

NIST HANDBOOK 146, Volume I

Software User's Guide for the HAZARD I Fire Hazard Assessment Method

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DISCLAIMER

The Department of Commerce makes no warranty, express or implied, to users of the HAZARD I Fire Hazard Assessment Method and associated computer programs, and accepts no responsibility for its use. Users of HAZARD I assume sole responsibility under Federal and State law for determining the appropriateness of its use in any particular application; for any conclusions drawn from the results of its use; and for any actions taken or not taken as a result of analyses performed using HAZARD I.

Users are warned that HAZARD I is intended for use only by persons competent in the field of fire safety and is intended only to supplement the informed judgment of the qualified user. The HAZARD I software package, used outside of the broader HAZARD I Fire Hazard Assessment Method, is a computer model which may or may not have predictive value when applied to a specific set of factual circumstances and which could lead to erroneous conclusions if not properly evaluated by an informed user.

INTENT AND USE

The algorithms, procedures, and computer programs described in this report constitute a prototype version of a methodology for predicting the consequences to the occupants of a building resulting from the involvement of particular products in a specified fire. They have been compiled from the best knowledge and understanding currently available, but have important limitations which must be understood and considered by the user. The hazard analysis method is intended for use by persons competent in the field of fire safety, and with some familiarity with personal computers. It is intended as a decision-making tool, but the scope of its use is exploratory.

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Ninety-three organizations participated in the beta test of HAZARD I. Their interest, time, and careful critique of the pre-release version of HAZARD I led to many enhancements to the final version.

The authors wish to express their appreciation for the contributions of all those involved in the development effort.

FAST_in, FAST, FASTplot, EXITT, and TENAB are written in FORTRAN 77 and compiled with Lahey Computer Systems F77L[®] FORTRAN compiler. The HAZARD I Interface Shell, MLTFUEL, and DETACT are written in Microsoft QuickBasic[®] with extensions using QuickPak Professional[®] from Crescent Software. Graphics capabilities in FAST and FASTplot were developed with MetaWindows[®] from Metagraphics Software Corporation. The METAPRNT utility for printing graphics is copyrighted and provided under license from Metagraphics Software Corporation. FIREDATA was written in DBase III[®] and compiled with the Clipper[®] DBase compiler.

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CHAPTER 1. OVERVIEW

This report describes a prototype method to assess the relative contribution of specific products to the overall hazards of fire and smoke in buildings. Although this initial version is focused on single family residential occupancies, it is potentially of use for other occupancies. It is intended that this prototype method will be used by those with experience in the field of fire safety to enable it to be tested widely. Constructive feedback from its initial use will better define its usefulness and limitations and will help to foster needed improvements. Users should exercise sound technical judgment in applying the algorithms and computer programs described herein.

1.1 The Need for Quantitative Hazard Analysis

Public fire safety is provided through a system of fire and building codes which are based on the judgment of experts in the field, and which incorporate test methods to measure the fire properties or performance of materials and products. These codes generally prescribe the construction methods and materials considered acceptable in various classes of occupancy, which are defined on the basis of use and the assumed capabilities of the users. They rely heavily on the concepts of compartmentation and the provision of duplicate, protected paths of egress. A number of active fire protection systems are also required, including various combinations of detection/alarm, suppression, and smoke control/management systems. These systems work together with the passive measures to provide additional time for safe evacuation of the affected area and reduction of the fire impact on the structure and its occupants.

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This system of fire and building codes works to provide a reasonable level of safety to the public. However, existing codes need continual revision as new materials or design and construction techniques are introduced. Quantitative tools for fire hazard analyses can provide the code official with ways of addressing such developments consistent with the intent of the code. The flexibility provided by these quantitative tools can help to ensure the safe and rapid introduction of new technology by providing information on the likely impact on fire safety before a performance record is established through use. Similarly, these methods can be of value to product manufacturers in identifying the potential fire safety benefits of proposed design changes.

There are many highly interactive factors which need to be considered in performing a quantitative fire hazard analysis. Experimental measurements of the burning behavior of materials of interest and details of the building in which they burn are needed to define the fire in terms of its release of energy and mass over time. The transport of this energy and mass through the building is influenced by its geometry, the construction materials used, and the fire protection systems employed. The response of occupants and the consequences of the fire depend on when the occupants are notified, their physical capabilities, the decisions they make, and their susceptibility to the hazards to which they are exposed.

Tools for fire hazard analysis make it possible to evaluate product fire performance against a fire safety goal. For example, a goal of fire safety has always been to "keep the fire contained until the people can get out." The problem is that it is very difficult to keep the "smoke" contained. Quantitative hazard analysis allows the determination of the impacts of smoke, such as toxicity, *relative* to the impact of other hazards of fire for a prescribed building and set of occupants. It determines if the time available for egress is greater than the time required; and if not, why not. Time is the critical factor. Having 3 minutes for safe escape when 10 minutes are

needed results in human disaster. But providing 30 minutes of protection when 10 are needed can lead to high costs. A hazard analysis method can help prevent both types of problem from occurring.

Quantitative hazard analysis techniques have the potential of providing significant cost savings. Alternative protection strategies can be studied within the hazard analysis framework to give the benefit-cost relation for each. In addition, measures are evaluated as a system with their many interactions, including the impact of both structure and contents. Providing these alternatives promotes the design flexibility which reduces redundancies and cost without sacrificing safety. New technology can be evaluated before it is brought into practice, thus reducing the time lag currently required for code acceptance. Thus, quantitative hazard analysis is a powerful complement to existing codes and standards and a useful tool in evaluating improvements to them.

1.2 Overall Approach

HAZARD I is a set of procedures combining expert judgment and calculations to estimate the consequences of a specified fire. These procedures involve four steps: 1) defining the context, 2) defining the scenario, 3) calculating the hazard, and 4) evaluating the consequences. Steps 1, 2, and 4 are largely judgmental and depend on the expertise of the user. Step 3, which involves use of the extensive HAZARD I software, requires considerable expertise in fire safety practice. The heart of HAZARD I is a sequence of procedures implemented in computer software to calculate the development of hazardous conditions over time, calculate the time needed by building occupants to escape under those conditions, and estimate the resulting loss of life based on assumed occupant behavior and tenability criteria. These calculations are performed for a specified building and set of fire scenarios of concern.

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The buildings and scenarios of interest to the user of a fire hazard assessment will depend on the purpose of the assessment. For example, product manufacturers generally will not be concerned with a particular building but rather with any scenarios significantly involving their products in all the building types they may be used. The interest of fire investigators will be with specific fires in specific buildings, since they are reconstructing incidents which have occurred.

A set of reference examples has been compiled to assist the user through the process, and to demonstrate the capabilities of the procedure. These include sets of prototypical residential buildings and common fire scenarios. The method described in this report allows the user to substitute his product for that in one of the examples using one of the prototypical buildings or scenarios, or perform an analysis on a different building or scenario provided, of course, that the phenomena involved are not beyond the technical capabilities of the models.

Not every situation merits a complete or new set of hazard calculations. For example, the user may find that his questions can be answered simply by estimating or inferring the expected performance of his product from review of the provided matrix of preworked examples. Obviously, over time as the number of preworked examples increases, many users will find the results they need simply by looking up estimated performance from such files. Alternatively, the potential user of HAZARD I may find that his concern involves situations beyond the current capabilities of the system, in which case he must revert to traditional approaches, i.e., some combination of experience, judgment and/or small- or full-scale fire tests. The third alternative is that the user chooses to run through a complete set of new calculations for his problem situation. The flow chart, figure 1-1, illustrates these three alternatives for the potential user of HAZARD I.

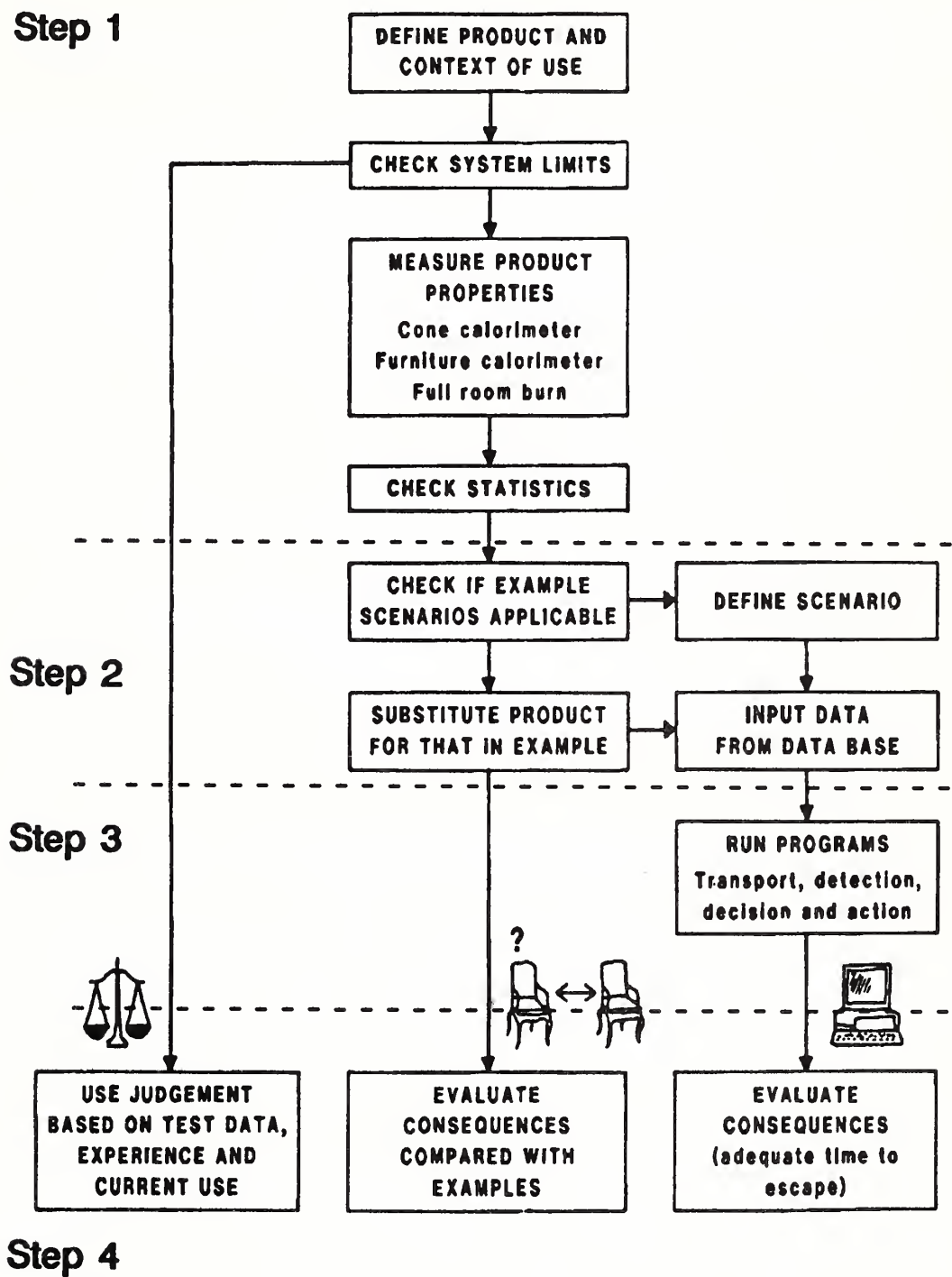


Figure 1-1. The overall method.

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1.3 Overview

The material contained in these three volumes encompasses the first version of the HAZARD I Fire Hazard Assessment Method. The set of computer disks contains the software necessary to conduct hazard analyses of products used in residential occupancies. All of the software provided will operate on any IBM¹ PC (XT, AT, or PS/2) or compatible MS-DOS computer with the following minimum hardware configuration:

- 640 k memory
- graphics card (IBM CGA, EGA, or VGA; or Hercules compatible)
- hard disk drive (about 2 Mb required for the files)
- math co-processor (8087, 80287, OR 80387)
- printer (with graphics capability)
- MS-DOS 3.0 or higher

The organization of the HAZARD I software package is shown in figure 1-2. It includes an interactive, user interface program for entering data into the fire model (FAST_in); a database program (FIREDATA) including files of thermophysical, thermochemical, and reference toxicity data; the FAST model (version 18) for multi-compartment energy and mass transport; a graphics utility for

¹ The use of company names or trade names within this report is made only for the purpose of identifying those computer hardware or software products with which the compatibility of the programs of HAZARD I has been tested. Such use does not constitute any endorsement of those products by the National Institute of Standards and Technology.

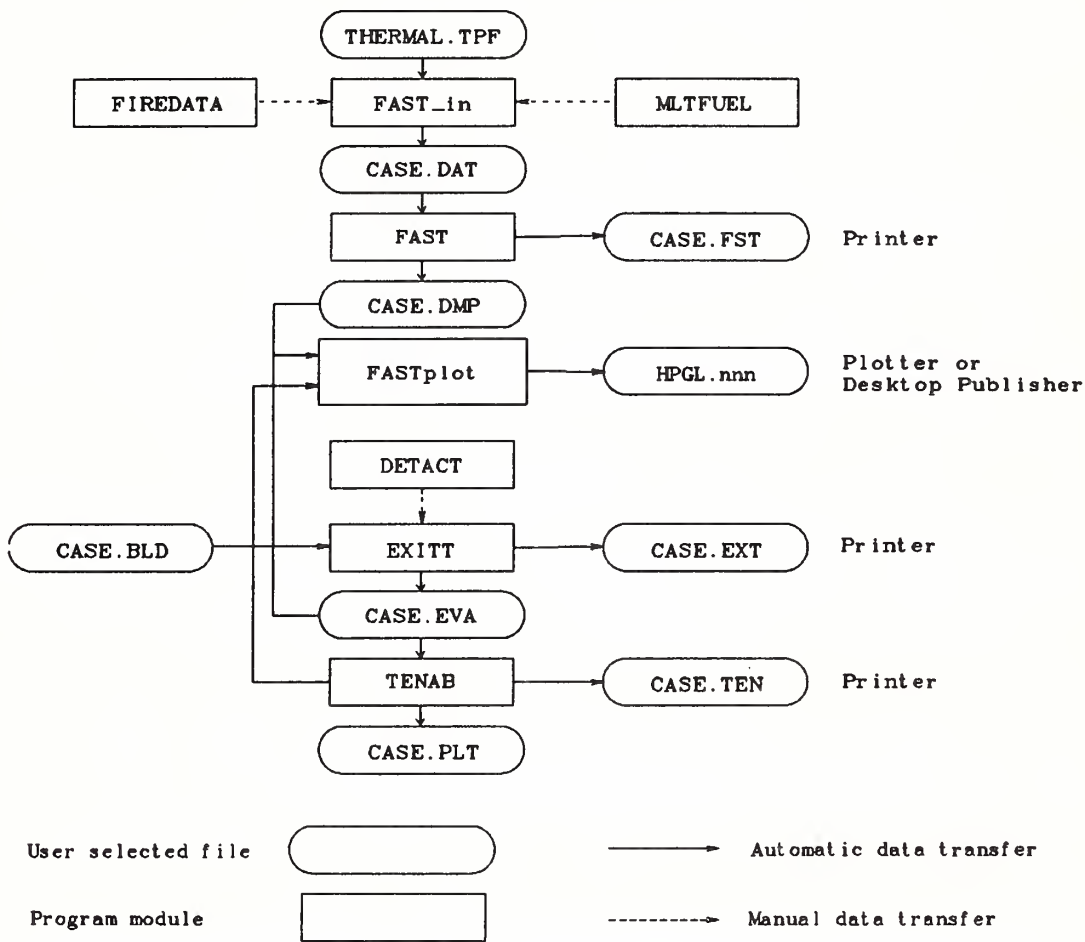


Figure 1-2. HAZARD I software.

plotting data (FASTplot); a detector/sprinkler activation model (DETECT); an evacuation model which includes human decision/behavior (EXITT); and a tenability model (TENAB) which evaluates the impact of the predicted exposure of the occupants in terms of incapacitation or lethality from temperature or toxic gases or incapacitation by second degree burns from radiant flux exposure. In addition to this **Technical Reference Guide**, the accompanying **HAZARD I Software User's Guide** includes detailed instructions for the use of the software, the form of the data provided to each of the modules, and examples of the use of the software.

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A set of eight representative example cases of typical residential fires, established by two panels of outside experts, is also included in the documentation. Details of the fires were specified by a panel composed of representatives of the major fire service organizations. The three single-family residences were verified as representing typical homes by a panel from the model code and architectural communities. A description of the process of developing these cases and a complete set of the output produced from each (input data file listings, program outputs and graphs of selected variables) are provided in the HAZARD I **Example Cases** volume.

While the scope of this first hazard assessment method is limited to residential occupancies, our goal is to extend it to other occupancy classes. Such an extension would be made in parallel with the improvements identified through user feedback.

1.4 Assumptions and Limitations

GENERAL: HAZARD I is a set of procedures combining expert judgment and calculations to estimate the consequences of a specified fire. These procedures involve four steps: 1) defining the context, 2) defining the scenario, 3) calculating the hazard, and 4) evaluating the consequences. Steps 1, 2, and 4 are largely judgmental and depend on the expertise of the user. Step 3, which involves use of the extensive HAZARD I software, requires considerable expertise in fire safety practice. The HAZARD I software consists of a collection of data, procedures, and computer programs which are used to *simulate* the important time-dependent phenomena involved in residential fires. The major functions provided include calculation of:

1. the production of energy and mass (smoke and gases) by one or more burning objects in one room, based on small- or large-scale measurements,
2. the buoyancy-driven transport of this energy and mass through a series of user-specified rooms and connections (doors, windows, cracks, etc.),
3. the resulting temperatures, smoke optical densities, and gas concentrations after accounting for heat transfer to surfaces and dilution by mixing with clean air,
4. the evacuation process of a user-specified set of occupants accounting for delays in notification, decision making, behavioral interactions, and inherent capabilities, and
5. the impact of the exposure of these occupants to the predicted room environments as they move through the building, in terms of the expected fatalities, and the time, location, and cause of each.

As can be seen from this list, the hazard analysis involves an interdisciplinary consideration of physics, chemistry, fluid mechanics, heat transfer, biology, toxicology, and human behavior. In some areas, fundamental laws (conservation of mass, energy, and momentum) can be used, whereas in others empirical correlations or even "educated guesses" must be employed to bridge gaps in existing knowledge. The necessary approximations required by considerations of operational practicality result in the introduction of uncertainties in the results. The user should understand the inherent assumptions and limitations of the procedures and programs, and use them judiciously - including sensitivity analyses for the ranges of values for key parameters - in order to make estimates of these uncertainties.

SCOPE: The scope of HAZARD I has been limited to one- and two-family residential structures. Models of the complex flows of

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heat and smoke through the HVAC systems and up the tall stairwells found in other occupancies are not yet sufficiently refined to include them in HAZARD I. Similarly, the focus has been on the inclusion of "rules" for the behavioral interactions of people within family units in the EXITT model. Large-building evacuation models, which include phenomena such as congestion in and around stairwells and behaviors typical of people in other occupancies, have not yet been incorporated into HAZARD I.

Since the majority of U.S. fire losses are in one- and two-family residential structures, this occupancy was selected for the first hazard system. The scope will be broadened in subsequent versions of the system.

PROGRAMS AND PROCEDURES: Figure 1-2 presents the HAZARD I software package developed to implement the assessment of hazard. Of the eight programs shown, three (FIREDATA, FAST_in, and FASTplot) perform utility and user interface functions only.

