of each year of processing, the short term average results reflect the cumulative high values for the years that have been processed. The PERIOD average results are given for only the current year, but the model carries the highest PERIOD values from year to year and includes the cumulative highest PERIOD averages in the summary table at the end of the run.

When setting up a batch file to perform a multiple year analysis, the user would first create an input runstream file for the first year with all of the applicable modeling options, the source inventory data, the receptor locations, the meteorology options for the first year and the output file options. To obtain the PM-10 design value, be sure to include the SIXTH highest value on the OU RECTABLE card (see Section 3.7.1). For the CO MULTYEAR card for the first year, the user would only specify the Savfil parameter, and may use a card such as:

```
CO MULTYEAR  YEAR1.SAV
```

For the subsequent years, the user could copy the input file created for Year-1, and edit the files to change the year parameters and meteorology filename on the ME pathway (and possibly in the title information), and edit the MULTYEAR cards. For the subsequent years, both the Savfil and Inifil parameters must be specified, with the Savfil for Year-1

becoming the Inifil for Year-2, and so on. The MULTYEAR cards might look like this:

```
CO MULTYEAR  YEAR1.SAV (First year)
CO MULTYEAR  YEAR2.SAV  YEAR1.SAV (Second year)
CO MULTYEAR  YEAR3.SAV  YEAR2.SAV (Third year)
CO MULTYEAR  YEAR4.SAV  YEAR3.SAV (Fourth year)
CO MULTYEAR  YEAR5.SAV  YEAR4.SAV (Sixth year)
```

3.2.12 Detailed Error Listing File

The ERRORFIL keyword on the CO pathway allows the user to request a detailed listing file of all the messages generated by the model. This includes the error and warning messages that are listed as part of the message summaries provided in the main output file, and also any informational messages (such as occurrences of calm winds) and quality assurance messages that are generated. The syntax and type of the ERRORFIL keyword are summarized below:

Syntax:	CO ERRORFIL (Errfil) (DEBUG)
Type:	Optional, Non-repeatable

where the Errfil parameter is the name of the detailed message file, and the DEBUG secondary keyword implements an option to obtain detailed output results including plume heights, sigmas, etc., for each hour calculated for debugging purposes. Note: The DEBUG option generates very large files and should be used with CAUTION! If the optional Errfil parameter is left blank, then the model will use a default filename of ERRORS.LST. A complete description of the error and other types of messages generated by the models is provided in Appendix E.

3.3 SOURCE PATHWAY INPUTS AND OPTIONS

The **SO**urce pathway contains the keywords that define the source information for a particular model run. The model currently handles three source types, identified as point, volume or area sources. The input parameters vary depending on the source type. For point sources, the user can also identify building dimensions for nearby structure that cause aerodynamic downwash influences on the source. The user can also identify groups of sources for which the models will combine the results. With the exception of the variable emission rate options on the EMISFACT keyword, all of the SO pathway inputs are identical between the Short Term and Long Term models.

The LOCATION keyword, which identifies the source type and location, must be the first card entered for each source. The only other requirement for order of the keywords is that the SRCGROUP keyword must be the last keyword before the SO FINISHED card. The user may group all of the LOCATION cards together, then group the source parameter cards together, or they may want to group all input cards for a particular source together as was done in the old ISC input file. All sources are given a source ID by the user, which is used to link the source parameter inputs to the correct source or sources. The source ID can be any alphanumeric string of up to eight characters.

The number of sources allowed in a given run is controlled by a Fortran PARAMETER statement in the computer code. The initial storage limits for each of the models is given in Section 2.3, which discusses storage allocation in general. These limits can easily be modified by the user and the code recompiled to accommodate different user needs.

3.3.1 Identifying Source Types and Locations

The LOCATION keyword is used to identify the source type and the location of each source to be modeled. The LOCATION card must be the first card entered for each source since it identifies the source type, which controls which parameters are needed and/or accepted. The syntax, type and order of the LOCATION keyword are summarized below:

Syntax:	SO LOCATION Srcid Srctyp Xs Ys (Zs)
Type:	Mandatory, Repeatable
Order:	Must be first card for each source input

where the Srcid parameter is the alphanumeric source ID defined by the user (up to eight characters), Srctyp is the source type, which is identified by one of the secondary keywords - POINT, VOLUME, or AREA, and Xs, Ys, and Zs are the x, y, and z coordinates of the source location in meters. Note that the source elevation, Zs, is an optional parameter. If the source elevation is omitted, it will be given a default value of 0.0, but the source elevation is only used if the CO TERRHGTS ELEV option is selected. The x (east-west) and y (north-south) coordinates are for the center of the source for POINT and VOLUME sources, and are for the southwest corner of the source for AREA sources. The source coordinates may be input as Universal Transverse Mercator (UTM) coordinates, or may be referenced to a user-defined origin.

The volume source algorithms in the ISC2 models may also be used to model the effects of certain kinds of line sources, such as conveyor belts and rail lines. Section 1.2.2 of Volume II provides technical information on how to model a line source with multiple volume sources. Also, as shown in Section 1.2.3 of Volume II, irregularly shaped areas may be modeled with the ISC2 MODELS by dividing up the area into several square areas of varying sizes.

The source ID entered on the LOCATION card identifies that source for the remainder of the SO pathway inputs. Since the model accepts alphanumeric strings of up to eight characters for the source ID, the sources can be identified with descriptive names, such as STACK1, STACK2, BOILER3, SLAGPILE, etc. This may also be especially useful if line sources or irregularly-shaped area sources are being modeled as multiple volume or square areas, as discussed above. Since they are part of the same physical source, they can be given names that will identify them as being related, such as LINE1A, LINE1B, LINE1C, etc.

3.3.2 Specifying Source Release Parameters

The main source parameters are input on the SRCPARAM card, which is a mandatory keyword for each source being modeled. Since the input parameters vary depending on the source type, the three source types handled by the ISC2 models (POINT, VOLUME and AREA) are discussed separately.

3.3.2.1 POINT Source Inputs.

The ISC2 POINT source algorithms are used to model releases from stacks and isolated vents, as well as other kinds of sources. The syntax, type and order for the SRCPARAM card for POINT sources are summarized below:

Syntax:	SO SRCPARAM Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Ptemis - point emission rate in g/s,

Stkhgt - release height above ground in meters,

Stktmp - stack gas exit temperature in degrees K,

Stkvel - stack gas exit velocity in m/s, and

Stkdia - stack inside diameter in meters.

It should be noted that the same emission rate is used for both concentration and deposition calculations in the ISC2 models. An example of a valid SRCPARAM input card for a point source is given below:

```
CO SRCPARAM  STACK1  16.71  35.0  444.0  22.7  2.74
```

where the source ID is STACK1, the emission rate is 16.71 g/s, the release height is 35.0 m, the exit temperature is 444.0 K, the exit velocity is 22.7 m/s, and the inside stack diameter is 2.74 m. All of the parameters must be present on the input card.

Since the ISC2 models use direction-specific building dimensions for all sources subject to building downwash, there are no building parameters entered on the SRCPARAM card. Building dimensions are entered on the BUILDHGT and BUILDWID cards described below in Section 3.3.3.

3.3.2.2 VOLUME Source Inputs.

The ISC2 VOLUME source algorithms are used to model releases from a variety of industrial sources, such as building roof monitors, multiple vents, and conveyor belts. The syntax, type and order for the SRCPARAM card for VOLUME sources are summarized below:

Syntax:	SO SRCPARAM Srcid Vlemis Relhgt Syinit Szinit
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Vlemis - volume emission rate in g/s,

Relhgt - release height (center of volume) above ground, in meters,

Syinit - initial lateral dimension of the volume in meters, and

Szinit - initial vertical dimension of the volume in meters.

It should be noted that the same emission rate is used for both concentration and deposition calculations in the ISC2 models. The following table, which is explained in more detail in Section 1.2.2 of Volume II of the User's Guide, summarizes the suggested procedures to be used for estimating the initial lateral and vertical dimensions for various types of volume and line sources.

TABLE 3-1.

SUMMARY OF SUGGESTED PROCEDURES FOR ESTIMATING INITIAL LATERAL DIMENSIONS σ_{yo} AND INITIAL VERTICAL DIMENSIONS σ_{zo} FOR VOLUME AND LINE SOURCES

Type of Source	Procedure for Obtaining Initial Dimension
(a) Initial Lateral Dimensions (σ_{yo})	
Single Volume Source	σ_{yo} = length of side divided by 4.3
Line Source Represented by Adjacent Volume Sources (see Figure 1-8(a))	σ_{yo} = length of side divided by 2.15
Line Source Represented by Separated Volume Sources (see Figure 1-8(b))	σ_{yo} = center to center distance divided by 2.15
(b) Initial Vertical Dimensions (σ_{zo})	
Surface-Based Source ($h_e \sim 0$)	σ_{zo} = vertical dimension of source divided by 2.15
Elevated Source ($h_e > 0$) on or Adjacent to a Building	σ_{zo} = building height divided by 2.15
Elevated Source ($h_e > 0$) not on or Adjacent to a Building	σ_{zo} = vertical dimension of source divided by 4.3

3.3.2.3 AREA Source Inputs.

The ISC2 AREA source algorithms are used to model releases from storage piles, slag dumps, lagoons, as well as from a variety of air toxic release sites. The current versions of the ISC2 models accept only square areas whose sides are oriented north-south and east-west. The syntax, type and order for the SRCPARAM card for AREA sources are summarized below:

Syntax:	SO SRCPARAM Srcid Aremis Relhgt Xinit
Type:	Mandatory, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source, and the other parameters are as follows:

Aremis - area emission rate in $g/s/m^2$,

Relhgt - release height above ground in meters, and

Xinit - length of the side of the square area in meters.

It should be noted that the same emission rate is used for both concentration and deposition calculations in the ISC2 models. It should also be noted that the emission rate for the area source is an emission rate per unit area, which is different from the point and volume source emission rates, which are total emissions for the source.

In order to model irregularly-shaped areas, the user may have to subdivide the area into smaller square areas of varying sizes. In addition, there are restrictions on the placement of receptors relative to area sources, and it is recommended that if the source-receptor separation is less than the source width, Xinit, then the area source should be subdivided into smaller area sources. More technical information about the application of the ISC2 area source algorithm is provided in Section 1.2.3 of Volume II of the User's Guide.

3.3.3 Specifying Building Downwash Information

As noted above, the ISC2 models include algorithms to model the effects of buildings downwash on emissions from nearby or adjacent point sources. The building downwash algorithms do not apply to volume or area sources. For a technical description of the building downwash algorithms, the user is referred to Volume II of the ISC2 User's Guide. The ISC2 models use direction-specific information for all building downwash cases, unlike the earlier version of the ISC models

which only used direction-specific information for shorter stacks which satisfied the Schulman-Scire criterion.

There are three keywords that are used to specify building downwash information, BUILDHGT, BUILDWID, and LOWBOUND. The syntax, type and order for the BUILDHGT keyword, used to input direction specific building heights, are summarized below:

Syntax:	SO BUILDHGT Srcid (or Srcrng) Dsbh(i),i=1,36 (16 for LT)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of specifying a range of sources (the Srcrng parameter) for which the building heights apply, instead of identifying a single source. This is accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10. Since the model reads the source range as a single input field there must not be any spaces between the source IDs. The model then places the building heights that follow (the Dsbh(i) parameter) into the appropriate arrays for all Srcid's that fall within that range, including STACK1 and STACK10.

When comparing a source ID to the range limits for a Srcrng parameter, the model separates the source IDs into three parts: an initial alphabetical part, a numerical part, and then the remainder of the string. Each part is then compared to the corresponding parts of the source range, and all three parts must satisfy the respective ranges in order for the source ID to be included. If there is no numeric part, then the ID consists of only one alphabetical part. If the ID begins with a numeric character, then the initial aphabetical part defaults to a single blank. If there is no trailing alphabetical part, then the third part also defaults to a single blank part. If

the trailing part consists of more than one alphabetical or numeric field, it is all lumped into one character field. For example, the source ID 'STACK2' consists of the parts 'STACK' plus '2' plus a single trailing blank, ' '. By comparing the separate parts of the source IDs, it can be seen that STACK2 falls between the range 'STACK1-STACK10.' For a three-part example, it can also be seen that VENT1B falls within the range of VENT1A-VENT1C. However, VENT2 does not fall within the range of VENT1A to VENT3B, since the third part of VENT2 is a single blank, which does not fall within the range of A to C. This is because a blank character will preceed a normal alphabetical character. Normally, the source ranges will work as one would intuitively expect for simple source names. Most importantly, for names that are made up entirely of numeric characters, such as for old input files converted using STOLDNEW (see Appendix C), the source ranges will be based simply on the relative numerical values. The user is strongly encouraged to check the summary of model inputs to ensure that the source ranges were interpreted as expected, and also to avoid using complex source names in ranges, such as AA1B2C-AB3A3C. Since the order of keywords within the SO pathway is quite flexible, it is also important to note that the building heights will only be applied to those sources that have been defined previously in the input file.

Following the Srcid or the Srcrng parameter, the user inputs 36 direction-specific building heights (Dsbh parameter) in meters for the Short Term model, beginning with the 10 degree flow vector (wind blowing toward 10 degrees from north), and incrementing by 10 degrees in a clockwise direction. For the Long Term model, the Dsbh parameter consists of 16 direction-specific building heights beginning with the flow vector for the north sector, and proceeding clockwise to

north-northwest. Some examples of building height inputs are presented below:

```
SO BUILDHGT  STACK1  34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT  STACK1  34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.
SO BUILDHGT  STACK1  34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34. 34.

SO BUILDHGT  STACK1  36*34.0

SO BUILDHGT  STACK1-STACK10  33*34.0  3*0.0

SO BUILDHGT  STACK1  35.43 36.45 36.37 35.18 32.92 29.66 25.50 20.56
SO BUILDHGT  STACK1  15.00 20.56 25.50 29.66 32.92 35.18 36.37 36.45
SO BUILDHGT  STACK1  35.43 33.33 35.43 36.45  0.00 35.18 32.92 29.66
SO BUILDHGT  STACK1  25.50 20.56 15.00 20.56 25.50 29.66 32.92 35.18
SO BUILDHGT  STACK1  36.37 36.45 35.43 33.33
```

The first example illustrates the use of repeat cards if more than one card is needed to input all of the values. The values are processed in the order in which they appear in the input file, and are identified as being repeat cards by repeating the Srcid parameter. The first and second examples produce identical results within the model. The second one illustrates the use of a repeat value that can simplify numerical input in some cases. The field "36*34.0" is interpreted by the model as "repeat the value 34.0 a total of 36 times." This is also used in the third example where the building height is constant for directions of 10 degrees through 330 degrees, and then is set to 0.0 (e.g. the stack may be outside the region of downwash influence) for directions 340 through 360. The third example also uses a source range rather than a single source ID. The last example illustrates building heights which vary by direction, and shows that the number of values on each card need not be the same. For improved readability of the input file, the user may want to put the numerical inputs into "columns," but there are no special rules regarding the spacing of the parameters on this keyword.

The BUILDWID keyword is used to input direction-specific building widths for downwash analyses. The syntax for this

keyword, which is very similar to the BUILDHGT keyword, is summarized below, along with the type and order information:

Syntax:	SO BUILDWID Srcid (or Srcrng) Dsbw(i),i=1,36 (16 for LT)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

For a description of the Srcid and Srcrng parameters, and for a discussion and examples of the numeric input options, refer to the BUILDHGT keyword above. The Dsbw(i) parameter contains the direction-specific building widths, 36 for the Short Term model, and 16 for the Long Term model. The directions proceed in a clockwise direction, beginning with the 10 degree flow vector for the Short Term model and beginning with the flow vector for the north sector for the Long Term model.

The LOWBOUND keyword is used to exercise the non-regulatory default option of calculating "lower bound" concentration or deposition values for downwash sources subject to enhanced lateral plume spread by super-squat buildings (width is more than five times the height). The syntax, type and order of this keyword is summarized below:

Syntax:	SO LOWBOUND Srcid (or Srcrng) Idswak(i),i=1,36 (16 for LT)
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid and Srcrng parameters are described above for the BUILDHGT keyword, and the Idswak(i) parameter is an array of lower bound wake option switches beginning with the 10 degree flow vector and incrementing by 10 degrees clockwise for the Short Term model and beginning with the flow vector for the north sector for the Long Term model. A value of 0 means to use the upper bound (regulatory default) for that sector, and a value of 1 means to use the lower bound for that sector. The use of repeat values is permitted for inputting the Idswak

array, e.g., a field of '36*1' indicates to use the lower bound for all 36 sectors. Since this is a non-regulatory default option, if the DFAULT option has been selected on the MODELOPT keyword (CO pathway), then any LOWBOUND inputs will be ignored, and the model will calculate the upper bound estimates. The model will generate a non-fatal warning message in such a case.

For a technical description of the "lower bound" option, the reader is referred to Section 1.1.5.3 of Volume II.

3.3.4 Using Variable Emission Rates

The ISC2 models provide the option of specifying variable emission rate factors for individual sources or for groups of sources. The factors may vary on different time scales, such as by season, hour-of-day, etc. Since the Short Term and Long Term models work on different averaging periods, the variable emission rate factors are somewhat different. Therefore the models are discussed separately.

3.3.4.1 Short Term Model Options.

The EMISFACT keyword provides the user the option of specifying variable emission rate factors for sources modeled by the Short Term model. The syntax, type and order of this keyword are summarized below:

Syntax:	SO EMISFACT Srcid (or Srcrng) Qflag Qfact(i),i=1,n
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of using the Srcrng parameter for specifying a range of sources for which the emission rate factors apply, instead of identifying a single source. This is

accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10. The use of the Srcrng parameter is explained in more detail in Section 3.3.3 above for the BUILDHGT keyword.

The parameter Qflag is the variable emission rate flag, and is one of the following secondary keywords:

SEASON - emission rates vary seasonally (n=4),

MONTH - emission rates vary monthly (n=12),

HROFDY - emission rates vary by hour-of-day (n=24),

STAR - emission rates vary by speed and stability category (n=36), and

SEASHR - emission rates vary by season and hour-of-day (n=96)

The Qfact array is the array of factors, where the number of factors is shown above for each Qflag option. The EMISFACT card may be repeated as many times as necessary to input all of the factors, and repeat values may be used for the numerical inputs. An example of each of these options is presented below, with column headers to indicate the order in which values are to be input.

```
**                              WINTER  SPRING  SUMMER  FALL
SO EMISFACT STACK1 SEASON       0.50    0.50    1.00    0.75

**                              JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
SO EMISFACT STACK1 MONTH        0.1 0.2 0.3 0.4 0.5 0.5 0.5 0.6 0.7 1.0 1.0 1.0

**                               1   2   3   4   5   6   7 8   9   10  11  12
SO EMISFACT STACK1 HROFDY       0.0 0.0 0.0 0.0 0.0 0.5 1.0   1.0 1.0 1.0 1.0 1.0

**                              13  14  15  16  17  18  19 20  21  22  23  24
SO EMISFACT STACK1 HROFDY       1.0 1.0 1.0 1.0 1.0 0.5 0.0 0.0 0.0 0.0 0.0 0.0


** or, equivalently:             1-5   6    7-17   18 19-24
SO EMISFACT STACK1 HROFDY       5*0.0  0.5  11*1.0  0.5 6*0.0

**              Stab. Cat.:     A       B       C       D E       F (6 WS Cat.)
SO EMISFACT STACK1 STAR         6*0.5   6*0.6   6*0.7   6*0.8 6*0.9   6*1.0

SO EMISFACT STACK1 SEASHR       enter 24 hourly scalars for each of the four
                                seasons (winter, spring, summer, fall)
```

3.3.4.2 Long Term Model Options.

The EMISFACT keyword provides the user the option of specifying variable emission rate factors for sources modeled by the Long Term model. The syntax, type and order of this keyword are summarized below:

Syntax:	SO EMISFACT Srcid (or Srcrng) Qflag Qfact(i),i=1,n
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid parameter is the same source ID that was entered on the LOCATION card for a particular source. The user also has the option of specifying a range of sources for which the emission rate factors apply, instead of identifying a single source. This is accomplished by two source ID character strings separated by a dash, e.g., STACK1-STACK10. The use of the Srcrng parameter is explained in more detail in Section 3.3.3 above for the BUILDHGT keyword.

The parameter Qflag is the variable emission rate flag, and is one of the following secondary keywords:

SEASON - emission rates vary seasonally (n=4),

QUARTR - emission rates vary by quarter (n=4),

MONTH - emission rates vary monthly (n=12),

SSTAB - emission rates vary by season and stability (n=24),

SSPEED - emission rates vary by season and speed (n=24),

STAR - emission rates vary by speed and stability only(n=36), and

SSTAR - emission rates vary by season, speed and stability (n=144),

The Qfact array is the array of factors, where the number of factors is shown above for each Qflag option. The EMISFACT card may be repeated as many times as necessary to input all of the factors, and repeat values may be used for the numerical

inputs. An example of each of these options is presented below, with column headers to indicate the order in which values are to be input.

```
**                          WINTER  SPRING  SUMMER FALL
SO EMISFACT STACK1 SEASON    0.50    0.50    1.00 0.75
**                          QUART1  QUART2  QUART3 QUART4
SO EMISFACT STACK1 QUARTR    0.50    0.50    1.00 0.75
**                          JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
SO EMISFACT STACK1 MONTH    0.1 0.2 0.3 0.4 0.5 0.5 0.5 0.6 0.7 1.0 1.0 1.0
**                           WINTER    SPRING    SUMMER FALL (6 Stab Cat.)
SO EMISFACT STACK1 SSTAB     6*0.50    6*0.50    6*1.00 6*0.75
**                           WINTER    SPRING    SUMMER FALL (6 WS Cat.)
SO EMISFACT STACK1 SSPEED    6*0.50    6*0.50    6*1.00 6*0.75
**            Stab. Cat.:    A      B      C      D E      F (6 WS Cat.)
SO EMISFACT STACK1 STAR    6*0.5  6*0.6  6*0.7  6*0.8 6*0.9  6*1.0
**            Stab. Cat.:    A      B      C      D E      F (6 WS Cat.)
**              Season 1:
SO EMISFACT STACK1 SSTAR   6*0.5  6*0.6  6*0.7  6*0.8 6*0.9  6*1.0
**              Season 2:
SO EMISFACT STACK1 SSTAR   6*0.5  6*0.6  6*0.7  6*0.8 6*0.9  6*1.0
**              Season 3:
SO EMISFACT STACK1 SSTAR   6*0.5  6*0.6  6*0.7  6*0.8 6*0.9  6*1.0
**              Season 4:
SO EMISFACT STACK1 SSTAR   6*0.5  6*0.6  6*0.7  6*0.8 6*0.9  6*1.0
```

If a monthly emission rate variation is selected, then the factors will only to apply to monthly STAR summaries. A warning message will be generated if no monthly averages are to be calculated. For the other variable emission rate choices, the model will determine the correct season or quarter and apply that factor to any monthly STAR summaries for which calculations are made. Also, if quarterly averages are being calculated, then none of the emission rate factors involving seasonal variation may be used (SEASON, SSTAB, SSPEED, or SSTAR). If a seasonal variation of emission rates is needed in the calculation of quarterly averages, then it must be implemented through the use of the MONTHly variable emission rate option.

3.3.5 Adjusting the Emission Rate Units for Output

The default emission rate units for the ISC2 models are grams per second for point and volume sources, and grams per

second per square meter for area sources. By default, the models convert these input units to output units of micrograms per cubic meter for concentration calculations and grams per square meter for deposition calculations. This is accomplished by applying a default emission rate unit factor of 1.0E06 for concentration and 3600 for deposition. The deposition factor essentially converts the emission rate to grams per hour for total deposition calculations. For the Long Term model, an additional factor is applied for deposition calculations to adjust the emissions for the number of hours in the STAR data period. This is done automatically by the ISCLT2 model, which allows the user to use the same set of source parameter inputs whether the model is calculating concentration or deposition in either model.

The EMISUNIT keyword on the SO pathway allows the user to specify a different unit conversion factor, and to specify the appropriate label for the output units for either concentration or deposition calculations. The syntax and type of the EMISUNIT keyword are summarized below:

Syntax:	SO EMISUNIT Emifac Emilbl Conlbl (or Deplbl)
Type:	Optional, Non-repeatable

where the parameter Emifac is the emission rate unit factor, Emilbl is the label for the emission units (up to 40 characters), and Conlbl and Deplbl are the output unit labels (up to 40 characters) for concentration and deposition calculations, respectively. For example, to produce output concentrations in milligrams per cubic meter, assuming input units of grams per sec, the following card could be input:

```
SO EMISUNIT  1.0E3  GRAMS/SEC  MILLIGRAMS/M**3
```

since there are 1.0E3 milligrams per gram. The emission rate unit factor applies to all sources for a given run. Since the model uses one or more spaces to separate different fields on the input runstream images, it is important that there not be any spaces within the label fields on this card. Thus, instead of entering 'GRAMS PER SECOND' for the emission label, a label of 'GRAMS/SECOND', or 'GRAMS-PER-SECOND' or an equivalent variation should be used.

3.3.6 Specifying Variables for Settling, Removal and Deposition Calculations

The ISC2 models include algorithms to handle the gravitational settling and removal by dry deposition of larger particulates. The input of source variables for settling and removal are controlled by three keywords on the SO pathway, SETVELOC, MASSFRAX, and REFLCOEF. As with building dimensions and variable emission rate factors described above, the settling and removal variables may be input for a single source, or may be applied to a range of sources.

The syntax, type and order for these three keywords are summarized below:

Syntax:	SO SETVELOC Srcid (or Srcrng) Vsn(i),i=1,Nvs SO MASSFRAX Srcid (or Srcrng) Phi(i),i=1,Nvs SO REFLCOEF Srcid (or Srcrng) Gamma(i),i=1,Nvs
Type:	Optional, Repeatable
Order:	Must follow the LOCATION card for each source input

where the Srcid or Srcrng identify the source or sources for which the inputs apply, and where the Vsn array consists of the gravitational settling velocities (m/s) for each of the settling categories (up to a maximum of 20 set by the NVSMAX PARAMETER in the computer code), the Phi array is the corresponding mass fractions (between 0 and 1) for each of the categories, and the Gamma array is the surface reflection

coefficients (between 0 and 1) for each of the categories. The use of the Srcrng parameter is explained in more detail in Section 3.3.3 above for the BUILDHGT keyword.

The number of categories for a particular source is Nvs. The user does not need to explicitly tell the model the number of categories being input, but all keyword inputs for a particular source or source range must be contiguous, and the number of categories must agree for each of the three keywords input for a particular source. For the best results, as many categories as possible should be used. As many continuation cards as needed may be used to define the inputs for a particular keyword. The model checks the inputs to ensure that the mass fractions sum to 1.0 (within 2 percent) for each source input, and that the mass fractions and reflection coefficients are within the proper range. A reflection coefficient of 0.0 means that plume material for that settling category is completely removed when it reaches the surface. A reflection coefficient of 1.0 means that all of the plume material is reflected from the surface without any deposition. A settling velocity of 0.0 m/s means that the plume material does not settle, i.e., the plume centerline remains horizontal, although plume material may still be deposited on the surface.

For a technical description of the ISC2 dry deposition algorithms, refer to Sections 1.3 and 2.3 of Volume II of the User's Guide, which includes techniques for calculating the gravitational settling velocities as a function of particle density and radius.

3.3.7 Using Source Groups

The ISC2 models allow the user to group contributions from particular sources together. Several source groups may be setup in a single run, and they may, for example, be used to model impacts from the source being permitted, the group of

increment consuming PSD sources, and the group of all sources for comparison to a NAAQS in a single run. There is always at least one source group in a run, which may consist of all sources, so the SRCGROUP keyword has been made mandatory in the ISC2 models. The syntax, type and order of the SRCGROUP keyword are summarized below:

Syntax:	SO SRCGROUP Grpid Srcid's and/or Srcrng's
Type:	Mandatory, Repeatable
Order:	Must be the last keyword in the SO pathway before FINISHED

where the Grpid parameter is an alphanumeric string of up to eight characters that identifies the group name. The Srcid's and Srcrng's are the individual source IDs and/or source ranges that make up the group of sources. Source ranges, which are described in more detail in the description of the BUILDHGT keyword (Section 3.3.3), are input as two source IDs separated by a dash, e.g., STACK1-STACK10. Individual source IDs and source ranges may be used on the same card. If more than one input card is needed to define the sources for a particular group, then additional cards may be input, repeating the pathway, keyword and group ID.

A special group ID has been reserved for use in specifying the group of <u>all</u> sources. When Grpid = <u>ALL</u>, the model will automatically setup a source group called <u>ALL</u> that includes all sources modeled for that particular run. If desired, the user can setup a group of all sources with a different group ID by explicitly specifying all sources on the input card(s).

As described in Section 2.3, the maximum number of source groups is controlled by a Fortran PARAMETER statement in the computer code. If the user attempts to define more than the allowable number of source groups, the model will generate an appropriate error message.

As discussed in Sections 1.2.4.6 and 3.2.9, it is sometimes important for a user to know the contribution of a particular source to the total result for a group. These source contribution analyses are facilitated in the Short Term model by the introduction of the EVENT model. The EVENT model uses the same source groups that are identified by ISCST2 (when the input file is generated using the CO EVENTFIL option), but the model is structured in a way that it retains individual source results for particular events. The Long Term model is able to provide source contribution information in the first pass, because of the different data structures and memory requirements for that model. Refer to the sections noted above for a more complete description of the EVENT model and its uses.

3.4 RECEPTOR PATHWAY INPUTS AND OPTIONS

The **RE**ceptor pathway contains keywords that define the receptor information for a particular model run. The receptor pathway inputs are identical between the ISCST2 model and the ISCLT2 model. The RE pathway is not used at all by the ISCEV2 (EVENT) model, since the receptor locations are defined on the EVent pathway in combination with particular time periods.

The RE pathway contains keywords that allow the user to define Cartesian grid receptor networks and/or polar grid receptor networks, with either uniform or non-uniform grid spacing, as well as discrete receptor locations referenced to a Cartesian or a polar system. The program is initially setup to allow five (5) gridded receptor networks of either (or both) types in a single run, plus discrete receptors of either type, up to a maximum limit on the total number of receptors. The limit on the number of receptors in a given run is controlled by a Fortran PARAMETER in the computer code (see Sections 2.3 and 4.2.2). The number of receptor networks allowed is also

controlled by a PARAMETER statement and may be easily changed by the user.

3.4.1 Defining Networks of Gridded Receptors

Two types of receptor networks are allowed by the ISC2 models. A Cartesian grid network, defined through the GRIDCART keyword, includes an array of points identified by their x (east-west) and y (north-south) coordinates. A polar network, defined by the GRIDPOLR keyword, is an array of points identified by direction and distance from a user-defined origin. Each of these keywords has a series of secondary keywords associated with it that are used to define the network, including any receptor elevations for elevated terrain and flagpole receptor heights. The GRIDCART and GRIDPOLR keywords can be thought of as "sub-pathways," since their secondary keywords include a STArt and an END card to define the start and end of inputs for a particular network.

3.4.1.1 Cartesian Grid Receptor Networks.

Cartesian grid receptor networks are defined by use of the GRIDCART keyword. The GRIDCART keyword may be thought of as a "sub-pathway," in that there are a series of secondary keywords that are used to define the start and the end of the inputs for a particular network, and to select the options for defining the receptor locations that make up the network. The syntax and type of the GRIDCART keyword are summarized below:

Syntax:	RE GRIDCART Netid	STA							
		XYINC	Xinit	Xnum	Xdelta	Yinit	Ynum	Ydelta	
	or	XPNTS	Gridx1	Gridx2	Gridx3	....		Gridxn, and	
		YPNTS	Gridy1	Gridy2	Gridy3	....		Gridyn	
		ELEV	Row	Zelev1	Zelev2	Zelev3	...	Zelevn	
		FLAG	Row	Zflag1	Zflag2	Zflag3	...	Zflagn	
		END							
Type:	Optional, Repeatable								

where the parameters are defined as follows:

Netid	Receptor network identification code (up to eight alphanumeric characters)
STA	Indicates the STArt of GRIDCART inputs for a particular network, repeated for each new Netid
XYINC	Keyword identifying uniform grid network generated from x and y increments
Xinit	Starting x-axis grid location in meters
Xnum	Number of x-axis receptors
Xdelta	Spacing in meters between x-axis receptors
Yinit	Starting y-axis grid location in meters
Ynum	Number of y-axis receptors
Ydelta	Spacing in meters between y-axis receptors
XPNTS	Keyword identifying grid network defined by a series of discrete x and y coordinates (used with YPNTS)
Gridx1	Value of first x-coordinate for Cartesian grid (m)
Gridxn	Value of 'nth' x-coordinate for Cartesian grid (m)
YPNTS	Keyword identifying grid network defined by a series of discrete x and y coordinates (used with XPNTS)
Gridy1	Value of first y-coordinate for Cartesian grid (m)
Gridyn	Value of 'nth' y-coordinate for Cartesian grid (m)
ELEV	Keyword to specify that receptor elevations follow (optional)
Row	Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row)
Zelev	An array of receptor terrain elevations (m) for a particular Row (units of meters may be changed to feet by use of CO ELEVUNIT keyword), number of entries per row equals the number of x-coordinates for that network
FLAG	Keyword to specify that flagpole receptor heights follow (optional)
Row	Indicates which row (y-coordinate fixed) is being input (Row=1 means first, i.e., southmost row)
Zflag	An array of receptor heights (m) above local terrain elevation for a particular Row (flagpole receptors), number of entries per row equals the number of x-coordinates for that network
END	Indicates the END of GRIDCART inputs for a particular network, repeated for each new Netid

The ELEV and FLAG keywords are optional inputs, and are only needed if elevated terrain or flagpole receptor heights are to be used. If the ELEV keyword is used and the model is being run with the flat terrain option (see Section 3.2.6), then the elevated terrain height inputs will be ignored by the model, and a non-fatal warning message will be generated. If the elevated terrain option is selected, and no elevated terrain heights are entered, the elevations will default to 0.0 meters, and warning messages will also be generated. The model handles flagpole receptor height inputs in a similar manner.