The principal current limitation of FIREDATA is that data are provided for only a small set of example products. Data provided in the cone and furniture calorimeter files are measured values from individual samples tested in these devices under a specified set of conditions. While the materials are identified generically, it should be understood that such data are not necessarily representative of the behavior of that generic material. Some variation would be expected, even on a set of samples from the same lot, and no attempt was made to obtain representative samples for test. Also, data in the thermophysical properties file were taken either from manufacturers' data or from literature sources with no attempt to verify values or to determine if they are the most representative values. Finally, the data in the toxicity file are published values from the sources indicated. Only some of the sources provide confidence intervals for these data. The material identifications are those provided in the sources.

SPECIFIED FIRE: An important limitation of HAZARD I is the absence of a fire growth model. It was not practical to adapt currently available fire growth models for direct inclusion in HAZARD I. Therefore, the system utilizes a user specified fire, expressed in terms of time specified rates of energy and mass released by the burning item(s). Such data can be obtained by measurements taken in large- and small-scale calorimeters, or from room burns. Their associated limitations are as follows:

1. For the Furniture Calorimeter, a product (chair, table, bookcase, etc.) is placed under a large collection hood and ignited by a 50 kW gas burner (simulating a wastebasket) placed adjacent to the item for 120 s. The combustion process then proceeds under assumed "free-burning" conditions, and the release rate data are measured. Potential sources of uncertainty here include measurement errors related to the instrumentation, and the degree to which "free-burning" conditions are not achieved (e.g., radiation from the gases under the hood or from the hood itself, and restrictions in the air entrained by the object causing locally reduced oxygen concentrations affecting the combustion chemistry). There are limited experimental data for upholstered furniture which suggest that prior to the onset of flashover in a compartment, the influence of the compartment on the burning behavior of the item is small. The differences obtained from the use of different types or locations of ignition sources have not been explored. These factors are discussed in reference [1].

2. Where small-scale calorimeter data are used, procedures are provided to extrapolate to the behavior of a full-size item. These procedures are based on empirical correlations of data which exhibit significant scatter, thus limiting their accuracy. For example, for upholstered furniture the peak heat release rates estimated by the "triangular approximation" method averaged 91% (range 46% to 103%) of values measured for a group of 26

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chairs with noncombustible frames, but only 63% (range 46% to 83%) of values measured for a group of 11 chairs with combustible frames [2]. Also, the triangle neglects the "tails" of the curve; these are the initial time from ignition to significant burning of the item, and the region of burning of the combustible frame, after the fabric and filler are consumed.

3. The data and procedures provided relate directly only to burning of contents items initiated by relatively large flaming sources. Almost no data are currently available for release rates under smoldering combustion, or for the high external flux and low oxygen conditions characteristic of post-flashover burning. While the program MLTFUEL allows multiple items burning simultaneously to be converted to a single "equivalent" specified fire, it does not account for the energy interchange of such items. Thus, for other ignition scenarios, multiple items burning simultaneously (which exchange energy by radiation and convection), combustible interior finish, and post-flashover conditions, the procedures provided give estimates which are often nonconservative (the actual release rates would be *greater* than estimated). At present, the only sure way to account for all of these complex phenomena is to conduct a full-scale room burn and input the release rates to the transport model. Subsequent versions of the hazard system will include detailed combustion models such as those in HARVARD V [3] or FIRST [4] which can be used as the source fire.

TRANSPORT: The distribution of energy and mass throughout the rooms included in the simulation is done in the model FAST, which is a zone (or control volume) model. The basic assumption of such models is that each room can be divided into two or more zones, each of which is internally uniform in temperature and composition. In FAST, all rooms have two zones except the fire room, which has an additional zone for the fire plume. The boundary between the two layers in a room is called the interface.

It has generally been observed that in the spaces close to the fire, buoyantly stratified layers form. While in an experiment the temperature can be seen to vary within a given layer, these variations are small compared to the temperature difference between the layers.

Beyond the basic zone assumptions, the model typically involves a mixture of established theory (e.g., conservation equations), empirical correlations where there are data but no theory (e.g., flow and entrainment coefficients), and approximations where there are neither (e.g., post-flashover combustion chemistry) or where their effect is considered secondary compared to the "cost" of inclusion. An example of a widely used approximation is to ignore the variation of the thermal properties of structural materials with temperature. While this would be fairly simple to add to the computer code, data are scarce over a broad range of temperature even for the most common materials, and the estimated error from this assumption is small.

With a highly complex model such as FAST, the only reasonable method of assessing impacts of assumptions and limitations is through the verification and validation process, which is ongoing at the Center for Fire Research (CFR). Until the results of this process are available, the user should be aware of the following:

1. Within FAST, the user can elect to have burning constrained by the available oxygen. This "constrained fire" (type 2) is not subject to the influences of radiation to enhance its burning rate, but is influenced by the oxygen available in the room. If a large mass loss rate is entered, the model will follow this input until there is insufficient oxygen available for that quantity of fuel to burn in the room. The unburned fuel (sometimes called excess pyrolyzate) is tracked as it flows out in the door jet, where it can entrain more oxygen. If this mixture is within the user-specified flammable range, it burns in the door plume. If not, it will be tracked throughout the building until it eventually collects as unburned fuel or burns in a vent. The energy released in the

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fire room and in each vent, as well as the total energy released, is detailed in the output of the model.

2. Similarly, an oxygen combustion chemistry scheme is employed, only in constrained (type 2) fires. Here user-specified hydrocarbon ratios and species yields are used by the model to predict concentrations. A balance among hydrogen, carbon, and oxygen molecules is maintained. Under some conditions, low oxygen can change the combustion chemistry, with an attendant increase in the yields of products of incomplete combustion such as CO. Guidance is provided on how the user can adjust the CO/CO₂ ratio. However, not enough is known about these chemical processes to build this relationship into the model at the present time. Some data exist in reports of full-scale experiments (e.g., [5]) which can assist in making such determinations.

3. The entrainment coefficients are empirically determined values. Small errors in these values will have a small effect on the fire plume or the flow in the plume of gases exiting the door of that room. In a multi-compartment model such as FAST, however, small errors in each door plume are multiplicative as the flow proceeds through many compartments, possibly resulting in a significant error in the furthest rooms. The data available from validation experiments [6] indicate that the values for entrainment coefficients currently used in most zone models produce good agreement for a three-compartment configuration. More data are needed for larger numbers of rooms to study this further.

4. In real fires, smoke and gases are introduced into the lower layer of each room primarily due to mixing at connections between rooms and from the downward flows along walls (where contact with the wall cools the gas and reduces its buoyancy). Doorway mixing has been included in FAST, using an empirically derived mixing coefficient. However, for wall flows the

associated theory is only now being developed. Thus the lower layer can accumulate smoke and gases. This may produce an underestimate of the lower layer concentrations.

5. Energy (heat) gains in the lower layer result only from convective heating from the floor and lower walls. It is assumed that the lower layer does not absorb energy by radiation from the upper layer. This may produce an underestimate of the lower layer temperatures resulting in an overestimate of the upper layer temperatures.

6. The only mechanisms provided in zone models to move energy and mass into the upper layer of a room are two types of plumes; those formed by the burning item(s) in the fire room, and those formed by the jet of upper layer gases flowing through an opening. Thus, when the model calculates the flow of warm, lower layer gases through a low opening (e.g., the undercut of a door) by expansion, they are assigned to the lower layer of the room into which they flowed where they remain until the upper layer in the source room drops to the level of the undercut and the door jet forms. Thus, for a time the receiving room will show a lower layer temperature which exceeds that in the upper layer (a physically impossible condition). However, no hazard will exist during this time as the temperatures are low, and no species produced by the fire are carried through the opening until the upper layer drops to the height of the undercut.

OCCUPANT BEHAVIOR AND EVACUATION: The EXITT model is a fairly-straightforward "node and arc" evacuation model to which an extensive series of behavioral rules has been added. The assumptions of interest are thus inherent in these rules, and the limitations are associated mostly with behavior not yet included. For example, the model does not have people re-entering the building, as they sometimes do. In addition, the current model is completely deterministic - a specific set of circumstances always results in a specific action. The data on which the rules were based sometimes

HAZARD I Software User's Guide

identifies several potential actions (e.g., under this condition, 60% of the time they do A and 40% of the time they do B). To model such behavior properly, the program would have to employ probabilistic branching.

Within the current model, some of the rules are qualitative (e.g., a man's first action is to investigate) and some are quantitative (e.g., a woman between the ages of x and y walks at z meters per minute). The assumed values in quantitative rules are called parameter values, and the documentation for the model identifies each, the reason for assigning that value, and how the user can change it (allowing a sensitivity analysis to be performed on those parameters for which the user might feel that the supporting data are weak).

ACTIVATION OF THERMAL DEVICES: The activation of smoke detectors, heat detectors, or sprinklers is handled in the program DETACT. The report (included as Appendix D of the **Technical Reference** volume) describes the underlying theory and assumptions used. The basic assumption is one of quasi-steady ceiling layer gas flow under an unconfined ceiling (no walls). It is consistent with the experimental study [7,8] done by Factory Mutual Research Corp. for the Fire Detection Institute (FDI) and on which the NFPA 72E [9] Appendix C methods were developed. As such, the assumptions employed in this program are those commonly used by the engineering and code communities and represent the current state-of-the-art. Smoke detectors are only crudely treated as heat detectors with an activation temperature of 13 °C above ambient based on recommendations contained in the FDI study.

TENABILITY CRITERIA: The impact of exposure to the occupants is evaluated in the program TENAB. Individual determinations are made for both incapacitation and lethality from temperature and toxicity, along with potential incapacitation from burns due to flux exposure. No interactions are currently included (e.g., temperature exposure does not change rate of uptake of toxic species). The basis for the threshold values used and the derivation

of the equations on which the toxicity calculation is based are provided in the **Technical Reference** in the chapter on Tenability Limits, which contains an extensive list of references. For all cases except flux exposure, the user can easily change the limit values used (and is encouraged to do so as a sensitivity test). Also, the method of presentation of the output of TENAB facilitates the observation of the sensitivity of the result to the limiting value selected.

The limiting values of temperature exposure are based on the general literature, which includes some human data. The flux criterion comes from work done with pig skin, which is generally considered to be very similar to human skin. The toxicity data, however, are from the combustion toxicology literature which is based entirely on animal exposures (primarily rodents for lethality studies and nonhuman primates for incapacitation studies). Thus, the model assumes that humans will exhibit a similar physiological response.

A toxicity parameter, Ct (concentration multiplied by exposure time, often referred to as "exposure dose"), is used to indicate the toxic impact of the smoke without differentiating the constituent gases or the possibility of diminished oxygen. This is a broad assumption. Another toxicity parameter, FED (the fractional effective dose), is also introduced. This represents the fraction of the lethal dose that has been accumulated by an individual over time. The FED parameter combines the effects and interactions of the gases CO, CO₂, and HCN along with the effect of diminished oxygen. The model on which the FED calculation is based, referred to as the N-Gas model [10], is under continuing development, and additional gases will be added as the data are obtained. It is expected the first irritant gas (HCl) will be included in the next version.

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1.5 References

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CHAPTER 2. GETTING STARTED

This part of the manual provides a step-by-step introduction to the HAZARD I system. It describes how to install the HAZARD I software on your computer and start it and guides you through the modules of HAZARD I using a simple example. When you have completed this chapter, you should have accomplished the following:

- Installed HAZARD I on the hard disk of your computer system.
- Modified the system configuration files so that the software will operate properly in your selected colors and engineering units.
- Become familiar with the elements of the HAZARD I system.

2.1 Protecting Your Original Disks

After installing the HAZARD I software on your computer system, you should place the original disks in a safe place in case the files should become corrupted or your hard disk fails. Since the software is never run from the floppy disks, it should not be necessary to make copies of the original disks.

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2.2 Installing HAZARD I on Your Computer

Two techniques are provided to install the HAZARD I software on your computer system. An automatic installation program which prompts you for the necessary information and copies the HAZARD I files onto your hard disk is included on the distribution disks for HAZARD I. For the more foolhardy (or those in need of specific custom installations for unique hardware), the operations performed by the installation module are detailed and may be done by hand and changed as appropriate for your system.

2.2.1 Automatic Installation

To install HAZARD I on your computer system, place the diskette labeled **"HAZARD I Installation Disk"** into diskette drive A: and type the following DOS commands

```
A:  
HAZARD/I
```

You will be asked several questions about your computer system and how you wish to install HAZARD I. You may answer none, some, or all of the questions as appropriate for your specific needs. Follow the directions on the screen closely and provide answers to questions as desired. Usually, the defaults provided by the program will be sufficient. On several of the screens, you will be asked to fill in information or change the defaults suggested by the installation module if desired. These screens are described in more detail below.

INSTALLATION MODULE FOR HAZARD I

HAZARDI Installation disk is in drive A

HAZARDI is installed in two subdirectories, one for HAZARD I programs and one for data files for model input and outputs.

Program Subdirectory:

C:\HAZARDI

Data Subdirectory:

C:\HAZARDI\DATA

HAZARD I is installed in two subdirectories on your hard disk, one for the program files that comprise HAZARD I and one for data files. On this screen, you are asked to enter (or verify) the names of these two directories and the drive letter where the installation diskette is located. For most installations, the defaults will be sufficient. However, for custom installations, any diskette drive connected to the machine may be used for the installation diskette and any valid nonexistent directories may be used for the program and data directories.

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INSTALLATION MODULE FOR HAZARD I

In this step of the installation, you may customize the display colors and engineering units used by HAZARD I. If the default colors and units are satisfactory, you can skip this step and proceed with the installation process. Place an X in the appropriate box below to continue.

Choose Custom Colors and Units:

Skip the step:

Once all of the files from the diskettes have been copied to the hard disk, you may change the colors and engineering units used by HAZARD I and FAST_in. Initially, you may wish to leave these at the defaults until you have worked through the example cases in chapters 2 and 3. Entering an X in the appropriate box will allow the program to continue. Details of the color changes and units changes are included below.

The last step in the installation process is to modify your computer's startup file AUTOEXEC.BAT as follows. The file AUTOEXEC.BAT is a file of commands which is executed each time your turn on your computer. The command SET HAZARDI will be added to the file to tell HAZARDI where to find its program and data files as you have selected them in this installation. If you do not wish to automatically modify the file, you must make the modification yourself as described in the HAZARD I User's Guide.

Modify AUTOEXEC.BAT:

Do not modify AUTOEXEC.BAT:

In order to locate the programs and data for HAZARD I, the installation module adds two or three lines to the automatic DOS startup file AUTOEXEC.BAT which contains the names of the two directories with the program modules and data are contained. If you wish to modify the file yourself, you may skip this step. However, the line must be added before the software will operate. Note that if you already have a complicated AUTOEXEC.BAT file, you may have to modify your DOS environment space manually. To modify the setup manually, see the next section on manual installation.

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Installation of HAZARD I successful, remove diskette from installation drive. Before you can run HAZARD I, you must reboot the computer. If you wish, the installation module will do the reboot for you. If you did not have the installation module automatically modify your AUTOEXEC.BAT file, you must make the modifications yourself as described in the HAZARD I User's Guide before you reboot and before the software will operate. If you have a RAM disk, you may wish to save its contents before rebooting.

Reboot computer:

Do not reboot computer:

Once the installation is complete, you must reboot the computer before using HAZARD I to set the configuration modified in the last step of the installation. If your computer is equipped with RAM disks or other volatile storage media, you may wish to save its contents first before rebooting. If you do not automatically reboot the computer, you must change back to the hard disk once the installation is finished.

2.2.2 Manual Installation

While the automatic installation should be appropriate for most installations, there may be some custom hardware configurations where the installation must be done by hand. This section provides the details of the operations performed by the automatic installation module and outlines the steps necessary for a custom installation.

HAZARD I is installed in two subdirectories on your hard disk. One subdirectory is used to store the programs and database portions of HAZARD I and the other is used for the various data files that are supplied with the software and that are created through the use of the software. Typically, the two subdirectories will be

Program: C:\HAZARDI
Data: C:\HAZARDI\DATA

Once the two subdirectories have been created, the obvious step in the installation process is to copy all of the files on the supplied diskettes the correct subdirectories of the hard disk. The files of HAZARD I are supplied on four 3½ in or seven 5¼ in diskettes. The files from these diskettes are placed in the two subdirectories as follows:

Program Subdirectory

CONEFRM1.FMT	FASTPLOT.EXE	MATDIR.DBF
CONEFRM2.FMT	FAST_IN.EXE	MLTFUEL.EXE
CONFORM.FMT	FIREDATA.EXE	PHYFORM.FMT
DECOMCC.DBF	FURNFORM.FMT	PHYFRM1.FTM
DECOMFC.DBF	FURNFRM1.FMT	PHYSICAL.DBF
DEACT.EXE	FURNFRM2.FMT	TENAB.EXE
EXITT.EXE	HAZARD.EXE	TOXFORM.FMT
FAST.EXE	HLPTXT.HAZ	TOXFRM1.FMT
FAST.183	FSETUP.EXE	TOXFRM2.FMT
		TOXICITY.DBF

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Data Subdirectory

DATA.DAT	HLPTXT.V18	SCEN-4.DAT
DEFAULTS.FCG	PARAM.FCG	SCEN-5.BLD
DEVFONT.004	SCEN-1.BLD	SCEN-5.DAT
DEVFONT.007	SCEN-1.DAT	SCEN-6.BLD
DEVFONT.024	SCEN-2.BLD	SCEN-6.DAT
DEVFONT.025	SCEN-2.DAT	SCEN-7.BLD
EXITT.FCG	SCEN-3.BLD	SCEN-7.DAT
F77LEER	SCEN-3.DAT	SCEN-8.BLD
FASTPLOT.FCG	SCEN-4.BLD	SCEN-8.DAT
		THERMAL.TPF

A simple DOS COPY command can be used to copy each of the files from the floppy diskettes to the appropriate subdirectory on the hard disk.

Once all of the files have been copied to the hard disk, two additional steps are necessary to prepare HAZARD I for use on your machine.

First, you must modify or create two files in the root directory of the disk that contains DOS. These two files, AUTOEXEC.BAT and CONFIG.SYS tailor the DOS operating system to be able to run HAZARD I. The file CONFIG.SYS must contain the two lines

```
FILES=15
BUFFERS=20
```

to tell DOS to reserve enough memory to allow simultaneous access to multiple files. Numbers larger than 15 for the FILES command or 20 for the BUFFERS command are acceptable.

The file AUTOEXEC.BAT must contain lines to allow HAZARD I to automatically locate its program and data files. The DOS PATH command is used to provide a set of subdirectories which are search automatically to locate executable program files. The PATH statement, located in the file AUTOEXEC.BAT must include the full

path specification to your HAZARD I program directory. Two DOS environment variables must be set with the DOS SET command to tell HAZARD I where to locate its data files and must contain, in order, the full specification for your program subdirectory and for your data subdirectory, separated by a semicolon. For the default subdirectories described above, these commands would be

```
PATH C:\HAZARDI
SET HAZARDI=C:\HAZARDI
SET HAZARDIDATA=C:\HAZARDI\DATA
```

If you already have a complicated AUTOEXEC.BAT file, you may need to increase the size of the DOS environment space. By default, DOS reserves 160 bytes of space to store various system information such as the PATH command and SET commands. If you get the message "OUT OF ENVIRONMENT SPACE" when the machine boots, you must increase this space. For DOS version 3.0 or higher, this can be accomplished by placing the command

```
SHELL=C:\COMMAND.COM /P /E:nnn
```

in your CONFIG.SYS file (where nnn is the desired size of the environment space in bytes and the DOS command processor is assumed to be in the root directory of drive C:). While values as large as 32,768 may be entered, a value of 512 is usually sufficient for HAZARD I. Refer to your DOS manual for details of the SHELL command.