The order of cards within the GRIDCART subpathway is not important, as long as all inputs for a particular network are contiguous and start with the STA secondary keyword and end

with the END secondary keyword. It is not even required that all ELEV cards be contiguous, although the input file will be more readable if a logical order is followed. The network ID is also not required to appear on each runstream image (except for the STA card). The model will assume the previous ID if none is entered, similar to the use of continuation cards for pathway and keywords. Thus, the following two examples produce the same 8 X 4 Cartesian grid network:

```
RE GRIDCART CAR1 STA
RE GRIDCART CAR1 XPNTS  -500.  -400.  -200.  -100. 100.  200.  400.  500.
RE GRIDCART CAR1 YPNTS  -500.  -250.   250.  500.
RE GRIDCART CAR1 ELEV  1  10.  10.  10.  10.  10.  10. 10.  10.
RE GRIDCART CAR1 ELEV  2  20.  20.  20.  20.  20.  20. 20.  20.
RE GRIDCART CAR1 ELEV  3  30.  30.  30.  30.  30.  30. 30.  30.
RE GRIDCART CAR1 ELEV  4  40.  40.  40.  40.  40.  40. 40.  40.
RE GRIDCART CAR1 FLAG  1  10.  10.  10.  10.  10.  10. 10.  10.
RE GRIDCART CAR1 FLAG  2  20.  20.  20.  20.  20.  20. 20.  20.
RE GRIDCART CAR1 FLAG  3  30.  30.  30.  30.  30.  30. 30.  30.
RE GRIDCART CAR1 FLAG  4  40.  40.  40.  40.  40.  40. 40.  40.
RE GRIDCART CAR1 END
```

```
RE GRIDCART CAR1 STA
                 XPNTS  -500.  -400.  -200.  -100. 100.  200.  400.  500.
                 YPNTS  -500.  -250.   250.  500.
                 ELEV  1  8*10.
                 FLAG  1  8*10.
                 ELEV  2  8*20.
                 FLAG  2  8*20.
                 ELEV  3  8*30.
                 FLAG  3  8*30.
                 ELEV  4  8*40.
                 FLAG  4  8*40.
RE GRIDCART CAR1 END
```

The Row parameter on the ELEV and FLAG inputs may be entered as either the row number, i.e., 1, 2, etc., or as the actual y-coordinate value, e.g., -500., -250., etc. in the example above. The model sorts the inputs using Row as the

index, so the result is the same. The above example could therefore be entered as follows, with the same result:

```
RE GRIDCART CAR1 STA
                 XPNTS  -500.  -400.  -200.  -100.  100.  200.  400.  500.
                 YPNTS  -500.  -250.   250.   500.
                 ELEV   -500.  8*10.
                 FLAG   -500.  8*10.
                 ELEV   -250.  8*20.
                 FLAG   -250.  8*20.
                 ELEV    250.  8*30.
                 FLAG    250.  8*30.
                 ELEV    500.  8*40.
                 FLAG    500.  8*40.
RE GRIDCART CAR1 END
```

Of course, one must use either the row number or y-coordinate value consistently within each network to have the desired result.

The following simple example illustrates the use of the XYINC secondary keyword to generate a uniformly spaced Cartesian grid network. The resulting grid is 11 x 11, with a uniform spacing of 1 kilometer (1000. meters), and is centered on the origin (0., 0.). No elevated terrain heights or flagpole receptor heights are included in this example.

```
RE GRIDCART CG1 STA
                 XYINC  -5000.  11  1000.  -5000.  11 1000.
RE GRIDCART CG1 END
```

3.4.1.2 Polar Grid Receptor Networks.

Polar receptor networks are defined by use of the GRIDPOLR keyword. The GRIDPOLR keyword may also be thought of as a "sub-pathway," in that there are a series of secondary keywords that are used to define the start and the end of the inputs for a particular network, and to select the options for defining the receptor locations that make up the network. The syntax and type of the GRIDPOLR keyword are summarized below:

Syntax:	RE GRIDPOLR Netid STA ORIG Xinit Yinit DIST Ring1 Ring2 Ring3 ... Ringn DDIR Dir1 Dir2 Dir3 ... Dirn, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... Zelevn FLAG Dir Zflag1 Zflag2 Zflag3 ... Zflagn END
Type:	Optional, Repeatable

where the parameters are defined as follows:

Netid	Receptor network identification code (up to eight alphanumeric characters)
STA	Indicates STArt of GRIDPOLR inputs for a particular network, repeat for each new Netid
ORIG Xinit Yinit	Keyword to specify the origin of the polar network (optional) x-coordinate for origin of polar network y-coordinate for origin of polar network
DIST Ring1 Ringn	Keyword to specify distances for the polar network Distance to the first ring of polar coordinates Distance to the 'nth' ring of polar coordinates
DDIR Dir1 Dirn	Keyword to specify discrete direction radials for the polar network First direction radial in degrees (1 to 360) The 'nth' direction radial in degrees (1 to 360)
GDIR Dirnum Dirini Dirinc	Keyword to specify generated direction radials for the polar network Number of directions used to define the polar system Starting direction of the polar system Increment (in degrees) for defining directions
ELEV Dir Zelev	Keyword to specify that receptor elevations follow (optional) Indicates which direction is being input An array of receptor terrain elevations for a particular direction radial
FLAG Dir Zflag	Keyword to specify that flagpole receptor heights follow (optional) Indicates which direction is being input An array of receptor heights above local terrain elevation for a particular direction (flagpole receptors)
END	Indicates END of GRIDPOLR subpathway, repeat for each new Netid

The ORIG secondary keyword is optional for the GRIDPOLR inputs. If omitted, the model assumes a default origin of (0., 0.,) in x,y coordinates. The ELEV and FLAG keywords are also optional inputs, and are only needed if elevated terrain or flagpole receptor heights are to be used. If the ELEV keyword is used and the model is being run with the flat terrain option (see Section 3.2.6), then the elevated terrain height inputs will be ignored by the model, and a non-fatal warning message

will be generated. If the elevated terrain option is selected, and no elevated terrain heights are entered, the elevations will default to 0.0 meters, and warning messages will also be generated. The model handles flagpole receptor height inputs in a similar manner.

As with the GRIDCART keyword described above, the order of cards within the GRIDPOLR subpathway is not important, as long as all inputs for a particular network are contiguous and start with the STA secondary keyword and end with the END secondary keyword. It is not even required that all ELEV cards be contiguous, although the input file will be more readable if a logical order is followed. The network ID is also not required to appear on each runstream image (except for the STA card). The model will assume the previous ID if none is entered, similar to the use of continuation cards for pathway and keywords.

The following example of the GRIDPOLR keyword generates a receptor network consisting of 180 receptor points on five concentric distance rings centered on an assumed default origin of (0.,0.). The receptor locations are placed along 36 direction radials, beginning with 10. degrees and incrementing by 10. degrees in a clockwise fashion.

```
RE GRIDPOLR POL1 STA
                 DIST  100.  300.  500.  1000.  2000.
                 GDIR  36    10.   10.
RE GRIDPOLR POL1 END
```

Another example is provided illustrating the use of a non-zero origin, discrete direction radials and the specification of elevated terrain and flagpole receptor heights.

```
RE GRIDPOLR POL1 STA
                 ORIG  500.  500.
                 DIST  100.  300.  500.  1000.  2000.
                 DDIR  90.   180.  270.  360.
                 ELEV  90.  5. 10. 15. 20. 25.
                 ELEV  180. 5. 10. 15. 20. 25.
                 ELEV  270. 5. 10. 15. 20. 25.
                 ELEV  360. 5. 10. 15. 20. 25.
                 FLAG  90.  5. 10. 15. 20. 25.
                 FLAG  180. 5. 10. 15. 20. 25.
                 FLAG  270. 5. 10. 15. 20. 25.
                 FLAG  360. 5. 10. 15. 20. 25.
RE GRIDPOLR POL1 END
```

As with the GRIDCART keyword described above, the user has the option of specifying the radial number (e.g. 1, 2, 3, etc.) on the ELEV and FLAG inputs, or the actual direction associated with each radial.

For purposes of model calculations, all receptor locations, including those specified as polar, are stored in the model arrays as x, y and z coordinates and flagpole heights. For the purposes of reporting the results by receptor in the main print file, the tables are labeled with the polar inputs, i.e., directions and distances.

3.4.2 Using Multiple Receptor Networks

For some modeling applications, the user may need a fairly coarsely spaced network covering a large area to identify the area of significant impacts for a plant, and a denser network covering a smaller area to identify the maximum impacts. To accommodate this modeling need, the ISC2 models allow the user to specify multiple receptor networks in a single model run. The user can define either Cartesian grid networks or polar networks, or both. With the use of the ORIG option in the GRIDPOLR keyword, the user can easily place a receptor network centered on the facility being permitted, and also place a network centered on another background source known to be a significant contributor to high concentrations. Alternatively, the polar network may be centered on a receptor location of special concern, such as a nearby Class I area.

As noted in the introduction to this section (3.4), the model initially allows up to 5 receptor networks in a single run. This limit can be changed by modifying the Fortran PARAMETER statement and recompiling the model. The variables that define each array, e.g., the distances and directions for a polar network, are stored in arrays, so that results can be presented for each network separately in the main output file of the model. Thus, increasing the number of networks allowed will increase the amount of memory needed to run the model, although the increase is relatively small. There are also limits on the number of distances or directions (or the number of x-points and the number of y-points for Cartesian grids) that can be specified for each network. These are initially set to 50 distances or x-points and 50 directions or y-points. These limits are also controlled by Fortran PARAMETER statements, and may be modified. More information on controlling the storage limits of the models is provided in Section 4.2.2 of this volume and in Volume III.

3.4.3 Specifying Discrete Receptor Locations

In addition to the receptor networks defined by the GRIDCART and GRIDPOLR keywords described above, the user may also specify discrete receptor points for modeling impacts at specific locations of interest. This may be used to model critical receptors, such as the locations of schools or houses, nearby Class I areas, or locations identified as having high concentrations by previous modeling analyses. The discrete receptors may be input as either Cartesian x,y points (DISCCART keyword) or as polar distance and direction coordinates (DISCPOLR keyword). Both types of receptors may be identified in a single run. In addition, for discrete polar receptor points the user specifies the source whose location is used as the origin for the receptor.

In the previous ISC models, discrete receptors were also used to identify receptors located along the plant boundary. In the new versions of the models, a special option has been added, controlled by the BOUNDARY keyword, which simplifies the input of plant boundary distances in a polar framework. This option is described in Section 3.4.4 below.

3.4.3.1 Discrete Cartesian Receptors.

Discrete Cartesian receptors are defined by use of the DISCCART keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE DISCCART Xcoord Ycoord (Zelev) (Zflag)
Type:	Optional, Repeatable

where the Xcoord and Ycoord parameters are the x-coordinate and y-coordinate (m), respectively, for the receptor location. The Zelev parameter is an optional terrain elevation (m) for the receptor for use in elevated terrain modeling. The Zflag parameter is the optional receptor height above ground (m) for modeling flagpole receptors. All of the parameters are in units of meters, except for Zelev, which defaults to meters but may be specified in feet by use of the CO ELEVUNIT keyword.

If neither the elevated terrain option (Section 3.2.6) nor the flagpole receptor height option (Section 3.2.7) are used, then the optional parameters are ignored if present. If only the elevated terrain height option is used (no flagpoles), then the third parameter (the field after the Ycoord) is read as the Zelev parameter. If only the flagpole receptor height option is used (no elevated terrain), then the third parameter is read as the Zflag parameter. If both options are used, then the parameters are read in the order indicated for the syntax above. If the optional parameters are left blank, then default values will be used. The default value for Zelev is 0.0, and

the default value for Zflag is defined by the CO FLAGPOLE card (see Section 3.2.7). Note: If both the elevated terrain and flagpole receptor height options are used, then the third parameter will always be used as Zelev, and it is not possible to use a default value for Zelev while entering a specific value for the Zflag parameter.

3.4.3.2 Discrete Polar Receptors.

Discrete polar receptors are defined by use of the DISCPOLR keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE DISCPOLR Srcid Dist Direct (Zelev) (Zflag)
Type:	Optional, Repeatable

where the Srcid is the alphanumeric source identification for one of the sources defined on the SO pathway which will be used to define the origin for the polar receptor location. The Dist and Direct parameters are the distance in meters and direction in degrees for the discrete receptor location. Degrees are measured clockwise from north. The Zelev parameter is an optional terrain elevation for the receptor for use in elevated terrain modeling. The units of Zelev are in meters, unless specified as feet by the CO ELEVUNIT keyword. The Zflag parameter is the optional receptor height above ground (meters) for modeling flagpole receptors.

If neither the elevated terrain option (Section 3.2.6) nor the flagpole receptor height option (Section 3.2.7) are used, then the optional parameters are ignored if present. If only the elevated terrain height option is used (no flagpoles), then the third parameter (the field after the Ycoord) is read as the Zelev parameter. If only the flagpole receptor height option is used (no elevated terrain), then the third parameter is read as the Zflag parameter. If both options are used, then the

parameters are read in the order indicated for the syntax above. If the optional parameters are left blank, then default values will be used. The default value for Zelev is 0.0, and the default value for Zflag is defined by the CO FLAGPOLE card (see Section 3.2.7). Note: If both the elevated terrain and flagpole receptor height options are used, then fourth parameter will always be used as Zelev, and it is not possible to use a default value for Zelev while entering a specific value for the Zflag parameter.

3.4.4 Specifying Plant Boundary Distances

The ISC2 models include a special option to simplify the input of discrete receptor locations for plant boundary distances. This option is controlled by the BOUNDARY keyword. The syntax and type of this keyword are summarized below:

Syntax:	RE BOUNDARY Srcid Dist(i),i=1,36
Type:	Optional, Repeatable

where the Srcid is the alphanumeric source identification for one of the sources defined on the SO pathway for which the boundary distances are to be defined. The location of the source will serve as the origin for 36 discrete polar receptors located at every 10 degrees around the source. The Dist array includes the distances (in meters) for each of the directions, beginning with the 10 degree radial and incrementing every 10 degrees clockwise. While the BOUNDARY keyword generates 36 discrete polar receptors, the results for these receptors are summarized separately from receptors defined by the DISCPOLR keyword in the main output file. The RE BOUNDARY card may be repeated for the source as many times as needed to input the 36 distances.

A related keyword, BOUNDELV, is used to define terrain elevations for the receptor locations identified with the

BOUNDARY keyword. The BOUNDELV keyword defines the terrain elevations in meters (or feet if the CO ELEVUNIT FEET card appears) for each of the 36 boundary receptor points. The syntax and type for this keyword are summarized below:

Syntax:	RE BOUNDELV Srcid Zelev(i),i=1,36
Type:	Optional, Repeatable

The purpose of the BOUNDARY and BOUNDELV keywords is to provide a short-cut for inputting the discrete polar receptors for the plant boundary. There is no corresponding keyword for inputting boundary receptor flagpole heights. The easiest way to input boundary receptors with flagpole receptor heights is to define them as discrete polar receptors using the DISCPOLR keyword. This method provides better assurance that the flagpole heights are associated with the correct receptor, and makes it easier to check and debug the input file. For applications where a uniform flagpole receptor height is used for all receptors, which can be specified as a parameter on the CO FLAGPOLE input card, those flagpole receptor heights will also apply to any boundary receptors identified through the BOUNDARY keyword.

3.5 METEOROLOGY PATHWAY INPUTS AND OPTIONS

The **ME**eteorology pathway contains keywords that define the input meteorological data for a particular model run. Because of differences in the meteorological data needs for the Short Term and Long Term models, some of the ME pathway inputs are different between the two models. These differences are highlighted in the discussions below. An effort has been made to keep the inputs as similar as possible.

3.5.1 Specifying the Input Data File and Format

The input meteorological data filename and format are identified by the INPUTFIL keyword on the ME pathway. The syntax of this keyword is very similar between the Short Term and Long Term models, but there are some differences due to the different formats of data available for the two types of models. Therefore the Short Term and Long Term model inputs are described separately.

3.5.1.1 Short Term Model Options.

The ISC2 Short Term model uses hourly meteorological data as one of the basic model inputs. The user has several options for specifying the format of the meteorological data using the INPUTFIL keyword. The syntax and type of this keyword are summarized below:

Syntax:	ME INPUTFIL Metfil (Format)
Type:	Mandatory, Non-repeatable

where the Metfil parameter is a character field of up to 40 characters that identifies the filename for the meteorological data file. For running the model on an IBM-compatible PC, the Metfil parameter may include the complete DOS pathname for the file, or will assume the current directory if only the filename is given. The optional Format parameter specifies the format of the meteorological data file. The user has the following five options for specifying the Format:

1) Use the default ASCII format for a sequential hourly file (if Format is left blank);

2) Specify the Fortran READ format for an ASCII sequential hourly file;

3) Use free-formatted READs for an ASCII sequential hourly file, by inputting the secondary keyword of FREE;

4) Use unformatted file generated by the RAMMET or MPRM preprocessors, by inputting the secondary keyword of UNFORM; or

5) Use "card image" data using a default ASCII format by specifying the secondary keyword of CARD - this option differs from option 1) by the addition of hourly wind profile exponents and hourly vertical potential temperature gradients in the input file.

The first record of the meteorological data input file contains the station number and year for both the surface station and the upper air (mixing height) station. For the formatted ASCII files, these four integer variables are read using a free-format READ, i.e., the variables must be separated by either a comma or by one or more blank spaces. For the UNFORMatted files, the four variables are read as integers without any format specification. The order of these variables is as follows:

Surface Station Number, e.g., WBAN Number for NWS Stations
Year for Surface Data (2 or 4 digits)
Upper Air Station Number (for Mixing Height Data)
Year for Upper Air Data (2 or 4 digits)

The model checks these variables against the values input by the user on the ME SURFDATA and ME UAIRDATA cards (see Section 3.5.3 below).

The rest of the records in the file include the sequential meteorological data. The order of the meteorological variables for the formatted ASCII files and the default ASCII format are as follows:

Variable	Fortran Format	Columns
Year (last 2 digits)	I2	1-2
Month	I2	3-4
Day	I2	5-6
Hour	I2	7-8
Flow Vector (deg.)	F9.4	9-17
Wind Speed (m/s)	F9.4	18-26
Ambient Temperature (K)	F6.1	27-32
Stability Class (A=1, B=2, ... F=6)	I2	33-34
Rural Mixing Height (m)	F7.1	35-41
Urban Mixing Height (m)	F7.1	42-48
Wind Profile Exponent (CARD only)	F8.4	49-56
Vertical Potential Temperature Gradient (K/m) (CARD only)	F8.4	57-65

Thus the following two cards would have the same effect, one using the default read format (Format parameter left blank) and the other explicitly providing the ASCII read format described above:

```
ME INPUTFIL  C:\DATA\METDATA.INP
ME INPUTFIL  C:\DATA\METDATA.INP (4I2,2F9.4,F6.1,I2,2F7.1)
```

The user-specified ASCII format is input as a character field of up to 60 characters, and may be used to specify the READ format for files that differ from the default format. The variables are identified in the READ format in the order given above, but by using the Fortran tab edit descriptor (Tx), the order of variables within the file may be different. A utility program, BINTOASC, is available for converting unformatted RAMMET meteorological files to the default ASCII format. This utility program is described in Appendix C.

For FREE-formatted reads, the model uses a Fortran free-format READ statement, meaning that the variables in the meteorological data file must be in the order listed above, and must be separated from each other by a comma or at least one blank. The format does not need to be the same on each record as long as the variables are appropriately delimited.

The UNFORM secondary keyword indicates to the model that the meteorological data are in an unformatted (sometimes called a "binary") file that was generated by the RAMMET or the MPRM preprocessor. The preprocessed data files consist of unformatted records that include 24 hours of meteorology per record. The variables are read from the unformatted records in the following order:

Year
Month
Julian Day (1-366)
Stability Class (hours 1 to 24)
Wind Speed, m/s (hours 1 to 24)
Ambient Temperature, K (hours 1 to 24)
Flow Vector, deg. (hours 1 to 24)
Randomized Flow Vector, deg. (hours 1 to 24)
Mixing Heights, m (hr 1 rural, hr 1 urban, ... to hr 24)

The following example illustrates the use of the unformatted file option:

```
ME INPUTFIL  C:\BIN\PREPIT.BIN  UNFORM
```

where the Metfil parameter has been used to identify a complete DOS pathname.

The ASCII file input options on the INPUTFIL card allow the user to read the "card image" meteorological data that may have been included in the input option file from applications of the previous ISCST model. This includes the option for inputting hourly wind profile exponents and vertical potential

temperature gradients through use of the CARD format option. However, the hourly decay coefficients that were allowed as part of the card image input in the original ISCST model are not supported in the ISCST2 model. If the CARD format is not used, then the default values of wind profile exponents and vertical potential temperature gradients are used unless the user specifies non-default inputs using the ME WINDPROF or ME DTHETADZ keyword options.

3.5.1.2 Long Term Model Options.

The ISC2 Long Term model uses joint frequency distributions of wind speed and wind direction by stability category as the main meteorological input. These are sometimes called STAR summaries for STability ARray. The input of other meteorological variables to the Long Term model, such as average temperatures and average mixing heights, are controlled by separate ME pathway keywords described later in this section.

Unlike the previous version of ISCLT, which included the STAR data in the input option file, the ISCLT2 model reads the STAR meteorological data from a separate data file. The meteorological data filename and format are defined by the INPUTFIL keyword, which has the following syntax and type:

Syntax:	ME INPUTFIL Metfil (Format)
Type:	Optional, Non-repeatable

where the Metfil parameter is a character field of up to 40 characters that identifies the filename for the meteorological data file. For running the model on an IBM-compatible PC, the Metfil parameter may include the complete DOS pathname for the file, or will assume the current directory if only the filename is given. The optional FORMAT parameter specifies the format

of the meteorological data file. The user has the following three options for specifying the Format:

1) Use the default ASCII format for the STAR file (if Format is left blank);

2) Specify the Fortran READ format for the ASCII STAR file; or

3) Use free-formatted READs for the ASCII STAR file, by inputting the secondary keyword of FREE.

The default ASCII format corresponds to the format of the data files generated by EPA's STAR utility program for the ISCLT model, and also the default format used by the previous version of ISCLT. Each record of STAR meteorological data consists of six values (default format of 6F10.0) corresponding to the six wind speed classes for a particular wind direction and stability category. The program reads stability category A first, and the first record contains the six values for the north wind direction. There are 16 cards for each stability category corresponding to the 16 wind direction categories entered clockwise from north (north, north-northeast, etc.). This pattern is repeated for each of the six stability categories, A through F.

The frequency data may be input as normalized frequencies, in which case the total of all frequencies for a particular STAR summary will add up to 1.0, or as the number of occurrences for each combination. If the total of normalized frequencies is not within 2 percent of 1.0, then the model will generate a non-fatal warning message. If the total adds up to 2.0 or more and is a whole number, then the model divides the number of occurrences for each STAR category by the total number to obtain the normalized frequency.

Without the optional STARDATA keyword (described in Section 3.5.4), it is assumed that the STAR summaries in the

input file corresponds to the averaging periods selected on the CO AVERTIME card (see Section 3.2.3.1). If SEASON averages are selected, then the model will assume that the meteorological data file consists of four seasons in the order of WINTER, SPRING, SUMMER, and FALL. If an ANNUAL average is to be calculated from an annual STAR summary, then the annual STAR should follow any seasonal STAR summaries to be used. For example, the following runstream image calculates averages for each of the four seasons and the annual average from a data file consisting of five STAR summaries (winter, spring, summer, fall, and annual):

```
CO AVERTIME  SEASON  ANNUAL
```

The following example calculates averages for the four seasons, and then calculates an annual average as a period average for the four seasons combined:

```
CO AVERTIME  SEASON  PERIOD
```

and the input meteorological file for this example would include only the four seasonal STAR summaries.

3.5.2 Specification of Anemometer Height

An important input for both the Short Term and the Long Term models is the specification of the anemometer height, i.e., the height above ground at which the wind speed data were collected. Since the models adjust the input wind speeds from the anemometer height to the release height (see Section 1.1.3 of Volume II), the accurate specification of anemometer height is important to obtaining the correct model results. The syntax and type of the ANEMHGHT keyword are summarized below:

Syntax:	ME ANEMHGHT Zref (Zrunit)
Type:	Mandatory, Non-repeatable

where the parameter Zref is the height of the anemometer measurement above ground, and the optional parameter Zrunit is used to specify the units of Zref. Valid inputs for Zrunit are the secondary keywords METERS or FEET. The default units for Zref are in meters if Zrunit is left blank.

3.5.3 Specifying Station Information

Two keywords are used to specify information about the meteorological stations, SURFDATA for the surface meteorological station, and UAIRDATA for the upper air station used in the determination of mixing heights. The syntax and type of these keywords are summarized below:

Syntax:	ME SURFDATA Stanum Year (Name) (Xcoord) (Ycoord)
Syntax:	ME UAIRDATA Stanum Year (Name) (Xcoord) (Ycoord)
Type:	Mandatory, Non-repeatable

where Stanum is the station number, e.g. the 5-digit WBAN number for NWS stations, Year is the year of data being processed (either 2 or 4 digits), Name is an optional character field (up to 40 characters with no blanks) specifying the name of the station, and Xcoord and Ycoord are optional parameters for specifying the x and y coordinates for the location of the stations. At the present time, the station locations are not utilized in the models. Therefore, no units are specified for Xcoord and Ycoord at this time, although meters are suggested in order to be consistent with the source and receptor coordinates.

3.5.4 Specifying the Meteorological STAR Data (Applies Only to ISCLT2)

The STARDATA keyword is used to define what STAR meteorological data summaries are actually included in the data file. The syntax and type of this keyword is summarized below:

Syntax:	ME STARDATA JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC WINTER SPRING SUMMER FALL QUART1 QUART2 QUART3 QUART4 MONTH SEASON QUARTR ANNUAL PERIOD
Type:	Optional, Non-repeatable

This keyword works is conjunction with the CO AVERTIME keyword (Section 3.2.3) to determine which STAR summaries are processed for a particular run. If the STARDATA keyword is omitted, then the model assumes that the meteorological data file consists only of the STAR summaries identified on the CO AVERTIME keyword. While the STARDATA keyword is identified as being optional, it is required in the case where the CO AVERTIME card specifies only the PERIOD average to be calculated. In this case, the model needs the STARDATA input in order to determine what STAR summaries are included in the data file to properly calculate the PERIOD average. A fatal error message will be generated (and processing aborted) if the STARDATA card is omitted for cases with only PERIOD averages being calculated.

The STARDATA keyword allows the user considerable flexibility in controlling which averaging periods to calculate from one run to another. As an example, suppose that the user has a STAR data file consisting of 12 monthly STAR summaries.

This would be identified to the model by including the following card on the ME pathway:

```
ME STARDATA  MONTH
```

The user could then generate annual average results by specifying only PERIOD on the CO AVERTIME card. The emission rate factor may be varied by month in the process. With the same meteorological data file, the user could also calculate results for the first quarter only by changing the AVERTIME card to read:

```
CO AVERTIME  JAN  FEB  MAR  PERIOD
```

This would result in results being produced for each of the first three months of the year and for the combined period of JAN-MAR. Each quarter could be calculated in turn simply by changing the AVERTIME card as follows:

```
CO AVERTIME  APR  MAY  JUN  PERIOD  (for Quarter 2)
CO AVERTIME  JUL  AUG  SEP  PERIOD  (for Quarter 3)
CO AVERTIME  OCT  NOV  DEC  PERIOD  (for Quarter 4)
```

By specifying MONTH on the ME STARDATA card, the model will be able to retrieve the correct STAR summary for each of these cases. The only requirement is that STAR summaries always be included in the following order within the meteorological data file:

```
JAN, FEB, MAR, ..., DEC, WINTER (or QUART1), SPRING (or QUART2),
SUMMER (or QUART3), FALL (or QUART4), and ANNUAL
```

Any number of STAR summaries may be included, up to a maximum of 17 (for 12 months, plus 4 seasons or quarters, plus 1 annual.

3.5.5 Specifying a Data Period to Process (Applies Only to ISCST2)

There are two keywords that allow the user to specify particular days or ranges of days to process from the sequential meteorological file input for the ISCST2 model. The STARTEND keyword controls which period within the meteorological data file is read by the model, while the DAYRANGE keyword controls which days or ranges of days (of those that are read) for the model to process. The default for the model is to read the entire meteorological data file (up to a full year) and to process all days within that period.

The syntax and type for the STARTEND keyword are summarized below:

Syntax:	ME STARTEND Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr)
Type:	Optional, Non-repeatable

where the Strtyr Strtmn Strtdy parameters specify the year, month and day of the first record to be read (e.g., 87 01 31 for January 31, 1987), and the parameters Endyr Endmn Enddy specify the year, month and day of the last record to be read. The Strthr and Endhr are optional parameters that may be used to specify the start and end hours for the data period to be read. If either Strthr or Endhr is to be specified, then both must be specified. Any records in the data file that occur before the start date are ignored, as are any records in the data file that occur after the end date. In fact, once the end date has been reached, the model does not read any more data from the meteorological file. If Strthr and Endhr are not specified, then processing begins with hour 1 of the start

date, and ends with hour 24 of the end date, unless specific days are selected by the DAYRANGE card described below.

Any PERIOD averages calculated by the model will apply only to the period of data actually processed. Therefore, if someone wanted to calculate a six-month average, they could select PERIOD averages on the CO AVERTIME card, and then specify the period as follows:

```
ME STARTEND  87 01 01  87 06 30
```

for the period January 1, 1987 through June 30, 1987.

The syntax and type for the DAYRANGE keyword are summarized below:

Syntax:	ME DAYRANGE Range1 Range2 Range3 ... Rangen
Type:	Optional, Repeatable

where the Range parameters specify particular days or ranges of days to process. The days may be specified as individual days (e.g. 1 2 3 4 5) or as a range of days (e.g. 1-5). The user also has the option of specifying Julian day numbers, from 1 to 365 (366 for leap years), or specifying month and day (e.g., 1/31 for January 31). Any combination of these may also be used. For example the following card will tell the model to process the days from January 1 (Julian day 1) through January 31 (1/31):

```
ME DAYRANGE  1-1/31
```

The DAYRANGE keyword is also repeatable, so that as many cards as needed may be included in the ME pathway.

As with the STARTEND keyword, any PERIOD averages calculated by the model will apply only to the period of data actually processed. If the STARTEND keyword is also used, then only those days selected on the DAYRANGE cards that fall within the period from the start date to the end date will be processed. Thus, if the ME pathway included the following two cards:

```
ME STARTEND  87 02 01  87 12 31
ME DAYRANGE  1-31
```

then no data would be processed, since the days 1 through 31 fall outside the period 2/1 to 12/31.

3.5.6 Correcting Wind Direction Alignment Problems

The WDROTATE keyword allows the user to correct the input meteorological data for wind direction alignment problems. All input wind directions or flow vectors are rotated by a user-specified amount. Since the model results at particular receptor locations are often quite sensitive to the transport wind direction, this optional keyword should be used only with extreme caution and with clear justification.

The syntax and type of this keyword are summarized below:

Syntax:	ME WDROTATE Rotang
Type:	Optional, Non-repeatable

where the Rotang parameter specifies the angle in degrees to rotate the input wind direction measurements. The value of Rotang is subtracted from the wind direction measurements. It may be used to correct for known (and documented) calibration errors, or to adjust for the alignment of a valley if the meteorological station is located in a valley with a different

alignment than the source location. Since the Short Term models use the flow vector (direction toward which the wind is blowing) as the basic input, the WDROTATE keyword may also be used to convert input data as wind direction (from which the wind is blowing) to flow vector by setting the parameter Rotang = 180.