Finally, a setup program supplied with the software must be run to initialize FAST and FAST_in. Change to the HAZARD I data subdirectory using the DOS CHDIR command and run the command FSETUP from the DOS prompt. Details of the setup program are provided below in section 2.2.3. In addition to the selection of colors and units as detailed below, the HAZARDI data subdirectory must be entered on screen two of the setup program as shown below:

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FAST_in v 2.1

Files

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Name of thermal data file THERMAL.TPF

Path for data files C:\HAZARD1\DATA

Resume file for FAST_in DATA.DAT

Use the cursor keys to point to the file or path to be changed.
To change the file name or path, enter a new name and press <enter>.

2.2.3 Custom Colors and Engineering Units

As a part of the installation process or as a separate step once the software has been installed, you may change the display colors and engineering units used by HAZARD I for its displays and for interactive data input with FAST_in. This section provides details on such customized installations.

04/01/89

SUB HEADING

MESSAGE OUTPUT

ERROR MESSAGE

NORMAL BACKGROUND
MESSAGE BACKGROUND
HELP BACKGROUND
ERROR BACKGROUND

This is a sample of the help message text screen. Usually it will have the same background as that used for the messages and error codes.

Age Group	Number of People
0-10	10
11-20	20
21-30	30
31-40	25
41-50	20
51-60	15
61-70	10
71-80	5
81-90	2
91-100	1

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FAST_in v 2.1

Files

04/01/89

Name of thermal data file THERMAL.TPF

Path for data files C:\HAZ\DATA

Resume file for FAST_in DATA.DAT

Use the cursor keys to point to the file or path to be changed.
To change the file name or path, enter a new name and press <enter>.

On this screen, you may specify the location of the input files for the FAST model and the name of the database of thermal properties for the model. In normal use, these should not be changed. If the location of the input files is changed, a corresponding change must be made to the environment variable to tell HAZARD I where to locate its data files as well. See the previous section on manual installation for details.

FAST_in v 2.1		Set Units		04/01/89	
Base Unit	Current Units	Possible Units			
Temperature	CELSIUS	KELVIN	CELSIUS	RANKINE	FAHRENHEIT
Pressure	PASCAL				
Length	METER				
Energy	KILOJOULE				
Mass	KILOGRAM				
Time	SECOND				
Time	SECOND				

To change units, highlight the basic unit to be changed, then point to the unit desired. Pointing is done either with the cursor keys or the mouse.

As supplied, most of the engineering units used for interactive input and display by FAST_in are standard SI units. Energy defaults to kJ since rates of energy release are typically specified in kJ/s. Using the up and down arrow keys to select the unit to change and the left and right arrow keys to change the units.

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2.2.4 Modifying the Installation

Once HAZARD I has been installed on your machine, you can modify or replace the installed version. Three options are available by typing

HAZARD/I

followed by an **enter** at the DOS prompt. First, you may completely reinstall HAZARD I from the floppy diskettes replacing an existing version of the software with a corrected and / or newer version performing the process as described in section 2.2.1. Second, you can change the colors and engineering units as described in section 2.2.3. Finally, you can add or change the working data subdirectory used by HAZARD I for storage of simulation results. The following screen allows you to select ONE of these options.

INSTALLATION MODULE FOR HAZARD I

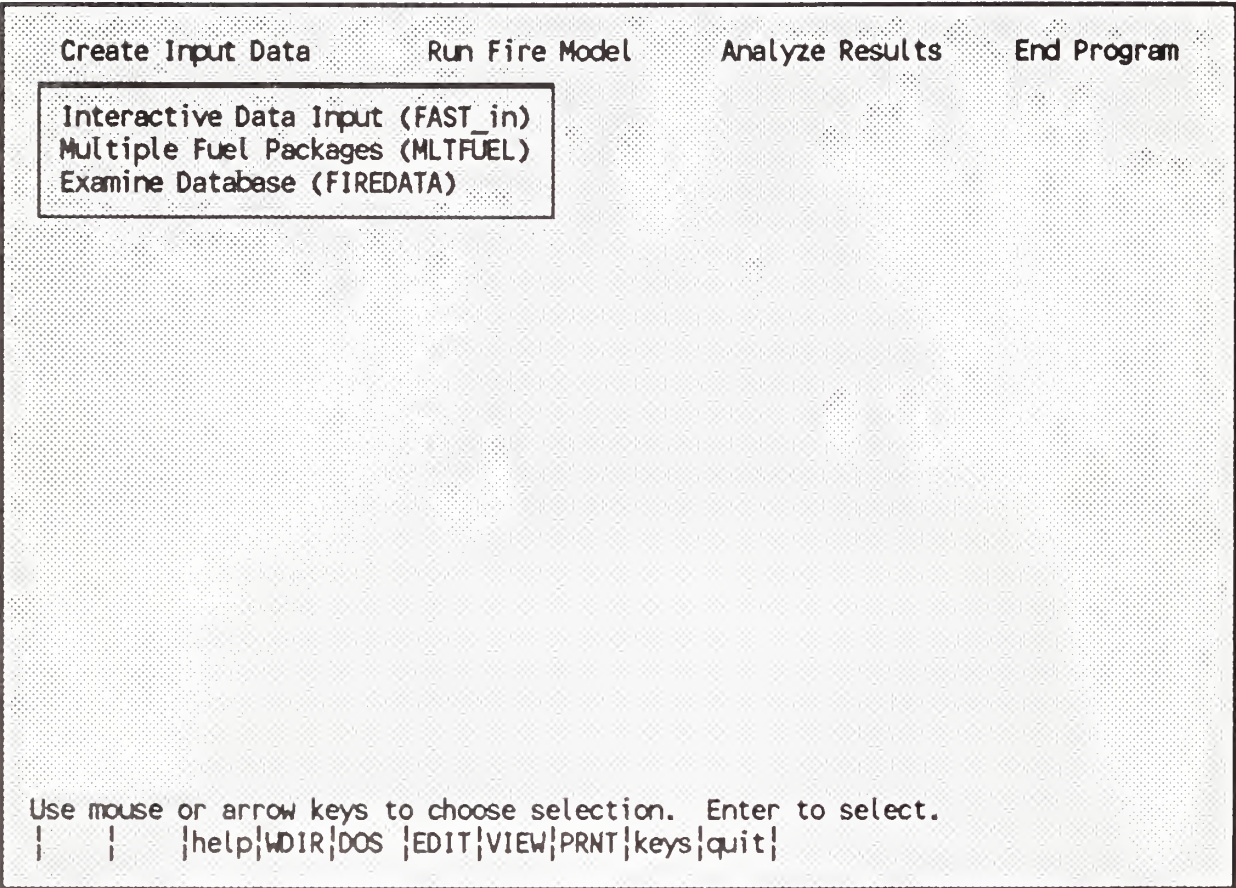
An existing version of HAZARD I has been located on your hard disk. You may: 1) completely reinstall HAZARD I replacing all programs and data files with those from the installation and program diskettes, 2) change the colors and engineering units used by the system, or 3) change the working data subdirectory for HAZARD I. Select one of these below by placing an X next to your choice.

Reinstall HAZARD I onto the hard disk:
Change colors and engineering units:
Change the working data subdirectory:

Since the first two options are described in detail above, only the third need be addressed here. By using multiple data subdirectories, you can organize your work with HAZARD I by project or topic and maintain a manageable set of data files to be used at one time. For this option, you will be asked to enter the name of the new data subdirectory. If the subdirectory does not exist, it will be created and your current default files will be copied to the new subdirectory. No data files or model simulation results will be copied. Finally, you will be given the option to automatically modify your AUTOEXEC.BAT file and reboot the computer as described in section 2.2.1 to make the change permanent. Normally you should allow the program to modify your AUOTEXEC.BAT file and reboot the computer.

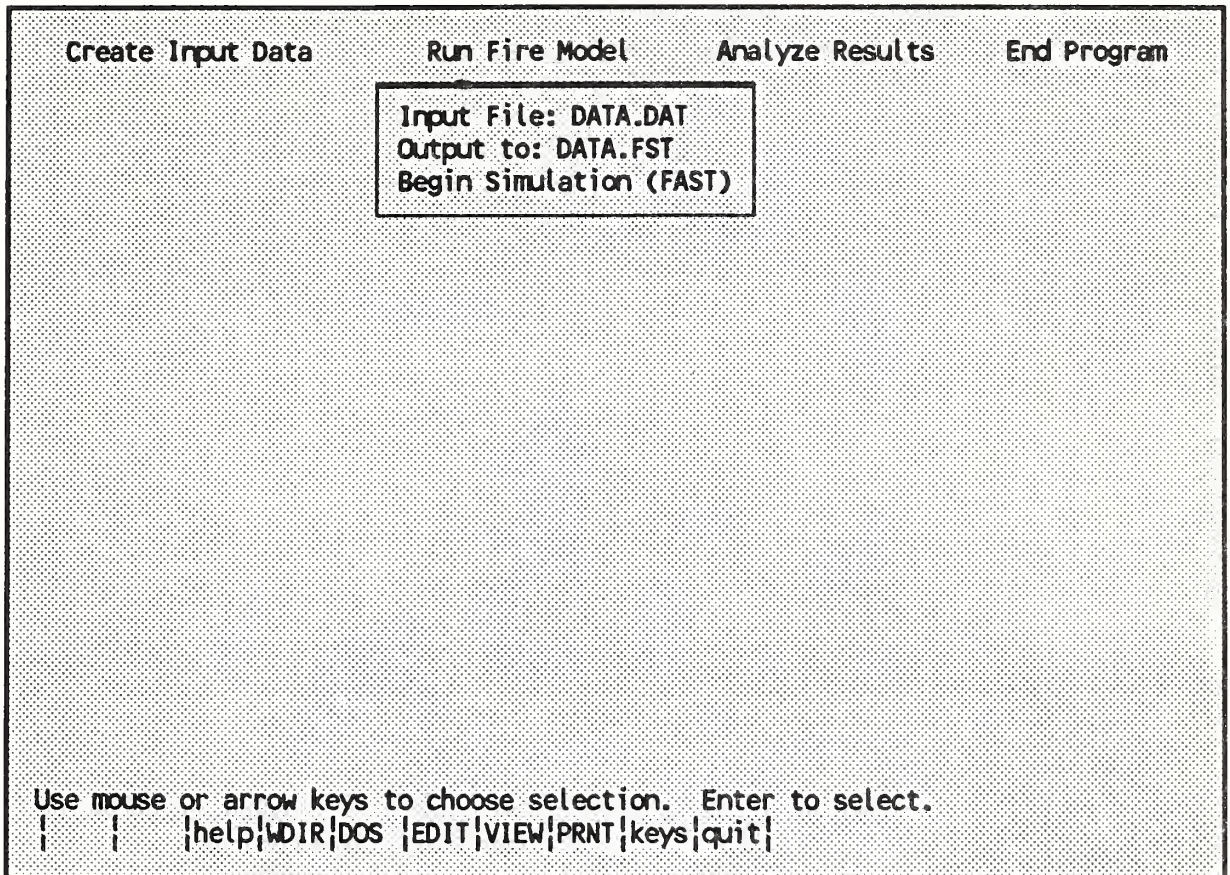
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2.3 Running HAZARD I



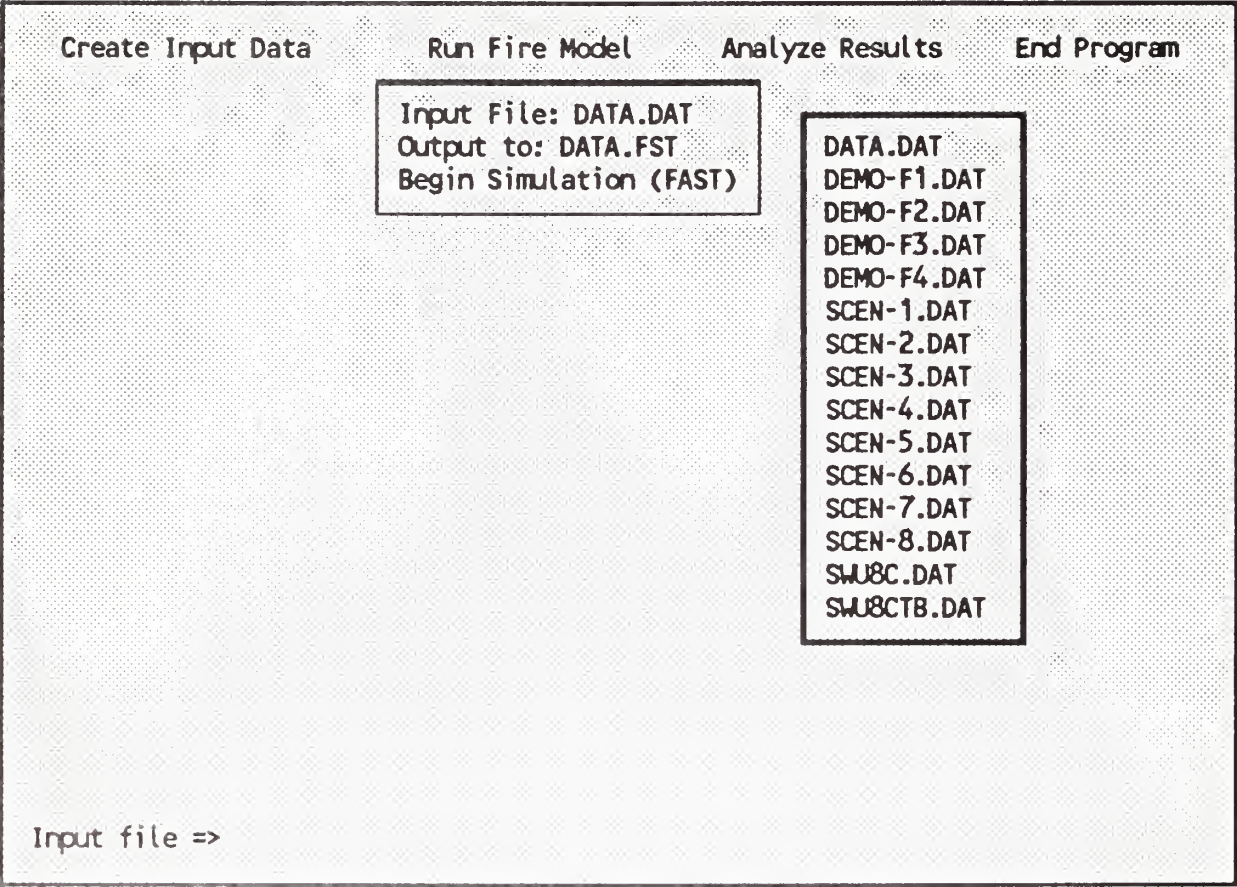
To begin HAZARD I simply type HAZARD and press an **enter**. This presents the HAZARD I Interface Shell (HIS) which provides an interactive, user friendly, interface to HAZARD I. The highlighted line at the top of the screen shows the major functions of HAZARD I. In this first pulldown menu, **Create Input Data**, the modules which are used to create input data for the models of HAZARD I are shown. The arrow keys or the mouse may be used to select the individual module to be executed. Press the down arrow key and the up arrow key several times and note that the highlighted selection bar moves to allow you to select any of the HAZARD I modules. To move the pulldown menu to the next set of modules, simply press the right arrow key.

Getting Started



The second pulldown menu, **Run Fire Model**, is used to execute the FAST model. The three selections on this pulldown menu allow you to select an input file to be run by FAST, specify the destination for any printed output from the FAST model, and begin model execution. With the highlighted selection bar on the **Input File** selection, press **enter** to select an input data set to model.

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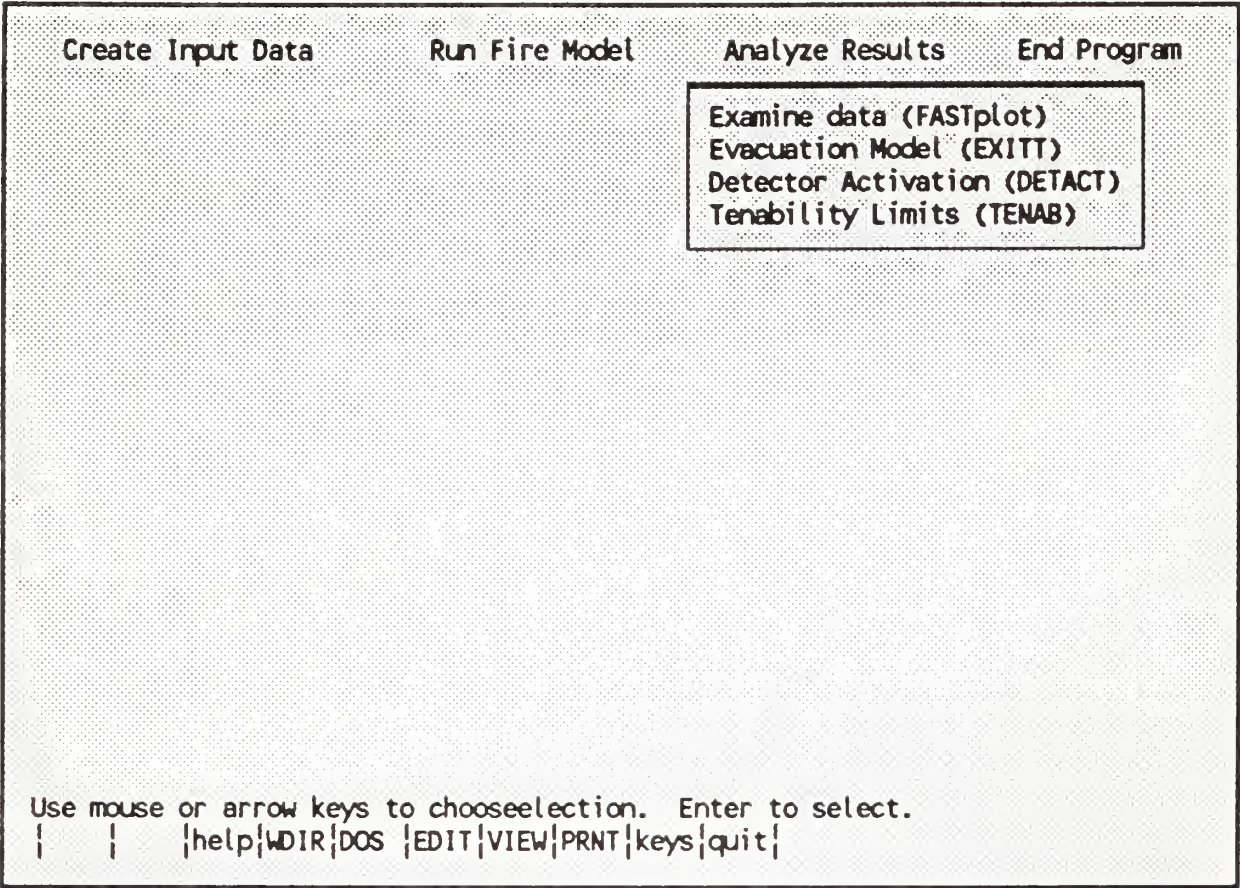
With **Input File** selected, a list of the files with the default FAST input file extension of .DAT is presented. To select a different file, use the arrow keys or the mouse to select the file and press **enter** or click the left mouse button. You may also type in the name of any existing DOS file to select that file as the input file. For now, move the highlighted selection bar to the file **DATA.DAT** and press **enter**.