3.5.7 Specifying Wind Speed Categories

Some of the parameters that may be input to the models are allowed to vary by wind speed category. Examples of such inputs are user-specified wind speed profile exponents, vertical potential temperature gradients, and variable emission rate factors. The models use six wind speed categories, and these are defined by the upper bound wind speed for the first five categories (the sixth category is assumed to have no upper bound). The default values for the wind speed categories are as follows: 1.54, 3.09, 5.14, 8.23, and 10.8 m/s. The syntax and type of the WINDCATS keyword, which may be used to specify different category boundaries, are summarized below:

Syntax:	ME WINDCATS Ws1 Ws2 Ws3 Ws4 Ws5
Type:	Optional, Non-repeatable

where the Ws1 through Ws5 parameters are the upper bound wind speeds of the first through fifth categories in meters per second. The upper bound values are inclusive, i.e., a wind speed equal to the value of Ws1 will be placed in the first wind speed category.

3.5.8 Specifying Wind Profile Exponents

While the model uses default wind profile exponents if the regulatory default option is selected (see the CO MODELOPT description in Section 3.2.2), for non-regulatory default applications the user can specify wind profile exponents

through use of the WINDPROF keyword on the ME pathway. The syntax and type of this keyword are summarized below:

Syntax:	ME WINDPROF Stab Prof1 Prof2 Prof3 Prof4 Prof5 Prof6
Type:	Optional, Repeatable

where the Stab parameter specifies the stability category for the following six values, and Prof1 through Prof6 are the wind profile exponents for each of the six wind speed categories. The Stab parameter may be input either alphabetically (A through F) or numerically (1 for A through 6 for F). The WINDPROF cards do not need to be input in any particular order.

The wind speed categories are either the default categories used by the model (with upper bound speeds of 1.54, 3.09, 5.14, 8.23, and 10.8 m/s for the first five categories - the sixth category is assumed to have no upper bound), or the categories specified by the user on the optional ME WINDCATS keyword (Section 3.5.6).

The following example will input the default exponents for the rural mode, and illustrates the use of a repeat value for applying the exponents to all six wind speed categories:

```
ME WINDPROF  A  6*0.07
ME WINDPROF  B  6*0.07
ME WINDPROF  C  6*0.10
ME WINDPROF  D  6*0.15
ME WINDPROF  E  6*0.35
ME WINDPROF  F  6*0.55
```

If the regulatory default option has been selected, then any inputs on the WINDPROF keyword are ignored by the model, and a non-fatal warning message is generated.

3.5.9 Specifying Vertical Temperature Gradients

While the model uses default vertical potential temperature gradients if the regulatory default option is selected (see the CO MODELOPT description in Section 3.2.2), for non-regulatory default applications the user can specify vertical potential temperature gradients through use of the DTHETADZ keyword on the ME pathway. The syntax and type of this keyword are summarized below:

Syntax:	ME DTHETADZ Stab Dtdz1 Dtdz2 Dtdz3 Dtdz4 Dtdz5 Dtdz6
Type:	Optional, Repeatable

where the Stab parameter specifies the stability category for the following six values, and Dtdz1 through Dtdz6 are the vertical potential temperature gradients for each of the six wind speed categories. The Stab parameter may be input either alphabetically (A through F) or numerically (1 for A through 6 for F). The DTHETADZ cards do not need to be input in any particular order.

The wind speed categories are either the default categories used by the model (with upper bound speeds of 1.54, 3.09, 5.14, 8.23, and 10.8 m/s for the first five categories - the sixth category is assumed to have no upper bound), or the categories specified by the user on the optional ME WINDCATS keyword (Section 3.5.6).

The following example will input the default values of DTDZ, and illustrates the use of a repeat value for applying the inputs to all six wind speed categories:

```
ME DTHETADZ  A  6*0.00
ME DTHETADZ  B  6*0.00
ME DTHETADZ  C  6*0.00
ME DTHETADZ  D  6*0.00
ME DTHETADZ  E  6*0.020
ME DTHETADZ  F  6*0.035
```

If the regulatory default option has been selected, then any inputs on the DTHETADZ keyword are ignored by the model, and a non-fatal warning message is generated.

3.5.10 Specifying Average Wind Speeds for the Long Term Model

The ISC2 Long Term model uses joint frequencies of wind speed class by wind direction sector by stability category as the basic meteorological input to the model. These STAR summaries (for STability ARray) are described in more detail in Section 3.5.1.2. The optional AVESPEED keyword on the ME pathway allows the user to specify the median wind speed for each of the wind speed categories in the STAR summary. The syntax and type of this keyword are summarized below:

Syntax:	ME AVESPEED Ws1 Ws2 Ws3 Ws4 Ws5 Ws6
Type:	Optional, Non-repeatable

where the Ws1 through Ws6 parameters are the median wind speeds (m/s) for each of the six wind speed categories. The default values used by the model in the absence of the AVESPEED keyword are as follows: 1.50, 2.50, 4.30, 6.80, 9.50, and 12.50 m/s.

3.5.11 Specifying Average Temperatures for the Long Term Model

Since temperature data are not included in the basic STAR meteorological data file used for input to the ISC2 Long Term model, the user must specify average values of ambient temperature for the model to use. The syntax and type of the AVETEMPS keyword are summarized below:

Syntax:	ME AVETEMPS Aveper Ta1 Ta2 Ta3 Ta4 Ta5 Ta6
Type:	Mandatory, Repeatable

where the Aveper parameter specifies the averaging period (i.e. season) for the following inputs, and may be one of the following secondary keywords: WINTER, SPRING, SUMMER, or FALL. The Ta1 through Ta6 parameters are the average ambient temperatures (K) for each of the six stability categories, A through F. The AVETEMPS keyword may be repeated for each of the averaging periods being processed. The following example illustrates the use of the AVETEMPS keyword for the four seasons:

```
ME AVETEMPS  WINTER  3*280.0  275.0  2*270.0
ME AVETEMPS  SPRING  3*285.0  280.0  2*275.0
ME AVETEMPS  SUMMER  6*293.0
ME AVETEMPS   FALL   280. 280. 275. 270. 265. 265.
```

where repeat values have been used for the unstable and stable classes for winter and spring, and for all classes for summer.

3.5.12 Specifying Average Mixing Heights for the Long Term Model

Since mixing height data are not included in the basic STAR meteorological data file used for input to the ISC2 Long Term model, the user must specify average values of mixing

height for the model to use. The syntax and type of the AVEMIXHT keyword are summarized below:

Syntax:	ME AVEMIXHT Aveper Stab Mixht1 Mixht2 Mixht3 Mixht4 Mixht5 Mixht6
Type:	Mandatory, Repeatable

where the Aveper parameter specifies the averaging period (i.e. season) for the following inputs, and may be one of the following secondary keywords: WINTER, SPRING, SUMMER, or FALL. The Stab parameter specifies the stability category (A through F or 1 through 6). The Mixht1 through Mixht6 parameters are the average mixing heights (m) for each of the six wind speed categories. The AVEMIXHT keyword may be repeated for each stability category and for each of the averaging periods being processed. The following example illustrates the use of the AVEMIXHT keyword for one season:

```
ME AVEMIXHT  WINTER  A  6*2250.0
ME AVEMIXHT  WINTER  B  6*2000.0
ME AVEMIXHT  WINTER  C  6*1500.0
ME AVEMIXHT  WINTER  D  6*1000.0
ME AVEMIXHT  WINTER  E  6*500.0
ME AVEMIXHT  WINTER  F  6*300.0
```

where repeat values have been used to apply the mixing heights to each of the wind speed categories.

3.6 EVENT PATHWAY INPUTS AND OPTIONS (APPLIES ONLY TO ISCEV2)

The ISCEV2 (EVENT) model is specifically designed to facilitate analysis of source contributions to specific events for short term averages (less than or equal to 24 hours). These events may be design concentrations generated by the ISCST2 model, occurrences of violations of an air quality standard, or user-specified events. These events are input to the ISCEV2 model through the **EV**ent pathway. Each event is defined by an averaging period and specific data period, a source group, and

a receptor location. Since the locations are only of interest in combination with particular averaging and data periods, the REceptor pathway is not used by the EVENT model.

There are two keywords that are used to define the events on the EV pathway. The EVENTPER keyword defines the averaging period, data period and source group, while the EVENTLOC keyword defines the receptor location for the event. Each event is also given an alphanumeric name that links the two input cards for that event.

The syntax and type of the EVENTPER and EVENTLOC keywords are summarized below:

Syntax:	EV EVENTPER Evname Aveper Grpid Date
Syntax:	EV EVENTLOC Evname XR= Xr YR= Yr (Zelev) (Zflag) or Evname RNG= Rng DIR= Dir (Zelev) (Zflag)
Type:	Mandatory, Repeatable

where the parameters are as follows:

Evname - event name (an alphanumeric string of up to 8 characters),

Aveper - averaging period for the event (e.g. 1, 3, 8, 24 hr)

Grpid - source group ID for the event (must be defined on SO pathway),

Date - date for the event, input as an eight digit integer for the ending hour of the data period (YYMMDDHH), e.g. 84030324 defines a data period ending at hour 24 on March 3, 1984. The length of the period corresponds to Aveper.

XR= - X-coordinate (m) for the event location, referenced to a Cartesian coordinate system

YR= - Y-coordinate (m) for the event location, referenced to a Cartesian coordinate system

RNG= - distance range (m) for the event location, referenced to a polar coordinate system with an origin of (0., 0.)

DIR= - radial direction (deg.) for the event location, referenced to a polar coordinate system with an origin of (0., 0.)

Zelev - optional terrain elevation for the event location (m)

Zflag - optional receptor height above ground (flagpole receptor) for the event location (m)

Each event is defined by the two input cards EVENTPER and EVENTLOC, and these inputs are linked by the event name, which must be unique among the events being processed in a given run. There is no particular requirement for the order of cards on the EV pathway. Note that the location for the event may be specified by either Cartesian coordinates or by polar coordinates, however, the polar coordinates must be relative to an origin of (0,0).

3.6.1 Using Events Generated by the ISCST2 Model

Since the ISCEV2 (EVENT) model was designed to work in conjunction with the ISCST2 model, the ISCST2 model has an option (CO EVENTFIL described in Section 3.2.9) to generate an input file for the ISCEV2 model. When this option is used, the ISCST2 model copies relevant inputs from the ISCST2 runstream input file to the ISCEV2 model input file, and generates the inputs for the EVent pathway from the results of the modeling run. These events are the design concentrations identified by the OU RECTABLE keyword (see Section 3.7.1.1), such as the highest and high-second-high 24-hour averages, etc., and any threshold violations identified by the OU MAXIFILE keyword (see Section 3.7.1.2). The inputs generated by the ISCST2 model correspond to the syntax described above for the EVENTPER and EVENTLOC keywords. The locations for events generated by the ISCST2 model are always provided as Cartesian coordinates.

To easily identify the events generated by the ISCST2 model, and to provide a mechanism for the ISCST2 model to manage the events generated from the model run, a naming convention is used for the EVNAME parameter. The following examples illustrate the event names used by the ISCST2 model:

H1H01001 - High-first-high 1-hour average for source group number 1

H2H24003 - High-second-high 24-hour average for source group number 3

TH030010 - Threshold violation number 10 for 3-hour averages

TH240019 - Threshold violation number 19 for 24-hour averages

The high value design concentrations are listed first in the ISCEV2 model input file, followed by the threshold violations (grouped by averaging period). To make it easier for the user to review the ISCEV2 model input file generated by the ISCST2 model, and determine which events are of most concern, the actual concentration or deposition value associated with the event is included as the last field on the EVENTPER card. This field is ignored by the ISCEV2 model, and is included only for informational purposes. The user should be aware that the same event may appear in the ISCEV2 model input file as both a design value and as a threshold violation, depending on the options selected and the actual results. Since the model processes the events by date sequence and outputs the results for each event as it is processed, the order of events in the output file will generally not follow the order of events in the input file, unless all of the events were generated by the MAXIFILE option.

3.6.2 Specifying Discrete Events

The user can specify discrete events by entering the EVENTPER and EVENTLOC cards as described above. The averaging period and source group selected for the event must be among those specified on the CO AVERTIME and SO SRCGROUP cards. If the ISCEV2 model input file was generated by the ISCST2 model, the user may include additional events for those averaging periods and source groups used in the original ISCST2 model run. They may also add averaging periods or define new source groups in the ISCEV2 model input file in order to define additional events.

3.7 OUTPUT PATHWAY INPUTS AND OPTIONS

The **OU**tput pathway contains keywords that define the output options for the model runs. Since the output options are somewhat different for each of the three models, the OU pathway options for the models are discussed separately.

3.7.1 Short Term Model Options

The ISCST2 model has three keywords that control different types of tabular output for the main output file of the model, and three keywords that control separate output file options for specialized purposes. The user may select any combination of outputs for a particular application.

3.7.1.1 Selecting Options for Tabular Printed Outputs.

The three tabular printed output options are controlled by the following keywords (the corresponding option switches from the previous ISCST model are indicated in parentheses):

RECTABLE - Controls output option for high value summary tables by receptor (ISW(17));

MAXTABLE - Controls output option for overall maximum value summary tables (ISW(18)); and

DAYTABLE - Controls output option for tables of concurrent values summarized by receptor for each day processed (ISW(16)).

While these tabular output options for the ISCST2 model correspond roughly to the indicated options from the previous version of the model, the ISCST2 model provides greater flexibility for the user to specify different output options by averaging period. The keywords are described in more detail in the order listed above.

The syntax and type for the RECTABLE keyword are summarized below:

Syntax:	OU RECTABLE Aveper FIRST SECOND ... SIXTH or 1ST 2ND ... 6TH
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 1, 3, 8 or 24 hr or MONTH) for which the receptor table is selected, and the secondary keywords, FIRST, SECOND, etc., indicate which high values are to be summarized by receptor for that averaging period. The RECTABLE card may be repeated for each averaging period. For cases where the user wants the same RECTABLE options for all short term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the Aveper parameter. The following example will select summaries of the highest, second highest and third highest values by receptor for all averaging periods:

```
OU RECTABLE  ALLAVE  FIRST  SECOND  THIRD
```

The model will also recognize a range of high values on the RECTABLE input card, and therefore the following card will have the effect:

```
OU RECTABLE  ALLAVE  FIRST-THIRD
```

The output file will include tables for only the high values selected. Tables for all source groups for a particular averaging period are grouped together, and the averaging periods are output in the order that they appear the CO AVERTIME card. For each averaging period and source group combination, the tables of high values for the receptor networks (if any) are printed first, followed by any discrete Cartesian receptors, any discrete polar receptors, and any boundary receptors.

The number of high values per receptor that the model can store is controlled by the NVAL PARAMETER in the Fortran computer code. The value of NVAL is initially set at 3, which corresponds to the option available in the previous version of ISCST for the three highest values by receptor. The NVAL PARAMETER can be changed (up to 10), and the model recompiled in order to meet other modeling needs, such as the highest of the sixth highest values by receptor for PM-10 modeling, assuming sufficient memory is available for the model's storage requirements. Changing the model storage limits is discussed in more detail in Section 4.2.2.

If the CO EVENTFIL keyword has been used to generate an input file for the ISCEV2 (EVENT) model, then the design values identified by the RECTABLE options, e.g., the high-second-high 24-hour average, are included in the events that are defined in the ISCEV2 model input file.

The syntax and type for the MAXTABLE keyword are summarized below:

Syntax:	OU MAXTABLE Aveper Maxnum
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 1, 3, 8 or 24 hr or MONTH) for which the receptor table is selected, and the Maxnum parameter specifies the number of overall maximum values to be summarized for each averaging period. The MAXTABLE card may be repeated for each averaging period. As with the RECTABLE keyword, for cases where the user wants the same MAXTABLE options for all short term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the Aveper parameter. The following example will select the maximum 50 table for all averaging periods:

```
OU MAXTABLE  ALLAVE  50
```

A separate maximum overall value table is produced for each source group. The maximum value tables follow the RECTABLE outputs in the main print file. All source group tables for a particular averaging period are grouped together, and the averaging periods are output in the order that they appear on the CO AVERTIME card.

The number of overall maximum values that the model can store for each averaging period and source group is controlled by the NMAX PARAMETER in the Fortran computer code. The value of NMAX is initially set at 50, which corresponds to the option available in the previous version of ISCST for the maximum 50 table. The NMAX PARAMETER can be changed (up or down), and the model recompiled in order to meet other modeling needs, assuming sufficient memory is available for the model's storage

requirements. Changing the model storage limits is discussed in more detail in Section 4.2.2.

The syntax and type for the DAYTABLE keyword are summarized below:

Syntax:	OU DAYTABLE Avper1 Avper2 Avper3 . . .
Type:	Optional, Non-repeatable

where the Avpern parameters are the short term averaging periods (e.g. 1, 3, 8 or 24 hr or MONTH) for which the daily tables are selected. The DAYTABLE card is non-repeatable, but as with the RECTABLE and MAXTABLE keywords, for cases where the user wants daily tables for all short term averaging periods being modeled, the input may be simplified by entering the secondary keyword ALLAVE for the first parameter. The following example will select the daily tables for all averaging periods:

```
OU DAYTABLE  ALLAVE
```

For each averaging period for which the DAYTABLE option is selected, the model will print the concurrent averages for all receptors for each day of data processed. The receptor networks (if any) are printed first, followed by any discrete Cartesian receptors, discrete polar receptors, and boundary receptors. Results for each source group are output. For example, if 1, 3, and 24-hour averages are calculated, and the OU DAYTABLE ALLAVE option is used, then for the first day of data processed, there will be 24 sets of tables of hourly averages (one for each hour in the day), eight sets of 3-hour averages (one for each 3-hour period in the day), and one set of 24-hour averages. The averages are printed as they are calculated by the model, but for hours where more than one averaging period is calculated (e.g., hour 24 is the end of an

hourly average, a 3-hour average, and a 24-hour average), the order in which the averages are output will follow the order used on the CO AVERTIME card. Note: This option can produce very large output files, especially when used with a full year of data and very short period averages, such 1-hour and 3-hour. It should therefore be used with CAUTION.

3.7.1.2 Selecting Options for Special Purpose Output Files.

The ISCST2 model provides options for three types of output files for specialized purposes. One option produces files of all occurrences of violations of user-specified threshold values (MAXIFILE keyword), another option produces files of concurrent (raw) results at each receptor suitable for post-processing (POSTFILE keyword), and a third option produces files of design values that can be imported into graphics packages in order to produce contour plots (PLOTFILE keyword). Each of these options is described in detail below. The MAXIFILE and PLOTFILE options are new features of the ISCST2 model. The POSTFILE option is similar to the output concentration file option in the previous version of ISCST (ISW(5)), but has been extended to provide the user with more flexibility in selecting only the desired outputs, and also allows for output of unformatted or formatted files of concurrent results.

The syntax and type for the MAXIFILE keyword are summarized below:

Syntax:	OU MAXIFILE Aveper Grpid Thresh Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the short term averaging period (e.g. 3, 8, 24 for 3, 8 and 24-hour averages, or MONTH for monthly averages) and Grpid is the source group ID for which

the MAXIFILE option is selected. The Thresh parameter is the user-specified threshold value, and Filnam is the name of the file where the MAXIFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 20-100, inclusive. By specifying the same filename and unit for more than one MAXIFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.8.2).

The MAXIFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. The resulting maximum value file will include several header records identifying the averaging period, source group and the threshold value for that file, and a listing of every occurrence where the result for that averaging period/source group equals or exceeds the threshold value. Each of these records includes the averaging period, source group ID, date for the threshold violation (ending hour of the averaging period), the x, y, z and flagpole receptor height for the receptor location where the violation occurred, and the concentration or deposition value.

Each of the threshold violations, except for monthly averages, identify events that may be modeled for source contribution information with the ISCEV2 (EVENT) model by selecting the CO EVENTFIL option (see Sections 3.2.9 and 3.6). Each of the threshold violations is included as an event on the EV pathway, and is given a name of the form THxxyyyy, where xx is the averaging period, and yyyy is the violation number for that averaging period. For example, an event name of TH240019 identifies the 19th threshold violation for 24-hour averages. Monthly average threshold violations are included in the file specified on the MAXIFILE card, but are not included in the

ISCEV2 model input file since the ISCEV2 model currently handles only averaging periods of up to 24 hours.

The following examples illustrate the use of the MAXIFILE option:

```
OU MAXIFILE  24  ALL   364.0  MAX24ALL.OUT
OU MAXIFILE  24  PSD    91.0  MAXPSD.OUT    50
OU MAXIFILE   3  PSD   365.0  MAXPSD.OUT    50
OU MAXIFILE   3  PLANT  25.0  C:\OUTPUT\MAXI3HR.FIL
OU MAXIFILE MONTH  ALL  10.0  MAXMONTH.OUT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. The FILNAM parameter may be up to 40 characters in length. It should also be noted that only one MAXIFILE card may be used for each averaging period/source group combination. Note: The MAXIFILE option may produce very large files for runs involving a large number of receptors if a significant percentage of the results exceed the threshold value.

The syntax and type for the POSTFILE keyword are summarized below:

Syntax:	OU POSTFILE Aveper Grpid Format Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g. 3, 8, 24 for 3, 8 and 24-hour averages, MONTH for monthly averages, or PERIOD for period averages) and Grpid is the source group ID for which the POSTFILE option is selected. The Format parameter specifies the format of the POSTFILE output, and may either be the secondary keyword UNFORM for unformatted concentration files (similar to those created by the original ISCST model), or the secondary keyword PLOT to obtain formatted files of receptor locations (x- and y-coordinates) and concentrations suitable for plotting contours of concurrent

values. The Filnam parameter is the name of the file where the POSTFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 20-100, inclusive. By specifying the same filename and unit for more than one POSTFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.8.2).

The POSTFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. If UNFORM is specified for the Format parameter, then the resulting unformatted file includes a constant-length record for each of the selected averaging periods calculated during the model run. The first variable of each record is an integer variable (4 bytes) containing the ending date (YYMMDDHH) for the averages on that record. The second variable for each record is an integer variable (4 bytes) for the number of hours in the averaging period. The third variable for each record is a character variable of length eight containing the source group ID. The remaining variables of each record contain the calculated average concentration or total deposition values for all receptors, in the order in which they were defined in the input runstream.

The following examples illustrate the use of the POSTFILE option:

```
OU POSTFILE  24  ALL    UNFORM   PST24ALL.BIN
OU POSTFILE  24  PSD    UNFORM   PST24PSD.BIN
OU POSTFILE   3  PLANT  UNFORM   C:\BINOUT\PST3HR.FIL
OU POSTFILE MONTH ALL     PLOT   PSTMONTH.PLT
OU POSTFILE PERIOD ALL    PLOT   PSTANN.PLT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. The Filnam parameter may be up to 40 characters in length. The use of separate files for each averaging period/source group combination allows the user flexibility to select only those results that are needed for post-processing for a particular run, and also makes the resulting unformatted files manageable. Note: The POSTFILE option can produce very large files, and should be used with some caution. For a file of hourly values for a full year (8760 records) and 400 receptors, the resulting file will use about 14 megabytes of disk space. To estimate the size of the file (in bytes), use the following equation:

$$\text{File Size (bytes)} = \frac{(\#\text{ of Hrs/Yr})}{(\#\text{ of Hrs/Ave})} * (\#\text{ of Rec} + 4) * 4$$

Divide the result by 1000 to estimate the number of kilobytes (KB) and divide by 1.0E6 to estimate the number of megabytes (MB).

The syntax and type for the PLOTFILE keyword are summarized below:

Syntax:	OU PLOTFILE Aveper Grpid Hivalu Filnam (Funit), or OU PLOTFILE PERIOD Grpid Filnam (Funit)
Type:	Optional, Repeatable

where the Aveper parameter is the averaging period (e.g. 3, 8, 24 for 3, 8 and 24-hour averages, MONTH for monthly averages, or PERIOD for period averages), Grpid is the source group ID for which the PLOTFILE option is selected, and Hivalu specifies which short term high values are to be output (FIRST for the first highest at each receptor, SECOND for the second highest at each receptor, etc.) Note that the Hivalu parameter is not specified for PERIOD averages, since there is only one period

average for each receptor. The Filnam parameter is the name of the file where the PLOTFILE results are to be written. The optional Funit parameter allows the user the option of specifying the Fortran logical file unit for the output file. The user-specified file unit must be in the range of 20-100, inclusive. By specifying the same filename and unit for more than one PLOTFILE card, results for different source groups and/or averaging periods may be combined into a single file. If the Funit parameter is omitted, then the model will dynamically allocate a unique file unit for this file (see Section 3.8.2).

The PLOTFILE card may be repeated for each combination of averaging period, source group, and high value, and a different filename should be used for each file. The resulting formatted file includes several records with header information identifying the averaging period, source group and high value number of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the appropriate high value at that location, and the averaging period, source group and high value number. The data are written to the file in the order of x-coord, y-coord, concentration (or deposition) so that the file can easily be imported into a graphics package designed to generate contour plots. Many such programs will read the PLOTFILEs directly without any modification, ignoring the header records, and produce the desired plots.

The following examples illustrate the use of the PLOTFILE option:

```
OU PLOTFILE  24  ALL    FIRST  PLT24ALL.FST
OU PLOTFILE  24  ALL    SECOND PLT24ALL.SEC
OU PLOTFILE  24  PSD      2ND  PLTPSD.OUT      75
OU PLOTFILE   3  PSD      2ND  PLTPSD.OUT      75
OU PLOTFILE   3  PLANT    1ST  C:\PLOTS\PLT3HR.FIL
OU PLOTFILE MONTH ALL   THIRD  PLTMONTH.OUT
OU PLOTFILE PERIOD ALL         PSTANN.PLT
```

where the 3-hour example illustrates the use of a DOS pathname for the PC, and the last example illustrates the use of monthly averages. As illustrated by the second and third examples, the high value parameter may also be input as secondary keywords using the standard abbreviations of 1ST, 2ND, 3RD, . . . 10TH. The Filnam parameter may be up to 40 characters in length. The use of separate files for each averaging period, source group, high value combination allows the user flexibility to select only those results that are needed for plotting from a particular run.

3.7.2 Short Term EVENT Model (ISCEV2) Options

The ISC2 Short Term EVENT model (ISCEV2) is designed specifically to perform source contribution analyses for short term average (less than or equal to 24-hour) events. The events may either be generated by the ISCST2 model, or they may be user-specified events, or both. Because of this rather narrow focus of applications for the ISCEV2 model, the output options are limited to a single keyword. The EVENTOUT keyword controls the level of detail in the source contribution output from the EVENT model. The syntax and type of the EVENTOUT keyword are summarized below:

Syntax:	OU EVENTOUT SOCONT DETAIL
Type:	Mandatory, Non-repeatable

where the SOCONT secondary keyword specifies the option to produce only the source contribution information in the output file, and the DETAIL secondary keyword specifies the option to produce more detailed summaries in the output file. The SOCONT option provides the average concentration (or total deposition) value (i.e., the contribution) from each source for the period corresponding to the event for the source group. The basic source contribution information is also provided with the DETAIL option. In addition, the DETAIL option provides the hourly average concentration (or total deposition) values for each source for every hour in the averaging period, and a summary of the hourly meteorological data for the event period. In general, the DETAIL option produces a larger output file than the SOCONT file, especially if there are a large number of sources. There is no default setting for the EVENTOUT options.

3.7.3 Long Term Model Options

The ISCLT2 model has three keywords available on the OU pathway to specify the output options. The RECTABLE and MAXTABLE keywords are similar to the corresponding keywords for the ISCST2 model in that RECTABLE specifies the options for tabular summaries of results by receptor, and MAXTABLE specifies options for tabular summaries of overall maximum results. These tabular output options are similar to the options available with the previous version of ISCLT through the option switches ISW(8), ISW(10), and ISC(11). The third keyword, PLOTFILE, is also similar to the corresponding keyword for ISCST2, and allows the user to generate separate output files suitable for importing into graphics packages to generate contour plots. However, the parameters on these keywords differ between the two models because of the different data structures of the models.

For the Short Term model there are several short term averages during the data period, from which the model sorts and

stores the highest, second highest and third highest values at each location, whereas for the Long Term model, there is only one long term average result at each location. Because of these differences in the data structure, the Long Term model is able to store the results for all sources at each receptor location, in addition to the combined source group values. Therefore, the output keywords for Long Term include options to summarize results for each source or for the source groups, and also to provide source contribution information for the maximum source group values (thereby eliminating the need for a Long Term EVENT model).

The syntax and type for the Long Term RECTABLE keyword are summarized below:

Syntax:	OU RECTABLE INDSRC and/or SRCGRP
Type:	Optional, Non-repeatable

where the INDSRC secondary keyword specifies that summaries of individual sources for each receptor are to be output, and the secondary keyword SRCGRP specifies that summaries of source group values for each receptor are to be provided. The user may select either option or both options in a given run. The individual source values are presented first in the output file, with the results by receptor network followed by any discrete Cartesian receptors, discrete polar receptors and boundary receptors. The source group results follow the same pattern as the individual source tables. A complete set of summary tables is output for each STAR summary processed, and for the PERIOD averages, if calculated.

The syntax and type for the Long Term MAXTABLE keyword are summarized below:

Syntax:	OU MAXTABLE Maxnum INDSRC and/or SRCGRP and/or SOCONT
Type:	Optional, Non-repeatable

where the Maxnum parameter specifies the number of maximum values to summarize, and where the INDSRC and SRCGRP secondary keywords specify that summaries of maximum values for individual sources and for source groups, respectively, are to be provided. The individual source maximum values are treated independently of the source group maxima with the INDSRC option. To obtain the contribution from each source to the maximum source group values (similar to the information obtained from ISCEV2), the user may select the SOCONT option. The user may select any combination of these options in a given run. If the SOCONT option is selected, and the SRCGRP option has not been selected, the model will automatically determine the maximum source group values so that the source contribution analysis can be performed, but the maximum source group values will not be included in the output file. The individual source values are presented first in the output file, followed by the maximum source group values, and the source contribution results, according to the options selected. A complete set of maximum value summary tables is output for each STAR summary processed, and for the PERIOD averages, if calculated.

The number of overall maximum values that the model can store for each source and source group is controlled by the NMAX PARAMETER in the Fortran computer code. The value of NMAX is initially set at 10 for the Long Term model, which corresponds to the option available in the previous version of ISCLT for the maximum 10 tables. The NMAX PARAMETER can be changed (up or down), and the model recompiled in order to meet other modeling needs, assuming sufficient memory is available

for the model's storage requirements. Changing the model storage limits is discussed in more detail in Section 4.2.2.

The syntax and type for the Long Term PLOTFILE keyword are summarized below:

Syntax:	OU PLOTFILE Aveper Grpid Filnam
Type:	Optional, Repeatable

where the Aveper parameter is the long term averaging period (e.g. WINTER, SPRING, etc.) and Grpid is the source group ID for which the PLOTFILE option is selected. The PLOTFILE card may be repeated for each combination of averaging period and source group, and a different filename should be used for each file. The resulting formatted file includes several records with header information identifying the averaging period and source group of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the long term average value at that location, the averaging period and the source group ID. The data are written to the file in the order of x-coord, y-coord, concentration (or deposition) so that the file can easily be imported into a graphics package designed to generate contour plots. Many such programs will read the PLOTFILEs directly without any modification, ignoring the header records, and produce the desired plots.

The example below illustrates the use of various Long Term model output options:

```
OU RECTABLE  INDSRC  SRCGRP
OU MAXTABLE  10  INDSRC  SRCGRP  SOCONT
OU PLOTFILE  WINTER  ALL  PLTWINT.OUT
OU PLOTFILE  SPRING  PSD  PSDSPRG.PLT
OU PLOTFILE  ANNUAL  PLANT C:\PLOTS\PLANT.ALL
```

where all of the tabular printed output options have been selected, and several plotfiles have also been selected.

3.8 CONTROLLING INPUT AND OUTPUT FILES

This section describes the various input and output files used by the ISC2 models, and discusses control of input and output (I/O) on the IBM-compatible PC environment. Much of this discussion also applies to operating the models in other environments.

3.8.1 Description of ISC2 Input Files

The two basic types of input files needed to run all of the ISC2 models are the input runstream file containing the modeling options, source data and receptor data, and the input meteorological data file. Each of these is discussed below, as well as a special file that may be used to initialize the ISCST2 model with intermediate results from a previous run.