Getting Started

Create Input Data	Run Fire Model	Analyze Results	End Program
<div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;">Input File: DATA.DAT Output to: DATA.FST Begin Simulation (FAST)</div>		<div style="border: 1px solid black; padding: 5px; margin: 10px auto; width: 80%;">Screen PRN LPT1 LPT2 LPT3 NUL</div>	
<div style="display: flex; justify-content: space-between;"><div>Output file =></div><div></div></div>			

Now press the down arrow key to move the highlighted selection bar to the **Output** to menu selection. Pressing the **enter** key brings up a list of the possible devices where the printed output from FAST may be sent. Note that by selecting DATA.DAT as the input file automatically sets the default **Output** to designation to DATA.FST. Any of the devices on the list may be selected with the arrow keys or the mouse or any valid DOS filename may be entered. Move the highlighted selection bar to **Screen** to direct the output from FAST to the screen and press **enter**.

HAZARD I Software User's Guide



To analyze the results of a model run with EXITT or TENAB, or to display the results graphically, press the right arrow key to present the **Analyze Results** pulldown menu. To access help which describes the function of each of the HAZARD I modules, press **F3**. A help screen is displayed describing the function of the module selected with the highlighted selection bar. Press **esc** to remove the help text and continue.

Getting Started

Create Input Data		Run Fire Model		Analyze Results		End Program	
Interactive Data Input (FAST_in)							
Multiple Fuel Packages (MLTFUEL)							
Ex^R	1	2	3	4	5	6	7
VERSN	18	demo #1 a single compartment					
TIMES	180	0	0	5	0		
TAMB	300.	101300.		0.			
EAMB	300.	101300.		0.			
HI/F	0.00						
WIDTH	3.30						
DEPTH	4.30						
HEIGHT	2.30						
HVENT	1	2	1	1.07	2.00	0.00	0.00
CEILI	GYPSUM						
FLOOR	WOOD						
CHEMI	0.	50.	3.0	18071430.	300.		
LFBO	1						
LFBT	2						
1:	1						

Finally, you can also view or edit a file from within HIS by pressing **f6** for edit or **f7** to view the file. Press **f6**, type **DATA.DAT** and press **enter** to select the file **DATA.DAT** to edit. You can move up and down in the file with the **Page up** and **Page down** keys and move right or left on the line with the arrow keys. Press **esc** to exit the editor and **esc** again to discard any changes that have been made to the file.

HAZARD I Software User's Guide

FAST_in v 2.3 Initialization

04/10/89

FILE: DATA.DAT

|file| |help| | 1R | 3R | | |keys|quit| input=>

FAST_in is the first module in HAZARD I and is used to create input for the fire model FAST. From within the HAZARD Interface Shell, select the **Interactive Data Input (FAST_in)** from the **Create Input Data** pulldown menu by pressing **enter**. The first screen in FAST_in is **Initialization**, from which the starting file is selected. The default file shown is the last file that was worked on. To select this file, you would simply press **enter**. To select a different file, you may enter its name at the input prompt *or* press **f1** to obtain a list of the available files. You can also begin a file with a generic data set for a one-room or three-room building by pressing **f5** or **f6**. (Note: Since FAST_in displays today's date in the upper right hand corner of the screen, your screens will not exactly match the screens presented in this manual.)

FAST_in v 2.3 Initialization

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ASSY.DAT
BELLES.DAT
BELLESG.DAT
DATA.DAT
DEMO-F1.DAT
DEMO-F2.DAT
DEMO-F3.DAT
DEMO-F4.DAT
XXXX.DAT

FILE: DATA.DAT

There are 9 files in this directory

Using the data path C:\FAST\DATA

|file| |help| | 1R | 3R | | |keys|quit| input=>

Now, press **f1** to see the list of available files, which appears in a window at the left of the screen. Also note that you are told the name of the directory being used (set in INSTALL) and how many files are in the directory.

Move the highlight bar to **DATA.DAT** and press **enter** to select this file.

NOTE: If you select a file which is not a valid FAST input file, a message will appear on the screen to inform you of that and you can make another selection.

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FAST_in v 2.3 Overview

04/10/89

File: DATA.DAT

Title: demo #1 a single compartment

Geometry		Time		Ambient Conditions	
Compartments	1	Simulation	180	Temperature	300.0
Vents...	1	Print	0	Pressure	1.0E+05
HVAC connect	0	Dump	0	Station elv.	0.0
		Display	5	Wind speed	0.0
				Scale height	10.0
				Power law	0.1600

Fire Specification

Type Specified fire(constrained)

Species tracked O2 CO2 CO TUHC H2O CO CT

Range: Alphanumeric (50)

Units: Name or Title

| go |rtn |help| | | |unit| key|quit| input=>

This is the **Overview** screen, which presents a summary of the file. The text colors (typically bright white on color monitors unless customized during the installation) show that the only data which can be changed on this screen are the title and time steps.

Move the highlight bar and note how the message line indicates the range of values and units for each data input.

Now try changing the **Print** interval by moving the highlight bar to it, entering a value, and pressing **enter**. If you enter a value outside the allowed range the value is not accepted and the message **Out of Range** appears on the message line.

Set the **Print** interval to 1 second, and move to the next screen with the **Page Down** key.

FAST_in v 2.3 Ambient conditions				04/10/89	
	(internal)		(external)		
Temperature	300.0		300.0		
Pressure	1.0E+05		1.0E+05		
Station elv.	0.0		0.0		
Wind speed			0.0		
Scale height			10.0		
Power law			0.1600		
Compartments	1		Maximum pressure differential	0.0	
Vents...	1		Maximum elevation change	2.30	
HVAC connect	0		Total internal volume	32.6	
Range: 200.0 to 350.0 Units: Temperature in KELVIN					
go rtn help unit keys quit input =>					

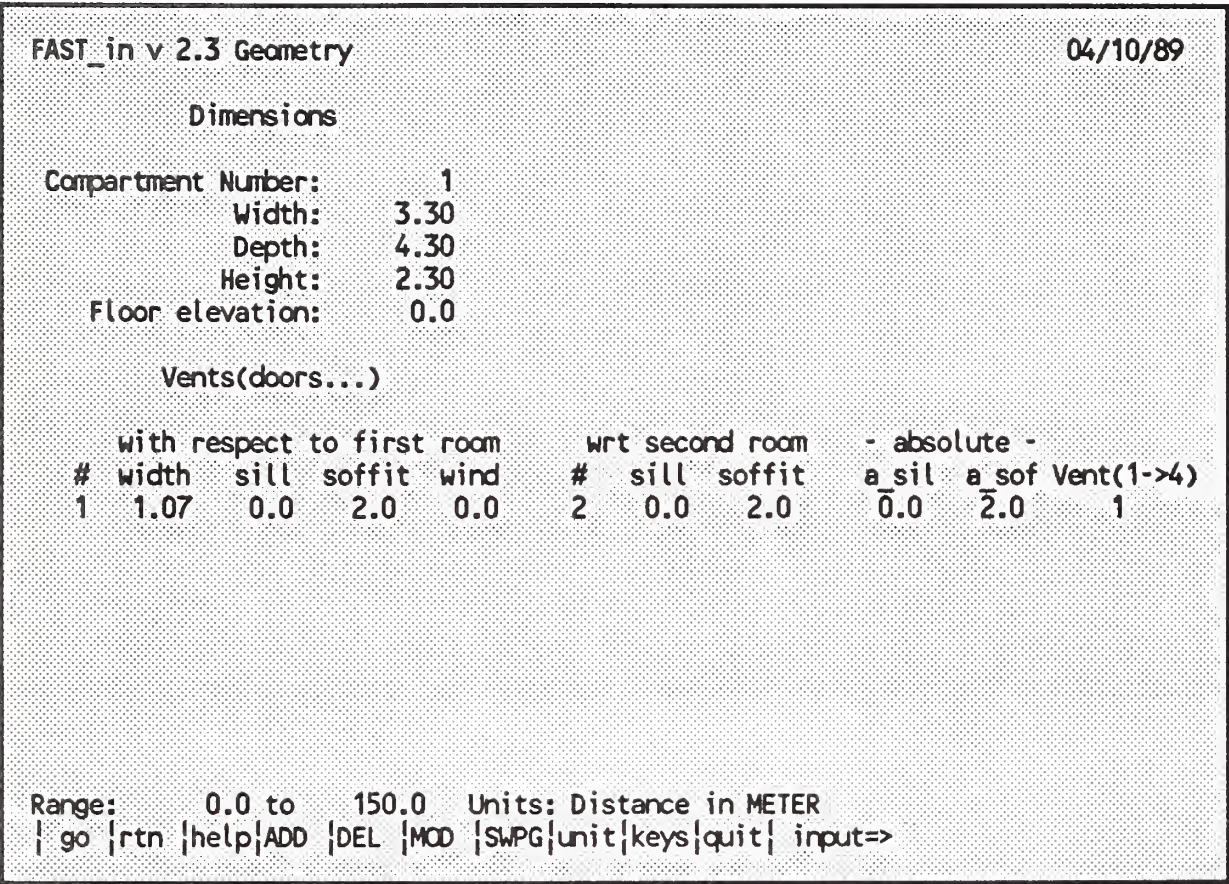
You are now at the **Ambient Conditions** screen where the pre-fire interior and exterior conditions are specified.

The interior and exterior are individually specified so that seasonal variations can be simulated. Press **F3** to see the help text for this screen, which explains the data which can be entered here. Press **ESC** to clear the help window.

Again, move the highlight bar over the data elements and note the ranges and units for each. However since these are fairly typical ambient values, we will not change them.

Proceed to the next screen by pressing **Page Down**.

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We have now reached the **Geometry** screen where the room dimensions and connections are specified. This is the only screen which is divided into two "pages," the first for rooms and the second for vents. You move between the pages with the **Switch Page** key, **f7**. Try jumping back and forth a few times.

Move the highlight bar to the **Soffit** entry on the **Vent** page. Although the range message states that the soffit height is limited to 150 meters, any height greater than the ceiling height (2.3 meters) will be limited to the ceiling height. Try entering a value greater than 2.3 and note that the entry is changed to 2.3 automatically by the program. In general, a vent cannot be taller than the ceiling, lower than the floor, or wider than the longest dimension of the first room that it connects.

Move to the next screen by pressing **Page Down**.

04/10/89

Wall properties: OFF

Now Page Down to the next screen.

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FAST_in v 2.3 Thermal Database						04/10/89	
	Conduct	Specifi	Density	Thickne	Emissiv	* CODES *	
DFIR30M	0.0002	0.9000	790.0	0.0160	0.9000		
PINEWOOD	0.0001	2.50	540.0	0.0160	0.8000		
CONCRETE	0.0018	1.00	2200.0	0.1500	0.9400		
REDOAK	0.0002	1.30	640.0	0.0160	0.9000		
FIBERB	0.0	1.25	240.0	0.0160	0.9000		
GYP SUM	0.0002	0.9000	790.0	0.0160	0.9000	38	U
WOOD	0.0	1.00	250.0	0.0160	0.9800		U
DFIR0M	0.0001	1.40	510.0	0.0130	0.9900		
DFIR10M	0.0002	1.50	560.0	0.0160	0.9000		
LIMEGLAS	0.0014	0.7600	2500.0	0.0160	0.9500		
GLASFIBR	0.0	0.7200	32.0	0.0880	0.9000		
KAOWOOL	0.0002	1.05	128.0	0.1160	0.9700		
GYP1/2	0.0002	0.9000	790.0	0.0130	0.9000		
GYP3/4	0.0002	0.9000	790.0	0.0190	0.9000		
GYPX5/8	0.0001	0.9000	770.0	0.0160	0.9000		
BRICK	0.0002	0.9000	790.0	0.0760	0.9000		
GLASS	0.0014	0.7600	2500.0	0.0060	0.1000		
FC1_L003	0.0002	1.50	790.0	0.0160	0.9000		

Range: 0.0 to 0.0100 Units: Conductivity in KILOJOULE/SECOND/METER/KEL
| go | rtn | help | ADD | DEL | PICK | | unit | keys | quit | input =>

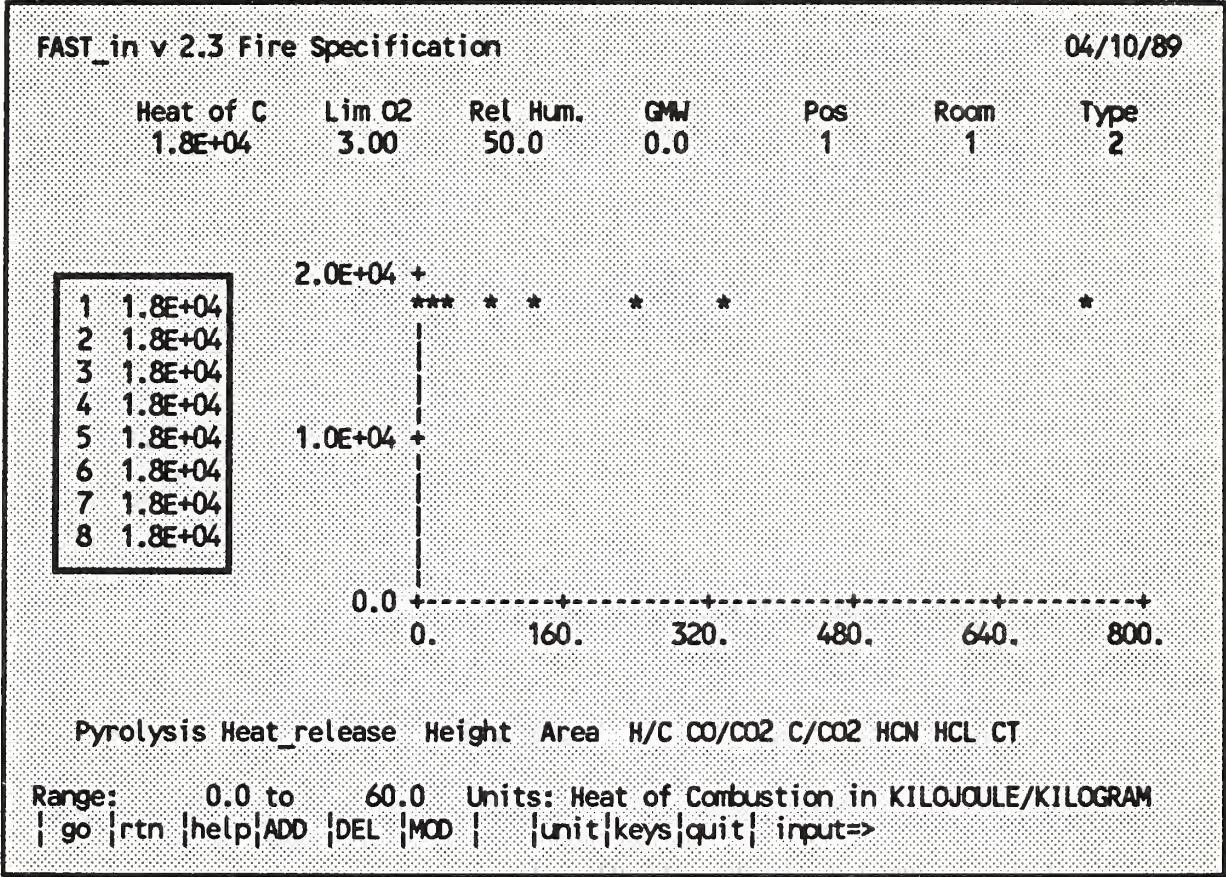
The materials in the database are displayed. If any of the entries are layered *assemblies*, only the innermost layer will be listed.

WARNING: IF THE DATABASE FILE CONTAINS ASSEMBLIES, DO NOT EDIT THE FILE WITH FAST_in AS THE SECOND AND THIRD LAYERS WILL BE DELETED.

The **Codes** column provides useful information about the materials used in the file being used. The **Help** screen identifies the meaning of these codes.

The database files usually contain more entries than can be displayed on the screen at one time. Therefore, the list will scroll up and down as you move through it.

Now, **Page Down** to the next screen.



The **Fire Specification** screen requires the most data entry. For time dependent variables, data are entered in a table and displayed in a graph, both in the center of the screen. Note that the text screen graph is not as precise as the actual numbers entered and should only be used as a visual indication of the curve.

Move the highlight bar across the entries to see which inputs are time dependent. Note that some of the data elements are in the *protected text* color. This indicates that these are off. To activate them, highlight the element and press the **ADD** key (f4). This will bring up a blank table and graph. Remember that chemistry is only done in a constrained (**Type 2**) fire. Thus, if you change the **Type** to 1, all species inputs (except CT) will be turned off. Also, the **Heat of C**, **Pyrolysis**, and **Heat_release** inputs are related. If you enter all three, the last two entered may force the third to change to be consistent. Now, press **Page Down** to go to the next screen.

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FAST_in v 2.3 Calculate,...

04/10/89

run this data set <f4> maximum time 180 seconds

quick estimates <f5> asks for a time interval

run time graphics (FAST) <f6> no

save data file(s) <f7>

write to log file <f8> no

| go | rtn | help| | | | | | keys| quit|

The **Calculate** screen takes no input, but rather performs its actions with function keys. To **run this data set** press **f4**, which begins the model running the current data and outputs tabular data to the screen, updated at each **Print** interval. Since we earlier set this to 1 second, try this now. If you failed to set the print interval on the initial screen, the output will not appear (since the print interval was zero) but the calculation will proceed.

Getting Started

FAST_in v 2.3 Results - temp..		04/10/89
Time:	0.0	
Compartment Number:	1	
Upper layer temp:	300.0	
Lower layer temp:	300.0	
Upper volume:	0.0326	
Layer depth:	0.0023	
Ceiling temp:	300.0	
Upper wall temp:	300.0	
Floor temp:	300.0	
Plume flow rat:	0.0	
Pyrolysis rate:	0.0	
Fire size:	0.0	
Vent fire:	0.0	0.0
Pressure:	0.0	
Units: Temperature in KELVIN		
<esc> to terminate gracefully, <f10> forced stop (no restart)		

While the model is running you can make it stop (gracefully) at the next time step by pressing **esc**.

WARNING : DON'T USE THE FORCED STOP (f10) EXCEPT IN AN EMERGENCY AS IT CAN LEAVE FILE FRAGMENTS ON YOUR DISK

When stopped, you can change any data input and re-start the run by again pressing **f4**. This will change to the new data at the next time interval boundary. More often you may want to change the units in which the data are being displayed. This is done by pressing **Page Down** to return to the results screen and pressing the **unit** key (**f8**), making the change, pressing **esc** to return to the **Calculate** screen, and re-starting (**f4**). Try changing the **Temperature** unit to **Fahrenheit** and running a few more time steps.

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FAST_in v 2.3 Files

04/10/89

stream file for FAST DATA.DAT *

thermal data base file THERMAL.TPF

dump file no file specified

a * indicates that the file has been modified and not saved

Use the cursor keys to point to the file to be saved. Then press <enter>.
To change the file name, enter a new name and press <enter>.

<esc> to exit, <f3> for help

input=>

When you are ready to save your file, you press **F7** at the **Calculate** screen, which brings up the files screen. Note that since we changed the **Print** interval, the file is marked as "modified and not saved." This is also where we name the dump file or change the thermal database file used for this run.

If there is a file on the disk with the same name, you will be asked if you wish to overwrite it. A "no" will bring you back to the input prompt to select a different file name.

Getting Started

FAST_in v 2.3 Overview04/10/89

File: DATA.DAT Title: demo #1 a single compartment

Geo	Overview	Time	Ambient Conditions	
	Ambient conditions			
Com	Geometry	Simulation	180	Temperature 300.0
	Thermal properties	Print	0	Pressure 1.0E+05
HVA	Thermal Database	Dump	0	Station elv. 0.0
	Fire Specification	Display	5	Wind speed 0.0
	Calculate,...			Scale height 10.0
	Results - temp...			Power law 0.1600
Fir	Flow Field			

Type Specified fire(constrained)

Species tracked O2 CO2 CO TUHC H2O CO CT

Range: Alphanumeric (50) Units: Name or Title

<esc> to exit, <f3> for help, <enter> to select

Now that we have seen the basic functions of, and data entry to each of the screens in FAST_in, we will examine some more advanced concepts.