3.8.1.1 Input Runstream File.

The input runstream file contains the user-specified options for running the various ISC2 models, includes the source parameter data and source group information, defines the receptor locations, specifies the location and parameters regarding the meteorological data, and specifies the output options. The basic structure of the input runstream file is the same for all three models, although the list of available keywords for defining options, and the exact syntax for certain keywords are slightly different between the Short Term and Long Term models. Details regarding the keywords and parameters used in the input runstream file are provided in Section 3, and Appendix B.

For the PC-executable versions of the models available on the SCRAM BBS, the runstream file is explicitly opened by the models using a Fortran OPEN statement, and the integer variable, INUNIT, specifies the unit number for the file. The variable INUNIT is initialized to a value of 5 in a BLOCK DATA subprogram of the model, which corresponds to the default input unit for Fortran. The INUNIT variable is included in a named COMMON block (FUNITS) in the MAIN1.INC include file, and is therefore available to all of the necessary subroutines.

Since the input runstream file is opened explicitly by the PC-executable versions of the models, the model will take the first parameter on the command line when running the model as the input filename. No DOS redirection symbol should be used preceding the runstream filename.

3.8.1.2 Meteorological Data File.

The input meteorological data is read into the models from a separate data file for all three models. The meteorological filename and format are specified within the input runstream file using the ME INPUTFIL keyword. The Short Term models accept meteorological data from unformatted sequential files generated by the RAMMET and MPRM preprocessors, and also accept a wide range of formatted ASCII files of hourly sequential records. The Long Term model accepts STability ARray (STAR) meteorological data from sequential ASCII files using either a default READ format, a user-specified READ format or free-formatted READs.

The meteorological data file is explicitly opened by the models using a Fortran OPEN statement, and the integer variable, MFUNIT, specifies the unit number for the file. The variable MFUNIT is initialized to a value of 19 in a BLOCK DATA subprogram of the model. The MFUNIT variable is included in a

named COMMON block (FUNITS) in the MAIN1.INC include file, and is therefore available to all of the necessary subroutines.

3.8.1.3 Initialization File for Model Re-start.

The ISCST2 model has an optional capability to store intermediate results to an unformatted (sometimes called binary) file for later re-starting of the model in the event of a power failure or user interrupt. This unformatted file may therefore be used as an input file to initialize the model. This option is controlled by the SAVEFILE (saves intermediate results to a file) and the INITFILE (initialize result arrays from a previously saved file) keywords on the CO pathway.

When initializing the model for the re-start option, the user specifies the name of the unformatted results file on the INITFILE keyword. The default filename used if no parameter is provided is TMP.FIL. The initialization file is explicitly opened by the ISCST2 model, and the integer variable, IRSUNT, specifies the unit number for the file. The variable IRSUNT is initialized to a value of 15 in a BLOCK DATA subprogram of the model. The IRSUNT variable is included in a named COMMON block (FUNITS) in the MAIN1.INC include file, and is therefore available to all of the necessary subroutines.

3.8.2 Description of ISC2 Output Files

The ISC2 models produce a variety of output files, including the main print file of model results, an unformatted file of intermediate results for later re-start of the model (ISCST2 only), and several output data files for specialized purposes. These files are described in detail below.

3.8.2.1 Output Print File.

Each of the ISC2 models produces a main output print file of model results. The contents and organization of this file for the ISCST2 model were shown in Figure 2-5. This file includes an echo of the input runstream images at the beginning of the file (up until a NO ECHO input is encountered). A summary of runstream setup messages and a summary of the inputs follow the echo of inputs. The input summary includes a summary of modeling options, source data, receptor data, and meteorological data, following the same order as the pathways in the runstream file. If model calculations are performed, then the model results are summarized next. The content and order of the model result summaries depend on the output options selected and on the particular model being run. Following the detailed model results are summary tables of the high values for each averaging period and source group (ISCST2 only). The final portion of the main output print file is the summary of messages for the complete model run.

For the PC-executable versions of the models available on the SCRAM BBS, the main print output file is explicitly opened by the models using a Fortran OPEN statement, and the integer variable, IOUNIT, specifies the unit number for the file. The variable IOUNIT is initialized to a value of 6 in a BLOCK DATA subprogram of the model, which corresponds to the default output unit for Fortran. The IOUNIT variable is included in a named COMMON block (FUNITS) in the MAIN1.INC include file, and is therefore available to all of the necessary subroutines.

Since the main print output file is opened explicitly, the model will take the second parameter on the command line when running the model as the output filename. No DOS redirection symbol should be used preceding the output filename. If an output file is not given on the command line, then the model will return an error message and abort execution.

By opening the printed output file explicitly, the outputs are not automatically formatted for the printer. This formatting is accomplished using the CARRIAGE CONTROL specifier in the OPEN statement for the Lahey extended memory version of the models, and by explicitly writing the ASCII form feed character to the file for the Microsoft DOS version.

3.8.2.2 Detailed Error Message File.

The user may select an option for the model to save a separate file of detailed error and other messages, through use of the CO ERRORFIL keyword. The format and syntax of these messages is described in Appendix E. The order of messages within the file is the order in which they were generated by the model. The file includes all types of messages that were generated.

The error message file is explicitly opened by the model using a Fortran OPEN statement, and the integer variable, IERUNT, specifies the unit number for the file. The variable IERUNT is initialized to a value of 10 in a BLOCK DATA subprogram of the model. The IERUNT variable is included in a named COMMON block (FUNITS) in the MAIN1.INC include file, and is therefore available to all of the necessary subroutines.

3.8.2.3 Intermediate Results File for Model Re-start.

The ISCST2 model has an optional capability to store intermediate results to an unformatted (sometimes called binary) file for later re-starting of the model in the event of a power failure or user interrupt. This unformatted file may therefore be used as an input file to initialize the model. This option is controlled by the SAVEFILE (saves intermediate results to a file) and the INITFILE (initialize result arrays from a previously saved file) keywords on the CO pathway.

When saving the intermediate results for the re-start option, the user specifies the name of the unformatted results file on the SAVEFILE keyword. The user has the option of specifying a single filename, two filenames (for alternate saves), or specifying no filename. The default filename used if no parameter is provided is TMP.FIL. If a single file is used, then the intermediate results file is overwritten on each successive dump, with the chance that the file will be lost if the interrupt occurs during the time that the file is opened. If two filenames are provided, then the model also saves to the second file on alternate dumps, so that the next most recent dump will always be available. The main save file is explicitly opened by the ISCST2 model, and the integer variable, IDPUNT, specifies the unit number for the file. The variable IDPUNT is initialized to a value of 12 in a BLOCK DATA subprogram of the model. If a second save file is used, then it is also opened explicitly, and the integer variable IDPUN2, initialized to a value of 14, specifies the unit number.

3.8.2.4 Maximum Value/Threshold File.

The user may select an option for the ISCST2 model to generate a file or files of concentration (or deposition) values exceeding a user-specified threshold. The OU MAXIFILE keyword controls this option. The user may select separate files for each averaging period and source group combination for which a list of threshold violations may be needed. Each file includes several records with header information identifying the averaging period, source group and threshold value, and then a record for every occurrence where the result for that averaging period/source group equals or exceeds the threshold value. Each of these records includes the averaging period, source group ID, date for the threshold violation (ending hour of the averaging period), the x, y, z and flagpole receptor height for the receptor location where the violation occurred, and the concentration or deposition value.

The structure of the threshold violation file is described in more detail in Appendix F. Each of the files selected by the user is opened explicitly by the model as an formatted file. The filenames are provided on the input runstream image. The user may specify the file unit on the MAXIFILE card through the optional FUNIT parameter. User-specified units must be greater than or equal to 20, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formula:

$$IMXUNT = 100 + IGRP*10 + IAVE$$

where IMXUNT is the Fortran unit number, IGRP is the source group number (the order in which the group is defined in the runstream file), and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 9 source groups and up to 9 short term averaging periods.

3.8.2.5 Sequential Results File for Postprocessing.

The user may select an option for the ISCST2 model to generate a file or files of concentration (or deposition) values suitable for postprocessing. The OU POSTFILE keyword controls this option. The user may select separate files for each averaging period and source group combination for which postprocessing may be needed. For each file requested, the user has the option of specifying whether to use unformatted files suitable for postprocessing or to use a plot format which could allow for inporting the x,y,conc files into a graphics package for plotting. For the unformatted file option, each file consists of sequential unformatted records of values at each receptor location for every averaging period calculated. For the plot file format option, each file consists of

formatted records listing the x-coordinate, y-coordinate and concurrent concentration (or deposition) values for each receptor and for all averaging periods calculated. For certain applications, these files may become quite large, and should only be used when needed, especially when using the plot format.

The structure of both types of postprocessing file is described in more detail in Appendix F. Each of the postprocessing files selected by the user is opened explicitly by the model as either an unformatted or a formatted file, depending on the option selected. The filenames are provided on the input runstream image. The user may specify the file unit on the POSTFILE card through the optional FUNIT parameter. User-specified units must be greater than or equal to 20, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formulas:

```
IPSUNT = 200 + IGRP*10 + IAVE      for short term averages
IAPUNT = 300 + IGRP*10 - 5         for PERIOD averages
```

where IPSUNT and IAPUNT are the Fortran unit numbers, IGRP is the source group number (the order in which the group is defined in the runstream file), and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 9 source groups and up to 9 short term averaging periods.

3.8.2.6 High Value Summary File for Plotting.

The user may select an option for the ISCST2 model to generate a file or files of the highest concentration (or deposition) values at each receptor suitable for importing into a graphics package in order to generate contour plots. The OU

PLOTFILE keyword controls this option. The user may select separate files for each averaging period, source group and high value combination for which a plot file may be needed. Each file includes several records with header information identifying the averaging period, source group and high value number of the results, and then a record for each receptor which contains the x and y coordinates for the receptor location, the appropriate high value at that location, and the averaging period, source group and high value number.

The structure of the plot file is described in more detail in Appendix F. Each of the plot files selected by the user is opened explicitly by the model as an formatted file. The filenames are provided on the input runstream image. The user may specify the file unit on the MAXIFILE card through the optional FUNIT parameter. User-specified units must be greater than or equal to 20, and are recommended to be less than or equal to 100. If no file unit is specified, then the file unit is determined internally according to the following formulas:

```
IPLUNT = (IVAL+3)*100 + IGRP*10 + IAVE   for short term aver.
IPPUNT = 300 + IGRP*10                   for PERIOD averages
```

where IPLUNT and IPPUNT are the Fortran unit numbers, IVAL is the high value number (1 for FIRST highest, 2 for SECOND highest, etc.), IGRP is the source group number (the order in which the group is defined in the runstream file), and IAVE is the averaging period number (the order of the averaging period as specified on the CO AVERTIME card). This formula will not cause any conflict with other file units used by the model for up to 9 source groups and up to 9 short term averaging periods.

3.8.3 Control of File Inputs and Outputs (I/O)

3.8.3.1 Control of I/O on DOS PCs.

The main input runstream file and the main output print file are both specified on the command line when running the models on a PC. Since the PC-executable file provided explicitly opens these two files, there is no need to use DOS redirection of input and output. Therefore, a standard command line to execute the ISCST2 model might look something like this:

```
C:\>ISCST2 TEST-ST.INP TEST-ST.OUT
```

where the "DOS prompt" has been given as "C:\>", but may look different on different systems, or may include a subdirectory specification. Since DOS redirection is not used for the output file, an output filename must be specified or the model will not execute properly. This is done to allow for the model to write an update to the PC terminal on the status of processing. The output file generated by the DOS version includes page feeds that are written directly to the file as part of the header for each page, rather than using the Fortran carriage control of '1'.

3.8.3.2 Controlling I/O on Other Computer Systems.

The PC-executable versions of the models that are available on the SCRAM BBS includes certain features that are specific to operating the models in a PC environment. These include specifying the input and output file names on the command line and writing an update on the status of the processing to the computer screen. In order to accomplish the latter, the output file is opened explicitly. The PC versions also include writing a date and time for the run on each page of the printed output file. The Fortran computer code that is

used to implement these PC-specific features has been commented out in the source code files available on SCRAM. This is done in order to make the most use of the features available for the PC while at the same time making the Fortran source code as "portable" to other computer systems as reasonably possible. This section briefly addresses the control of model input and output for non-PC computer systems.

With the PC-specific code commented out in the ISC2 source code, the models will use the default input unit (Fortran unit 5) for reading the input runstream file, and the default output unit (Fortran unit 6) for writing the printed output file. These files are not opened explicitly by the models with the PC code commented out. These files have to be defined, using the $DEFINE command in VAX/VMS and using the DD statement in the JCL for the IBM/MVS. Refer to Section 4.3 for additional information about running the models in other environments.

4.0 COMPUTER NOTES

This section provides information regarding the computer aspects of the ISC2 models, including the minimum hardware requirements for executing the models on a PC, instructions regarding compiling and running the models on a PC, and information regarding porting the models to other computer systems. A more detailed Programmer's Guide is provided in Volume III of the ISC2 Model User's Guide, including details regarding the design of the computer code.

4.1 MINIMUM HARDWARE REQUIREMENTS

4.1.1 Requirements for Execution on a PC

The ISC2 models were developed on an IBM-compatible PC, and were designed to run of PCs with certain minimum hardware requirements. The basic requirements are as follows:

- 80x86 processor (e.g., 8086, 80286, 80386, 80486)
- 640 K of RAM
- Hard Disk with sufficient storage space to handle the executable file, input data files, and output files (file sizes will vary, generally about 2 MB will be sufficient for routine applications)

While a math coprocessor (80x87 chip) is optional for execution of the DOS versions of the ISC2 models on a PC, it is highly recommended, especially for the ISCST2 model, due to the large increase in execution speed that will be experienced. The model may be expected to run about five to ten times faster with a math coprocessor than without one. The DOS models are compiled using an emulator library, meaning that a math coprocessor will be used if one is present, but the models will also run without one.

While the model was designed assuming a PC with a minimum of 640 K of RAM, the minimum amount of available RAM for loading the various models (as provided on the SCRAM BBS) are approximately as follows:

ISCST2.EXE - 476K
ISCLT2.EXE - 473K
ISCEV2.EXE - 411K

Because additional memory is needed (for buffers) when the models open files (such as the input runstream file, the printed output file, the error message file, etc.), the amount of memory needed to actually run the models will be somewhat larger than the figures given above. Depending on the number of externally files being used for a particular application, an additional 10K of memory should be sufficient.

The amount of available memory on a particular machine will depend on the machine configuration including the amount of memory used by the operating system, memory used by any special device drivers, and any memory-resident utility programs. Generally, a 640K PC with minimal memory overhead will have about 550 to 580K of RAM available for applications, such as the ISC2 models. The amount of available RAM can be determined by executing the DOS CHKDSK command. This is done by entering the command 'CHKDSK C:' to check the C: drive. Refer to the DOS manual for more information about CHKDSK.

For particularly large applications, involving a large number of sources, source groups, receptors and averaging periods, the user may find that the 640K RAM limit available with DOS is not enough. Volume III of the ISC2 User's Guide contains information on increasing the capacity of the model and setting it up to run on systems (with 80386 processors and higher) that make use of extended memory beyond the 640K limit of DOS. There are special requirements for the operating

system and Fortran language compiler needed to utilize the extended memory on these machines.

4.1.2 Requirements for Execution on a DEC VAX Minicomputer

ISCST2 will run on any DEC VAX minicomputer or workstation which has enough main memory to do the real application run. More than 5 MBytes user disk space is recommended.

4.1.3 Requirements for Execution on an IBM Mainframe

ISCST2 will run on any IBM 3090 or above mainframe as long as the machine supports enough memory. The size of the desired memory depends on the size of the application case run. At least 5 MBytes user disk space is recommended.

4.2 COMPILING AND RUNNING THE MODELS ON A PC

As mentioned earlier, the ISC2 models were developed on an IBM-compatible PC, using the Microsoft Optimizing FORTRAN Compiler (Version 5.1). This section provides details regarding compiling and running the models on a PC.

4.2.1 Microsoft Compiler Options

The DOS versions of the executable files (.EXE) of the models provided on the SCRAM BBS were compiled with the Microsoft Optimizing FORTRAN Compiler (Version 5.1) using the following command line:

```
FL /c /FPi /AH /DMICRO *.FOR
```

where /c instructs the compiler to compile without linking; the /FPi option instructs the compiler to use in-line instructions for floating point operations and link with an emulator library (uses 80x87 coprocessor if present); the /AH option that the

huge memory model be used, allowing arrays or common blocks to exceed 64K; and the /DMICRO option instructs the compiler to use the conditional compilation blocks defined for the Microsoft compiler. These conditional blocks of code implement the PC-specific features of the model including writing the date and time fields on each page of the printed output file and writing an update to the screen on the status of processing. The *.FOR parameter tells the compiler to compile all files in the default directory ending with an extension of *.FOR. This assumes that all of the source code modules and the include files are in a single directory, or that the compiler has been setup to search for the include files in the appropriate directory. This command line for the compiler makes full use of the compiler's optimization routines to speed up the code. To disable optimization, the /Od option would be added.

The source modules for the ISCST2 model are as follows:

```
ISCST2.FOR - Main program, error handling and other
             utilities
SETUP.FOR  - Main SETUP subroutines and initialization
             module
INPSUM.FOR - Subroutines to summarize the input data
COSET.FOR  - Subroutines to process CO pathway inputs
SOSET.FOR  - Subroutines to process SO pathway inputs
RESET.FOR  - Subroutines to process RE pathway inputs
MESET.FOR  - Subroutines to process ME pathway inputs
OUSET.FOR  - Subroutines to process OU pathway inputs
METEXT.FOR - Extracts and checks the meteorological data
CALC1.FOR  - Main calculation subroutines, including
             source-type specific
CALC2.FOR  - Secondary group of calculation subroutines
             for hourly values
CALC3.FOR  - Group of subroutines to process and sort
             averages
CALC4.FOR  - Group of subroutines to output results as
             calculated (e.g. DAYTABLE and POSTFILE
             results)
PRISE.FOR  - Plume rise subroutines
SIGMAS.FOR - Dispersion parameter subroutines
OUTPUT.FOR - Model output subroutines
MAIN1.INC  - First INCLUDE file, used throughout model
```

MAIN2.INC - Second INCLUDE file, used for MODNAM variable only
MAIN3.INC - Third INCLUDE file, contains only results arrays

Once the source files have been compiled successfully, and object (.OBJ) files have been generated for each source file, the model is ready to be linked and an executable file created. The executable file on the SCRAM BBS was linked using a memory overlay manager so that only certain portions of the code are resident in memory at any given time. This allows for a more efficient use of available memory by the model, and therefore allows for larger runs to be performed than would be possible without using overlays. This is accomplished with the following command line for the linker provided with the Microsoft compiler:

```
LINK /E ISCST2+SETUP+(INPSUM)+(COSET)+(SOSET)+(RESET)+(MESET)+(OUSE T)+(METEXT+CALC1+
      CALC2+CALC3+PRISE+SIGMAS+CALC4)+(OUTPUT)
```

The /E option instructs the linker to produce a packed Sexecutable file that occupies less disk space. The linker will prompt for the name of the executable file (which will default to ISCST2.EXE), and the names of any special library modules to link (none are needed). The ISCST2 and SETUP modules are always memory resident, and any module or group of modules within parentheses are overlayed into the same area of memory only when needed. Linking without the overlay manager will increase the minimum load size for the executable file by about 160K for the ISCST2 model. Since most of the overlay swapping occurs during the setup processing, which is only a very small fraction of the execution time for normal sized applications, the use of overlays does not significantly effect the execution time of the model. The load size of the model can be reduced somewhat by placing the SETUP and CALC4 modules in separate overlays. Placing SETUP in an overlay will only effect performance (execution speed) for the setup processing stage, and will only be significant for relatively long input

runstream files (e.g. with a large number of sources or with many discrete receptors). If the application does not make use of the SAVEFILE, DAYTABLE, MAXIFILE and/or POSTFILE keyword options (where results are output as their are calculated), then moving the CALC4 module to a separate overlay will not effect performance at all, since it is only called if one of those options is used. An example of the LINK command to minimize the load size of the model is as follows:

```
LINK /E ISCST2+(SETUP)+(INPSUM)+(COSET)+(SOSET)+(RESET)+(MESET)+(OU SET)+(CALC1+CALC2+CALC3+
        PRISE+SIGMAS)+(CALC4)+(OUTPUT)
```

This overlay structure will reduce the load size by about 24K for the ISCST2 model.

4.2.2 Modifying PARAMETER Statements for Unusual Modeling Needs

As discussed in Section 2.3, the ISC2 models make use of a static storage allocation design, where the model results are stored in explicitly dimensioned data arrays, and the array limits are controlled by PARAMETER statements in the Fortran computer code. These array limits also correspond to the limits on the number of sources, receptors, source groups and averaging periods that the model can accept for a given run. Depending on the amount of memory available on the particular computer system being used, and the needs for a particular modeling application, the storage limits can easily be changed by modifying the PARAMETER statements and recompiling the model.

The limits on the number of receptors, sources, source groups, averaging periods, and events (for ISCEV2 model) are initially set as follows for the three models for the DOS and extended memory (EM) versions on the PC:

PARAMETER Name	Limit Controlled	ISCST2	ISCEV2	ISCLT2
NREC	Number of Receptors	600 (DOS) 1200 (EM)	-	500 (DOS) 1200 (EM)
NSRC	Number of Sources	100 (DOS) 300 (EM)	100 (DOS) 500 (EM)	100 (DOS) 300 (EM)
NGRP	Number of Source Groups	2 (DOS) 5 (EM)	25 (DOS) 50 (EM)	3 (DOS) 5 (EM)
NAVE	Number of Short Term Averages	2 (DOS) 4 (EM)	4 (DOS) 4 (EM)	-
NEVE	Number of Events	-	2500 (DOS) 5000 (EM)	-

Fortran PARAMETER statements are also used to specify the array limits for the number of high short term values by receptor to store for the ISCST2 model (NVAL, initially set to 6), and the number of overall maximum values to store (NMAX, initially set to 50 for ISCST2 and to 10 for Long Term). The NMAX limits correspond to the limits available in the previous versions of the model, but can also be modified by the user and the model recompiled in order to meet particular needs.

In addition to the parameters mentioned above, parameters are used to specify the number of receptor networks in a particular run (NNET), and the number of x-coordinate (or distance) and y-coordinate (or direction) values (IXM and IYM) for each receptor network. Initially, the models allow up to 5 receptor networks (of either type) and up to 50 x-coordinates (or distances) and up to 50 y-coordinates (or directions). The source arrays also include limits on the number of variable emission rate factors per source (NQF, initially set to 96 for Short Term, 36 for the DOS Long Term, and 144 for the EM Long Term), the number of sectors for direction-specific building dimensions (NSEC, initially set to 36 for Short Term and 16 for Long Term), and the number of settling and removal categories (NVSMAX, initially set to 20).

To modify the array limits for the model, the user must first edit the appropriate PARAMETER values in the MAIN1.INC file for that model. Once the array limits have been customized to a particular application's needs, then the entire model must be recompiled and linked (see Section 4.2.1 above). Because the high value arrays in the ISCST2 model are 4-dimensional arrays (NREC,NVAL,NGRP,NAVE) and there are three arrays with these dimensions (the sorted high values, the data period for each value, and the calm and missing value flag for each value), the model's storage requirements are particularly sensitive to increasing the number of source groups or the number of high values to store at each receptor location. For example, the amount of storage space required to store these three arrays with the initial PARAMETER values for the DOS version is about 130K. To increase the number of source groups from 2 to 4 would double the storage requirement, adding at least another 130K to the load size of the model.

The user should first determine the types of applications for which they most typically use the models, and then modify the appropriate PARAMETER values accordingly. If someone never (or very rarely) uses variable emission rate factors, then modifying the NQF parameter could free up some memory. Setting NQF to 24 (which would still handle HROFDY factors), will free up about 29K for a model using 100 sources. The user may also wish to reduce the NVSMAX parameter if settling and removal categories are rarely used.

Often, when a larger number of source groups has been used with the previous version of the ISCST model, it has been for the purpose of performing source contribution (or source culpability) analyses. Since the ISCEV2 (EVENT) model provides this type of information without having to specify a separate source group for each source, the need for large numbers of source groups in the new models should be lessened. If the storage limits available on the 640K PC environment are too

restrictive for particular applications, then the user should examine the possibility of using a different hardware environment or a different operating system where the 640K barrier will not be limiting. Such systems are available for PCs with 80386 and 80486 processors. The extended memory (EM) versions of the models provided on the SCRAM BBS require an 80386 or 80486 processor with at least 4 MB of RAM (3 MB of available extended memory). The setup and application of the models on the DEC VAX minicomputer and the IBM 3090 mainframe computer are also described in the next section of this User's Guide, and in more detail in Volume III of the ISC2 User's Guide.

4.3 PORTING THE MODELS TO OTHER HARDWARE ENVIRONMENTS

The ISC2 models are designed and coded to allow them to run on most operating environments, including DOS, UNICOS, UNIX, SunOS, VAX/VMS, and TSO/MVS. The ISC2 models use ANSI Standard FORTRAN 77 with the exception of two widely supported language extensions, namely the INCLUDE statement and the DO WHILE ... END DO loop construct. Although the users do not need to make major changes, they may experience some minor differences from machine to machine on the exact syntax of the INCLUDE statement. These common language extensions may not be supported on older versions of some compilers as well. The following sections address portability of the models to various systems in more detail.

4.3.1 Non-DOS PCs

The only requirement for porting the models to non-DOS PC environments is the availability of a Fortran compiler capable of operating in and compiling for the non-DOS operating system. The extended memory (EM) versions of the models available on the SCRAM BBS were compiled using the Lahey F77L-EM/32 Fortran Compiler, which uses the Ergo Computing OS/386 operating system

to access extended memory in 32-bit protected mode. The EM executable files are bound with the Ergo OS/386 operating system and a load module to allow the models to be run on DOS machines.

One significant advantage to installing and running the models in 32-bit protected mode on PCs is the ability to address a much larger memory storage area. This allows for the data storage limits controlled by the Fortran PARAMETER statements to be set much higher than is possible for the DOS versions. By using the 32-bit instruction set, the protected mode versions also tend to run about 20 to 30 percent faster than the DOS versions. More information about compiling the models with the Lahey F77L-EM/32 compiler is provided in Appendix D.

4.3.2 DEC VAX

4.3.2.1 Compiler/System Dependent Preprocessing.

The ISC2 codes as provided on the SCRAM BBS are compatible with VAX-11 FORTRAN Version 2 and above, except that the PC-specific features have been commented out. These features include writing the date and time on each page of the printed output file and writing an update to the screen on the status of processing.

4.3.2.2 Creating An Executable ISCST2.

Although the users can specify any way they want to group and store the code and data files, the easiest way is to copy all the source codes modules, INCLUDE files and meteorology data into a subdirectory. The user can then write a .COM file to compile, link and create an executable.

The files needed to make the ISCST2 executable are the following:

MAIN1.INC, MAIN2.INC, MAIN3.INC, ISCST2.FOR, SETUP.FOR, COSET.FOR, SOSET.FOR, RESET.FOR, MESET.FOR, OUSET.FOR, INPSUM.FOR, METEXT.FOR, CALC1.FOR, CALC2.FOR, PRISE.FOR, SIGMAS.FOR, CALC3.FOR, CALC4.FOR, OUTPUT.FOR

The following is a sample command file named MAKEISC.COM:

```
$SET DEF [USERNAME.ISCST]
$ FOR ISCST2.FOR
$ FOR SETUP.FOR
$ FOR COSET.FOR
$ FOR SOSET.FOR
$ FOR RESET.FOR
$ FOR MESET.FOR
$ FOR OUSET.FOR
$ FOR INPSUM.FOR
$ FOR METEXT.FOR
$ FOR CALC1.FOR
$ FOR CALC2.FOR
$ FOR PRISE.FOR
$ FOR SIGMAS.FOR
$ FOR CALC3.FOR
$ FOR CALC4.FOR
$ FOR OUTPUT.FOR
$LINK ISCST2,SETUP,COSET,SOSET,RESET,MESET,OUTSET,-
INPSUM,METEXT,CALC1,CALC2,PRISE,SIGMAS,CALC3,CALC4,OUTPUT
$ EXIT
```

To make the executable file, the users should run the MAKEISC.COM file by typing @makeisc after the command line prompt and pressing ENTER.

4.3.2.3 Running ISCST2.

The VAX/VMS operating system is somewhat different from the DOS and UNIX operating environments. The users are not able to direct system I/O on the command line prompt. Instead, the users need to generate a .COM file first, and then run the .COM file online or submit the .COM file to a system batch queue.

Here is an example of the .COM runfile named RUNISC.COM:

```
$SET DEF [USERNAME.ISCST]
$DEFINE/USER_MODE SYS$INPUT TEST-ST.INP
$DEFINE/USER_MODE SYS$OUTPUT TEST-ST.OUT
$RUN ISCST2
$EXIT
```

The users can either type in @runisc ENTER to run the model online or SUBMIT runisc on the command line prompt to submit a batch job.

4.3.3 IBM 3090

4.3.3.1 Compiler/System Dependent Preprocessing.

The ISC2 codes as provided on the SCRAM BBS are compatible with the IBM VS FORTRAN (Version 2), except that the PC-specific features have been commented out. These features include writing the date and time on each page of the printed output file and writing an update to the screen on the status of processing. The syntax for the INCLUDE statement is different on the IBM VS FORTRAN, and the user will have to replace the statements such as:

```
INCLUDE 'MAIN1.INC'
```

with a corresponding statement such as:

```
INCLUDE (MAIN1)
```

throughout the ISC2 source code. This can easily be accomplished with the editor, and there are three INCLUDE files used in each of the models. For the ISCST2 model, the INCLUDE file names are MAIN1.INC, MAIN2.INC, and MAIN3.INC.

4.3.3.2 Creating An Executable ISCST2.

The ISCST2 model can be compiled and linked in one step under VS FORTRAN by executing the appropriate procedure (e.g., VSF2CG to compile and load) in the JCL for the compile job. It is easiest to concatenate all of the source (*.FOR) files into a single partitioned data set member, and identify that file name with a DD statement in the JCL. Special procedures may be needed to access the INCLUDE files, where each INCLUDE file should be a member in a partitioned data set.

4.3.3.3 Running ISCST2.

When running the ISCST2 model under IBM/MVS, special attention is needed to defining and controlling the file I/O. The input runstream file is read from the default input unit, Fortran unit number 5, and the output print file is written to the default output unit, Fortran unit number 6. The input meteorological data file is read from Fortran unit 19. Other system files include the temporary error/message file (unit 10) and the temporary event file for ISCST2 (unit 18). These files, as well as any user-specified optional output files, must be defined with DD statements in the JCL.

4.3.4 Various UNIX machines (CRAY, SUN, DEC VAX, AT&T)

4.3.4.1 Compiler/System Dependent Preprocessing.

The ISC2 codes as provided on the SCRAM BBS are compatible with any ANSI Standard FORTRAN 77 Compiler operating under UNICOS, UNIX, and SUN OS, except that the PC-specific features have been commented out. These features include writing the date and time on each page of the printed output file and writing an update to the screen on the status of processing.

4.3.4.2 Creating An Executable ISCST2.

Although the users can specify any way they want to group and store the code and data files, the easiest way is to copy all the source codes modules, INCLUDE files and meteorology data into a subdirectory. The users should make sure that every source file has suffix .f and the file name should be a lower case ASCII character string, because the UNICOS, UNIX, and SUN OS is case-sensitive. Also, for the same reason, all of the .INC file should be in UPPER CASE. The user can then write a make file to compile, link and create an executable.

The files needed to make the ISCST2 executable are the following:

MAIN1.INC, MAIN2.INC, MAIN3.INC, ISCST2.F, SETUP.F, COSET.F, SOSET.F, RESET.F, MESET.F, OUSET.F, INPSUM.F, METEXT.F, CALC1.F, CALC2.F, PRISE.FOR, SIGMAS.F, CALC3.F, CALC4.F, OUTPUT.F

Compiling ISCST2 is relatively easy under UNIX operating environment due to the similarity between DOS and UNIX. For a DEC VAX workstation running Utrix 4.3, the command:

```
f77 -o iscst2 *.f
```

will generate an ISCST2 executable. For a CRAY running UNICOS 5.1, the following commands will generate an ISCST2 executable under UNICOS:

```
cft77 iscst2.f
cft77 setup.f
cft77 coset.f
cft77 soset.f
cft77 reset.f
cft77 meset.f
cft77 ouset.f
cft77 inpsum.f
cft77 metext.f
cft77 calc1.f
cft77 calc2.f
cft77 prise.f
cft77 sigmas.f
cft77 calc3.f
cft77 calc4.f
cft77 output.f
segldr -o iscst2 *.o
```

The command for compiling ISCST2 under the SUN OS environment is similar to the one for VAX Utrix 4.3.

4.3.4.3 Running ISCST2.

Before running ISCST2, the users need to check the meteorology data file and make sure the file name matches the one in the input file. File names in UNIX are case sensitive, so the characters in the file name need to match the ones in the input file. Then the user can type:

```
iscst2 <inputfile >outputfile
```

to run the executable.