While the **Page Up** and **Page Down** keys are convenient for moving one screen at a time, you sometimes want to jump screens. Pressing **f1** (labeled **go**) brings up a **navigation window**. Simply move the highlight bar to the screen you want and press **enter**.

Now use this feature to jump to the **Geometry** screen.

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FAST_in v 2.3 Geometry

04/10/89

Dimensions

Compartment Number: 1

Width: 3.30

Floor

Compartment #

2

V

Width

with

Depth (breadth)

#

width

1

1.0

Interior height

Height of floor above reference level
(reference is specified in "Ambient")

solute -

l a sof Vent(1->4)

2.0 1

Range: 0.0 to 150.0 Units: Distance in METER

<esc> to exit, <f1> to accept the data,

input=>

To delete a compartment, highlight any dimension of that compartment and press **f5** (DEL). *NOTE: You cannot delete the compartment that contains the fire.*

To add a compartment, press **f4** (ADD) while on the rooms page. This opens a window asking for the data . After entering the data, press **f1** to add the data to your file or **esc** to return to the screen and *not* add the data to the file. *NOTE: The range and units shown are for the input that you are on within the **add a compartment** window. If you want to change units, you must do so before you go into the add mode.* The new room and the outdoors are *automatically* numbered so that the outdoors is always the highest numbered compartment.

Once you accept the data, it will be displayed on the **Geometry** screen. Now press **esc** to return to the screen.

FAST_in v 2.3 Geometry

04/10/89

Dimensions

Compartment Number: 1

Width: 3.30

Floor

First Compartment

V Second Compartment

with Vent number

width

1 1.0 Width

Soffit (with respect to first comp)

Sill (with respect to first comp)

solute -

l a sof Vent(1->4

2.0 1

Range: 1 to 2 Units: Compartment number

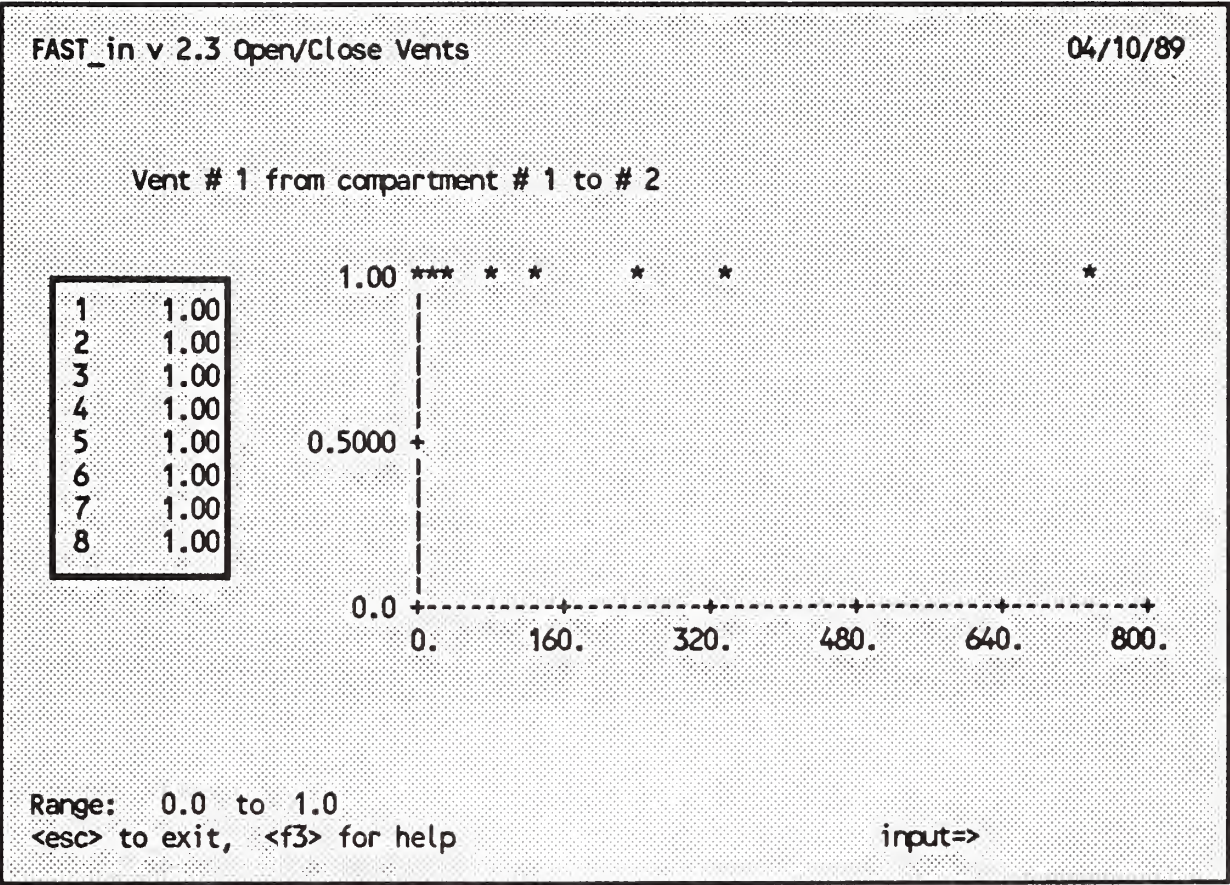
<esc> to exit, <f1> to accept the data

input=>

Adding or deleting a vent is identical to adding or deleting a room except it is done from the vent page on the Geometry screen. Press **SWPG (f7)** to move to the vent page and **ADD (f4)** to see the **add a vent** window. *NOTE: The order of the compartments (first or second) entered makes no difference other than that the soffit and sill dimensions are with respect to the floor of the first compartment.*

Now press **esc** to return to the screen.

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The final operation done on this screen is to **modify a vent**, which means to open or close the vent at a previously defined time interval.

Move the highlight bar to the desired vent and press **O/C (f6)** to bring up the **Open/Close Vents** screen. This presents a table and graph similar to those used for time dependent variables on the **Fire Specification** screen. The default values are all 1.0, indicating 100% open. At any existing interval, the vent can be closed by entering a 0 or open any fraction by entering the appropriate value between 0 and 1. *NOTE: The value entered multiplies the width of the associated vent.* As with other time dependent variables, a linear interpolation is performed between intervals.

FAST_in v 2.3 Thermal Database						04/10/89	
	Conduct	Specifi	Density	Thickne	Emissiv	* CODES *	
DFIR30M	0.0002	0.9000	790.0	0.0160	0.9000		
PINEWOOD	0.0001	2.50	540.0	0.0160	0.8000		
CONCRETE	0.0018	1.00	2200.0	0.1500	0.9400		
REDOAK				160	0.9000		
FIBERB				160	0.9000		
GYP SUM				160	0.9000	38	U
WOOD				160	0.9800		U
DFIR0M				130	0.9900		
DFIR10M				160	0.9000		
LIMEGLAS				160	0.9500		
GLASFIBR				880	0.9000		
KAOWOOL				160	0.9700		
GYP1/2				130	0.9000		
GYP3/4				190	0.9000		
GYPX5/8				160	0.9000		
BRICK				760	0.9000		
GLASS				060	0.1000		
FC1_L003				160	0.9000		

Name

Conductivity

Specific heat

Density

Thickness

Emissivity

Range: Alphanumeric (8) Units: Name or Title
<esc> to exit, <f1> to accept the data input=>

Press **esc** then use the **navigation window** to move to the **Thermal Database** screen.

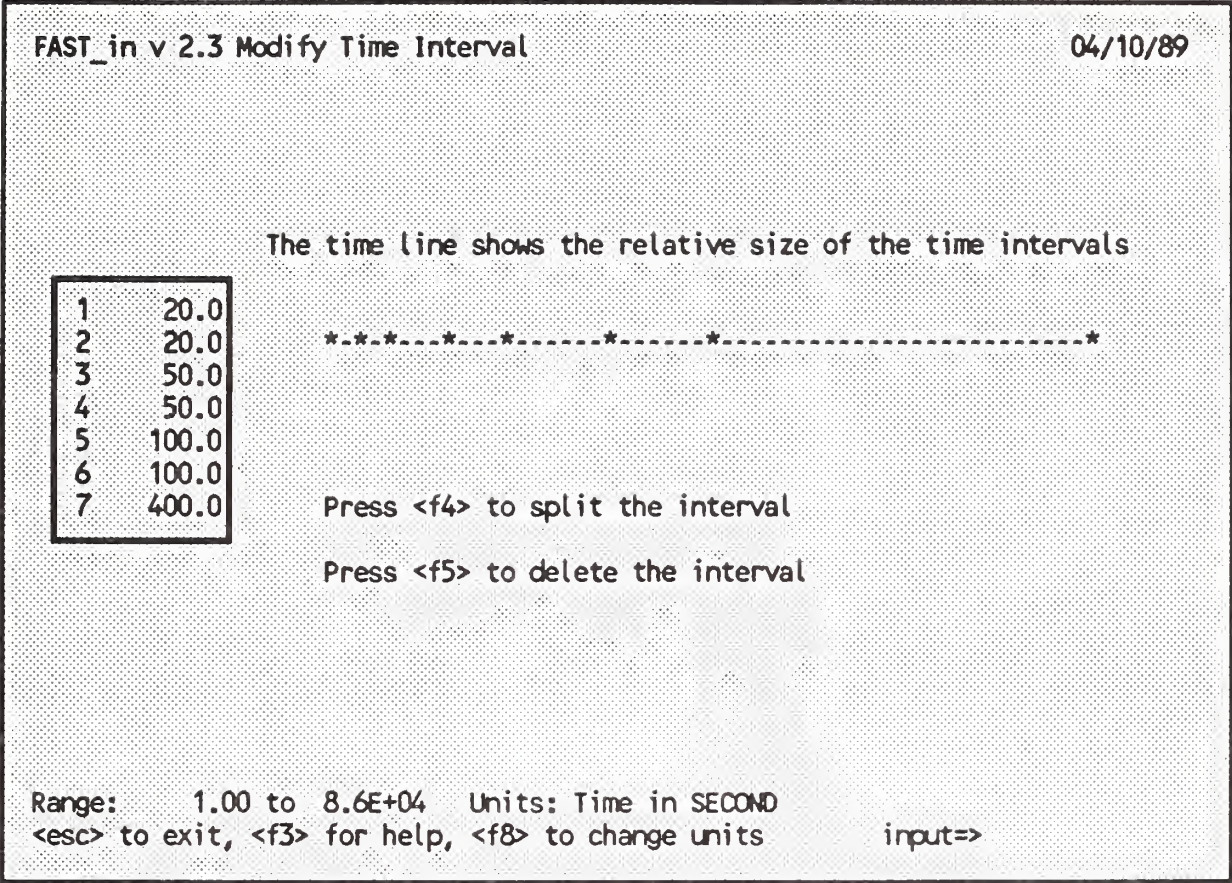
Adding a material to the database is similar to adding a room or vent. Press **ADD (f4)** to open the add window and enter the data.

WARNING: IF THE DATABASE FILE CONTAINS ASSEMBLIES, DO NOT USE THIS FEATURE AS THE SECOND AND THIRD LAYERS WILL BE DELETED.

If you wish to enter an assembly or if the database contains assembly data, you cannot use FAST_in to modify the data. You must use a text editor such as the one built into the HIS to modify the file.

Press **esc** to return to the screen.

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Time dependent variables can change value only at a specified time **interval**. Thus, we must be able to change these intervals. *NOTE: The set of time intervals form a single time line which applies to all time dependent variables.*

Navigate to the **Fire Specification** screen and highlight any time dependent variable except species. Press **MOD (f6)** to obtain the **Modify Time Interval** screen. Highlight an interval and press **f4** to split it in half, **f5** to delete it, or **input** a value from the keyboard. The time line display will show the changes as they are entered. Press **esc** to return to the **Fire Specification** screen.

One or more of the data files have been altered
and not saved. Do you want to quit anyway?

Yes or No

input=>

To end FAST_in, press f10. Since you have made changes to the input file, you will be told that the modified file has not been saved. If you answer N, you will return to FAST_in and can save the file. For now answer Y to leave FAST_in without changing the data file.

CHAPTER 3. LEARNING

In chapter 2, we examined the use of the Hazard Interface Shell (HIS), Fast_in, and FAST to simulate a building fire. In this chapter, we will learn how to use the remaining modules of HAZARD I to perform a hazard analysis. This will be accomplished by working our way through one of the example cases documented in the **Reference Guide**.

The modules MLTFUEL, FIREDATA, DETACT, EXITT, and TENAB operate in a traditional, interactive manner. That is, they obtain input by asking a series of questions which are answered in a specific sequence. They are not as "user friendly" (e.g., they operate only in SI units), but their use is generally straightforward. In HAZARD II, we plan to implement a user interface to these modules similar to FAST_in, called FAST_out.

3.1 Organizing Data Files in HAZARD I

By using a consistent set of naming conventions for the files used and generated by HAZARD I and separating your data files by topics as appropriate, use of the large number of data files within HAZARD I becomes more manageable. This section details the naming conventions used by the software and introduces the concept of multiple data subdirectories to organize your work with HAZARD I.

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3.1.1 Naming Files

HAZARD I allows the use of any valid MS-DOS filename (up to eight characters with an optional, three-letter extension) for user-named data files created by the modules. However to assist the user, we have designed the software to display, and sometimes default to, data files of the specific type required at that point. To differentiate among the different files used within HAZARD I, we **assume** a specific and consistent file naming scheme. Thus to benefit from this feature, the user must follow this file naming convention.

As illustrated in the HAZARD I flowchart, all data files for a given **case** under study should use a common filename (up to eight characters) which is descriptive of that case. For example, a case involving a townhouse might use **TWNHOUSE**, or an analysis of a building for a client named Collins might be called **COLLINS**. The differentiation of the specific data file type comes from the (three letter) extension. The extensions assumed by the HAZARD I software are:

<u>Extension</u>	<u>File Type</u>
.TPF	Thermal Properties database file for FAST and FAST_in
.DAT	Input data file to FAST
.FST	Printer output from FAST
.DMP	Output data file from FAST to FASTplot and TENAB
.BLD	Building input file to EXITT
.EXT	Printer output from EXITT
.EVA	Evacuation map from EXITT to TENAB
.TEN	Printer output from TENAB
.PLT	Output data file from TENAB to FASTplot

One additional file is used by HAZARD I for storage of graphics output files from FASTplot. Since it may be desirable to create multiple graphs from a single test case, the file names for this type

of file are different than those above. For graphics files, the form is

HPGL.nnn Plotter file from FASTplot formatted for a Hewlett-Packard plotter. **nnn** is an automatically selected three digit number from 000 to 999.

3.1.2 Data Subdirectories

By using multiple data subdirectories, you can organize your work with HAZARD I by project or topic and maintain a manageable set of data files to be used at one time. Sets of data can be separated by topic such as furniture fires, kitchen fires, and the like; by project sponsor; or by any convenient categorization. Files for each of the separate categories are kept in a separate subdirectory on your hard disk and the HIS has the capability to switch temporarily or permanently to any other data subdirectory. To switch permanently, see section 2.2.4 of this **Software User's Guide**. To switch temporarily, you can use the **WDIR** function key within the HIS as described in section 4.1.2 of this **Software User's Guide**.

3.2 The Example Case

The example case with which we will be working is based on scenario 2, the kitchen grease fire in the ranch house. As we proceed, you may wish to compare your results to that in the **Example Cases** volume for this case.

3.3 Defining the Context

The product of interest in this case is kitchen cabinets for which we wish to estimate the contribution to the occupant hazard for their

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most common involvement in residential fires. The product is sold for residential use for both new construction and for remodeling. Such cabinetry typically includes both base and overhead assemblies, and may include free standing units (islands). While consisting of a series of individual units, they are normally installed abutting each other such that long, continuous surfaces (for flame spread) are formed. We wish to compare our current product with one made with a new core material which burns at half the rate, but uses a nitrogen containing filler resulting in a 1% yield of HCN.

A review of fire incident data (NFIRS) reveals that the primary ignition exposure comes from grease fires on the stove surface, and secondarily from fires in counter top appliances (which will not be addressed directly in this example). The ranch house is selected as the target building since it represents approximately 70% of the U.S. single-family housing stock. A typical ranch house arrangement is provided in the HAZARD I example cases discussed in chapter 4 of the **Technical Reference Guide**. If the performance of the cabinets in other houses (two-story, apartment, or mobile home) or ignition scenarios were of interest, these could be analyzed in a similar manner.

3.4 Defining the Scenario(s) of Concern

Since occupant characteristics in homes are extremely variable, it is decided that a mixed family composition should be used to represent the range of characteristics which might be expected. The family members selected include:

The father, aged 30, located in the master bathroom.

The mother, aged 30, in the hall near the washer/dryer.

A daughter, aged 7, in the living room watching TV.

A son, aged 5, watching TV with his sister.

A grandmother, aged 71, in bedroom 3.

All occupants are assumed to be awake and fully capable at the time of the fire. The doors to the grandmother's room (#3), the master bedroom, and the master bath are closed (all others are open). For this example, only a single scenario will be examined.

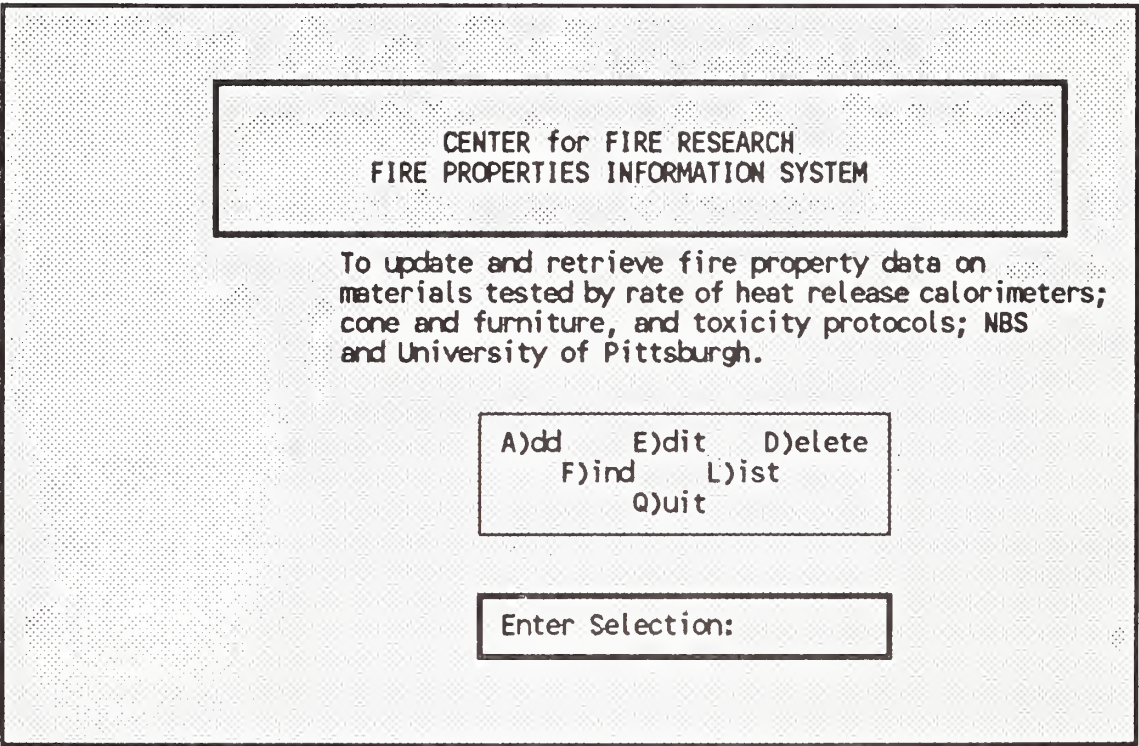
3.5 Calculating the Hazard

Following the Step-by-Step Procedure for Conducting a Hazard Analysis in chapter 3 of the **Technical Reference Guide**, the HAZARD I software is used to predict the consequences of the scenario described above with the current cabinets.