4.3.5 Advanced Topics.

For more detailed information about porting and installing the ISC2 models to other computer environments, refer to Volume III of the ISC2 User's Guide. Volume III provides a more detailed description of the design and structure of the computer code, including module calling trees, data dictionary, and a description of the model loop structures. Volume III also includes instructions for compiling the ISC2 models with compilers that do not support the INCLUDE and DO WHILE ... END DO Fortran language extensions.

5.0 REFERENCES

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APPENDIX A. ALPHABETICAL KEYWORD REFERENCE

This appendix provides an alphabetical listing of all of the keywords used by the ISC2 models. Each keyword is identified as to the pathway for which it applies, the keyword type (either mandatory or optional, and either repeatable or non-repeatable), and with a brief description of the function of the keyword. For a more complete description of the keywords, including a list of associated parameters, refer to the Detailed Keyword Reference in Section 3 or the Functional Keyword/Parameter Reference in Appendix B.

Keyword	Path	Type	Keyword Description
ANEMHGHT	ME	M - N	Input height of anemometer above stack base
AVERTIME	CO	M - N	Averaging time(s) to process (up to four short term plus period averages)
AVEMIXHT	ME	M - R	Average mixing height for each wind speed, stability category and season (Applies Only to Long Term)
AVESPEED	ME	O - N	Average (median) wind speed for each speed category in the STAR summary (Applies Only to Long Term)
AVETEMPS	ME	M - R	Average ambient temperature for each stability category and season (Applies Only to Long Term)
BOUNDARY	RE	O - R	Defines discrete polar receptor locations corresponding to minimum plant boundary distances for each 10 degree sector
BOUNDELV	RE	O - R	Defines terrain elevations for discrete receptors specified with BOUNDARY keyword
BUILDHGT	SO	O - R	Building height values for each wind sector
BUILDWID	SO	O - R	Building width values for each wind sector
DAYRANGE	ME	O - R	Specifies days or ranges of days to process (default is to process all data read in), applies only to ISCST2 processing
DAYTABLE	OU	O - N	Option to summaries for each averaging period for each day processed. (Applies to ISCST2 Only)
DCAYCOEF	CO	O - N	Optional decay coefficient for exponential decay

Type: M - Mandatory N - Non-repeatable
O - Optional R - Repeatable

Keyword	Path	Type	Keyword Description
DISCCART	RE	O - R	Defines the discretely placed receptor locations referenced to a Cartesian system
DISCPOLR	RE	O - R	Defines the discretely placed receptor locations referenced to a polar system
DTHETADZ	ME	O - R	Input optional vertical potential temperature gradients
ELEVUNIT	CO	O - N	Defines input units for receptor elevations (defaults to meters)
EMISFACT	SO	O - R	Optional input for variable emission rate factors
EMISUNIT	SO	O - N	Optional conversion factors for emissions, concentrations, and depositions
ERRORFIL	CO	O - N	Option to generate detailed error listing file (error file is mandatory for CO RUNORNOT NOT case)
EVENTFIL	CO	O - N	Specifies whether to generate an input file for EVENT model (Applies only to ISCST2)
EVENTOUT	OU	M - N	Specifies the level of output information provided by the EVENT model
EVENTPER	EV	M - R	Describes data and averaging period for an event
EVENTLOC	EV	M - R	Describes receptor location for an event
FINISHED	ALL	M - N	Identifies the end of inputs for a particular pathway
FLAGPOLE	CO	O - N	Specifies whether to accept receptor heights above local terrain (m) for use with flagpole receptors, and allows for a default flagpole height to be specified
GRIDCART	RE	O - R	Defines a Cartesian grid receptor network
GRIDPOLR	RE	O - R	Defines a polar receptor network
HALFLIFE	CO	O - N	Optional half life used for exponential decay

Keyword	Path	Type	Keyword Description
INITFILE	CO	O - N	Option to initialize model from file of intermediate results generated by SAVEFILE option
INPUTFIL	ME	M - N	Describes input meteorological data file
LOCATION	SO	M - R	Identifies coordinates for particular source
LOWBOUND	SO	O - R	Switch to use non-DFAULT option for "lower bound" wake calculations, controlled by sector
MASSFRAX	SO	O - R	Optional input of mass fraction for each settling velocity category
MAXIFILE	OU	O - R	Option to list events exceeding a threshold value to file (if CO EVENTFIL option is used, these events are included in the input file generated for the EVENT model)
MAXTABLE	OU	O - R	Option to summarize the overall maximum values
MODELOPT	CO	M - N	Job control and dispersion options
MULTYEAR	CO	O - N	Specifies that run is part of a multi-year run, e.g., for PM-10 H6H in five years
PLOTFILE	OU	O - R	Option to write certain results to a storage file suitable for input to plotting routines
POLLUTID	CO	M - N	Identifies type of pollutant being modeled
POSTFILE	OU	O - R	Option to write results to a mass storage file for postprocessing
RECTABLE	RE	O - R	Option to output value(s) by receptor
REFLCOEF	SO	O - R	Optional input of surface reflection coefficients for each settling velocity category
RUNORNOT	CO	M - N	Identifies whether to run model or process setup information only

Keyword	Path	Type	Keyword Description
SAVEFILE	CO	O - N	Option to store intermediate results for later restart of the model after user or system interrupt (Applies to ISCST2 Only)
SETVELOC	SO	O - R	Input variables for optional settling velocities
SRCGROUP	SO	M - R	Identification of source groups
SRCPARAM	SO	M - R	Identifies source parameters for a particular source
STARDATA	ME	O - N	Identifies which STAR summaries are included in the meteorological data file
STARTEND	ME	O - N	Specifies start and end dates to be read from input meteorological data file (default is to read entire file), applies only to ISCST2 processing
STARTING	ALL	M - N	Identifies the start of inputs for a particular pathway
SURFDATA	ME	M - N	Describes surface meteorological station
TERRHGTS	CO	O - N	Specifies whether to assume flat terrain (default) or to allow use of receptors on elevated terrain
TITLEONE	CO	M - N	First line of title for output
TITLETWO	CO	O - N	Optional second line of title for output
UAIRDATA	ME	M - N	Describes upper air meteorological station
WDROTATE	ME	O - N	Wind direction rotation adjustment
WINDCATS	ME	O - N	Upper bound of wind speed categories
WINDPROF	ME	O - R	Input optional wind profile exponents

APPENDIX B. FUNCTIONAL KEYWORD/PARAMETER REFERENCE

This appendix provides a functional reference for the keywords and parameters used by the input runstream files for the ISC2 models. The keywords are organized by functional pathway, and within each pathway the order of the keywords is based on the function of the keyword within the models. The pathways used by the models are as follows, in the order in which they appear in the runstream file and in the tables that follow:

CO - for specifying overall job **CO**ntrol options;
SO - for specifying **SO**urce information;
RE - for specifying **RE**ceptor information (ISCST2 and ISCLT2 models only);
ME - for specifying **ME**teorology information and options;
EV - for specifying **EV**ent information (ISCEV2 model only); and
OU - for specifying **OU**tput options.

The pathways and keywords are presented in the same order as in the Detailed Keyword Reference in Section 3, and in the Quick Reference Card pull-out at the end of the manual.

Two types of tables are provided for each pathway. The first table lists all of the keywords for that pathway, identifies each keyword as to its type (either mandatory or optional and either repeatable or non-repeatable), and provides a brief description of the function of the keyword. The second type of table, which takes up more than one page for most pathways, presents the parameters for each keyword, in the order in which they should appear in the runstream file where order is important, and describes each parameter in detail. Also indicated for certain keywords or parameter descriptions are cases where the inputs apply on to a certain model, either ISCST2, ISCEV2, or ISCLT2.

The following convention is used for identifying the different types of input parameters. Parameters corresponding

to secondary keywords which should be input "as is" are listed on the tables with all capital letters and are underlined. Other parameter names are given with an initial capital letter and are not input "as is." In all cases, the parameter names are intended to be descriptive of the input variable being represented, and they often correspond to the Fortran variable names used in the model code. Parentheses around a parameter indicate that the parameter is optional for that keyword. The default that is taken when an optional parameter is left blank is explained in the discussion for that parameter.

TABLE B-1

DESCRIPTION OF CONTROL PATHWAY KEYWORDS

CO Keywords	Type	Keyword Description
STARTING	M - N	Identifies the start of CONTROL pathway inputs
TITLEONE	M - N	First line of title for output
TITLETWO	O - N	Optional second line of title for output
MODELOPT	M - N	Job control and dispersion options
AVERTIME	M - N	Averaging time(s) to process
POLLUTID	M - N	Identifies type of pollutant being modeled
HALFLIFE	O - N[1]	Optional half life used for exponential decay
DCAYCOEF	O - N[1]	Optional decay coefficient
TERRHGTS	O - N	Specifies whether to assume flat terrain (default) or to allow use of receptors on elevated terrain
ELEVUNIT	O - N	Defines input units for receptor elevations (defaults to meters)
FLAGPOLE	O - N	Specifies whether to accept receptor heights above local terrain (m) for use with flagpole receptors, and allows for a default flagpole height to be specified
RUNORNOT	M - N	Identifies whether to run model or process setup information only
EVENTFIL[2]	O - N	Specifies whether to generate an input file for EVENT model (Applies to ISCST2 Only)
SAVEFILE[3]	O - N	Option to store intermediate results for later restart of the model after user or system interrupt (Applies to ISCST2 Only)
INITFILE[3]	O - N	Option to initialize model from file of intermediate results generated by SAVEFILE option (Applies to ISCST2 Only)
MULTYEAR[3]	O - N	Option to process multiple years of meteorological data (one year per run) and accumulate high short term values across years (Applies to ISCST2 Only)
ERRORFIL	O - N	Option to generate detailed error listing file (error file is mandatory for CO RUNORNOT NOT case)
FINISHED	M - N	Identifies the end of CONTROL pathway inputs

Type: M - Mandatory N - Non-Repeatable
O - Optional R - Repeatable

1) Either HALFLIFE or DCAYCOEF may be specified. If both cards appear a warning message will be issued and the first value entered will be used in calculations. Default assumes a half life of 4 hours for SO_2 modeled in urban mode.

2) The EVENTFIL keyword controls whether or not to generate an input file for the ISCEV2 (EVENT) model. The primary difference between ISCST2 and ISCEV2 processing is in the treatment of source group contributions. The ISCST2 model treats the source groups independently, whereas the ISCEV2 model determines individual source contributions to particular events, such as the design concentrations determined from ISCST2, or user-specified events. By specifying the EVENTFIL keyword, an input runstream file will be generated that can be used directly with the ISCEV2 model. The events included in the generated ISCEV2 model input file are defined by the RECTABLE and MAXIFILE keywords on the OU pathway, and are placed in the EVent pathway.

3) The SAVEFILE and INITFILE keywords work together to implement the model's re-start capabilities. Since the MULTYEAR option utilizes the re-start features in a special way to accumulate high short term values from year to year, it cannot be used together with the SAVEFILE or INITFILE keyword in the same model run.

TABLE B-2

DESCRIPTION OF CONTROL PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters	
TITLEONE	Title1	
where:	Title1	First line of title for output, character string of up to 68 characters
TITLETWO	Title2	
where:	Title2	Optional second line of title for output, character string of up to 68 characters
MODELOPT	DFAULT CONC or DEPOS RURAL or URBAN GRDRIS NOSTD NOBID NOCALM MSGPRO	
where:	DFAULT	Specifies use of regulatory default options (final rise, stack tip downwash, BID, calms processing, "upper bound" wake calcs, default exponents and DTDZ), overrides presence of GRDRIS, NOSTD, NOBID, NOCALM, and MSGPRO keywords
	CONC	Specifies calculation of concentration values
	DEPOS	Specifies calculation of deposition values
	RURAL	Specifies use of rural dispersion
	URBAN	Specifies use of urban dispersion
	GRDRIS	Option to use gradual plume rise
	NOSTD	Option to use no stack-tip downwash
	NOBID	Option to use no buoyancy-induced dispersion
	NOCALM	Option to bypass calms processing routine (ST only)
	MSGPRO	Option to use missing data processing routines (ST only)
AVERTIME	Time1 Time2 Time3 Time4 MONTH PERIOD	(ISCST2 and ISCEV2 only)
where:	TimeN	Nth optional averaging time (1, 2, 3, 4, 6, 8, 12, 24-hr; number of periods limited by NAVE parameter)
	MONTH	Option to calculate MONTHly averages (counts toward NAVE limit)
	PERIOD	Option to calculate averages for the entire data PERIOD
AVERTIME	JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC WINTER SPRING SUMMER FALL or QUART1 QUART2 QUART3 QUART4 MONTH SEASON QUARTR ANNUAL PERIOD	(ISCLT2 model)
where:	JAN	Option to calculate JANuary averages from STAR data
	FEB	Option to calculate FEBruary averages from STAR data
	DEC	Option to calculate DECember averages from STAR data
	WINTER	Option to calculate WINTER averages from STAR data
	SPRING	Option to calculate SPRING averages from STAR data
	SUMMER	Option to calculate SUMMER averages from STAR data
	FALL	Option to calculate FALL averages from STAR data
	QUART1	Option to calculate QUART1 averages from STAR data
	QUART2	Option to calculate QUART2 averages from STAR data
	QUART3	Option to calculate QUART3 averages from STAR data
	QUART4	Option to calculate QUART4 averages from STAR data
	MONTH	Option to calculate averages for all twelve MONTHs
	SEASON	Option to calculate averages for all four SEASONs
	QUARTR	Option to calculate averages for all four QUARTeRs
	ANNUAL	Option to calculate annual values from an ANNUAL STAR summary
	PERIOD	Option to calculate averages for the entire data PERIOD

TABLE B-2 (CONT.)

DESCRIPTION OF CONTROL PATHWAY KEYWORDS AND PARAMETERS

POLLUTID	Pollut	
where:	Pollut	Identifies type of pollutant being modeled. Any name of up to eight characters may be used, e.g., SO2, NOX, CO, PM10, TSP or OTHER. Selection of SO2 with the URBAN DFAULT options forces use of a half life of 4 hours for exponential decay. Use of PM10, PM-10 or OTHER allows for the use of the MULTYEAR option.
HALFLIFE	Haflif	
where:	Haflif	Half life used for exponential decay (s)
DCAYCOEF	Decay	
where:	Decay	Decay coefficient for exponential decay (s^{-1}) = 0.693/HAFLIF
TERRHGTS	FLAT or ELEV	
where:	FLAT	Specifies that flat terrain will be assumed for all calculations (default)
	ELEV	Specifies that receptors may be located on elevated terrain (chopped off at release height) Note that if ELEVated receptors are allowed, then receptor heights must be input on the RE pathway, or they will be assumed to be 0.0.
ELEVUNIT	METERS or FEET	
where:	METERS	Specifies input units for terrain elevations of meters
	FEET	Specifies input units for terrain elevations of feet Note: This keyword applies to receptor elevations only.
FLAGPOLE	(Flagdf)	
where:	Flagdf	Default value for height of (flagpole) receptors above local ground level, a default value of 0.0 m is used if this optional parameter is omitted

TABLE B-2 (CONT.)

DESCRIPTION OF CONTROL PATHWAY KEYWORDS AND PARAMETERS

RUNORNOT	RUN or NOT	
where:	RUN NOT	Indicates to run full model calculations Indicates to process setup data and report errors, but to not run full model calculations
EVENTFIL	(Evfile) (Evopt)	
where:	Evfile Evopt	Identifies the filename to be used to generate a file for input to EVENT model (Default=EVENTFIL.INP) Optional parameter to specify the level of output detail selected for the EVENT model: either SOCONT or DETAIL (default is DETAIL if this parameter is omitted)
SAVEFILE	(Savfil) (Dayinc) (Savfl2)	
where:	Savfil Dayinc Savfl2	Specifies name of disk file to be used for storing intermediate results (default = TMP.FIL) file is overwritten after each dump) Number of days between dumps (optional: default is 1) Optional second disk filename to be used on alternate dumps - eliminates risk of system crash during the dump. If blank, file is overwritten each time.
INITFILE	(Inifil)	
where:	Inifil	Specifies name of disk file of intermediate results to be used for initializing run (default = TMP.FIL)
MULTYEAR	Savfil (Inifil)	
where:	Savfil Inifil	Specifies name of disk file to be used for storing results at end of the year Optional name of disk file used for initializing the results arrays from previous year(s). The Inifil parameter is not used for the first year in the multi-year run.
ERRORFIL	(Errfil) (DEBUG)	
where:	Errfil DEBUG	Specifies name of detailed error listing file (default = ERRORS.LST) Option to provide detailed output for debugging purposes, e.g., plume heights, sigmas, etc. Generates Very Large Files -- Use with CAUTION!!!

TABLE B-3

DESCRIPTION OF SOURCE PATHWAY KEYWORDS

SO Keywords	Type	Keyword Description
STARTING	M - N	Identifies the start of SOURCE pathway inputs
LOCATION	M - R	Identifies coordinates for particular source
SRCPARAM	M - R	Identifies source parameters for a particular source
BUILDHGT	O - R	Building height values for each wind sector
BUILDWID	O - R	Building width values for each wind sector
LOWBOUND	O - R	Switch to use non-DFAULT option for "lower bound" wake calculations, controlled by sector
EMISFACT	O - R	Optional input for variable emission rate factors
EMISUNIT	O - N	Optional conversion factors for emissions, concentrations, and depositions
SETVELOC	O - R	Input variables for optional settling velocities
MASSFRAX	O - R	Optional input of mass fraction for each settling velocity category
REFLCOEF	O - R	Optional input of surface reflection coefficients for each settling velocity category
SRCGROUP[1]	M - R	Identification of source groups
FINISHED	M - N	Identifies the end of SOURCE pathway inputs

1) Source groups are treated independently for ISCST2. The ISCEV2 (EVENT) model provides the contribution from each source to the group total for each specified event.

TABLE B-4

DESCRIPTION OF SOURCE PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters	
LOCATION	Srcid Srctyp Xs Ys (Zs)	
where:	Srcid	Source identification code (alphanumeric string of up to eight characters)
	Srctyp	Source type: POINT, VOLUME, AREA
	Xs	x-coord of source location, SW corner for AREA (in m)
	Ys	y-coord of source location, SW corner for AREA (in m)
	Zs	Optional z-coord of source location (elevation above mean sea level, defaults to 0.0 if omitted)
SRCPARAM	Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia Vlemis Relhgt Syinit Szinit Aremis Relhgt Xinit	
where:	Srcid	Source identification code
	__Emis	Source emission rate: in g/s for Ptemis or Vlemis, g/s/m^2 for Aremis for concentration or deposition
	___Hgt	Source physical release height above ground (center of height for VOLUME)
	Stktmp	Stack gas exit temperature (K)
	Stkvel	Stack gas exit velocity (m/s)
	Stkdia	Stack inside diameter (m)
	Syinit	Initial lateral dimension of VOLUME source (m)
	Szinit	Initial vertical dimension of VOLUME source (m)
	Xinit	Length of side of square AREA source (m)
BUILDHGT	Srcid (or Srcrng) Dsbh(i), i=1,36 (16 for LT)	
where:	Srcid	Source identification code
	Srcrng	Range of sources (inclusive) for which building dimensions apply, entered as two alphanumeric strings separated by a '-'
	Dsbh	Array of direction-specific building heights (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise
BUILDWID	Srcid (or Srcrng) Dsbw(i), i=1,36 (16 for LT)	
where:	Srcid	Source identification code
	Srcrng	Range of sources (inclusive) for which building dimensions apply
	Dsbw	Array of direction-specific building widths (m) beginning with 10 degree flow vector and incrementing by 10 degrees clockwise

TABLE B-4 (CONT.)

DESCRIPTION OF SOURCE PATHWAY KEYWORDS AND PARAMETERS

LOWBOUND	Srcid (or Srcrng) Idswak(i), i=1,36 (16 for LT)	
where:	Srcid	Source identification code
	Srcrng	Range of sources (inclusive) for which LOWBOUND option applies
	Idswak	Array of direction-specific wake option switches beginning with 10 degree flow vector and incrementing by 10 degrees clockwise (0=upper bound, 1=lower bound)
EMISFACT	Srcid (or Srcrng) Qflag Qfact(i), i=1,n	
where:	Srcid	Source identification code
	Srcrng	Range of sources (inclusive) for which emission rate factors apply
	Qflag	Variable emission rate flag: Short Term Model: SEASON for seasonal; MONTH for monthly; HROFDY for hour-of-day; STAR for speed-by-stability; SEASHR for season-by-hour Long Term Model: SEASON for seasonal; MONTH for monthly; SSTAB for season-by-stability; SSPEED for season-by-speed; STAR for speed-by-stability; SSTAR for season-by-speed-and-stability
	Qfact	Array of scalar emission rate factors, for: SEASON, n=4; MONTH, n=12; HROFDY, n=24; STAR, n=36; SSTAB, n=24; SSPEED, n=24; SEASHR, n=96; SSTAR, n=144
EMISUNIT	Emifac Emilbl Conlbl or Deplbl	
where:	Emifac	Emission rate factor used to adjust units of output (default value is 1.0 E06 for CONC for grams to micrograms; and 3600. for DEPOS for grams/sec to grams/hour; Note that ISCLT2 emission rates are automatically adjusted for the number of hours in the STAR period for DEPOSition calculations)
	Emilbl	Label to use for emission units (default is grams/sec)
	Conlbl	Label to use for concentrations (default is micrograms/m^3)
	Deblbl	Label to use for deposition (default is grams/m^2)

TABLE B-4 (CONT.)

DESCRIPTION OF SOURCE PATHWAY KEYWORDS AND PARAMETERS

SETVELOC	Srcid (or Srcrng) Vsn(i), i=1,Nvs	
where:	Srcid Srcrng Vsn	Source identification code Range of sources (inclusive) for which settling velocities apply Array of gravitational settling velocities (m/s)
MASSFRAX	Srcid (or Srcrng) Phi(i), i=1,Nvs	
where:	Srcid Srcrng Phi	Source identification code Range of sources (inclusive) for which mass fractions apply Array of mass fractions for each settling velocity category
REFLCOEF	Srcid (or Srcrng) Gamma(i), i=1,Nvs	
where:	Srcid Srcrng Gamma	Source identification code Range of sources (inclusive) for which reflection coefficients apply Array of surface reflection coefficients for each gravitational settling velocity category
SRCGROUP	Grpid Srcid's Srcrng's	
where:	Grpid Srcid's Srcrng's	Group ID (Grpid = ALL specifies group including all sources), number of source groups limited by NGRP parameter in the computer code Discrete source IDs to be included in group Source ID ranges to be included in group Note: Card may be repeated with same Grpid if more space is needed to specify sources

TABLE B-5

DESCRIPTION OF RECEPTOR PATHWAY KEYWORDS

(APPLIES TO ISCST2 AND ISCLT2)

RE Keywords	Type	Keyword Description
STARTING	M - N	Identifies the start of RECEPTOR pathway inputs
GRIDCART	O - R[1]	Defines a Cartesian grid receptor network
GRIDPOLR	O - R[1]	Defines a polar receptor network
DISCCART	O - R[1]	Defines the discretely placed receptor locations referenced to a Cartesian system
DISCPOLR	O - R[1]	Defines the discretely placed receptor locations referenced to a polar system
BOUNDARY	O - R[1]	Defines discrete polar receptor locations corresponding to minimum plant boundary distances for each 10 degree sector
BOUNDELV	O - R	Defines terrain elevations for discrete receptors specified with BOUNDARY keyword
FINISHED	M - N	Identifies the end of RECEPTOR pathway inputs

1) At least one of the following must be present: GRIDCART, GRIDPOLR, DISCCART, DISCPOLR, or BOUNDARY. Multiple receptor networks can be specified in a single run, including both Cartesian and polar, up to an overall maximum controlled by the NREC parameter.

TABLE B-6

DESCRIPTION OF RECEPTOR PATHWAY KEYWORDS AND PARAMETERS

(APPLIES TO ISCST2 AND ISCLT2)

Keyword	Parameters	
GRIDCART	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta or XPNTS Gridx1 Gridx2 Gridx3 .... GridxN, and YPNTS Gridy1 Gridy2 Gridy3 .... GridyN ELEV Row Zelev1 Zelev2 Zelev3 ... ZelevN FLAG Row Zflag1 Zflag2 Zflag3 ... ZflagN END	
where:	Netid	Receptor network identification code (up to eight alphanumeric characters)
	STA	Indicates STArt of GRIDCART subpathway, repeat for each new Netid
	XYINC	Keyword identifying grid network generated from x and y increments
	Xinit	Starting x-axis grid location in meters
	Xnum	Number of x-axis receptors
	Xdelta	Spacing in meters between x-axis receptors
	Yinit	Starting y-axis grid location in meters
	Ynum	Number of y-axis receptors
	Ydelta	Spacing in meters between y-axis receptors
	XPNTS	Keyword identifying grid network defined by a series of x and y coordinates
	Gridx1	Value of first x-coordinate for Cartesian grid
	GridxN	Value of 'nth' x-coordinate for Cartesian grid
	YPNTS	Keyword identifying grid network defined by a series of x and y coordinates
	Gridy1	Value of first y-coordinate for Cartesian grid
	GridyN	Value of 'nth' y-coordinate for Cartesian grid
	ELEV	Keyword to specify that receptor elevations follow
	Row	Indicates which row (y-coordinate fixed) is being input
	Zelev	An array of receptor terrain elevations for a particular Row
	FLAG	Keyword to specify that flagpole receptor heights follow
	Row	Indicates which row (y-coordinate fixed) is being input
	Zflag	An array of receptor heights above local terrain elevation for a particular Row (flagpole receptors)
	END	Indicates END of GRIDCART subpathway, repeat for each new Netid

TABLE B-6 (CONT.)

DESCRIPTION OF RECEPTOR PATHWAY KEYWORDS AND PARAMETERS

(APPLIES TO ISCST2 AND ISCLT2)

GRIDPOLR	Netid STA ORIG Xinit Yinit DIST Ring1 Ring2 Ring3 ... RingN DDIR Dir1 Dir2 Dir3 ... DirN, or GDIR Dirnum Dirini Dirinc ELEV Dir Zelev1 Zelev2 Zelev3 ... ZelevN FLAG Dir Zflag1 Zflag2 Zflag3 ... ZflagN END	
where:	Netid	Receptor network identification code (up to eight alphanumeric characters)
	STA	Indicates STArt of GRIDPOLR subpathway, repeat for each new Netid
	ORIG	Optional keyword to specify the origin of the polar network (assumed to be at x=0, y=0 if omitted)
	Xinit	x-coordinate for origin of polar network
	Yinit	y-coordinate for origin of polar network
	DIST	Keyword to specify distances for the polar network
	Ring1	Distance to the first ring of polar coordinates
	RingN	Distance to the 'nth' ring of polar coordinates
	DDIR	Keyword to specify discrete direction radials for the polar network
	Dir1	First direction radial in degrees (1 to 360)
	DirN	The 'nth' direction radial in degrees (1 to 360)
	GDIR	Keyword to specify generated direction radials for the polar network
	Dirnum	Number of directions used to define the polar system
	Dirini	Starting direction of the polar system
	Dirinc	Increment (in degrees) for defining directions
	ELEV	Keyword to specify that receptor elevations follow
	Dir	Indicates which direction is being input
	Zelev	An array of receptor terrain elevations for a particular direction radial
	FLAG	Keyword to specify that flagpole receptor heights follow
	Dir	Indicates which direction is being input
	Zflag	An array of receptor heights above local terrain elevation for a particular direction (flagpole receptors)
	END	Indicates END of GRIDPOLR subpathway, repeat for each new Netid

TABLE B-6 (CONT.)

DESCRIPTION OF RECEPTOR PATHWAY KEYWORDS AND PARAMETERS

(APPLIES TO ISCST2 AND ISCLT2)

DISCCART	Xcoord Ycoord (Zelev) (Zflag)	
where:	Xcoord	x-coordinate for discrete receptor location
	Ycoord	y-coordinate for discrete receptor location
	Zelev	Elevation above sea level for discrete receptor location (optional), used only for ELEV terrain
	Zflag	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword
DISCPOLR	Srcid Dist Direct (Zelev) (Zflag)	
where:	Srcid	Specifies source identification for which discrete polar receptor locations apply (used to define the origin for the discrete polar receptor)
	Dist	Downwind distance to receptor location
	Direct	Direction to receptor location, in degrees clockwise from North
	Zelev	Elevation above sea level for receptor location (optional), used only for ELEV terrain
	Zflag	Receptor height (flagpole) above local terrain (optional), used only with FLAGPOLE keyword
BOUNDARY	Srcid Dist(i), i=1,36	
where:	Srcid	Specifies source identification for which boundary distances apply
	Dist	Array of 36 values corresponding to minimum plant boundary distances for every 10-degree sector, beginning with the 10 degree flow vector Note: Discrete receptor coordinates are generated with an origin referenced to the location of the source identified with Srcid
BOUNDELV	Srcid Zelev(i), i=1,36	
where:	Srcid	Specifies source identification for which boundary distances apply
	Zelev	Array of 36 values corresponding to terrain elevation for plant boundary distances for 10-degree sectors, beginning with the 10 degree flow vector

TABLE B-7

DESCRIPTION OF METEOROLOGY PATHWAY KEYWORDS

ME Keywords	Type	Keyword Description
STARTING	M - N	Identifies the start of METEOROLOGY pathway inputs
INPUTFIL	M - N	Describes input meteorological data file
ANEMHGHT	M - N	Input height of anemometer above stack base
SURFDATA	M - N	Describes surface meteorological station
UAIRDATA	M - N	Describes upper air meteorological station
STARTEND	O - N	Specifies start and end dates to be read from input meteorological data file (default is to read entire file). (Applies to ISCST2 Only)
DAYRANGE	O - R	Specifies days or ranges of days to process (default is to process all data read in). (Applies to ISCST2 Only)
WDROTATE	O - N	May be used to correct for alignment problems of wind direction measurements, or to convert wind direction from to flow vector
WINDPROF	O - R	Input optional wind profile exponents
DTHETADZ	O - R	Input optional vertical potential temperature gradients
WINDCATS	O - N	Input upper bounds of wind speed categories, five values input - sixth category is assumed to have no upper bound. (Applies to Short Term Only)
AVESPEED	O - N	Average (median) wind speed for each speed category in the STAR summary. (Applies to ISCLT2 Only)
AVETEMPS	M - R	Average ambient temperatures for each stability category and season. (Applies to ISCLT2 Only)
AVEMIXHT	M - R	Average mixing heights for each wind speed, stability category and season. (Applies to ISCLT2 Only)
FINISHED	M - N	Identifies the end of METEOROLOGY pathway inputs

TABLE B-8

DESCRIPTION OF METEOROLOGY PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters	
INPUTFIL	Metfil (Format)	
where:	Metfil	Specify filename for meteorological input file
	Format	Specify format for input file: options are to provide FORTRAN read format for ASCII file, (YR,MN,DY,HR,AFV (or WD),WS,TA,KST,ZIRUR,ZIURB); use default ASCII format (4I2,2F9.4,F6.1,I2,2F7.1) if blank; use free format if FREE; use default ASCII format with hourly WINDPROF and DTHETADZ if CARD ; or use unformatted RAMMET file if UNFORM
ANEMHGHT	Zref (Zrunit)	
where:	Zref	Reference (anemometer) height above ground for wind speed measurement; also assumed to be height above stack base
	Zrunit	Units of Zref: METERS or FEET (default is METERS)
SURFDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum	Station number, e.g. 5-digit WBAN number for NWS surface station
	Year	Year of data being processed (four digits)
	Name	Station name (optional)
	Xcoord	x-coordinate of station location (m) (optional)
	Ycoord	y-coordinate of station location (m) (optional)
UAIRDATA	Stanum Year (Name) (Xcoord Ycoord)	
where:	Stanum	Station number, e.g. 5-digit WBAN number for NWS upper air station
	Year	Year of data being processed (four digits)
	Name	Station name (optional)
	Xcoord	x-coordinate of station location (m) (optional)
	Ycoord	y-coordinate of station location (m) (optional)
STARTEND	Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr) (Applies to ISCST2 Only)	
where:	Strtyr	Year of first record to be read
	Strtmn	Month of first record to be read
	Strtdy	Day of first record to be read
	Strthr	Hour of first record to be read (optional)
	Endyr	Year of last record to be read
	Endmn	Month of last record to be read
	Enddy	Day of last record to be read
	Endhr	Hour of last record to be read (optional) Note: File read begins with hour 1 of the start date and ends with hour 24 of the end date if Stahr and Endhr are omitted.

TABLE B-8 (CONT.)