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3.5.1 FIREDATA

The first step is to search FIREDATA for any appropriate data on the burning rates of a pan of oil and kitchen cabinets. From within the HIS, select FIREDATA from the **Create Input Data** pull-down menu.



The initial screen of FIREDATA asks whether you wish to A)dd, E)dit, D)elele, F)ind, L)ist, or Q)uit. Searching is done with Find. The other functions are discussed in the FIREDATA section of chapter 4.

Data is retrieved by a two pass procedure

1-Material keyword(s) is entered and a data base selected. Material identification field is searched for presence of keyword(s). The Material Code & Identification fields are listed

2-Desired MATERIAL CODE is entered. Program will display data until end-of-file or STOP command is entered.

Press any key to continue...
Enter Material Name:

Selecting F brings up a screen with instructions and a request for a word on which to search. Since we are looking for burning rate data on oil, we will type oil at the prompt. This brings up a request for which database to search. Select F)urniture Calorimeter for data on full-scale items.

CKG001 COOKING OIL,CORN;COTTONSEED;ETC IN 12IN.PAN
Press any key to continue...
Enter MATERIAL CODE or 'EXIT' CKG001

After searching the database, we obtain a single matching entry. Entering the material code (shown at the left) CKG001 at the prompt brings up the first page of data.

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Decomposition Data from Furniture Calorimeter			
Material Code: CKG001			
Material ID: COOKING OIL,CORN;COTTONSEED;ETC IN 12IN.PAN			
Configuration:POOL			
Ignition Source:			
Initial Mass:	0.000 kg	Final Mass:	0.000 kg
Ignition Time:	0.0 s		
		Units	Average
Heat of Combustion		kJ/kg	40000.0
CO	Yield	kg/kg	0.0000
CO2	Yield	kg/kg	0.0000
HC	Yield	kg/kg	0.0000
HCl	Yield	kg/kg	0.0000
HCN	Yield	kg/kg	0.0000
H2O	Yield	kg/kg	0.0000
SOOT	Yield	kg/kg	0.0000
Extinction Area		m2/kg	0.000
Press any key to continue...			

This page gives the general information on this data entry along with selected average data values such as the average (net) heat of combustion. If you do not intend to print this data sheet, copy down the information you need before moving to the second page of data.

For this screen you will need the heat of combustion value (40000 kJ/kg) for input to MLTFUEL.

Time Dependent Data						
Time	Heat	Mass	CO	CO2	Yield	Yield
(s)	Release	Loss	Yield	Yield	Yield	Yield
	(kW)	(kg/s)	(kg/kg)	(kg/kg)	(kg/kg)	(kg/kg)
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
5.0	116.00	0.002920	0.000	0.000	0.000	0.000
1000.0	116.00	0.002920	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
Enter P)rinter or E)xit:						

The second page presents the time dependent data for this item. Note that the burning rate is constant (as expected for a flammable liquid of constant surface area). Also note that there are no data available for species production rates for this item (the database fills empty cells with zeros). Again, copy down the required data (mass loss rate for MLTFUEL) or select P)rinter to print the data sheet.

This will bring you back to the request for a search word. Entering **cabinet** (to look for a kitchen cabinet) brings only a television cabinet, which is not appropriate as a kitchen cabinet. In fact, we chose to use data for a wardrobe closet, which can be searched by either or both of these words. Doing so returns the material code CLT001, and the data sheet presented in the two screens on the next page. Such substitutions can be based on similarity in mass, surface area, material, etc.

A list of all of the data contained in the database can be obtained with the L)ist option detailed in chapter 4.

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Decomposition Data from Furniture Calorimeter

Material Code: CLT001
Material ID: WARDROBE CLOSET,PLYWOOD,FR PAINT NBSIR83-2787 TEST42
Configuration: CENTER
Ignition Source: CARDBOARD BOX/PAPER 0.9KG

Initial Mass: 37.330 kg Final Mass: 0.000 kg
Ignition Time: 0.0 s

	Units	Average
Heat of Combustion	kJ/kg	15900.0
CO Yield	kg/kg	0.0000
CO2 Yield	kg/kg	0.0000
HC Yield	kg/kg	0.0000
HCl Yield	kg/kg	0.0000
HCN Yield	kg/kg	0.0000
H2O Yield	kg/kg	0.0000
SOOT Yield	kg/kg	0.0000
Extinction Area	m2/kg	0.000

Press any key to continue...

Time Dependent Data

Time	Heat	Mass	CO	CO2	SMOKE	Yield
(s)	Release	Loss	Yield	Yield	Yield	Yield
	(kW)	(kg/s)	(kg/kg)	(kg/kg)	(kg/kg)	(kg/kg)
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
30.0	0.00	0.000000	0.000	0.000	0.000	0.000
100.0	500.00	0.031400	0.075	0.320	0.016	0.000
130.0	1300.00	0.081700	0.082	0.610	0.019	0.000
170.0	5300.00	0.333000	0.010	1.130	0.004	0.000
220.0	250.00	0.015700	0.024	1.510	0.000	0.000
230.0	600.00	0.037700	0.029	0.930	0.000	0.000
370.0	250.00	0.015700	0.038	0.600	0.000	0.000
1200.0	50.00	0.003100	0.000	0.790	0.000	0.000
0.0	0.00	0.000000	0.000	0.000	0.000	0.000

Enter P)rinter or E)xit:

We note that the wardrobe exhibited a very high peak of energy released at 170 s due to the rapid burning of its contents. Since this would be unrepresentative of a kitchen cabinet, we choose to lower this one data point to the value at the prior interval, and flatten the peak of curve. As was done for the cooking oil, copy down or print the information from the two screens of information. For the wardrobe, you will need the heat of combustion, mass loss rate and yields for CO, CO₂, and soot.

When finished with the database, simply press **enter** until the screen for selecting the database to search comes up. Selecting **E)xit** here, and **Q)uit** on the first FIREDATA screen will take you back to the HIS.

3.5.2 MLTFUEL

When multiple items are involved in a fire, they usually become involved in a sequence. That is, one is ignited and after growing to a certain size, ignites the next. MLTFUEL is a utility module which converts the data on multiple items burning simultaneously into a single burning rate curve as required by FAST. While the units of the results will be the same as the units input (everything is multiplied by dimensionless parameters), it is suggested that SI units be used to avoid confusion later.

MLTFUEL allows you to input individual heat of combustion, mass loss rates, and species yields as presented in the description of FIREDATA, above. All of the species yields calculated by the FAST model can be determined for up to five items burning simultaneously.

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3.5.2.1 Establishing the time-line

The rate of heat release curve for the first item ignited (the pan of oil) is considered first, in this case, a constant rate of 116 kW. The procedure for determining the time of ignition of the second item (detailed in chapter 6 of the **Technical Reference Guide**) is used to establish the ignition delay, or offset, in the two curves. For this example, we assume that the burning oil boils over at 120 s, igniting the cabinet. Thus, the ignition delay in the rate of heat release curve for the wardrobe cabinet is 120 s. For MLTFUEL, this 120 s delay is entered manually by adding 120 s to the time values obtained from FIREDATA for the wardrobe (the 100 s value becomes 220 s for instance).

3.5.2.2 Entering the data

MLTFUEL can now be selected from the HIS. We have 2 items burning together. In MLTFUEL, items are added one by one until the desired composite burning curve is obtained. The initial screen for MLTFUEL allows you begin input for the first item.

MLTFUEL Version 2.0

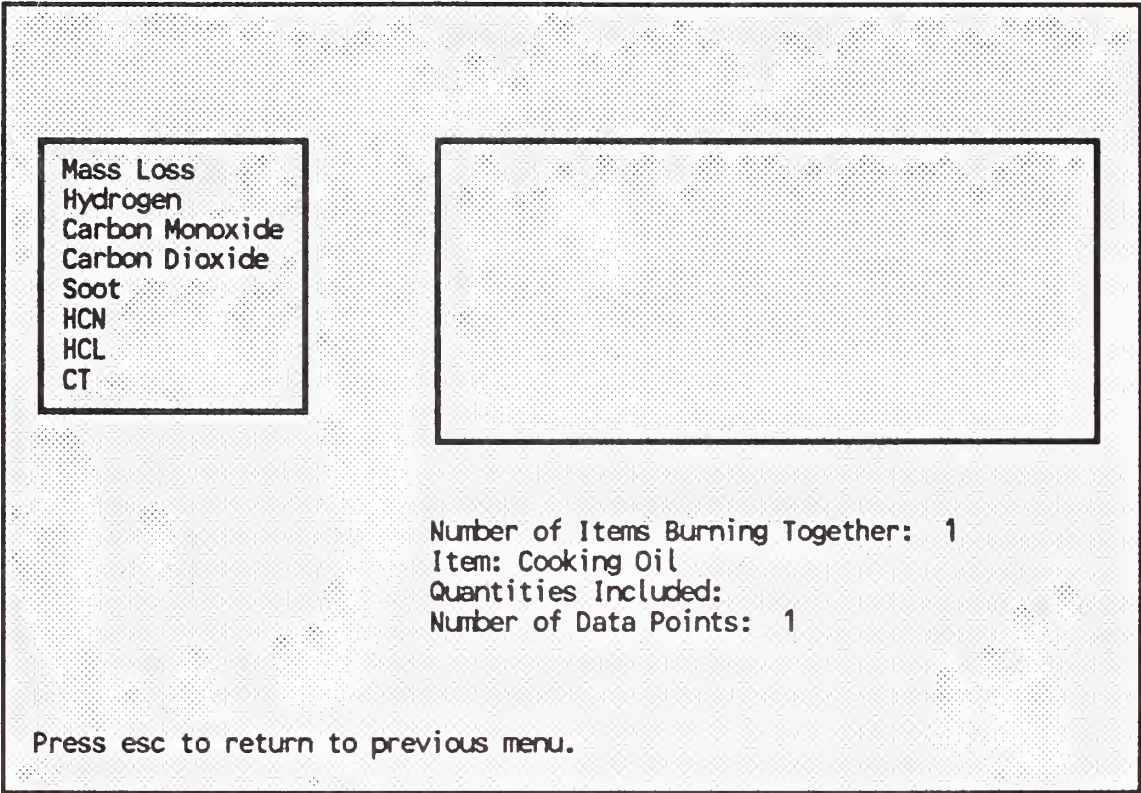
Once information for the first item has been entered, you may add or delete an item by using the function keys. After the name of the item and the heat of combustion have been entered, you can select from eight different quantities for each item. A mass loss rate curve must be entered for each item. All species entries for an item are optional. Once the data has been entered, the heat of combustion, mass loss rate, and species yields may be viewed or printed with the function keys. Data for any quantity may be changed by selecting the item, quantity, and time with the arrow and enter keys and modifying the selected entry.

Description: Cooking Oil
Heat of Combustion: 40000

MLTFUEL Version 2.0, Created April 1, 1989

For item 1 (the oil), enter the name of the item and the heat of combustion you obtained from FIREDATA (Cooking Oil and 40000 kJ/kg). Press enter after each entry. Once you have entered the heat of combustion, you will be presented with a second screen showing a list of quantities which may be entered.

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From this screen, you select the quantity to be entered. The mass loss rate and the species which can be used by the FAST model are available. A summary of the current item is shown in the lower right hand corner of the screen. Although we will eventually have two items burning together in this composite fire, only the first one has been added at this point. Thus, only one item is shown in the summary.

Using the arrow keys or the mouse, position the highlighted selection bar over **Mass Loss** and press enter. Initially, the only entry is a time of 0 and a rate of 0. For the cooking oil, this is a correct entry so press **f4** to **ADD** another entry.

The screenshot shows a data entry interface. At the top left, a box contains '0: 0.0000'. To its right is a large rectangular area with a coordinate system (x and y axes with arrows). Below the graph area, a box contains 'Time: 5' and 'Mass Loss: .0029'. To the right of this box, the text 'her: 1' is visible. At the bottom left, a text prompt reads 'Press esc to return to previous menu.'

Enter 5 for the time and .00292 for the mass loss rate. Press **esc** to return to the quantity selection menu. Since species yields for the cooking oil are all zero, we have completed entry for this item. If you discover a mistake in an entry, simply position the highlighted menu selection bar over the item and press **enter**. The current values for the item appear and may be changed. Try this with the 5 s entry and note that the entry box appears in the lower right hand corner of the screen with the values for this entry. Since the entry is correct, just press **enter** twice to return to the quantity selection menu. Finally, press **esc** again to return to the main program screen to enter the second item.

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MLTFUEL Version 2.0

Burning Item	Burn Time	Quantities Included
Cooking Oil	0 to 5	MDOT

Cooking Oil

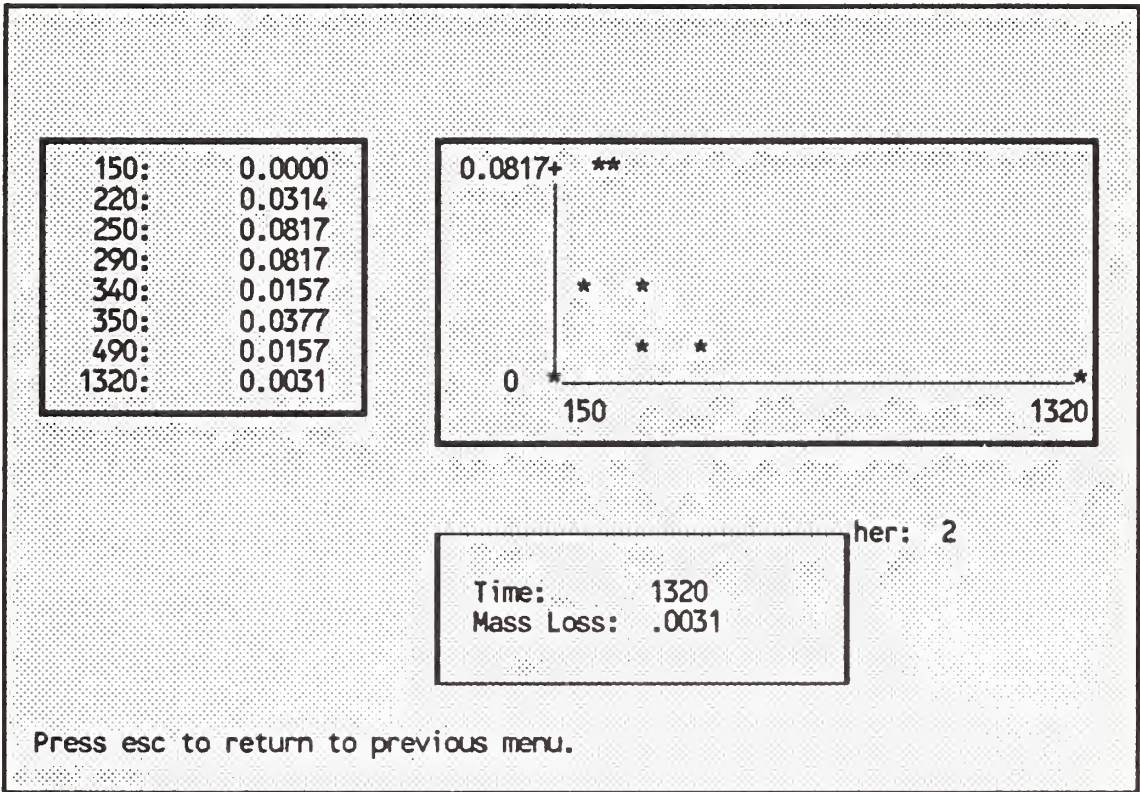
Since there are more intervals and more species to be entered for the kitchen cabinets, the entry will be more involved. Press the **ADD** key, **f4**, to add the second item and enter the name of the item (we used **Kitchen Cabinet**) and the heat of combustion (**15900** from the **FIREDATA** output). As before, pressing **enter** presents a list of species to be added to the calculation. With **MLTFUEL**, each curve is entered separately. Thus, the timeline and mass loss curve will be entered first and followed by the yield curves for each species.

Data for Kitchen Cabinets
(modified from FIREDATA wardrobe data)

Time	Mass Loss	CO	CO ₂	Soot
150	0.	0.	0.	0.
220	0.0314	0.075	0.320	0.016
250	0.0817	0.0817	0.610	0.019
290	0.0817	0.0817	0.610	0.019
340	0.0157	0.024	1.510	0.
350	0.0377	0.029	0.930	0.
490	0.0157	0.038	0.600	0.
1320	0.0031	0.	0.790	0.

Since the ignition time for the kitchen cabinets is assumed to be 120 s, the times from the FIREDATA output was shifted by 120 s and the data entered as shown in the table. Note also the mass loss and yields for the high peak at 290 s in the table above (170 s in the FIREDATA output) was replaced with the value at the prior time interval as discussed in the FIREDATA section, above.

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To enter each of the curves, select the appropriate quantity with the arrow keys or the mouse and press **enter**. Begin with the mass loss curve and define the timeline and mass loss curve. For the first entry, change the default entry (0 sec and 0 mass loss rate) by positioning the highlighted selection bar over the desired entry and pressing **enter**. Type 150 and 0. each followed by an **enter** to define the first time point for the kitchen cabinets. For the seven additional time points, use the **ADD** key, **f4**, to add an entry and enter the appropriate time and mass loss rate. Once the entry for a single quantity is complete, just press **esc** to return to the quantity selection menu, select another quantity and press **enter** to define values for the quantity.

For the CO, CO₂, and soot yields, you will just change the yield values for each time point (initially zero). Once you have defined the time curve for with the mass loss rate, the other quantities for the item use the same time curve. You do not have to re-enter the time curve for each species. For any single entry, position the highlighted menu selection over the desired time point and press enter. Since the time points are correct, press enter again to move to the yield entry and type the correct value for the species and time of interest. Once all of the values for the kitchen cabinets have been entered, press esc to return to the main program screen.

MLTFUEL Version 2.0

Burning Item	Burn Time	Quantities Included
Cooking Oil	0 to 5	MDOT
Kitchen Cabinet	150 to 1320	MDOT CO CO2 C

Cooking Oil
Kitchen Cabinet

To view the effective mass loss rate and species yields, press the **VIEW** key, f7. Once you are satisfied with this composite fuel, the results may be printed using the **PRNT** key, f8. Since the time line, mass loss rates, and species yields must be manually input into the Fire Specification in FAST_in, you should print or copy down the

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values for the composite fuel. The calculated values shown on the **VIEW** screen and as printed on a printer are shown below. The outcome of the fire can be very sensitive to the fire modeled as specified from these values. The ignition delay, mass loss rates, and species yields used for the fire specification can all affect the predicted results. Keeping a record by printing the results or copying down the results from the **VIEW** screen will allow you to study the effects of changes in future simulations.

MLTFUEL Version 2.0

Average Heat of Combustion = 27950

Time	MDot	H/C	CO/CO2	C/CO2	HCN	HCL	Ct
0	0.0000		0.0000	0.0000			
5	0.0042		0.0000	0.0000			
150	0.0042		0.0000	0.0000			
220	0.0220		0.2344	0.0500			
250	0.0506		0.1339	0.0311			
290	0.0506		0.1339	0.0311			
340	0.0131		0.0159	0.0000			
350	0.0256		0.0312	0.0000			
490	0.0131		0.0633	0.0000			
1320	0.0059		0.0000	0.0000			

Press esc to return to previous menu.