DESCRIPTION OF METEOROLOGY PATHWAY KEYWORDS AND PARAMETERS

DAYRANGE	Range1 Range2 Range3 ... RangeN (Applies to ISCST2 Only)	
where:	Range1	First range of days to process, either as individual day (XXX) or as range (XXX-YYY); days may be input as Julian dates (XXX) or as month and day (XX/YY)
	RangeN	The 'nth' range of days to process
STARDATA	JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC (ISCLT2 Model) WINTER SPRING SUMMER FALL or QUART1 QUART2 QUART3 QUART4 MONTH SEASON QUARTR ANNUAL	
where:	JAN	Option to calculate JANuary averages from STAR data
	FEB	Option to calculate FEBruary averages from STAR data
	DEC	Option to calculate DECember averages from STAR data
	WINTER	Option to calculate WINTER averages from STAR data
	SPRING	Option to calculate SPRING averages from STAR data
	SUMMER	Option to calculate SUMMER averages from STAR data
	FALL	Option to calculate FALL averages from STAR data
	QUART1	Option to calculate QUART1 averages from STAR data
	QUART2	Option to calculate QUART2 averages from STAR data
	QUART3	Option to calculate QUART3 averages from STAR data
	QUART4	Option to calculate QUART4 averages from STAR data
	MONTH	Option to calculate averages for all twelve MONTHs
	SEASON	Option to calculate averages for all four SEASONs
	QUARTR	Option to calculate averages for all four QUARTeRs
	ANNUAL	Option to calculate annual values from an ANNUAL STAR summary
	PERIOD	Option to calculate averages for the entire data PERIOD
WDROTATE	Rotang	
where:	Rotang	Specifies angle (in degrees) to rotate wind direction measurements to correct for alignment problems; value of Rotang is subtracted from WD measurements, i.e., rotation is counterclockwise; may also be used to adjust input of wind direction from values to flow vector values by setting Rotang = 180
WINDPROF	Stab Prof1 Prof2 Prof3 Prof4 Prof5 Prof6	
where:	Stab	Specifies stability category (A through F) for the following six values by wind speed class
	Prof1	Wind speed profile exponent for first speed class
	Prof2	Wind speed profile exponent for second speed class
	Prof3	Wind speed profile exponent for third speed class
	Prof4	Wind speed profile exponent for fourth speed class
	Prof5	Wind speed profile exponent for fifth speed class
	Prof6	Wind speed profile exponent for sixth speed class Note: Card is repeated for each stability class
DTHETADZ	Stab Dtdz1 Dtdz2 Dtdz3 Dtdz4 Dtdz5 Dtdz6	
where:	Stab	Specifies stability category (A through F) for the following six values by wind speed class
	Dtdz1	Vertical temperature gradient for first speed class
	Dtdz2	Vertical temperature gradient for second speed class
	Dtdz3	Vertical temperature gradient for third speed class
	Dtdz4	Vertical temperature gradient for fourth speed class
	Dtdz5	Vertical temperature gradient for fifth speed class
	Dtdz6	Vertical temperature gradient for sixth speed class Note: Card is repeated for each stability class

TABLE B-8 (CONT.)

DESCRIPTION OF METEOROLOGY PATHWAY KEYWORDS AND PARAMETERS

WINDCATS	Ws1 Ws2 Ws3 Ws4 Ws5 (Applies to Short Term Only)	
where:	Ws1	Upper bound of first wind speed category (m/s)
	Ws2	Upper bound of second wind speed category (m/s)
	Ws3	Upper bound of third wind speed category (m/s)
	Ws4	Upper bound of fourth wind speed category (m/s)
	Ws5	Upper bound of fifth wind speed category (m/s) (sixth category is assumed to have no upper bound)
AVESPEED	Ws1 Ws2 Ws3 Ws4 Ws5 Ws6 (Applies to ISCLT2 Only)	
where:	Ws1	Median speed of first wind speed category (m/s)
	Ws2	Median speed of second wind speed category (m/s)
	Ws3	Median speed of third wind speed category (m/s)
	Ws4	Median speed of fourth wind speed category (m/s)
	Ws5	Median speed of fifth wind speed category (m/s)
	Ws6	Median speed of sixth wind speed category (m/s)
AVETEMPS	Aveper Ta1 Ta2 Ta3 Ta4 Ta5 Ta6 (Applies to ISCLT2 Only)	
where:	Aveper	Specifies averaging period (see AVERTIME keyword) for the following temperatures (K)
	Ta1	Average temperature of stability category A
	Ta2	Average temperature of stability category B
	Ta3	Average temperature of stability category C
	Ta4	Average temperature of stability category D
	Ta5	Average temperature of stability category E
	Ta6	Average temperature of stability category F
		Note: Card is repeated for each averaging period
AVEMIXHT	Aveper Stab Mixht1 Mixht2 Mixht3 Mixht4 Mixht5 Mixht6 (Applies to ISCLT2 Only)	
where:	Aveper	Specifies averaging period (see AVERTIME keyword) for the following mixing heights (m)
	Stab	Specifies stability category (A through F) for the following six values by wind speed class
	Mixht1	Average mixing height for first speed class
	Mixht2	Average mixing height for second speed class
	Mixht3	Average mixing height for third speed class
	Mixht4	Average mixing height for fourth speed class
	Mixht5	Average mixing height for fifth speed class
	Mixht6	Average mixing height for sixth speed class
		Note: Card is repeated for each stability class and for each averaging period

TABLE B-9

DESCRIPTION OF EVENT PATHWAY KEYWORDS

(APPLIES TO ISCEV2 MODEL ONLY)

EV Keywords	Type	Keyword Description
STARTING	M - N	Identifies the start of EVENT pathway inputs
EVENTPER	M - R	Describes data and averaging period for an event
EVENTLOC	M - R	Describes receptor location for an event
FINISHED	M - N	Identifies the end of EVENT pathway inputs

TABLE B-10

DESCRIPTION OF EVENT PATHWAY KEYWORDS AND PARAMETERS

(APPLIES TO ISCEV2 MODEL ONLY)

Keyword	Parameters	
EVENTPER	Evname Aveper Grpid Date	
where:	Name	Specify name of event to be processed (e.g. H2H24ALL), (up to eight alphanumeric characters)
	Grpid	Specify source group ID for event
	Aveper	Specify averaging period for event
	Date	Specify data period for event (ending YYMMDDHH for averaging period)
EVENTLOC	Evname XR= Xr YR= Yr (Zelev) (Zflag) or RNG= Rng DIR= Dir (Zelev) (Zflag)	
where:	Evname	Specify name of event to be processed (e.g. H2H24ALL), (up to eight alphanumeric characters)
	XR=	X-coordinate for event (discrete Cartesian receptor)
	YR=	Y-coordinate for event (discrete Cartesian receptor)
	RNG=	Distance range for event (discrete polar receptor)
	DIR=	Radial direction for event (discrete polar receptor)
	Zelev	Terrain elevation for event (optional)
	Zflag	Receptor height above ground for event (optional)

Note: EVENT locations can be input as either discrete Cartesian receptors (XR=, YR=) or as discrete polar receptors (RNG=, DIR=). Events that are specified in the file generated by the ISCST2 model (CO EVENTFIL card) are always given as discrete Cartesian coordinates. Discrete polar receptors are assumed to be relative to an origin of (0,0).

TABLE B-11

DESCRIPTION OF OUTPUT PATHWAY KEYWORDS

OU Keywords	Type	Keyword Description
STARTING	M - N	Identifies the start of OUTPUT pathway inputs
RECTABLE	O - R	Option to specify value(s) by receptor for output
MAXTABLE	O - R	Option to summarize the overall maximum values
DAYTABLE	O - N	Option to print summaries for each averaging period for each day processed. (Applies to ISCST2 Only)
MAXIFILE	O - R	Option to list events exceeding a threshold value to file (if CO EVENTFIL option is used, these events are included in the input file generated for the EVENT model). (Applies to ISCST2 Only)
POSTFILE[1]	O - R	Option to write results to a mass storage file for postprocessing. (Applies to ISCST2 Only)
PLOTFILE[1]	O - R	Option to write certain results to a storage file suitable for input to plotting routines
EVENTOUT[2]	M - N	Specifies the level of output information provided by the EVENT model. (Applies to ISCEV2 Only)
FINISHED	M - N	Identifies the end of OUTPUT pathway inputs

1) POSTFILE is used to output concurrent concentration values for particular source groups and averaging times across the receptor network, suitable for postprocessing, such as might be done for implementing the intermediate terrain policy. PLOTFILE is used to output specific design values, such as second high concentrations, across the receptor network, suitable for plotting concentration contours.

2) EVENTOUT is the only keyword on the OU pathway for the Short Term EVENT model.

TABLE B-12

DESCRIPTION OF OUTPUT PATHWAY KEYWORDS AND PARAMETERS

Keyword	Parameters	
RECTABLE	Aveper FIRST SECOND . . . SIXTH (Short Term Model) or Aveper 1ST 2ND . . . 6TH (Short Term Model) INDSRC and/or SRCGRP (Long Term Model)	
where:	Aveper	Averaging period to summarize with high values (keyword ALLAVE specifies all averaging periods)
	FIRST	Select summaries of FIRST highest values by receptor
	SECOND	Select summaries of SECOND highest values by receptor
	SIXTH	Select summaries of SIXTH highest values by receptor
	1ST	Select summaries of 1ST highest values by receptor
	2ND	Select summaries of 2ND highest values by receptor
	6TH	Select summaries of 6TH highest values by receptor Note: If two keywords are input separated by a dash (e.g. FIRST-THIRD), then summaries of all high values in that range are provided. The number of high values allowed is controlled by the NVAL parameter in the computer code (initially set at 3). Also, if the CO EVENTFIL keyword is exercised, then the events generated by the RECTABLE keyword are included in the input file for EVENT model.
	INDSRC	Specifies that summaries of individual source values for each receptor point will be provided
	SRCGRP	Specifies that summaries of source group values for each receptor point will be provided Note: Either INDSRC or SRCGRP or both may be specified
MAXTABLE	Aveper Maxnum (Short Term Model) Maxnum INDSRC and/or SRCGRP and/or SOCONT (Long Term Model)	
where:	Aveper	Averaging period to summarize with maximum values (keyword ALLAVE specifies all averaging periods)
	Maxnum	Specifies number of overall maximum values to summarize (number of maximum values permitted is limited by the NMAX parameter in the computer code, initially set at 50 for Short Term and 10 for Long Term)
	INDSRC	Specifies that summaries of maximum values for individual sources will be provided (independent of source group maxima)
	SRCGRP	Specifies that summaries of maximum values by source group will be provided
	SOCONT	Specifies that summaries of individual source contributions for locations of maximum source group values will be provided Note: Any combination of Long Term parameters is acceptable

TABLE B-12 (CONT.)

DESCRIPTION OF OUTPUT PATHWAY KEYWORDS AND PARAMETERS

DAYTABLE	Avper1 Avper2 Avper3 . . .	(Applies to ISCST2 Only)
where:	Avper1	Averaging period to summarize with values by receptor for each day of data processed (keyword ALLAVE for first parameter specifies all averaging periods)
MAXIFILE	Aveper Grpid Thresh Filnam (Funit)	(Applies to ISCST2 Only)
where:	Aveper	Specifies averaging period for list of values equal to or exceeding a threshold value
	Grpid	Specifies source group to be output to file
	Thresh	Threshold value (e.g. NAAQS) for list of exceedances
	Filnam	Name of disk file to store maximum values
	Funit	Optional parameter to specify the file unit Note: If the CO EVENTFIL keyword is exercised, then the events generated by the MAXIFILE keyword are included in the input file for the EVENT model.
POSTFILE	Aveper Grpid Format Filnam (Funit)	(Applies to ISCST2 Only)
where:	Aveper	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages, PERIOD for period averages
	Grpid	Specifies source group to be output to file
	Format	Specifies format of file, either UNFORM for unformatted files or PLOT for formatted files for plotting
	Filnam	Specifies filename for output file
	Funit	Optional parameter to specify the file unit
PLOTFILE	Aveper Grpid Hivalu Filnam (Funit)	(ISCST2 short term values)
	Aveper Grpid Filnam (Funit)	(ISCLT2 model and ISCST2 PERIOD averages)
where:	Aveper	Specifies averaging period to be output to file, e.g., 24 for 24-hr averages, PERIOD for period averages, WINTER for winter averages, etc.
	Grpid	Specifies source group to be output to file
	Hivalu	Specifies high value summary (e.g. FIRST, SECOND, 1ST, 2ND, etc.) to be output to file
	Filnam	Specifies filename for output file
	Funit	Optional parameter to specify the file unit
EVENTOUT	SOCONT or DETAIL	(Applies to ISCEV2 Only)
where:	SOCONT	Specifies the option to provide source contribution information only in the event output
	DETAIL	Specifies the option to include hourly concentrations for each source and hourly meteorological data in the event output

APPENDIX C. UTILITY PROGRAMS

C.1 CONVERTING INPUT RUNSTREAM FILES - STOLDNEW

The ISCST2C.ZIP file contains a PC-executable file, STOLDNEW.EXE, which is a file conversion utility program that may be used to convert old ISCST model input files to the proper format for the ISCST2 model. To run the file conversion utility, type STOLDNEW at the DOS prompt. The program will prompt the user for the name of the old ISCST input file being converted and for the name of the new file to be generated in the ISCST2 format. The program will also generate a file called SUMMARY.OLD that contains a summary of model inputs in the same format as would appear at the beginning of an old ISCST model run.

Even though the STOLDNEW utility should convert most ISCST input files without any difficulty, users are strongly encouraged to check the results of STOLDNEW carefully before using the input file with the ISCST2 model. The purpose of this is primarily to check for rounding of the inputs in the conversion process. Some inputs that may vary over a considerable range, such as the emission rate, are converted using an Fortran G format with a full seven significant digits. However, most inputs are converted using a Fortran F format specifier that uses a fixed number of decimal places. Some rounding is possible on some of these fixed format inputs, depending on how many decimal places were used for inputting the data in the old format.

The STOLDNEW utility program will prompt the user to input additional filenames where appropriate. Specifically, the program prompts for the name of the meteorological data file (including a DOS path if desired), which is inserted into the appropriate field on the ME INPUTFIL keyword. If the option for using unformatted preprocessed data was specified for the

old ISCST input, then the meteorology data filename should be the name of the file containing the preprocessed data. If the "card image" meteorological data option was specified for the old ISCST model input, then the hourly "card image" meteorological data are included as part of the old runstream option file. In this case, the STOLDNEW program prompts for the name of the file that it uses for writing out the card image data in the ASCII format used by the ISCST2 model. The format field on the ME INPUTFIL card will include the default ASCII format used by the ISCST2 model (which would have the same effect as leaving the field blank), unless the card image data includes hourly wind profile exponents or hourly vertical potential temperature gradients. In the latter case, STOLDNEW will insert the CARD keyword for the meteorological data format on the ME INPUTFIL card.

Another case where the STOLDNEW program will prompt for a filename is when the option for generating a separate file of concurrent concentration values is selected in the old runstream file (ISW(5)=1). In this case, the program will request the name to use for the concentration file, and will insert that name in the appropriate field for the OU POSTFILE keyword inputs. A separate POSTFILE card will be generated for each combination of averaging period and source group, with all of the concentration results being written to a single file on file unit 20. This will result in a concentration file that is nearly identical to the file generated by the original ISCST model.

It should be noted that the ISCST2 model does not support the use of hourly decay coefficients, which were allowed for the original ISCST model when "card image" meteorological data were used. If hourly decay coefficients are detected in the original ISCST runstream file, then STOLDNEW will write a warning message to the screen and within the new runstream file indicating that the hourly values of decay coefficients will be

ignored. The only other option available in the original ISCST model that is not available with ISCST2 is the option to list the meteorological data for each day processed as part of the main printed output file. In lieu of this option, a separate utility program, called METLIST, is available with the ISC2 package that produces a listing of meteorological data for the period of interest. The METLIST program is described in more detail in Section C.3.

C.2 CONVERTING UNFORMATTED RAMMET FILES TO ASCII FORMATTED FILES - BINTOASC

The ISCST2D.ZIP file contains the BINTOASC utility program. This is a PC-executable program that converts unformatted (binary) meteorological data files generated by the RAMMET or MPRM preprocessor programs to the default ASCII format used by the ISCST2 Model. The ASCII data file consists of sequential hourly records.

To run this program, type BINTOASC at the DOS prompt. The program will prompt for the name of the unformatted data input file and the name of the ASCII formatted output file. The BINTOASC program will convert unformatted data files generated by the Microsoft version of PCRAMMET available on the SCRAM BBS, as well as files generated by versions of RAMMET, PCRAMMET or MPRM compiled with either the Lahey or the Ryan-McFarland FORTRAN compilers. The program will write a message to the screen indicating which of the three types of files has been identified. If the program encounters an error reading the data file, then a message will be written to the screen indicating which compilers are supported. The program may also have encountered a read error due to the use of "short integers" (INTEGER*2) in the storing of some of the data in the unformatted file. The program assumes that all integer variables occupy four bytes of storage.

Once the type of unformatted file has been determined the program will prompt the user as follows:

Do You Want to Convert the Entire Data File? (Y or N)

If the user responds with either a 'Y' or a 'y', then the program will convert the entire data file (up to 366 days for a leap year). If the user responds with either an 'N' or an 'n', then the program will prompt the user as follows:

Enter the Start Date and End Date (e.g. 1,365):

The user can select a single day or a range of (Julian) days within the year to convert to the ASCII file.

If the BINTOASC program encounters a calm hour in the unformatted data file, which is identified by a wind speed of 1.0 m/s and a flow vector equal to the flow vector for the previous hour, then it writes out a wind speed of 0.0 for that hour, which is interpreted by the ISC2 Short Term models as a calm hour. The flow vector variable written to the ASCII file corresponds to the randomized flow vector in the unformatted data file. The structure of the RAMMET-generated unformatted data file and the default ASCII file are described in detail in Appendix F.

C.3 LISTING HOURLY METEOROLOGICAL DATA - METLIST

The ISCST2D.ZIP file contains the METLIST utility program. This is a PC-executable program that creates a listing file of meteorological data for a specified day or range of days, which can be sent to a printer. The program lists one day of data per page, with appropriate column headers for the meteorological variables. The previous version of the ISCST model included an option to print the hourly meteorological data within the main output file. This option has not been

included in the ISCST2 model. The user can use the METLIST program instead to create a listing for the data period of interest, and refer to that listing as needed to examine the meteorological data. Since the ISCST2 model also uses ASCII sequential hourly files (see Sections 3.5.1 and C.1), the meteorological data file can be examined directly through an editor or listing program, or the ASCII file itself can be printed. Therefore, the need for an option to list meteorological data within the program has been reduced. Also, the ISCEV2 model contains the option to list the hourly meteorological data for specific events that are of interest to the user.

To use this program, type METLIST from the command line prompt. The program will prompt the user for the following information:

> Enter Meteorology File Name: (Enter the name of the file containing the meteorological data)
>
> Options for File Formats are:
>
> ASCII
> UNFORM
> FREE
> CARD
> Fortran format specifier
> Enter File Format: (Select the format of the meteorological file by entering one of the four keywords above or by entering a Fortran format specifier, e.g. (4I2,2F9.4,F6.1,I2,2F7.1))
>
> Enter Output File Name: (Enter the name of the file to which the meteorological data listing will be stored)
>
> Enter Day Range: (Enter the Julian start day and Julian end day, e.g. 1,10)

The ASCII data format option for the METLIST program corresponds with the default ASCII format used by the ISCST2 and ISCEV2 models. The Fortran specifier for this format is '(4I2,2F9.4,F6.1,I2,2F7.1)'. The other format options are

described in Section 3.5.1.1. The METLIST program was compiled using the Microsoft FORTRAN Compiler, and therefore only supports unformatted data files generated by Microsoft versions of PCRAMMET, RAMMET or MPRM. To use unformatted data files generated by either the Lahey or the Ryan-McFarland compiler, the user should first convert the unformatted data file to the default ASCII format using the BINTOASC utility program (described in Section C.2), and then use the METLIST program and select the ASCII format option.

APPENDIX D. BATCH FILE DESCRIPTIONS FOR COMPILING THE MODELS ON A PC

D.1 MICROSOFT/DOS VERSIONS

The ISC2 models were developed on an IBM-compatible PC using the Microsoft Optimizing FORTRAN Compiler (Version 5.1). The models are provided on the Support Center for Regulatory Air Models (SCRAM) Bulletin Board System (BBS) as executable files designed to run on DOS PCs. These DOS versions were compiled with the Microsoft emulator library option that allows the models to utilize a math coprocessor if available, but also run in the absence of one. The batch file provided for compiling the ISCST2 model with the Microsoft compiler (FLISCST2.BAT) includes the following commands:

```
FL /c /FPi /AH /DMICRO ISCST2.FOR
FL /c /FPi /AH SETUP.FOR
FL /c /FPi /AH COSET.FOR
FL /c /FPi /AH SOSET.FOR
FL /c /FPi /AH RESET.FOR
FL /c /FPi /AH MESET.FOR
FL /c /FPi /AH OUSET.FOR
FL /c /FPi /AH INPSUM.FOR
FL /c /FPi /AH METEXT.FOR
FL /c /FPi /AH CALC1.FOR
FL /c /FPi /AH CALC2.FOR
FL /c /FPi /AH PRISE.FOR
FL /c /FPi /AH SIGMAS.FOR
FL /c /FPi /AH CALC3.FOR
FL /c /FPi /AH CALC4.FOR
FL /c /FPi /AH OUTPUT.FOR
LINK @ISCST2.LRF
```

where /c instructs the compiler to compile without linking; the /FPi option instructs the compiler to use in-line instructions for floating point operations and link with an emulator library (uses 80x87 coprocessor if present); and the /AH option that the huge memory model be used, allowing arrays or common blocks to exceed 64K. The /DMICRO option for the ISCST2.FOR source file instructs the compiler to use the conditional compilation blocks defined for the Microsoft compiler. These enable the PC-specific features, such as writing the date and time on each page of the output file and writing an update to the screen on the status of processing. To implement the PC-specific code,

the user should delete the field 'CPC' used to comment out certain lines in the ISCST2.FOR file. Each of the source files (*.FOR) for the ISCST2 model are listed separately in this batch file, which assumes that all of the source code modules and the include files are in a single directory, or that the compiler has been setup to search for the include files in the appropriate directory. The command line options for the compiler make full use of the compiler's optimization routines to speed up the code. To disable optimization, the /Od option would be added. Disabling optimization will increase the model's execution time by about 10 percent, and will also increase the size of the code.

Once the source files have been compiled successfully, and object (.OBJ) files have been generated for each source file, the model is ready to be linked and an executable file created. The executable file on the SCRAM BBS was linked using a memory overlay manager so that only certain portions of the code are resident in memory at any given time. This allows for a more efficient use of available memory by the model, and therefore allows for larger runs to be performed than would be possible without using overlays. This is accomplished with the following command line for the linker provided with the Microsoft compiler, which is included in the link response file, ISCST2.LRF:

```
/E ISCST2+SETUP+(INPSUM)+(COSET)+(SOSET)+(RESET)+(MESET)+(OUSE T)+(METEXT+CALC1+CALC2+CALC3+
   PRISE+SIGMAS+CALC4)+(OUTPUT)
```

The /E option instructs the linker to produce a packed executable file that occupies less disk space. The linker will prompt for the name of the executable file (which will default to ISCST2.EXE), and the names of any special library modules to link (none are needed). With this memory overlay structure, the ISCST2 and SETUP modules are always memory resident, and any module or group of modules within parentheses are overlayed into the same area of memory only when needed. Linking without

the overlay manager will increase the minimum load size for the executable file by about 160K for the ISCST2 model.

Similar batch files are available for compiling and linking the ISCLT2 and ISCEV2 models. The batch file for the ISCLT2 model, FLISCLT2.BAT, includes the following commands:

```
FL /c /FPi /AH /DMICRO ISCLT2.FOR
FL /c /FPi /AH SETUPLT.FOR
FL /c /FPi /AH COSETLT.FOR
FL /c /FPi /AH SOSETLT.FOR
FL /c /FPi /AH RESETLT.FOR
FL /c /FPi /AH MESETLT.FOR
FL /c /FPi /AH OUSETLT.FOR
FL /c /FPi /AH INPSUMLT.FOR
FL /c /FPi /AH METEXTLT.FOR
FL /c /FPi /AH CALC1LT.FOR
FL /c /FPi /AH CALC2LT.FOR
FL /c /FPi /AH CALC3LT.FOR
FL /c /FPi /AH PRISELT.FOR
FL /c /FPi /AH SIGMASLT.FOR
FL /c /FPi /AH OUTPUTLT.FOR
LINK @ISCLT2.LRF
```

The only difference between this and the file for the ISCST2 model is the source file names. This file invokes the following command line from the ISCLT2.LRF link response file:

```
/E ISCLT2+SETUPLT+(COSETLT)+(SOSETLT)+(RESETLT)+(MESETLT)+(OUS ETLT)+(INPSUMLT)+(METEXTLT+
   CALC1LT+CALC2LT+CALC3LT+PRISELT+SIGMASLT+CALC4LT)+(OUTPUTLT )
```

The batch file for the ISCEV2 model, FLISCEV2.BAT, includes the following commands:

```
FL /c /FPi /AH /DMICRO EVISCST2.FOR
FL /c /FPi /AH EVSETUP.FOR
FL /c /FPi /AH EVCOSET.FOR
FL /c /FPi /AH EVSOSET.FOR
FL /c /FPi /AH EVMESET.FOR
FL /c /FPi /AH EVEVSET.FOR
FL /c /FPi /AH EVOUSET.FOR
FL /c /FPi /AH EVINPSUM.FOR
FL /c /FPi /AH EVMETEXT.FOR
FL /c /FPi /AH EVCALC1.FOR
FL /c /FPi /AH EVCALC2.FOR
FL /c /FPi /AH EVPRISE.FOR
FL /c /FPi /AH EVSIGMAS.FOR
FL /c /FPi /AH EVOUTPUT.FOR
LINK @ISCEV2.LRF
```

which invokes the following command from the ISCEV2.LRF link response file:

```
/E EVISCST2+EVSETUP+(EVCOSET)+(EVSOSET)+(EVMESET)+(EVEVSET)+(E VOUSET)+(EVINPSUM)+(EVMETEXT+
   EVCALC1+EVCALC2+EVPRISE+EVSIGMAS)+(EVOUTPUT)
```

D.2 LAHEY/EXTENDED MEMORY VERSIONS

While the ISC2 models were developed on an IBM-compatible PC using the Microsoft Optimizing FORTRAN Compiler (Version 5.1), the models have also been compiled using the Lahey F77L-EM/32 Fortran Compiler (Version 4.02) to generate PC-executable files capable of utilizing extended memory on 80386 and 80486 PCs with at least 4 MB of RAM. The extended memory (EM) versions of the models are also provided on the SCRAM BBS. The batch file provided for compiling the ISCST2 model (ISCST2EM.EXE) with the Lahey compiler (F77LISCS.BAT) includes the following commands:

```
F77L3 ISCST2.FOR /NO /NW /D1LAHEY
F77L3 SETUP.FOR  /NO /NW
F77L3 COSET.FOR  /NO /NW
F77L3 SOSET.FOR  /NO /NW
F77L3 RESET.FOR  /NO /NW
F77L3 MESET.FOR  /NO /NW
F77L3 OUSET.FOR  /NO /NW
F77L3 INPSUM.FOR /NO /NW
F77L3 METEXT.FOR /NO /NW
F77L3 CALC1.FOR  /NO /NW
F77L3 CALC2.FOR  /NO /NW
F77L3 PRISE.FOR  /NO /NW
F77L3 SIGMAS.FOR /NO /NW
F77L3 CALC3.FOR  /NO /NW
F77L3 CALC4.FOR  /NO /NW
F77L3 OUTPUT.FOR /NO /NW
UP L32 @ISCST2EM.LRF
```

where /NO option instructs the compiler not to list the compiler options to the screen, the /NW option suppresses a certain level of warning messages, and the /D1LAHEY option for the ISCST2.FOR source file instructs the compiler to use the conditional compilation blocks defined for the Lahey compiler. These conditional blocks of code enable the PC-specific features, such as writing the date and time on each page of the output file and writing an update to the screen on the status of processing. To implement the PC-specific code, the user should delete the field 'CPC' used to comment out certain lines in the ISCST2.FOR file. Each of the source files (*.FOR) for the ISCST2 model are listed separately in this batch file,

which assumes that all of the source code modules and the include files are in a single directory, or that the compiler has been setup to search for the include files in the appropriate directory. The 'UP L32 @ISCST2EM.LRF' links the model using the ISCST2EM.LRF link response file, which includes the following command:

```
ISCST2+SETUP+COSET+SOSET+RESET+MESET+OUSET+INPSUM+METEX T+CALC1+CALC2+
CALC3+CALC4+PRISE+SIGMAS+OUTPUT
```

There are no memory overlays used for the Lahey versions, since they make use of extended memory.

Similar batch files are available for the ISCLT2 (F77LISCL.BAT) and the ISCEV2 (F77LISCE.BAT) models, except for the specification of the appropriate source file names provided in the previous section. The executable filenames for these models are ISCLT2EM.EXE and ISCEV2EM.EXE.

APPENDIX E. EXPLANATION OF ERROR MESSAGE CODES

E.1 INTRODUCTION

One of the significant operational improvements of the ISC2 models is an improved error handling procedure. The input runstream is checked to identify parameters that are missing or potentially in error, and the input source and meteorological data are checked and flagged for possible erroneous values.

The ISC2 models use a "defensive programming" approach to eliminate as much as possible of the user's work in debugging the input runstream file. Also, a great deal of effort has been made to eliminate the possibility of run time errors, such as "divide by zero," and to point out questionable input data. Error messages are reported to the user in two ways. A summary of messages is provided in the main output result file, and the user can also request a detailed message listing file.

Message Summary: Whether the user selects a detailed error listing file or not, the ISC2 models output a summary of messages within the output result file. This message table gives the number of messages of each type, together with a detailed list of all the fatal errors and warning messages. During setup processing, if no errors or warnings are generated, then the model simply reports to the user that "SETUP Finishes Successfully."

Detailed Message Listing File: The ISC2 models provide the option of saving a detailed list of all messages generated by the model in a separate output file. The user can select this option by specifying the keyword "ERRORFIL" followed by a filename inside the COntrol pathway. For example, the following statements will save all the error messages to an ASCII text file named "errormsg.out":

```
CO STARTING
   ERRORFIL  errormsg.out
CO FINISHED
```

E.2 THE OUTPUT MESSAGE SUMMARY

There are two message summaries provided in the standard output file of the ISC2 models. The first one is located after the echo of input runstream file images and before the input data summary. This summary will take one of two forms, depending on whether any fatal error or non-fatal warning messages were generated, and also depending on whether the option to RUN or NOT to run was selected on the CO RUNORNOT card. If there are no errors or warnings generated during the setup processing, and the RUN option was selected, then the model simply reports that "SETUP Finishes Successfully." If any fatal errors or warning messages were generated during the setup processing, or if the option NOT to run was selected, then a more detailed summary is provided. This summary provides a message count for each type of message, and a detailed listing of each fatal error and warning message generated. The second message summary table is located at the very end of the standard output result file, and it sums up the messages generated by the complete model run - both setup processing and run-time processing.

An example of a setup processing message summary is shown in Figure E-1.

```
*** Message Summary For The ISC2 Model Setup ***

 --------- Summary of Total Messages ---------

A Total of          0 Fatal Error Message(s)
A Total of          0 Warning Message(s)
A Total of          0 Information Message(s)


   ******** FATAL ERROR MESSAGES ********
                *** NONE ***

   ********   WARNING MESSAGES   ********
                *** NONE ***

   ***********************************
   *** SETUP Finishes Successfully ***
   ***********************************
```

FIGURE E-1. EXAMPLE OF AN ISC2 MESSAGE SUMMARY

E.3 DESCRIPTION OF THE DETAILED MESSAGE LAYOUT

Three types of messages can be produced by the models during the processing of input runstream images and during model calculations. These are described briefly below:

- Errors that will halt any further processing, except to identify additional error conditions (type E);
- Warnings that do not halt processing but indicate possible errors or suspect conditions (type W); and
- Informational messages that may be of interest to the user but have no direct bearing on the validity of the results (type I).