If the list is longer than can be viewed within the window, it can be scrolled by pressing the **Page Up**, **Page Down**, or arrow keys. The complete list will be automatically printed, along with the input data, as shown on the next page for the present example.

MLTFUEL Version 2.0

Composite Fuel

Item 1 : Cooking Oil
Item 2 : Kitchen Cabinets
Number of time intervals: 9

Average Heat of Combustion = 27950

Time	MDot	H/C	CO/CO2	C/CO2	HCN	HCL	Ct
0	0.0000		0.0000	0.0000			
5	0.0042		0.0000	0.0000			
150	0.0042		0.0000	0.0000			
220	0.0220		0.2344	0.0500			
250	0.0506		0.1344	0.0311			
290	0.0506		0.1344	0.0311			
340	0.0131		0.0159	0.0000			
350	0.0256		0.0312	0.0000			
490	0.0131		0.0633	0.0000			
1320	0.0059		0.0000	0.0000			

Individual Items

Item 1 : Cooking Oil

Heat of Combustion = 40000

Time	Mdot	H	CO	CO2	C	HCN	HCL	Ct
0	0.0000							
5	0.0029							

Item 2 : Kitchen Cabinets

Heat of Combustion = 15900

Time	Mdot	H	CO	CO2	C	HCN	HCL	Ct
150	0.0000		0.0000	0.0000	0.0000			
220	0.0314		0.0750	0.3200	0.0160			
250	0.0817		0.0820	0.6100	0.0190			
290	0.0817		0.0820	0.6100	0.0190			
340	0.0157		0.0240	1.5100	0.0000			
350	0.0377		0.0290	0.9300	0.0000			
490	0.0157		0.0380	0.6000	0.0000			
1320	0.0031		0.0000	0.7900	0.0000			

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3.5.3 FAST_in

Since we learned how to use FAST_in in the previous chapter, we will move quickly through this step. Start FAST_in and select SCEN-2.DAT from the files list. Set the **DUMP INTERVAL** and **DISPLAY INTERVAL** on the **Overview** screen to **60** seconds each, to update the dump file and run-time graphics every minute. For this 1500 s simulation, this will result in 25 display intervals. (The maximum number of display intervals allowed is 50.) Now use the **Navigation window** (f1) to jump to the **Fire Specification** screen and see how the data which we just obtained with MLTFUEL was entered into the file. **Page Down** to the **Calculate** screen. Now set the dump file name to **SCEN-2.DMP**, turn on the **Run time graphics** (f6), and save the file (f7) to the existing file name. **Quit** FAST_in with f10.

3.5.4 FAST

Without changing the default input and output filenames (SCEN-2.DAT and SCEN-2.FST) respectively, begin the simulation run. The time required to complete the run will vary greatly with the type of PC on which it is run. The range is about an hour on a 386 machine, to 20 hours on an 4.7 MHz 8086 PC. With the run time graphics turned on, you will be able to follow the results by the graphic presentation. When FAST finishes, the screen will clear and you will press **esc** to return to the HIS.

3.5.5 FASTplot

The dump file created by FAST is unique, and can only be read by modules of HAZARD I. FASTplot is an interface to these files, allowing you to select variables of interest from the large number predicted by FAST (as many as 450 separate variables can be

predicted). Once the items of interest have been **ADDED** to a working list, they can be **PLOT**ted, **LIST**ed to the screen, printer, or a file in any of several formats.

In this section, we will demonstrate some of the basic plotting operations using FASTplot. Refer to the chapter 4 of this guide for instructions on the more advanced features. Begin FASTplot from the HIS by selecting it from the third menu.

Before data can be presented with FASTplot, the data must first be read from the FAST dump file created in the last section. Two steps are necessary to achieve this end. Select a dump file by typing

FILE SCEN-2.DMP

and pressing **enter**. FASTplot responds by identifying the file as a FAST dump file.

The **ADD** command is used to select variables from the file to be added to the working list of variables which can be displayed by FASTplot. Begin by **ADD**ing upper layer temperature in each room to the working list by typing

ADD TE,TE,TE,TE,TE,TE

and pressing **enter**. The abbreviation **TE** is used for layer temperature. For each room in the simulation (six plus the outdoors in this example), you are prompted for a room number and a layer (Upper or Lower). Once all the variables have been **ADDED** to the working list, pressing **enter** once again begins the read of the variables from the FAST dump file. Many other variables can be added in this manner. To see a the possible variables which can be added, type **VAR** followed by an **enter** to see the list.

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```
FASTplot Version 3.6.4, 05 Dec 1988
Command > FILE SCEN-2.DMP

Fast V18.3 Created 8/31/88, Run 12/8/88

Command > ADD TE,TE,TE,TE,TE,TE
What compartment number (1 ... 7) for Temperature 1
And which layer U
Variable matched to Temperature in compartment 1, layer=U

What compartment number (1 ... 7) for Temperature 2
And which layer U
Variable matched to Temperature in compartment 2, layer=U

What compartment number (1 ... 7) for Temperature 3
And which layer U
Variable matched to Temperature in compartment 3, layer=U

What compartment number (1 ... 7) for Temperature 4
And which layer U
Variable matched to Temperature in compartment 4, layer=U

What compartment number (1 ... 7) for Temperature 5
And which layer U
Variable matched to Temperature in compartment 5, layer=U

What compartment number (1 ... 7) for Temperature 6
And which layer U
Variable matched to Temperature in compartment 6, layer=U