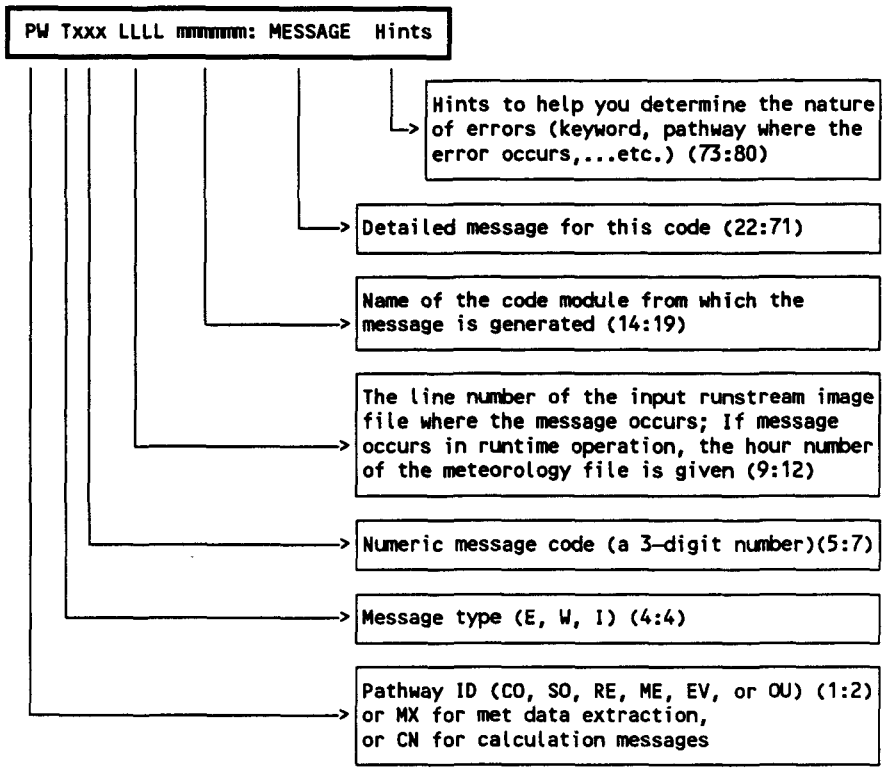
The messages have a consistent structure which contains the pathway ID, indicating which pathway the messages are generated from; the message type followed by a three-digit message number; the line number of the input runstream image file for setup messages (or the meteorology hour number for

runtime messages); the name of the module (e.g. the subroutine name) from which the message is generated; a detailed message corresponding to the message code; and an 8-character simple hint to help the user spot the possible source of the problem.

The following is an example of a detailed message generated from the CO pathway:

```
CO E100    8 EXPATH: Invalid Pathway Specified. The Troubled Pathway is FF
```

The message syntax is explained in more detail below (values in parentheses give the column numbers within the message line for each element):



The three message types are identified with the letters E (for errors), W (for warnings), and I (for informational messages). The 3-digit message codes are grouped into general categories corresponding to the different stages of the processing. Theses categories are:

100 - 199	Input Runstream Image Structure Processing
200 - 299	Parameter Setup Processing
300 - 399	Data and Quality Assurance Processing
400 - 499	Run Time Message Processing
500 - 599	Input/Output Message Processing

A detailed description of each of the message codes currently used in the models is provided in the next section.

E.4 DETAILED DESCRIPTION OF THE ERROR/MESSAGE CODES

INPUT RUNSTREAM IMAGE STRUCTURE PROCESSING, 100-199

This type of message indicates problems with the basic syntax and/or structure of the input runstream image. Typical messages include errors like "Missing mandatory keyword", "Illegal Keyword", ..., etc. If a fatal error of this kind is detected in a runstream image, a fatal error message is written to the message file and any attempt to process data is prohibited, although the remainder of the runstream file is examined for other possible errors. If a warning occurs, data may still be processed, although the inputs should be checked carefully to be sure that the condition causing the warning does not indicate an error.

100 Invalid Pathway Specified. The pathway ID should be a 2 character string. It should be one of the following: CO for control pathway, SO for source pathway, RE for receptor pathway (or EV for event pathway for ISCEV2 model), ME for meteorology data setting pathway, and OU for output format pathway. Its position is normally confined to columns 1 and 2 (1:2) of the input runstream file. However, the model does allow for a shift of the entire input runstream file of up to 3 columns. If the inputs are shifted, then all input records must be shifted by the same amount. The invalid pathway is repeated at the end of the message.

105 Invalid Keyword Specified. The keyword ID should be an 8-character string. Its position is normally confined to columns 4 to 11 (4:11) of the input runstream file. However, the model does allow for a shift of the entire input runstream file of up to 3 columns. If the inputs are shifted, then all input records must be shifted by the same amount. There should be a space between keyword ID and any other data fields. For a list of valid keywords, refer to Appendix A or Appendix B. The invalid keyword is repeated at the end of the message.

110 Keyword is Not Valid for This Pathway. The input keyword is a valid 8-character string, but it is not valid for the particular pathway. Refer to Appendix A, Appendix B or Section 3 for the correct usage of the keyword. The invalid keyword is repeated at the end of the message.

115 Starting and Finishing Statements do not match. Only One STARTING and one FINISHED statement,respectively, is allowed at the very beginning and the very end of each pathway block. Check the position and frequency to make sure the input runstream file meets the format requirement. The pathway during which the error occurs is included at the end of the message.

120 Pathway is Out of Sequence. The pathways are not input in the correct order. The correct order is CO, SO, RE, ME, and OU for the ISCST2 and ISCLT2 models, and CO, SO, ME, EV, and OU for the ISCEV2 model. The offending pathway is given as a hint.

125 Missing FINISHED Statement - Runstream file is incomplete. One or more FINISHED statements are missing. A 5-digit status variable is given as a hint. Each digit corresponds to a pathway in the appropriate order, and is a '1' if the pathway is complete and a '0' if the FINISHED is missing. For example, a status of '10111' indicates that the SO pathway was missing a FINISHED statement. Normally such an error will generate additional messages as well.

130 Missing Mandatory Keyword. To run the model, certain mandatory keywords must present in the input runstream file. For a list of mandatory keywords, see Appendix A or Appendix B. For more detailed information on keyword setup, see the description of message code 105. The missing keyword is included with the message.

135 Duplicate Non-repeatable Keyword Encountered. More than one instance of a non-repeatable keyword is encountered. For a list of non-repeatable keywords, see Appendix A or Appendix B. The repeated keyword is included with the message.

140 Invalid Order of Keyword. A keyword has been placed out of the acceptable order. The order for most keywords is not critical, but the relative order of a few keywords is important for the proper interpretation of the input data. The keyword reference in Section 3 identifies any requirements for the order of keywords. The keyword that was out of order is included with the message.

145 Conflicting Options: MULTYEAR and Re-Start Option. The multiple year option for processing PM-10 values makes use of the re-start routines in the model with some slight changes to handle the period averages from year to year. As a result, the MULTYEAR keyword cannot be specified with either the SAVEFILE or INITFILE keywords.

150 Conflicting Options: MULTYEAR for Wrong Pollutant. The multiple year option is provided specifically for the processing of PM-10 values to obtain the "high-sixth-high in five years" design value. Its treatment of the high short term values for multiple year periods is not consistent with existing air quality standards for other pollutants. To use the MULTYEAR option, the user must specify a pollutant type (on the CO POLLUTID card) of PM-10, PM10, or OTHER.

155 Conflicting Decay Keyword. The ISC2 models allow for the user to specify the rate of exponential decay either in terms of the half-life (HALFLIFE keyword) or the decay coefficient (DCAYCOEF keyword). If both keywords are specified, then only the first one will be used, and inputs for the second one will be ignored.

160 Duplicate ORIG Secondary Keyword for GRIDPOLR. Only one origin card may be specified for each grid of polar receptors. The network ID for the effected grid is included with the message.

170 Invalid Secondary Key for Receptor GRID. The network ID for the effected grid is included with this message. Refer to Appendix B for the correct syntax of secondary keywords.

175 Missing Secondary Keyword END for Receptor Grid. The END secondary keyword is required for each grid of receptors input by the user (keywords GRIDCART and GRIDPOLR). It signals the end of inputs and triggers the processing of data for that particular network.

180 Conflicting Secondary Keyword for Receptor Grid. Two incompatible secondary keywords have been input for the same grid of receptors, e.g. GDIR and DDIR for the keyword GRIDPOLR, where GDIR specifies to generate directions with uniform spacing, and DDIR specifies that discrete, non-uniform directions are being specified.

185 Missing Receptor Keywords. No Receptors Specified. Since none of the RE pathway keywords are mandatory, a separate error check is made to determine if any of the RE keywords are specified. At least one of the following keywords must be present: GRIDCART, GRIDPOLR, DISCCART, DISCPOLR, or BOUNDARY.

190 No Keywords for OU Pathway and No PERIOD Averages. All of the OU pathway keywords are optional, and in fact the model will run if no keywords are specified on the OU pathway as long as PERIOD averages are being calculated. However, if there are no OU keywords and no PERIOD

averages, then there will be no output generated by the model, and this fatal error message will be generated.

195 DAYTABLE Option Used With SAVEFILE or INITFILE. This is a non-fatal warning message that is generated to warn the user that the DAYTABLE results, which outputs concurrent short term results as they are calculated, will be overwritten if the model run is re-started.

PARAMETER SETUP PROCESSING, 200-299

This type of message indicates problems with processing of the parameter fields for the runstream images. Some messages are specific to certain keywords, while others indicate general problems, such as an invalid numeric data field. If a fatal error of this kind is detected in a runstream image, a fatal error message is written to the message file and any attempt to process data is prohibited, although the remainder of the runstream file is examined for other possible errors. If a warning occurs, data may still be processed, although the inputs should be checked carefully to be sure that the condition causing the warning does not indicate an error.

200 Missing Parameter(s). No options were selected for the indicated keyword. Check Appendix B for the list of parameters for the keyword in question.

201 Not Enough Parameters Specified For The Keyword. Check if there are any missing parameters following the indicated keyword. See Appendix B for the required keyword parameters.

202 Too Many Parameters Specified For The Keyword. Refer to Appendix B or Section 3 for the list of acceptable parameters.

203 Invalid Parameter Specified. The inputs for a particular parameter are not valid for some reason. Refer to Appendix B or Section 3. The invalid parameter is included with the message.

204 Option Parameters Conflict. Forced by Default to: Some parameters under the indicated keyword conflict with the other model parameters setting. Refer to Appendix B or Section 3 for the correct parameter usage. The default setting is specified with the message.

205 No Option Parameter Setting. Forced by Default to: No setting was specified for a particular parameter. Refer to Appendix B or Section 3 for the correct parameter usage. The default setting is specified with the message.

206 Regulatory DFAULT Specified With Non-default Option. The DFAULT option on the CO MODELOPT card always overrides the specified non-default option, and a warning message is generated.

207 No Parameters Specified. Default Values Used For. The keyword for which no parameters are specified is included with the message. Refer to Appendix B or Section 3 for a discussion of the default condition.

208 Illegal Numerical Field Encountered. The model may have encountered a non-numerical character for a numerical input, or the numerical value may exceed the limit on the size of the exponent, which could potentially cause an underflow or an overflow error.

209 Negative Value Appears For A Non-negative Variable. The effected variable name is provided with the message.

210 Number of Short Term Averages Exceeds Maximum. The user has specified more short term averages on the CO AVERTIME card than the model array limits allow. This array limit is controlled by the NAVE PARAMETER specified in the MAIN1.INC file. The value of NAVE is provided with the message.

211 Duplicate Parameter(s) Specified for Keyword. A duplicate parameter or set of parameters has been specified for the indicated keyword. For example, if more than one POSTFILE keyword is included for the same averaging period and source group, then this error message will be generated.

212 END Encountered Without (X,Y) Points Properly Set. This error occurs during setting up the grid of receptors for a Cartesian Network. This message may occur for example if X-coordinate points have been specified without any Y-coordinate points for a particular network ID.

213 ELEV Inputs Inconsistent With Option: Input Ignored. This happens when the user inputs elevated terrain heights for receptors when the TERRHGTS option is FLAT. The input terrain heights are ignored and the model proceeds with FLAT terrain modeling.

214 ELEV Inputs Inconsistent With Option: Defaults Used. This happens when the user does not input elevated terrain heights for receptors when the TERRHGTS option is ELEV. The model assumes that the missing terrain heights are at

0.0 meters for those receptors and proceeds with ELEV terrain modeling.

215 FLAG Inputs Inconsistent With Option: Input Ignored. This happens when the user inputs receptor heights above ground for flagpole receptors when the FLAGPOLE keyword option has not been specified. The input flagpole heights are ignored in the model calculations.

216 FLAG Inputs Inconsistent With Option: Defaults Used. This happens when the user does not input receptor heights above ground for flagpole receptors when the FLAGPOLE keyword option has been specified. The model assumes that the missing flagpole heights are equal to the default value specified on the CO FLAGPOLE card. If no default height is specified on the FLAGPOLE card, then a default of 0.0 meters is assumed.

217 More Than One Delimiter In A Field. For example, 12//34 is an illegal input data item for the DAYRANGE card, and STACK1--STACK-20 is an illegal specification for a range of sources.

218 Number of (X,Y) Points Not Match With Number Of ELEV Or FLAG. Check the number of elevated terrain heights or flagpole receptor heights for the gridded network associated with the indicated line number in the runstream file.

219 Number Of Receptors Specified Exceeds Maximum. The user has specified more receptors on the RE pathway than the model array limits allow. This array limit is controlled by the NREC PARAMETER specified in the MAIN1.INC file. The value of NREC is provided with the message.

220 Missing Origin (Use Default = 0,0) In GRIDPOLR. This is a non-fatal warning message to indicate that the ORIG secondary keyword has not been specified for a particular grid of polar receptors. The model will assume a default origin of (X=0, Y=0).

221 Missing Distance Setting In Polar Network. No distances have been provided (secondary keyword DIST) for the specified grid of polar receptors.

222 Missing Degree Or Distance Setting In Polar Network. Missing a secondary keyword for the specified grid of polar receptors.

223 Missing Distance or Degree Field. No data fields have been specified for the indicated secondary keyword.

224 Number of Receptor Networks Exceeds Maximum. The user has specified more receptor networks of gridded receptors on the RE pathway than the model array limits allow. This array limit is controlled by the NNET PARAMETER specified in the MAIN1.INC file. The value of NNET is provided with the message.

225 Number of X-Coords Specified Exceeds Maximum. The user has specified more X-coordinate values for a particular grid of receptors than the model array limits allow. This array limit is controlled by the IXM PARAMETER specified in the MAIN1.INC file. The value of IXM is provided with the message.

226 Number of Y-Coords Specified Exceeds Maximum. The user has specified more Y-coordinate values for a particular grid of receptors than the model array limits allow. This array limit is controlled by the IYM PARAMETER specified in the MAIN1.INC file. The value of IYM is provided with the message.

227 No Receptors Were Defined on the RE Pathway. Either through lack of inputs or through errors on the inputs, no receptors have been defined.

228 Default(s) Used for Missing Parameters on Keyword. Either an elevated terrain height or a flagpole receptor height or both are missing for a discrete receptor location. Default value(s) will be used for the missing parameter(s).

229 Too Many Parameters - Inputs Ignored on Keyword. Either an elevated terrain height or a flagpole receptor height or both are provided when the corresponding option has not been specified. The unneeded inputs are ignored.

230 Not Enough Numerical Values Specified. For example, less than 36 distance fields may have been specified for a particular group of BOUNDARY receptors.

231 Too Many Numerical Values Specified. For example, more than 36 distance fields may have been specified for a particular group of BOUNDARY receptors.

232 Number Of Specified Sources Exceeds Maximum. The user has specified more sources than the model array limits allow. This array limit is controlled by the NSRC PARAMETER specified in the MAIN1.INC file. The value of NSRC is provided with the message.

233 Building Dimensions Specified for a Non-POINT Source. Building dimensions can only be specified for a POINT

source, since the VOLUME and AREA source algorithms do not include building downwash.

234 Too Many Sectors Input. For example, the user may have input too many building heights or widths for a particular source.

235 Number of Source Groups Specified Exceeds Maximum. The user has specified more source groups than the model array limits allow. This array limit is controlled by the NGRP PARAMETER specified in the MAIN1.INC file. The value of NGRP is provided with the message.

236 Not Enough BUILDHGTs Specified for a Source ID. There should be 36 building heights for Short Term and 16 for Long Term.

237 Not Enough BUILDWIDs Specified for a Source ID. There should be 36 building widths for Short Term and 16 for Long Term.

238 Not Enough LOWBOUNDs Specified for a Source ID. There should be 36 lower bound flags specified for Short Term and 16 for Long Term.

239 Not Enough QFACTs Specified for a Source ID. The number of variable emission rate factors specified for a particular source is less than the model expects based on the variable emission rate flag. Check the EMISFACT keyword on the SO pathway in Appendix B of Section 3 for the appropriate number.

240 Inconsistent Number of Settling Velocity Categories for a particular source. The number of parameters must be the same for the SETVELOC, MASSFRAX and REFLCOEF keywords for a particular source.

242 No Settling/Removal Categories Specified for Source ID. There were no settling/removal categories specified for the indicated source. When modeling for total deposition, the user must include the SETVELOC, MASSFRAX and REFLCOEF keywords for each source.

244 Too Many Settling and Removal Parameters specified for a particular source. The limit is controlled by the NVSMAX PARAMETER in the computer code, set initially to 20.

245 Number of Settling/Removal Categories Exceeds Maximum. The user has specified more settling/removal categories than the model array limits allow. This array limit is controlled by the NVSMAX PARAMETER specified in the MAIN1.INC file. The value of NVSMAX is provided with the message.

248 No Sources Were Defined on the SO Pathway. There must be at least one LOCATION card and one SRCPARAM card to define at least one source on the SO pathway. Either no cards were input or there were errors on the inputs.

250 Duplicate XPNT/DIST or YPNT/DIR Specified for GRID. One of the grid inputs, either an X-coordinate, Y-coordinate, polar distance range or polar direction, has been specified more than once for the same grid of receptors. This generates a non-fatal warning message.

252 Duplicate Receptor Network ID Specified. A network ID for a grid of receptors (GRIDCART or GRIDPOLR keyword) has been used for more that one network.

255 Boundary Receptor Distances Not Defined Yet. The user has input the BOUNDELV keyword for a particular source before any BOUNDARY keyword has been specified for that source.

260 Number of Emission Factors Exceeds Maximum. The user has selected an option for variable emission rate factors that exceeds the array storage limit for emission rate factors. The array limit is controlled by the NQF PARAMETER specified in the MAIN1.INC file. The value of NQF is provided with the message.

270 Number of High Values Specified Exceeds Maximum. The user has selected a high short term value on the OU RECTABLE card that exceeds the array storage limit for high values by receptor. The array limit is controlled by the NVAL PARAMETER specified in the MAIN1.INC file. The value of NVAL is provided with the message.

280 Number of Maximum Values Specified Exceeds Maximum. The user has selected a value for the number of overall maximum values on the OU MAXTABLE card that exceeds the array storage limit for overall maximum values. The array limit is controlled by the NMAX PARAMETER specified in the MAIN1.INC file. The value of NMAX is provided with the message.

290 Number of Events Specified Exceeds Maximum. The user has specified more events than the ISCEV2 model array limits allow. The array limit is controlled by the NEVE PARAMETER specified in the EVMAIN1.INC file. The value of NEVE is provided with the message.

SETUP DATA AND QUALITY ASSURANCE PROCESSING, 300-399

This type of message indicates problems with the actual values of the parameter data on the input runstream image. The basic structure and syntax of the input card is correct, but

one or more of the inputs is invalid or suspicious. These messages include quality assurance checks on various model inputs. Typical messages will tell the consistency of parameters and data for the setup and run of the model. If a fatal error of this kind is detected in a runstream image, a fatal error message is written to the message file and any attempt to process data is prohibited. If a warning occurs, data may or may not be processed, depending on the processing requirements specified within the run stream input data.

300 Specified Source ID Has Not Been Defined Yet. The message indicates that the user attempts to use a source ID on a keyword before defining this source ID on a SO LOCATION card. It could indicate an error in specifying the source ID, an omission of a LOCATION card, or an error in the order of inputs.

310 Attempt to Define Duplicate LOCATION Card for Source. There can be only one LOCATION card for each source ID specified. The source ID is included with the message.

315 Attempt to Define Duplicate SRCPARAM Card for Source. There can be only one SRCPARAM card for each source ID specified. The source ID is included with the message.

320 Source Parameter May Be Out-of-Range for Parameter. The value of one of the source parameters may be either too large or too small. The name of the parameter is provided with the message. Use the line number provided to locate the card in question.

325 Negative Exit Velocity (Set=1.0E-5) for Source ID. The exit velocity for the specified source ID was input as a negative value. Since the model currently cannot handle sources with downward momentum, the exit velocity is set to a very small value (1.0E-5 m/s) and modeling proceeds. This non-fatal message is generated to warn the user that the input may be in error.

330 Mass Fraction Parameters Do Not Sum to 1. (within +/- 2 percent) for a particular source.

332 Mass Fraction Parameter Out-of-Range for a particular source. Must be between 0.0 and 1.0, inclusive.

334 Reflection Coefficient Out-of-Range for a particular source. Must be between 0.0 and 1.0, inclusive.

340 Possible Error in the Anemometer Height. The value of the anemometer height may be either too large or too small

350 Julian Day Out Of Range. This error occurs if the Julian Day selected is less than zero or greater than 366. Check ME setup to ensure the Julian Day selection.

355 Specified Averaging Period Not Being Calculated. This is a non-fatal warning message for the ISCLT2 model generated when average temperatures or mixing heights are specified for a STAR averaging period that was not specified on the CO AVERTIME card. The inputs will be ignored, and processing will continue.

360 2-digit Year Specified. Valid for the range 1901-2099. Four-digit years are valid for the entire range of Gregorian dates, but two digit years are accepted.

362 Averaging Time Conflict: PERIOD with ANNUAL Data. The PERIOD average is not compatible with the specification of an ANNUAL STAR summary on the CO AVERTIME card or the ME STARDATA card.

364 Averaging Time Conflict: PERIOD with MONTH and SEASON or QUARTR. The PERIOD average is not compatible with the presence of monthly STAR summaries and seasonal or quarterly summaries in the same data file.

366 Possible Averaging Time Conflict: PERIOD Average Only. The CO AVERTIME card has specified the PERIOD average only. There could be a conflict unless the ME STARDATA card is used to specify the STAR summaries in the data file.

368 Averaging Time Conflict: PERIOD Average with No STARDATA. The ISCLT2 model cannot process the PERIOD average unless the STAR summaries in the data file are identified, either through the CO AVERTIME card or the ME STARDATA card.

369 Averaging Time Conflict: Both SEASON and QUARTR. The ISCLT2 model cannot process both seasonal and quarterly STAR summaries in the same model run, since they occupy the same areas in the data storage.

370 Invalid Date: 2/29 In a Non-leap Year. The year has been identified as a leap year, and a date of 2/29 (February 29) has been specified on the DAYRANGE card. Check the year and/or the date specification.

380 This Input Variable is Out-of-Range. The indicated value may be too large or too small. Use the line number to locate the card in question, and check the variable for a possible error.

390 Invalid Averaging Period Specified for the Event. An invalid averaging period has been specified for the event name indicated for the ISCEV2 model. This may be an averaging period that was not selected on the CO AVERTIME card, or it may be an averaging period of greater than 24 hours, which cannot be handled by ISCEV2.

395 Monthly QFACT Specified With No Monthly Averages. The monthly variable emission rate option for the ISCLT2 model can only be used with monthly STAR summaries.

398 STAR Data Not Available for the Specified Average. The STAR summaries identified on the ME STARDATA card do not include one of the averaging periods selected on the CO AVERTIME card for the ISCLT2 model.

RUNTIME MESSAGE PROCESSING, 400-499

This type of message is generated during the model run. Setup processing has been completed successfully, and the message is generated during the performance of model calculations. Typical messages will tell the information and error during the model run. If a fatal error of this kind is detected during model execution, a fatal error message is written to the message file and any further processing of the data is prohibited. The rest of the meteorological data file will be read and quality assurance checked to identify additional errors. If a warning occurs, data may or may not be processed, depending on the processing requirements specified within the run stream input data.

400 No Convergence Reached in SUB. CUBIC. The CUBIC module is used to solve a cubic equation for the Schulman-Scire BLP plume rise and for the vertical virtual distance for URBAN mode. The routine uses Newton's method, which is an iterative approach to determining the solution to the cubic equation. This message is generated if the routine does not converge within 24 iterations. The message is provided for informational purposes and processing will continue. The date of occurrence is provided with the message.

410 Flow Vector Out-of-Range. The flow vector must be between 0 and 360 degrees, inclusive. The date of occurrence is provided with the message (in the form of year, month, day, hour as YYMMDDHH)

420 Wind Speed Out-of-Range. The wind speed value may be either too large or too small. An error is generated if the speed is less than 0.0, and a warning is generated if the speed is greater than 30.0 m/s. The date of occurrence is provided with the message (in the form of year, month, day, hour as YYMMDDHH).

430 Ambient Temperature Data Out-of-Range. The ambient temperature value may be either too large or too small. An warning is generated if the temperature is less than 250.0 K or greater than 320 K. The date of occurrence is provided with the message (in the form of year, month, day, hour as YYMMDDHH).

440 Calm Hour Identified in Meteorology Data File. This message is generated if a calm hour is identified, and provides the date of occurrence (in the form of year, month, day, hour as YYMMDDHH). The message will be generated whether or not the calms processing option is used.

450 Error in Meteorology File - Record Out of Sequence. There is an error in the sequence of the hourly meteorological data file. The message also provides the date of occurrence (in the form of year, month, day, hour as YYMMDDHH).

460 Missing Hour Identified in Meteorology Data File. At least one of the meteorological variables is missing or invalid for the hour specified (in the form of year, month, day, hour as YYMMDDHH). If the missing data processing option is not used, then this message will be generated and any further calculations with the data will be aborted. The model will continue to read through the meteorological data file and check the data.

470 Mixing Height Value is Less Than or Equal to 0.0. This is an informational message that may indicate an error in the meteorological data file. Since the plume will always be above a mixing of 0.0 or less, no calculations are performed for the hour specified (in the form of year, month, day, hour as YYMMDDHH).

480 Sum of STAR Frequencies Does Not Total to 1.0. The ISCLT2 model accepts STAR data files with either normalized frequencies or with a frequency count. For normalized frequencies, the sum of the STAR frequencies should total 1.0. If the sum is less than 0.98 or greater than 1.02, this non-fatal warning message is generated. The actual sum of the frequencies for each STAR summary is included in the printed output file at the end of the listing for the STAR frequency input. The frequency array is not

automatically normalized to 1.0 as was done by the original ISCLT model.

INPUT/OUTPUT MESSAGE PROCESSING, 500-599

This type of message is generated during the model input and output. Typical messages will tell the type of I/O operation (e.g., opening, reading or writing to a file), and the type of file. If a fatal error of this kind is detected in a runstream image, a fatal error message is written to the message file and any attempt to process data is prohibited. If a warning occurs, data may or may not be processed, depending on the processing requirements specified within the run stream input data.

500 Fatal Error Occurs During Opening of the Data File. The file specified can not be opened properly. This may be the runstream file itself, the meteorological data file, or one of the special purpose output files. This may happen when the file called is not in the specified path, or an illegal filename is specified. If no errors are found in the filename specification, then this message may also indicate that there is not enough memory available to run the program, since opening a file causes a buffer to be opened which takes up additional memory in RAM. For the special purpose output files, the hint field includes character string identifying the type of file and the file unit number, e.g., 'PLTFL312'.

510 Fatal Error Occurs During Reading of the File. File is missing, incorrect file type, or illegal data field encountered. Check the indicated file for possible problems. As with error number 500, this message may also indicate that there is not enough memory available to run the program if no other source of the problem can be identified.

520 Fatal Error Occurs During Writing to the File. Similar to message 510, except that it occurs during a write operation.

530 Error Occurs Reading Met Station or Year: File Says. This error occurs only with the ST models. The surface and upper air station numbers and years specified on the ME pathway do not agree with the values on the first record of the meteorological data file. The value from the file is printed out to help resolve the problem.

540 No RECTABLE/MAXTABLE/DAYTABLE for Averaging Period. No printed output options selected for a particular averaging period. This is a non-fatal warning condition for the ISCST2 model.

550 File Unit/Name Conflict for the Output Option. This error indicates that a problem exists with the filename and file unit specification for one of the special purpose output files. The associated keyword is provided as a hint. The same filename may have been used for more than one file unit, or vice versa.

560 User Specified File Unit < 20 for OU Keyword. A file unit of less than 20 has been specified for the indicated special purpose output files. This is a fatal error condition. File units of less than 20 are reserved for system files. Specify a unit number in the range of 20 to 100.

565 Possible conflict With Dynamically Allocated FUNIT. A file unit specified for the indicated special purpose output files is in the range > 100, and may therefore conflict with file units dynamically allocated for special purpose files by the model. This is typically a non-fatal warning condition.

570 Problem Reading Temporary Event File for Event. The ISCST2 model stores high value events in a temporary file that is used to create the input file for the ISCEV2 model, if requested, and also to store the high values for the summary tables at the end of the printed output file. A problem has been encountered reading this file, possibly because the concentration or deposition value was too large and overflowed the fixed format field of F14.5.

575 End-of-File Reached Trying to Read STAR Data. The ISCLT2 model has encountered an end-of-file for the STAR meteorological data trying the read the indicated averaging period. Check the data file for the correct number of STAR summaries or modify the CO AVERTIME and/or ME STARDATA cards.

APPENDIX F. DESCRIPTION OF FILE FORMATS

F.1 ASCII METEOROLOGICAL DATA

The ISCST2 and ISCEV2 models are designed to accept a wide range of ASCII meteorological data file formats. The use of ASCII files for meteorological data has two distinct advantages over the use of unformatted data files, such as are generated by the RAMMET and MPRM preprocessors (see the next section). The first advantage is the portability of the data files to different compilers and computer systems used for running the models. The second advantage is that the data file can be examined easily to determine its contents, and listed to the computer screen or to a printer for later reference. The user may specify the use of the default ASCII format by leaving the formet field blank on the ME INPUTFIL card. The user may also specify FREE-formatted reads for the meteorological data, may specify the Fortran read format explicitly, or may select the CARD option, which allows for the input of hourly wind profile exponents and vertical potential temperature gradients.

The first record of the meteorological data input file contains the station number and year for both the surface station and the upper air (mixing height) station. For the formatted ASCII files, these four integer variables are read using a free-format READ, i.e., the variables must be separated by either a comma or by one or more blank spaces. The order of these variables is as follows:

Surface Station Number, e.g., WBAN Number for NWS data
Year for Surface Data (2 or 4 digits)
Upper Air Station Number (for Mixing Height Data)
Year for Upper Air Data (2 or 4 digits)

The model checks these variables against the values input by the user on the ME SURFDATA and ME UAIRDATA cards (see Section 3.5.3).

The rest of the records in the file include the sequential meteorological data. The order of the meteorological variables for the formatted ASCII files and the default ASCII format are as follows:

Variable	Fortran Format	Columns
Year (last 2 digits)	I2	1-2
Month	I2	3-4
Day	I2	5-6
Hour	I2	7-8
Flow Vector (deg.)	F9.4	9-17
Wind Speed (m/s)	F9.4	18-26
Ambient Temperature (K)	F6.1	27-32
Stability Class (A=1, B=2, ... F=6)	I2	33-34
Rural Mixing Height (m)	F7.1	35-41
Urban Mixing Height (m)	F7.1	42-48
Wind Profile Exponent (CARD only)	F8.4	49-56
Vertical Potential Temperature Gradient (K/m) (CARD only)	F8.4	57-65

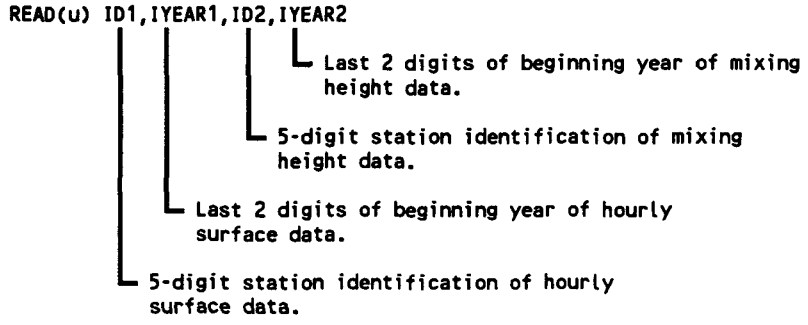
Calm hours are identified in the ASCII meteorological data files by a wind speed of 0.0 m/s. For unformatted RAMMET files that are converted to the ASCII format by BINTOASC (see Section C.2), the conversion program checks for calm hours based on the RAMMET convention of a wind speed equal to 1.0 m/s and a flow vector equal to the flow vector for the previous hour, and sets the wind speed to 0.0 in the ASCII file.

F.2 RAMMET METEOROLOGICAL DATA

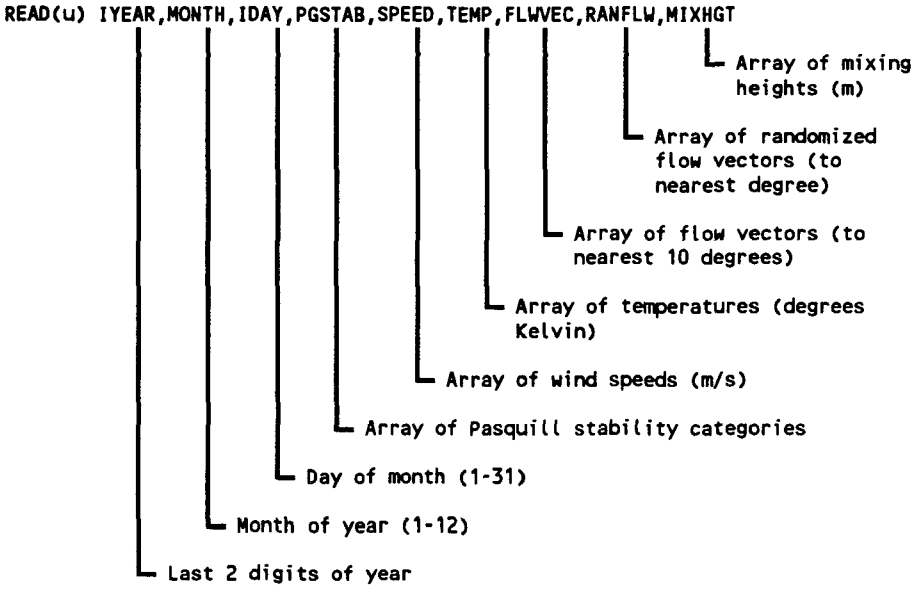
The RAMMET preprocessor generates an unformatted file of meteorological data from National Weather Service observations suitable for use by several dispersion models, including the ISCST2 model. The file contains two types of records, the first is a header record and the second is the meteorological data. The second contains the data for one 24-hour period

(midnight to midnight) and is repeated until all data are listed. The data are written unformatted to the file. This type of file may also be generated by the MPRM processor designed for processing on-site meteorological data.

The format of the header record is:



The format of the meteorological records are:



The DIMENSION statements used to define the arrays are:

```
DIMENSION IKST(24), AWS(24), ATA(24), AFV(24), AFVR(24), AZI(2,24)
```

The first index in the AZI (mixing height) array controls which of the two mixing height values is referenced. AZI(1,i) refers to the rural mixing height values, where i equals from 1

to 24 and refers to hour of day in local standard time. AZI(2,i) refers to the urban mixing height values.

The following preset values are used to indicate missing data:

IKST	0
AWS	-9
ATA	-99
AFV	-99
AFVR	-99
AZI	-999

F.3 STAR SUMMARY JOINT FREQUENCY DISTRIBUTIONS

For the ISC2 Long Term dispersion model, the input file describing the meteorological conditions is a joint frequency distribution. These frequency distributions are called STAR summaries for STability ARray. The frequency distribution is constructed using 16 wind direction sectors, with the first 22.5 sector centered on winds from the North (increasing clockwise), six wind speed classes and six stability classes. The wind speed classes are 0-3, 3-6, 6-10, 10-16, 16-21 and >21 kts. The Pasquill stability categories for the ISCLT dispersion model are grouped into classes as,

Class	Pasquill category	Remarks
1	A	Very unstable conditions
2	B	Moderately unstable conditions
3	C	Slightly unstable conditions
4	D	Neutral conditions
5	E	Slightly stable conditions
6	F	Very stable conditions

A separate STAR summary may be used for each averaging period, such as a month or a season, or for the entire annual data period.

The format of the meteorological file is:

```
LOOP ON I=1,6
LOOP ON K=1,16

READ(u,f)  FREQ( (I,J,K),J=1,6 )
           |      |  |  |
           |      |  |  └─ Index associated with wind speed class
           |      |  └─ Index associated with wind direction sector
           |      └─ Index associated with stability class
           └─ Frequency of occurrence (decimal), of stability class I, with
              wind speed class J, for wind from wind sector K

FORMAT(6F10.0)
```

Hence the meteorological file consists of 96 records for each STAR summary, the first 16 are for stability class 1, the next 16 are for stability class 2, and so forth.

F.4 THRESHOLD VIOLATION FILES (MAXIFILE OPTION)

The OU MAXIFILE card for the ISCST2 model allows the user the option to generate a file or files of threshold violations for specific source group and averaging period combintations. The file consists of several header records, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, and the threshold value. Any value equal to or exceeding the threshold value will be included in the file. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the averaging period, the source group ID, the date (YYMMDDHH) for the end of averaging period, the X and

Y coordinates of the receptor location, the receptor terrain elevation and flagpole receptor height, and the concentration or deposition value that violated the threshold. The following example from a threshold file identifies the contents of the MAXIFILE:

```
* ISCST2 (92062): A Simple Example Problem for the ISCST2 Model
* MODELING OPTIONS USED:
*  CONC   RURAL  FLAT          DFAULT
*         MAXI-FILE FOR  3-HR VALUES >= A THRESHOLD OF 30.00
*         FOR SOURCE GROUP: ALL
*         FORMAT: (1X,I3,1X,A8,1X,I8,2(1X,F13.5),2(1X,F7.2),1X,F13.5)
*AVE   GRP      DATE          X             Y        ELEV    FLAG       CONC
*
   3 ALL      64010206     76.60445      64.27876    .00     .00      30.24433
   3 ALL      64010218     76.60445      64.27876    .00     .00      42.91793
   3 ALL      64010424     76.60445      64.27876    .00     .00      34.63943
   3 ALL      64010506     76.60445      64.27876    .00     .00      38.86485
   3 ALL      64010506    153.20890     128.55750    .00     .00      33.00018
   3 ALL      64010512     86.60254      50.00000    .00     .00      36.78835
   3 ALL      64010515     86.60254      50.00000    .00     .00      33.48913
   3 ALL      64010518     76.60445      64.27876    .00     .00      44.44987
   3 ALL      64010521    128.55750     153.20890    .00     .00      34.85760
   3 ALL      64010524       .00000     100.00000    .00     .00      58.49796
   3 ALL      64010524      -.00001     200.00000    .00     .00      38.87197
```

F.5 POSTPROCESSOR FILES (POSTFILE OPTION)

The OU POSTFILE card for the ISCST2 model allows the user the option of creating output files of concurrent concentration or deposition values suitable for postprocessing. The model offers two options for the type of file generated - one is an unformatted file similar to the concentration file generated by the previous version of ISCST, and the other is a formatted file of X, Y, CONC (or DEPO) values suitable for inputting to plotting programs.

The unformatted POSTFILE option generates a separate unformatted data record of concurrent values for each averaging period and source group specified. The averaging period and source group combinations may be written to separate files, or combined into a single file, as with the earlier ISCST model. Each record begins with the date variable for the end of the

averaging period (an integer variable of the form YYMMDDHH), the averaging period (e.g., an interger value of 3 for 3-hour averages), and the source group ID (eight characters). Following these three header variables, the record includes the concentration or deposition values for each receptor location, in the order in which the receptors are defined on the RE pathway. The results are output to the unformatted file or files as they are calculated by the model.

The formatted plot file option for the POSTFILE keyword includes several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, and the number of receptors included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration or deposition value for that location, the receptor terrain elevation, the averaging period, the source group ID, and the either the date variable for the end of the averaging period (in the form of YYMMDDHH) for short term averages or the number of hours in the period for PERIOD averages. The following example from a formatted postprocessor

file for PERIOD averages identifies the contents of the POSTFILE:

```
* ISCST2 (92062): A Simple Example Problem for the ISCST2 Model
* MODELING OPTIONS USED:
*  CONC   RURAL  FLAT          DFAULT
*         POST/PLOT FILE OF PERIOD VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   180 RECEPTORS.
*         FORMAT: (3(1X,F13.5),1X,F8.2,2X,A6,2X,A8,2X,I8)
*        X            Y          CONC        ZELEV  AVE     GRP      NUM HRS
*
     17.36482     98.48077       .09078       .00 PERIOD  ALL          240
     34.72964    196.96150       .04353       .00 PERIOD  ALL          240
     52.09445    295.44230       .02323       .00 PERIOD  ALL          240
     86.82409    492.40390       .00646       .00 PERIOD  ALL          240
    173.64820    984.80770       .00389       .00 PERIOD  ALL          240
     34.20201     93.96926       .00053       .00 PERIOD  ALL          240
     68.40403    187.93850       .22839       .00 PERIOD  ALL          240
    102.60600    281.90780       .14398       .00 PERIOD  ALL          240
    171.01010    469.84630       .06481       .00 PERIOD  ALL          240
```

F.6 HIGH VALUE RESULTS FOR PLOTTING (PLOTFILE OPTION)

The OU PLOTFILE card for the ISCST2 model allows the user the option of creating output files of highest concentration or deposition values suitable for importing into graphics software to generate contour plots. The formatted plot files generated by the PLOTFILE include several lines of header information, each identified with an asterisk (*) in column one. The header information includes the model name and version number, the first line of the title information for the run, the list of modeling option keywords applicable to the results, the averaging period and source group included in the file, the high value (e.g. 2ND highest) included for plotting, and the number of receptors included. The header also includes the format used for writing the data records, and column headers for the variables included in the file. The variables provided on each data record include the X and Y coordinates of the receptor location, the concentration or deposition value for that location, the receptor terrain elevation, the averaging period, the source group ID, and either the high value included for short term averages or the number of hours in the period

for PERIOD averages. The following example from a formatted postprocessor file for high second highest 24-hour averages identifies the contents of the PLOTFILE:

```
* ISCST2 (92062): A Simple Example Problem for the ISCST2 Model
* MODELING OPTIONS USED:
*  CONC   RURAL  FLAT          DFAULT
*         PLOT FILE OF  HIGH 2ND  HIGH 24-HR VALUES FOR SOURCE GROUP: ALL
*         FOR A TOTAL OF   180 RECEPTORS.
*         FORMAT: (3(1X,F13.5),1X,F8.2,3X,A5,2X,A8,2X,A4)
*        X            Y          CONC        ZELEV  AVE     GRP       HIVAL
*
     17.36482     98.48077       .00038       .00 24-HR  ALL       2ND
     34.72964    196.96150       .00759       .00 24-HR  ALL       2ND
     52.09445    295.44230       .00223       .00 24-HR  ALL       2ND
     86.82409    492.40390       .00058       .00 24-HR  ALL       2ND
    173.64820    984.80770       .00012       .00 24-HR  ALL       2ND
     34.20201     93.96926       .00032       .00 24-HR  ALL       2ND
     68.40403    187.93850       .73597       .00 24-HR  ALL       2ND
    102.60600    281.90780       .46271       .00 24-HR  ALL       2ND
    171.01010    469.84630       .22714       .00 24-HR  ALL       2ND
```

The PERIOD average PLOTFILE uses the same format for the data records as the PERIOD average formatted POSTFILE shown in the previous section.

APPENDIX G.

QUICK REFERENCE CARD PULL-OUT FOR ISCST2 AND ISCLT2 MODELS

CO Keywords	Type	Parameters	Section
TITLEONE	M-N	Title1	3.2.1
TITLETWO	O-N	Title2	3.2.1
MODELOPT	M-N	DFAULT CONC RURAL GRDRIS NOSTD NOBID NOCALM MSGPRO or or DEPOS URBAN	3.2.2
AVERTIME	M-N	Time1 Time2 Time3 Time4 MONTH PERIOD (ST Model) JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC (LT Model) WINTER SPRING SUMMER FALL or QUART1 QUART2 QUART3 QUART4 MONTH SEASON QUARTR ANNUAL PERIOD	3.2.3
POLLUTID	M-N	Pollut	3.2.4
HALFLIFE	O-N	Haflif	3.2.5
DCAYCOEF	O-N	Decay	3.2.5
TERRHGTS	O-N	FLAT or ELEV	3.2.6
ELEVUNIT	O-N	METERS or FEET	3.2.6
FLAGPOLE	O-N	(Flagdf)	3.2.7
RUNORNOT	M-N	RUN or NOT	3.2.8
EVENTFIL	O-N	(Evfile) (Evopt) (ST model only)	3.2.9
SAVEFILE	O-N	(Savfil) (Dayinc) (Savfl2) (ST model only)	3.2.10
INITFILE	O-N	(Inifil) (ST model only)	3.2.10
MULTYEAR	O-N	Savfil (Inifil) (ST model only)	3.2.11
ERRORFIL	O-N	(Errfil) (DEBUG)	3.2.12

SO Keywords	Type	Parameters	Section
LOCATION	M-R	Srcid Srctyp Xs Ys (Zs) (Srctyp = POINT, VOLUME, or AREA)	3.3.1
SRCPARAM	M-R	Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia (POINT Source) Vlemis Relhgt Syinit Szinit (VOLUME Source) Aremis Relhgt Xinit (AREA Source)	3.3.2
BUILDHGT	O-R	Srcid (or Srcrng) Dsbh(i),i=1,Nsec	3.3.3
BUILDWID	O-R	Srcid (or Srcrng) Dsbw(i),i=1,Nsec	3.3.3
LOWBOUND	O-R	Srcid (or Srcrng) Idswak(i),i=1,Nsec	3.3.3
EMISFACT	O-R	Srcid (or Srcrng) Qflag Qfact(i),i=1,Nqf	3.3.4
EMISUNIT	O-N	Emifac Emilbl Conlbl (or Deplbl)	3.3.5
SETVELOC	O-R	Srcid (or Srcrng) Vsn(i),i=1,Nvs	3.3.6
MASSFRAX	O-R	Srcid (or Srcrng) Phi(i),i=1,Nvs	3.3.6
REFLCOEF	O-R	Srcid (or Srcrng) Gamma(i),i=1,Nvs	3.3.6
SRCGROUP	M-R	Grpid Srcid's Srcrng's	3.3.7

Type: M - Mandatory N - Non-repeatable
O - Optional R - Repeatable

RE Keywords	Type	Parameters	Section
GRIDCART	O-R	Netid STA XYINC Xinit Xnum Xdelta Yinit Ynum Ydelta or XPNTS Gridx1 Gridx2 Gridx3 ... GridxN, and YPNTS Gridy1 Gridy2 Gridy3 ... GridyN ELEV Row Zelev1 Zelev2 Zelev3 ... ZelevN FLAG Row Zflag1 Zflag2 Zflag3 ... ZflagN END	3.4.1
GRIDPOLR	O-R	Netid STA ORIG Xinit Yinit DIST Ring1 Ring2 Ring3 ... RingN DDIR Dir1 Dir2 Dir3 ... DirN or GDIR Dirnum Dirini Dirinc ELEV Rad Zelev1 Zelev2 Zelev3 ... ZelevN FLAG Rad Zflag1 Zflag2 Zflag3 ... ZflagN END	3.4.1
DISCCART	O-R	Xcoord Ycoord (Zelev) (Zflag)	3.4.3
DISCPOLR	O-R	Srcid Range Direct (Zelev) (Zflag)	3.4.3
BOUNDARY	O-R	Srcid Dist(I),I=1,36	3.4.4
BOUNDELV	O-R	Srcid Zelev(I),I=1,36	3.4.4

Note: While all RE keywords are optional, at least one receptor must be defined for each run.

ME Keywords	Type	Parameters	Section
INPUTFIL	M-N	Metfil (Format)	3.5.1
ANEMHGHT	M-N	Zref (Zrunit)	3.5.2
SURFDATA	M-N	Stanum Year (Name) (Xcoord Ycoord)	3.5.3
UAIRDATA	M-N	Stanum Year (Name) (Xcoord Ycoord)	3.5.3
STARTEND	O-N	Strtyr Strtmn Strtdy (Strthr) Endyr Endmn Enddy (Endhr) (ST only)	3.5.5
DAYRANGE	O-R	Range1 Range2 Range3 ... RangeN (ST model only)	3.5.5
STARDATA	O-N	JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC (LT model only) WINTER SPRING SUMMER FALL or QUART1 QUART2 QUART3 QUART4 MONTH SEASON QUARTR ANNUAL PERIOD	3.5.4
WDROTATE	O-N	Rotang	3.5.6
WINDPROF	O-R	Stab Prof1 Prof2 Prof3 Prof4 Prof5 Prof6	3.5.8
DTHETADZ	O-R	Stab Dtdz1 Dtdz2 Dtdz3 Dtdz4 Dtdz5 Dtdz6	3.5.9
WINDCATS	O-N	Ws1 Ws2 Ws3 Ws4 Ws5	3.5.7
AVESPEED	O-N	Ws1 Ws2 Ws3 Ws4 Ws5 Ws6 (LT model only)	3.5.10
AVETEMPS	M-R	Aveper Ta1 Ta2 Ta3 Ta4 Ta5 Ta6 (LT model only)	3.5.11
AVEMIXHT	M-R	Stab Mixht1 Mixht2 Mixht3 Mixht4 Mixht5 Mixht6 (LT model only)	3.5.12

OU Keywords	Type	Parameters	Section
RECTABLE	O-R	Aveper FIRST SECOND ... SIXTH or 1ST 2ND ... 6TH (ST Model) INDSRC and/or SRCGRP (LT Model)	3.7.1 3.7.3
MAXTABLE	O-R	Aveper Maxnum (ST Model) Maxnum INDSRC and/or SRCGRP and/or SOCONT (LT Model)	3.7.1 3.7.3
DAYTABLE	O-N	Avper1 Avper2 Avper3 Avper4 (ST model only)	3.7.1
MAXIFILE	O-R	Aveper Grpid Thresh Filnam (Funit) (ST model only)	3.7.1
PLOTFILE	O-R	Aveper Grpid Hivalu Filnam (Funit) (ST model) Aveper Grpid Filnam (Funit) (LT model & ST period ave)	3.7.1 3.7.3
POSTFILE	O-R	Aveper Grpid Format Filnam (Funit) (ST model only)	3.7.1

APPENDIX H.

QUICK REFERENCE CARD PULL-OUT FOR ISCEV2 (EVENT) MODEL

(USED FOR EVENT/SOURCE CONTRIBUTION ANALYSES)

CO Keywords	Type	Parameters	Section
TITLEONE	M-N	Title1	3.2.1
TITLETWO	O-N	Title2	3.2.1
MODELOPT	M-N	DFAULT CONC RURAL GRDRIS NOSTD NOBID NOCALM MSGPRO or or DEPOS URBAN	3.2.2
AVERTIME	M-N	Time1 Time2 Time3 Time4 MONTH PERIOD	3.2.3
POLLUTID	M-N	Pollut	3.2.4
HALFLIFE	O-N	Haflif	3.2.5
DCAYCOEF	O-N	Decay	3.2.5
TERRHGTS	O-N	FLAT or ELEV	3.2.6
FLAGPOLE	O-N	(Flagdf)	3.2.7
RUNORNOT	M-N	RUN or NOT	3.2.8
ERRORFIL	O-N	(Errfil) (DEBUG)	3.2.12

Note: MONTH and PERIOD averages are ignored by the EVENT model, which can only handle short term averages of up to 24 hours.

SO Keywords	Type	Parameters	Section
LOCATION	M-R	Srcid Srctyp Xs Ys (Zs) (Srctyp = POINT, VOLUME, or AREA)	3.3.1
SRCPARAM	M-R	Srcid Ptemis Stkhgt Stktmp Stkvel Stkdia (POINT Source) Vlemis Relhgt Syinit Szinit (VOLUME Source) Aremis Relhgt Xinit (AREA Source)	3.3.2
BUILDHGT	O-R	Srcid (or Srcrng) Dsbh(i),i=1,Nsec	3.3.3
BUILDWID	O-R	Srcid (or Srcrng) Dsbw(i),i=1,Nsec	3.3.3
LOWBOUND	O-R	Srcid (or Srcrng) Idswak(i),i=1,Nsec	3.3.3
EMISFACT	O-R	Srcid (or Srcrng) Qflag Qfact(i),i=1,Nqf	3.3.4
EMISUNIT	O-N	Emifac Emilbl Conlbl (or Deplbl)	3.3.5
SETVELOC	O-R	Srcid (or Srcrng) Vsn(i),i=1,Nvs	3.3.6
MASSFRAX	O-R	Srcid (or Srcrng) Phi(i),i=1,Nvs	3.3.6
REFLCOEF	O-R	Srcid (or Srcrng) Gamma(i),i=1,Nvs	3.3.6
SRCGROUP	M-R	Grpid Srcid's Srcrng's	3.3.7

Type: M - Mandatory N - Non-repeatable
O - Optional R - Repeatable

ME Keywords	Type	Parameters	Section
INPUTFIL	M-N	Metfil (Format)	3.5.1
ANEMHGHT	M-N	Zref (Zrunit)	3.5.2
SURFDATA	M-N	Stanum Year (Name) (Xcoord Ycoord)	3.5.3
UAIRDATA	M-N	Stanum Year (Name) (Xcoord Ycoord)	3.5.3
WDROTATE	O-N	Rotang	3.5.6
WINDCATS	O-N	Ws1 Ws2 Ws3 Ws4 Ws5	3.5.7
WINDPROF	O-R	Stab Prof1 Prof2 Prof3 Prof4 Prof5 Prof6	3.5.8
DTHETADZ	O-R	Stab Dtdz1 Dtdz2 Dtdz3 Dtdz4 Dtdz5 Dtdz6	3.5.9

EV Keywords	Type	Parameters	Section
EVENTPER	M-R	Evname Aveper Grpid Date	3.6.1
EVENTLOC	M-R	Evname XR= Xr YR= Yr (Zelev) (Zflag) or RNG= Rng DIR= Dir (Zelev) (Zflag)	3.6.2

OU Keywords	Type	Parameters	Section
EVENTOUT	M-N	SOCONT or DETAIL	3.7.2

Note: RE Pathway is not used for the ISCEV2 (EVENT) model. Receptor locations for specific events are identified on the EVent Pathway in combination with particular data periods.

GLOSSARY

ASCII -- American Standard Code for Information Interchange, a standard set of codes used by computers and communication devices. Sometimes used to refer to files containing only such standard codes, without any application-specific codes such as might be present in a document file from a word processor program.

CD-144 Format -- Card Deck-144 data format available from NCDC for National Weather Service surface observations commonly used for dispersion models. Each record represents an 80-column "card image".

CO -- COntrol, the 2-character pathway ID for input runstream images used to specify overall job control options.

CO Pathway -- Collective term for the group of input runstream images used to specify the overall job control options, including titles, dispersion options, terrain options, etc.

Directory -- A logical subdivision of a disk used to organize files stored on a disk.

Dispersion Model -- A group of related mathematical algorithms used to estimate (model) the dispersion of pollutants in the atmosphere due to transport by the mean (average) wind and small scale turbulence.

DOS -- Disk Operating System. Software that manages applications software and provides an interface between applications and the system hardware components, such as the disk drive, terminal, and keyboard.

EBCDIC -- Extended Binary Coded Decimal Interchange Code, the collating sequence used on IBM mainframe computers.

Echo of inputs -- By default, the ISC2 models will echo the input runstream images, character by character, into the main printed output file. This serves as a record of the inputs as originally entered by the user, without any rounding of the numerical values. The echoing can be suppressed with the NO ECHO option.

EOF -- End-of-File.

EPA -- U. S. Environmental Protection Agency.

Error message -- A message written by the model to the error/message file whenever an error is encountered that will inhibit data processing.

Error/Message File -- A file used for storage of messages written by the model.

EV -- **EV**ent, the 2-character pathway ID for input runstream images used to specify event inputs for the Short Term EVENT model.

EV Pathway -- Collective term for the group of input runstream images used to specify the event periods and location for the Short Term EVENT model.

EVENT Model -- A new ISC Short Term model (ISCEV2) developed with Version 2 of ISCST, specifically designed to provide source contribution (culpability) information for specific events of interest, e.g., design values or threshold violations.

Extended Memory -- Additional memory on 80386 and 80486 PCs that allows programs to address memory beyond the 640 KB limit of DOS. Special software is required to utilize this extra memory.

Fatal Error -- Any error which inhibits further processing of data by the model. Model continues to read input images to check for errors during setup, and will continue to read input meteorological data during calculation phase.

Flow Vector -- The direction towards which the wind is blowing.

GMT -- Greenwich Mean Time, the time at the 0° meridian.

Informational Message -- Any message written to the error/message file that may be of interest to the user, but which have no direct bearing on the validity of the results, and do not affect processing.

Input Image -- User supplied input, read through the default input device, controlling the model options and data input. A single card or record from the input runstream file. Each input image consists of a pathway ID (may be blank indicating a continuation of the previous pathway), a keyword (may also be blank for continuation of a keyword), and possibly one or more parameter fields.

Input Runstream File -- The basic input file to the ISC2 models controlling the modeling options, source data, receptor locations, meteorological data file specifications, and output options. Consists of a series of input images grouped into functional pathways.

ISCEV2 -- Industrial Source Complex - Short Term EVENT Dispersion Model, Version 2.

ISCST2 -- Industrial Source Complex - Short Term Dispersion Model, Version 2.

ISCLT2 -- Industrial Source Complex - Long Term Dispersion Model, Version 2.

JCL -- Job Control Language, an IBM mainframe's operating system control language for batch jobs.

Joint Frequency Distribution -- The joint frequency of wind direction sector, wind speed class and stability category (see also STAR).

Julian Day -- The number of the day in the year, i.e., Julian Day = 1 for January 1 and 365 (or 366 for leap years) for December 31.

KB -- Kilobyte, 1000 bytes, a unit of storage on a disk

Keyword -- The 8-character codes that follow immediately after the pathway ID in the input run stream data.

LST -- Local Standard Time.

Math Co-processor -- A computer chip used to speed up floating point arithmetic in a personal computer.

MB -- Megabyte, one million bytes, a unit of storage on a disk

ME -- **ME**teorology, the 2-character pathway ID for input runstream images used to specify meteorological data options

ME Pathway -- Collective term for the group of input runstream images used to specify the input meteorological data file and other meteorological variables, including the period to process from the meteorological file for the ISCST2 model.

Meteorological Data File -- Any file containing meteorological data, whether it be mixing heights, surface observations or on-site data.

Missing Value -- Alphanumeric character(s) that represent breaks in the temporal or spatial record of an atmospheric variable.

Mixing Height -- The depth through which atmospheric pollutants are typically mixed by dispersive processes.

MPRM -- Meteorological Processor for Regulatory Models, a program designed for the purpose of processing on-site meteorological data to prepare them for input to the

regulatory models, such as ISC. Produces a file comparable to the RAMMET pre-processor output, and also capable of producing STAR summaries.

NCDC -- National Climatic Data Center, the federal agency responsible for distribution of the National Weather Service upper air, mixing height and surface observation data.

NO ECHO -- Option to suppress echoing of the runstream input images to the main printed output file.

NWS -- National Weather Service.

On-site Data -- Data collected from a meteorological measurement program operated in the vicinity of the site to be modeled in the dispersion analysis.

OU -- **OU**tput, the 2-character pathway ID for input runstream images used to specify output options.

OU Pathway -- Collective term for the group of input runstream images used to specify the output options for a particular run.

Overlay -- One or more subprograms that reside on disk and are loaded into memory only when needed.

Pasquill Stability Categories -- A classification of the dispersive capacity of the atmosphere, originally defined using surface wind speed, solar insolation (daytime) and cloudiness (nighttime). They have since been reinterpreted using various other meteorological variables.

Pathway -- One of the six major functional divisions in the input runstream file for the ISC2 models. These are **CO**ntrol, **SO**urce, **RE**ceptor, **ME**teorology, **EV**ent, and **OU**tput (see these entries in this section for a description).

PC -- Personal Computer, a wide ranging class of computers designed for personal use, typically small enough to fit on a desktop.

Quality Assessment -- Judgment of the quality of the data.

Quality Assessment Check -- Determining if the reported value of a variable is reasonable (see also Range Check).

Quality Assessment Message -- Message written to the error/message file when a data value is determined to be suspect.

Quality Assessment Violation -- Occurrences when data values are determined to be suspect (see also Range Check Violation).

RAM -- Random Access Memory on a personal computer.

RAMMET -- Meteorological processor program used for regulatory applications capable of processing twice-daily mixing heights (TD-9689 format) and hourly surface weather observations (CD-144 format) for use in dispersion models such as ISCST, CRSTER, MPTER and RAM.

Range Check -- Determining if a variable falls within predefined upper and lower bounds.

Range Check Violation -- Determination that the value of a variable is outside range defined by upper and lower bound values (see also Quality Assessment Violation).

RE -- **RE**ceptor, the 2-character pathway ID for input runstream images used to specify receptor locations.

RE Pathway -- Collective term for the group of input runstream images used to specify the receptor locations for a particular run.

Regulatory Applications -- Dispersion modeling involving regulatory decision-making as described in the Guideline on Air Quality Models (Revised), (EPA, 1987b).

Regulatory Model -- A dispersion model that has been approved for use by the regulatory offices of the EPA, specifically one that is included in Appendix A of the Guideline on Air Quality Models (Revised), (EPA, 1987b), such as the ISC2 model.

Runstream File -- Collectively, all input images required to process input options and input data for the ISC2 models.

SCRAM BBS -- Support Center for Regulatory Air Models - Bulletin Board System, an electronic bulletin board system used by EPA for disseminating air quality dispersion models, modeling guidance, and related information.

Secondary Keyword -- A descriptive alphabetical keyword used as a parameter for one of the main runstream keywords to specify a particular option.

SO -- **SO**urce, the 2-character pathway ID for input runstream images used to specify input source parameters and source groups.

SO Pathway -- Collective term for the group of input runstream images used to specify the source input parameters and source group information.

STAR -- STability ARray, a joint frequency distribution summary of stability category, wind speed and wind direction. The STAR data are used as input for the ISC2 Long Term dispersion model.

Station Identification -- An integer or character string used to uniquely identify a station or site as provided in the upper air (TD-5600 and TD-6201), mixing height (TD-9689), and surface weather (CD-144 and TD-3280) data formats available from NCDC. There are no standard station numbers for on-site data or card image/screening data, and the user may include any integer string

Subdirectory -- A directory below the root, or highest level, directory or another subdirectory, used for organization of files on a storage medium such as a PC hard disk.

Surface Weather Observations -- A collection of atmospheric data on the state of the atmosphere as observed from the earth's surface. In the U.S. the National Weather Service collect these data on a regular basis at selected locations.

Surface Roughness Length -- Height at which the wind speed extrapolated from a near-surface wind speed profile becomes zero.

Syntax -- The order, structure and arrangement of the inputs that make of the input runstream file, specifically, the rules governing the placement of the various input elements including pathway IDs, keywords, and parameters.

TD-1440 Format -- A format available from NCDC for summarizing NWS surface observations in an 80-column format; the CD-144 format is a subset of this format. This format has been superseded by the TD-3280 format.

TD-3280 Format -- The current format available from NCDC for summarizing NWS surface weather observations in an elemental structure, i.e., observations of a single atmospheric variable are grouped together for a designated period of time.

TD-5600 Format -- A format available from NCDC for reporting NWS upper air sounding data. This format has been superseded by the TD-6201 format.

TD-6201 Format -- The current format available from NCDC for reporting NWS upper air data. The file structure is

essentially the same as the TD-5600 format except that there is more quality assurance information.

TD-9689 Format -- The format available from NCDC for mixing heights estimated from morning upper air temperature and pressure data and hourly surface observations of temperature.

UNAMAP -- User's Network for Applied Modeling of Air Pollution, a collection of dispersion models and closely related support utilities, used for disseminating models prior to the SCRAM BBS.

Unformatted File -- A file written without the use of a FORTRAN FORMAT statement, sometimes referred to as a binary file.

Upper Air Data (or soundings) -- Meteorological data obtained from balloon- borne instrumentation that provides information on pressure, temperature, humidity, and wind away from the surface of the earth.

Vertical Potential Temperature Gradient -- The change of potential temperature with height, used in modeling the plume rise through a stable layer, and indicates the strength of the stable temperature inversion. A positive value means that potential temperature increases with height above ground and indicates a stable atmosphere.

Warning Message -- A message written by the model to the error/message file whenever a problem arises that may reflect an erroneous condition, but does not inhibit further processing.

Wind Profile Exponent -- The value of the exponent used to specify the profile of wind speed with height according to the power law (see Section 1.1.3 of Volume II).

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16. ABSTRACT

This volume of the User's Giude for the Industrial Source Complex (ISC2) Dispersion Models (Version 2) provides user instructions for setting up and running the ISC2 models. The volume is organized to provide different levels of detail to meet the different needs of various types of users, from novice users to experienced modelers. The ISC2 User's Guide has been developed as part of a larger effort to restructure and reprogram the original ISC models, and to improve the "end-user" documentation for the models. Volume II of the ISC2 User's Guide provides a technical description of the dispersion algorithms utilized in the ISC2 models. Volume III provides a guide to programmers, including a description of the structure of the computer code and information about installing and maintaining the code on various computer systems.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field. Group
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