Enter variable(s) to add to the list:
<ENTER> To initiate read

Now reading in the data values.....
The largest possible step is 26
```

Add interface height to the working list for each room using the keyword INTE in the same manner as was done above to add the temperature variables. Since interface height is layer independent, you will be prompted only for a room number for each variable.

Once the working list has been established, the variables in the list may be displayed as a list or as a graph. To display as a graph, the PLOT command is used

Command > VAR

Here are the possible variables for processing:

vent flow	Vent	kg/s
vent entrainment	Jet	kg/s
radiation field to a target	Target	W/m**2
heat release in flame out a vent	Vfire	kW
heat release rate of the fire	Heat release	kW
total radiative heat flux into the layer	Radiation	W
total convective heat flux into the layer	Convection	W
pyrolysis rate of the fuel	Pyrolysis	kg/s
mass flux from the plume into the upper layer	Plume	kg/s
entrained mass flow in the plume	Entrain	kg/s
hcl wall surface concentration	Hcl	
pressure	Pressure	Pa
heat release in lower layer	Lplume	kW
heat release in upper layer	Uplume	kW
wall surface temperature	Wall	C
layer temperature	Temperature	C
volume of the upper layer	Volume	m**3
layer mass density	Mass	kg/m**3
species density	Species	as appro.
layer height	Interface	m

Command > PLOT

The present list is as follows:

#	Variable	Comp	Lay	Spec	File
1	Temperature	1	U		SCEN-2.DMP
2	Temperature	2	U		"
3	Temperature	3	U		"
4	Temperature	4	U		"
5	Temperature	5	U		"
6	Temperature	6	U		"
7	Interface	1	U		"
8	Interface	2	U		"
9	Interface	3	U		"
10	Interface	4	U		"
11	Interface	5	U		"
12	Interface	6	U		"

Select 1->4 graphs by grouping variables
with parentheses followed by <RETURN> (1 2 3 4 5 6)

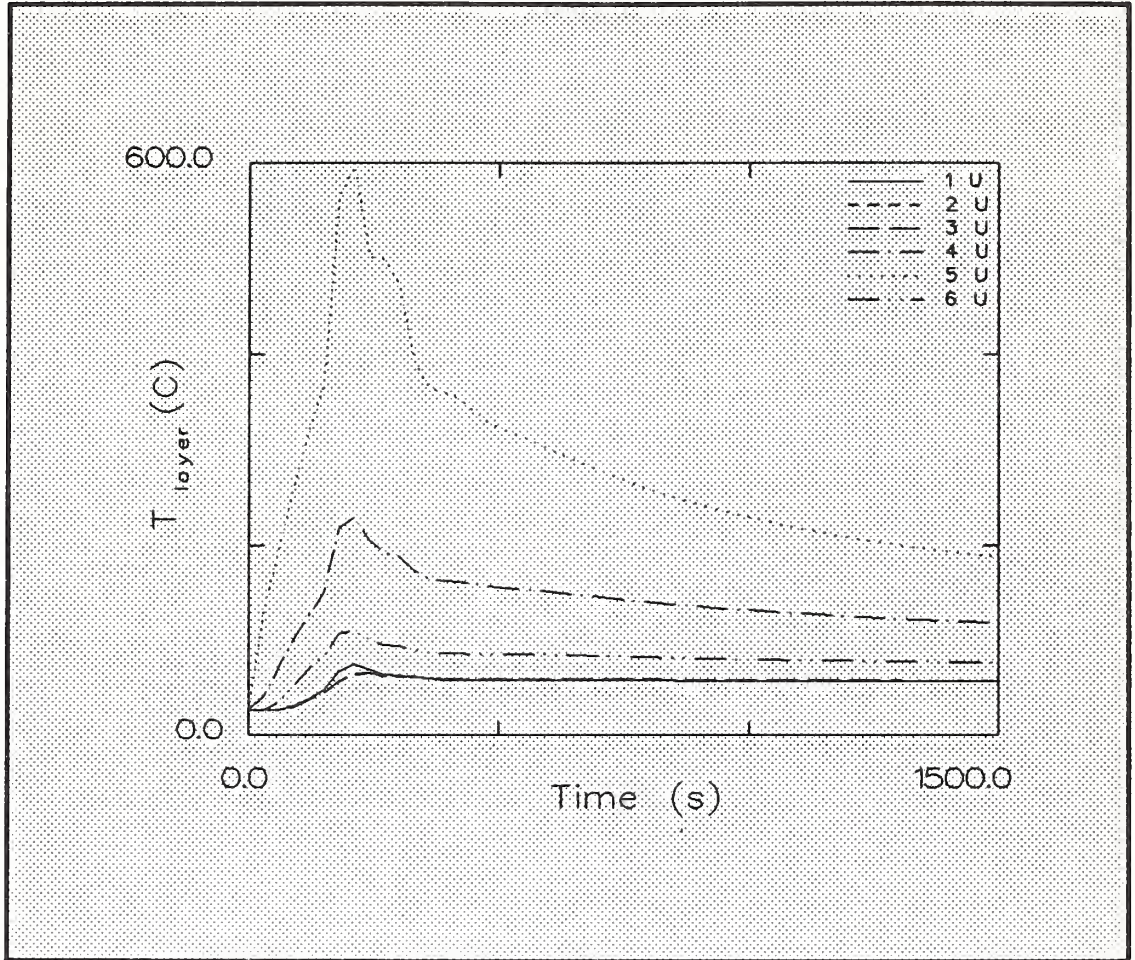
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Once a list of the variables on the working list is displayed, the variables to be plotted are selected by grouping variable numbers from the left hand column of the list in up to four parenthetical groups to producing up to four graphs on a single screen. For now, let's just display all of the upper layer temperatures on a single graph by entering

(1 2 3 4 5 6)

at the prompt. The resulting graph is displayed on the screen and shown on the next page. Press **enter** once you have examined the graph to return to the FASTplot command prompt.

For certain printers, a utility program called METAPRNT is provided which allows you to print copies of the graph on the screen. Details of the use of the utility is provided in the FASTplot section of chapter 4 in this Software User's Guide.



To view the variables as a table of number, the **LIST** command is used. A table of up to five columns can be produced. After typing **LIST**, you will be presented with a list of the variables and prompted for the variables to be **LISTed** and the beginning and ending times to be listed. Just like the **PLOT** command, enter the variable numbers such as

1 2 7 8

to list upper layer temperatures and interface heights in rooms 1 and 2 in the example. Beginning and ending times are specified as time steps. Each time step corresponds to the interval between successive

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data points in the FAST dump file. To list the first 20 time steps, enter 0 20 at the prompt. Finally, the END command is used to exit FASTplot and return to the HIS.

Command > LIST
The present list is as follows:
Variable Comp Lay Spec File

1 Temperature 1 U SCEN-2.DMP
2 Temperature 2 U "
3 Temperature 3 U "
4 Temperature 4 U "
5 Temperature 5 U "
6 Temperature 6 U "
7 Interface 1 U "
8 Interface 2 U "
9 Interface 3 U "
10 Interface 4 U "
11 Interface 5 U "
12 Interface 6 U "

The maximum number of variables allowed is 5.
List the variables for output 1 2 7 8
Time steps go from 0 to 25
Enter time interval desired (<ENTER> for entire duration) 0 9

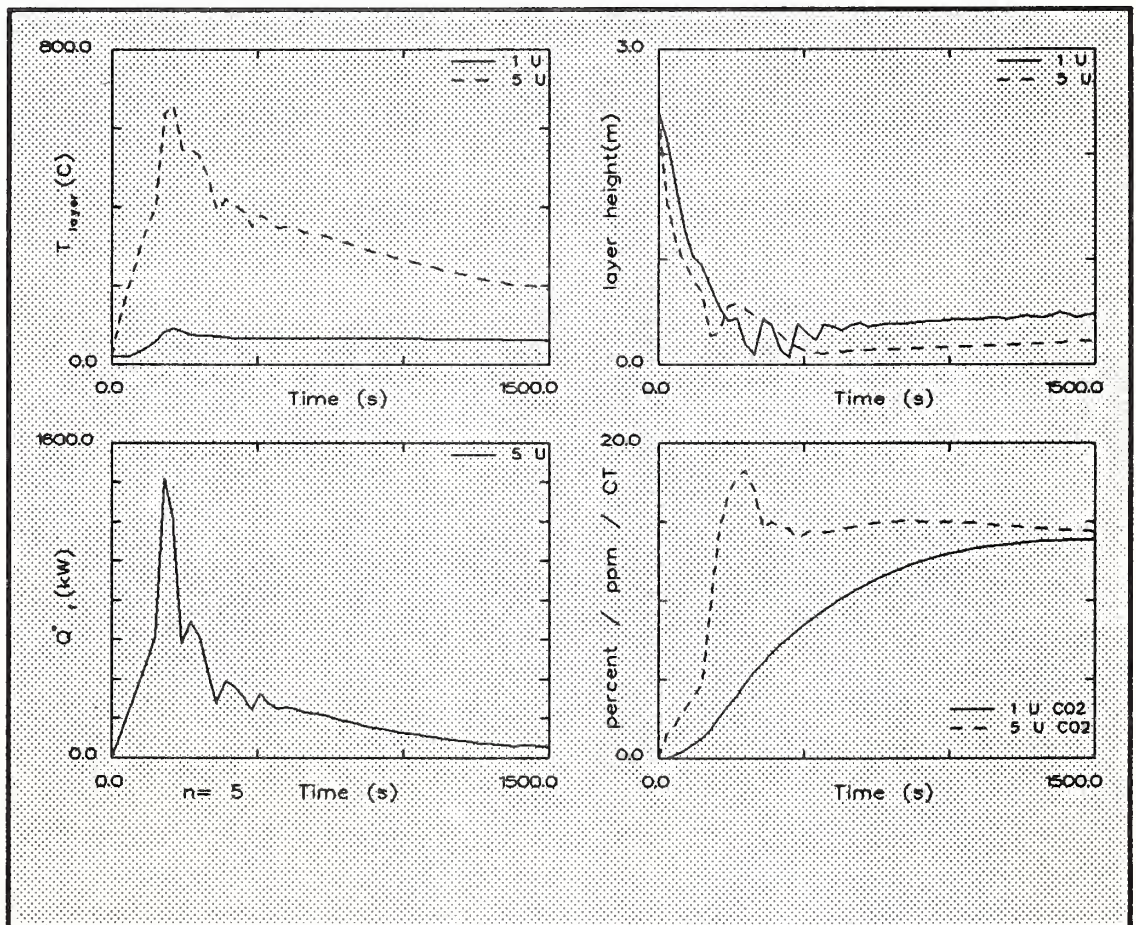
Time (s) Temperature Temperature Interface Interface
L,S,F->T U, 0,0->0 U, 0,0->0 U, 0,0->0 U, 0,0->0
0. 27.0 27.0 2.40 2.40
60. 27.1 27.1 1.69 2.39
120. 39.5 38.1 1.05 1.49
180. 68.5 57.2 0.838 0.471
240. 70.7 65.9 0.433 0.204
300. 63.7 62.8 0.172 3.424E-02
360. 60.7 60.7 0.378 8.491E-03
420. 59.4 59.8 0.227 8.679E-03
480. 59.4 59.7 0.307 1.023E-02
540. 59.2 59.7 0.364 9.739E-03

Command > END

As a final example, we will create a four-graph display. Begin FASTplot anew from the HIS and select the file SCEN-2.DMP. Add seven variables to the working list as follows

Upper layer TEMperature in room 1
 Upper layer TEMperature in room 5
 INTERface height in room 1
 INTERface height in room 5
 HEAT release rate in the upper layer in room 5
 The SPECies CO₂ in the upper layer in room 1
 The SPECies CO₂ in the upper layer in room 5

Generate the plot with the PLOT command by placing the variables in four groups with the plot specified as (1 2)(3 4)(5 6 7). The graph produced are shown below. Return to the HIS with END.



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3.5.6 EXITT

EXITT is used to provide estimates of building evacuation times. Two DOS files provide the necessary inputs to EXITT. The first, a FAST dump file, was produced above by the FAST model execution in section 3.6. The second describes the building and occupants and is created by the user using an ASCII text editor such as the one built into the HIS. The details of creating the file which contains the node map of the building and the description of the occupant set is left to chapter 4. To create the file, the movement paths through the building are defined as a series of nodes (a node is a room, a location in a room, a door, or a window) connected by a series of paths which define the allowable movements throughout the building (and thus the distances between adjacent nodes). For this example, we will use the supplied example file for the test case, the DOS file SCEN-2.BLD. All of the building and occupant descriptions are detailed in the *Examples Cases* volume.

Begin EXITT by selecting it from the HIS. You will be presented with at least five prompts: two (or more) prompts for FAST dump files (FAST can generate multiple dump files for a single fire by using the RESTRT option as described in chapter 4), one prompt for the Building / Occupant file, one prompt for the printed output from EXITT, and one prompt for the EXITT dump file (which automatically passes the results of the EXITT run to TENAB for tenability analysis). The responses for the five prompts are shown below.

FAST dump file 1:	SCEN-2.DMP
FAST dump file 2:	just press enter
Building/Occupant file:	SCEN-2.BLD
EXITT output file:	SCEN-2.EXT
EXITT dump file:	SCEN-2.EVA

EXITT Version: 18.1 - Creation Date: 2/09/89 - Run Date: 4/01/89

The set of FAST dump files in the current directory are:
SCEN-1.DMP SCEN-2.DMP SCEN-3.DMP SCEN-4.DMP SCEN-5.DMP
SCEN-6.DMP SCEN-7.DMP SCEN-8.DMP

Enter the FAST dump file name - Hit RETURN when no more FAST files
To CANCEL enter:/CANCEL SCEN-2.DMP

The set of FAST dump files in the current directory are:
SCEN-1.DMP SCEN-2.DMP SCEN-3.DMP SCEN-4.DMP SCEN-5.DMP
SCEN-6.DMP SCEN-7.DMP SCEN-8.DMP

Enter the FAST dump file name - Hit RETURN when no more FAST files
To CANCEL enter:/CANCEL

The set of BUILDING-OCCUPANT files in the current directory are:
SCEN-1.BLD SCEN-2.BLD SCEN-3.BLD SCEN-4.BLD SCEN-5.BLD
SCEN-6.BLD SCEN-7.BLD SCEN-8.BLD

Enter the BUILDING file name
To CANCEL enter:/CANCEL SCEN-2.BLD

Enter the EXITT output file name
To CANCEL enter:/CANCEL SCEN-2.EXT

Enter the EXITT dump file name
To CANCEL enter:/CANCEL SCEN-2.EVA

Simulation completed

Return to the HIS by pressing **esc**. The results of the EXITT simulation are written to the file SCEN-2.EXT. This file may be viewed by pressing the **VIEW** key, **f7** and entering the name of the file, SCEN-2.EXT. Use the **Page Up** and **Page Down** keys to browse through the file to examine the results of the simulation.

3.5.7 TENAB

TENAB follows a person's escape route through a building as determined by EXITT, and for each occupant, determines several tenability measures based upon the person's exposure to hazardous

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conditions. TENAB requires two input files and creates two output files. The first, a FAST dump file, was produced above by the FAST model execution in section 3.6. The second, an EXITT dump file was produced by the EXITT model execution in section 3.8.

Begin TENAB by selecting it from the HIS. You will be presented with five prompts: two prompts for FAST dump files (since FAST can generate multiple dump files to represent a single fire with the RESTRT option), one prompt for the EXITT dump file, one prompt for the printed output from TENAB, and one prompt for the TENAB dump file (which automatically passes the results of the TENAB run to FASTplot for display). The responses for the five prompts are shown below and on the screen on the next page.

FAST dump file 1:	SCEN-2.DMP
FAST dump file 2:	just press enter
EXITT dump file:	SCEN-2.EVA
TENAB output file:	SCEN-2.TEN
TENAB dump file:	SCEN-2.PLT

Return to the HIS by pressing **esc**. The results of the TENAB simulation are written to the file SCEN-2.TEN. This file may be viewed by pressing the **VIEW** key (**f7**) and entering the name of the file, SCEN-2.TEN. Use the **Page Up** and **Page Down** keys to browse through the file to examine the results of the simulation. The file may be printed by pressing the **PRNT** key, **f8**.

TENAB Version: 18.1 - Creation Date: 2/09/89 - Run Date: 4/01/89

The set of FAST dump files in the current directory are:
SCEN-1.DMP SCEN-2.DMP SCEN-3.DMP SCEN-4.DMP SCEN-5.DMP
SCEN-6.DMP SCEN-7.DMP SCEN-8.DMP

Enter the FAST dump file name - Hit RETURN when no more FAST files
To CANCEL enter:/CANCEL SCEN-2.DMP

The set of FAST dump files in the current directory are:
SCEN-1.DMP SCEN-2.DMP SCEN-3.DMP SCEN-4.DMP SCEN-5.DMP
SCEN-6.DMP SCEN-7.DMP SCEN-8.DMP

Enter the FAST dump file name - Hit RETURN when no more FAST files
To CANCEL enter:/CANCEL

The set of EXITT dump files in the current directory are:
SCEN-1.EVA SCEN-2.EVA SCEN-3.EVA SCEN-4.EVA SCEN-5.EVA
SCEN-6.EVA SCEN-7.EVA SCEN-8.EVA

Enter the EXITT dump file name created by EXITT - If none hit RETURN
To CANCEL enter:/CANCEL SCEN-2.EVA

Enter the TENAB output file name
To CANCEL enter:/CANCEL SCEN-2.TEN

Enter the TENAB dump file name
To CANCEL enter:/CANCEL SCEN-2.PLT

TENAB output being written to file: SCEN-2.TEN

TENAB dump file being written to file: SCEN-2.PLT

3.6 Evaluating the Consequences

Once the consequences of the specified scenario have been calculated, the user must interpret the results. This is the last step in the overall process. Depending on the application, the user typically will run additional cases/scenarios and compare results. For example, calculated consequences may be compared with previously worked or representative cases. Alternatively, the user may run scenarios with and without the product in question to quantify the difference in consequences/loss. Finally, variations in product properties may be assessed in successive calculations.

For the present example, the approach used is to run scenarios with and without the new product. Therefore, we now go back to MLTFUEL to reduce the pyrolysis rate of the cabinets by half (remember to recalculate the yield ratios as the results will change). Then enter the new data into FAST_in (on the **Fire Specification** screen), append the graphics file (f6 on the **Calculate** screen) and save the modified file with a new name (we used SCEN-2M for Modified).

Repeating each step followed in the original scenario will produce the same final result, that the occupants successfully escape. A better (and more general) way to evaluate the differences in the products is to compare the time to hazards for each room (this is discussed in the **Technical Reference Guide**). This is done by manual input of EXITT data into TENAB as described in chapter 4 and shown on the next two pages. When asked for an EXITT dump file, enter **con** and you will be prompted for the data after all of the file names have been entered. The number of nodes is 6 (one for each room). The next six lines are of the form 1,1,0,0; 2,2,0,0; etc. (for person 1, in room 1, at time 0, standing at height 0). Just press enter to indicate the end of data input.

Enter the EXITT dump file name
To CANCEL enter:/CANCEL con

Enter the TENAB output file name
To CANCEL enter:/CANCEL SCEN-2M.TEN

Enter the TENAB dump file name
To CANCEL enter:/CANCEL SCEN-2M.PLT

Enter the number of nodes (including doors and windows)
FAST was run with 6 rooms 6

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key
1 1 0 0

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key
2 2 0 0

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key
3 3 0 0

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key
4 4 0 0

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key
5 5 0 0

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key
6 6 0 0

Enter occupant no, node no, time (sec), floor elevation of node
When done just press the enter key

The number of room run with FAST is 6
The outside is considered "room" 7 by FAST
At a window is considered "room" 8 by FAST
The number of nodes run with EXITT is 6

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Please enter the FAST room number associated with each EXITT node

FAST room number associated with EXITT node number	1	1
FAST room number associated with EXITT node number	2	2
FAST room number associated with EXITT node number	3	3
FAST room number associated with EXITT node number	4	4
FAST room number associated with EXITT node number	5	5
FAST room number associated with EXITT node number	6	6

Incapacitation Critical Values:

- | | |
|-------------------------------------|-------------------|
| 1. FED(CO,CO2,O2,HCN,HAZ I BETA)... | 0.50 |
| 2. FED(CO,CO2,O2,HCN,PURSER)..... | 1.00 |
| 3. FED(CO2,PURSER)..... | 1.00 |
| 4. TEMP(AVERAGE, HAZ I BETA)..... | 65.00 (DEG C) |
| 5. FED(TEMPERATURE,PURSER)..... | 1.00 |
| 6. CT(HAZ I BETA) | 450.00 (G-MIN/M3) |

Lethality Critical Values:

- | | |
|-------------------------------------|-------------------|
| 7. FED(CO,CO2,O2,HCN,HAZ I BETA)... | 1.00 |
| 8. TEMP(AVERAGE, HAZ I BETA)..... | 100.00 (DEG C) |
| 9. CT(HAZ I BETA) | 900.00 (G-MIN/M3) |

To change a value, select an option and its new value
When done just press ENTER

TENAB output being written to file: SCEN-2M.TEN

TENAB dump file being written to file: SCEN-2M.PLT

Performing this analysis on both example case runs (FAST dump files SCEN-2.DMP and SCEN-2M.DMP) reveals that the cabinets constructed of the new core material delay the onset of hazardous conditions by about 30 seconds (out of about 3 minutes) for most rooms and criteria, both thermal and toxicity. Thus for this example, the trade-off of increased toxic potency (additional HCN release) for reduced burning rate (by half) was a good one. By examining the cost differential of the two cabinet constructions, a cost-benefit ratio is obtained. Finally, you may decide to examine the sensitivity of these results to variations in some parameters or assumptions as a test of validity.

CHAPTER 4. REFERENCE

Each of the eight programs which make up HAZARD I may be executed from the main program shell or as a stand alone program. Instructions for the use of each module are provided below with the instructions for the use of the programs divided by each major function of the program (entering data or calculating results, for instance).

4.1 HAZARD I Interface Shell

The HAZARD I Interface Shell (HIS) provides an interactive, user-friendly method to access all of the modules of HAZARD I. To begin operation of the HIS, just enter

HAZARD

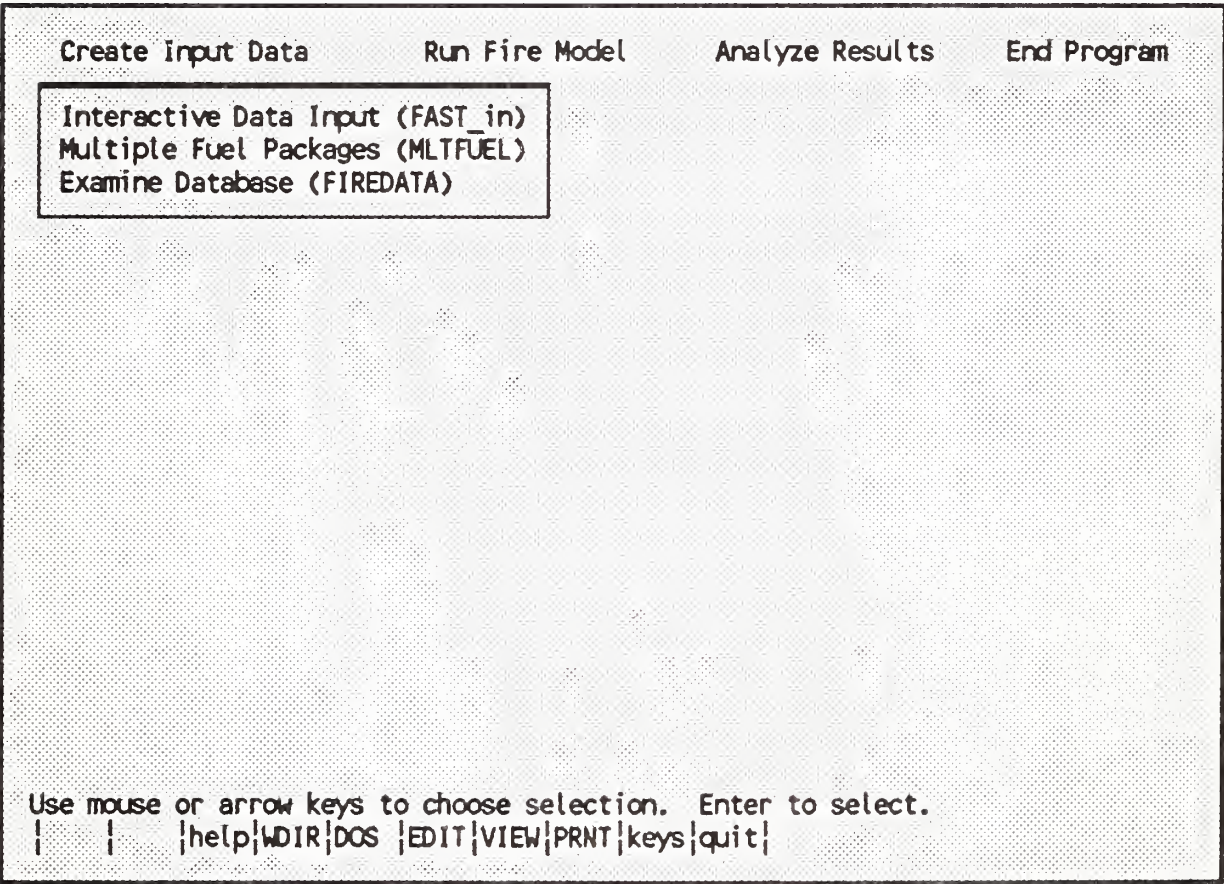
followed by an enter at the DOS prompt.

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4.1.1 Running a HAZARD I Module

Operation of the HIS revolves around several pulldown menus which list the major functions of HAZARD I:

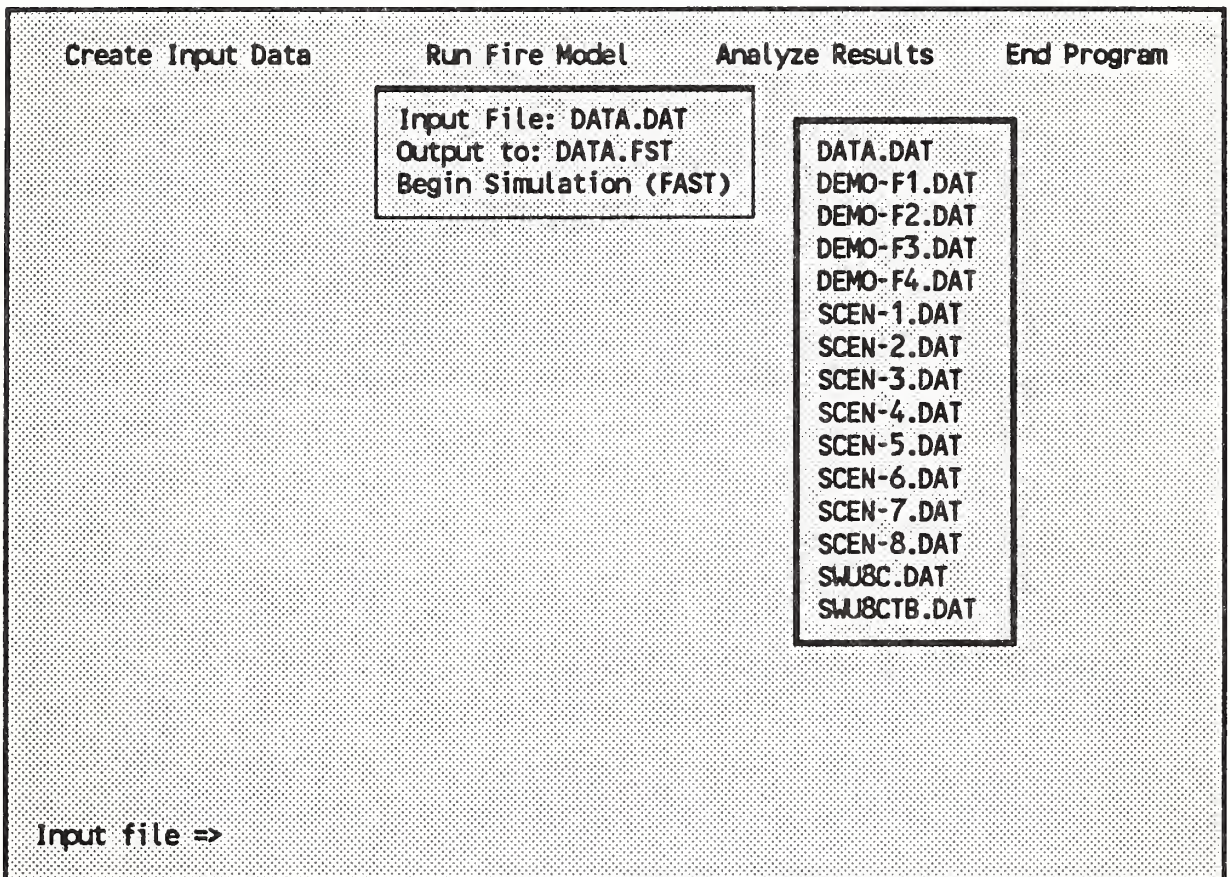
- **Create Input Data** (FAST_in, MLTFUEL, and FIREDATA modules)
- **Run Fire Model** (FAST module)
- **Analyze Results** (FASTplot, DETACT, EXITT, and TENAB modules)
- **End**



The HIS allows the user to select any of the modules of HAZARD I by using the arrow keys or the mouse cursor to position the highlighted selection bar over the desired module. Pressing an **enter**

or clicking the left mouse button begins operation of the desired module.

Two additional operations under the Run Fire Model pulldown menu allow the user to define the input file and destination of the printed output for the FAST model.



When **Input file** is selected, the user is presented with a pop-up menu of all of the input files for the FAST model (those with the default extension of **DAT**). At this point, the user may highlight one of the files in the list with the cursor keys or the mouse and select the file with the enter key or the left mouse button. Alternatively, the name of any existing DOS file may be entered by typing in the name of the file.

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NOTE: Any valid existing DOS file may be selected. It is up to the user to insure the file selected is in the proper format to be used as an input file for the FAST model. Use of the default extensions suggested above will minimize potential problems in file selection.

Once a valid filename has been entered, the name of the file will appear in the menu list. In addition, the name of the **Output to** menu selection will be changed to the name of the input file with the default extension **FST**.

The screenshot displays the 'Run Fire Model' menu selection. At the top, there are four menu items: 'Create Input Data', 'Run Fire Model', 'Analyze Results', and 'End Program'. Below 'Run Fire Model', there is a box containing the text: 'Input File: DATA.DAT', 'Output to: DATA.FST', and 'Begin Simulation (FAST)'. To the right of this box, there is another box containing the text: 'Screen', 'PRN', 'LPT1', 'LPT2', 'LPT3', and 'NUL'. At the bottom left, there is a label 'Output file =>'.

Usually, the printed output from the FAST model will be placed in a disk file with the same name as the input file but with the default extension of **FST**. The **Output to** menu selection allows the user to specify a different location for the output. Since the **Input file** menu selection changes the **Output to** destination, **Output to**

should be selected after the input file has been specified. Once again, the user is presented with a list of possibilities for the output. At this point, the user may highlight one of the devices in the list with the cursor keys or the mouse and select the file with the enter key or the left mouse button. Alternatively, the name of any DOS file may be entered by typing in the name of the file. IF **Screen** is specified, the user should insure that the FAST input file does not contain any graphics specifications or the text will overwrite the graphics and unpredictable output will result. IF a printer device is selected (such as PRN, LPT1, or LPT2), the user **MUST** insure the printer is online and working as HAZARD I does not check and an attempt to print to a nonexisting or offline printer will lock up the machine. If NUL is selected, no output will be generated. If a file name is entered from the keyboard, care should be exercised to avoid overwriting an existing file with the output from the FAST model. Use of the default extensions suggested above will minimize potential problems in file selection.

4.1.2 Utility Functions

The HIS has several built-in utility functions which allow the user to view a file, change a file, or leave the HIS temporarily to execute DOS commands. All of the utility commands are accessed from the functions keys **f1** to **f10** with the following assignments:

- f3 help** for each of the modules in the HIS, pressing **f3** will provide the user with a short description of the function of the module.
- f4 WDIR** temporarily change the working data directory used by the HAZARD I software for the storage of data files. As detailed in section 3.1.2 of this **Software User's Guide**, the user may organize work in multiple subdirectories on disk. This function key allows the user to change to another data subdirec-

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tory while in a single HAZARD I session by entering an already created data subdirectory. To create or permanently change the data subdirectory, see section 2.2.4.

- f5 DOS** exit temporarily to DOS. The user may enter any DOS commands. When ready to return to HAZARD I, simply type

EXIT

and **enter** at the DOS prompt.

- f6 EDIT** any file up to 500 lines in length may be edited from within the HIS. Press **f6** and enter the name of the file to be edited. If the file does not exist, a new file will be created. Once all desired changes to the file have been made, press **esc** to exit the editor. If the file exists, you will then be asked if the file is to be replaced (whether you have made any changes or not). Answering **Y** followed by **enter** to replace the file with the new version or **N** followed by **enter** to discard any changes made.

The editor features on-line help (by pressing **f3**), both horizontal and vertical scrolling, as well as block operations for insert, delete, and copy. All of the standard editing keys are supported. For example, **Home** and **End** move to the beginning and end of the line, the **PgUp** and **PgDn** keys scroll the screen by pages, and **Ctrl-PgUp** and **Ctrl-PgDn** move to the first and last lines, respectively. The cursor may also be moved to the top or bottom of the edit window with the **Ctrl-Home** and **Ctrl-End** keys. The **Ctrl-Left** and **Ctrl-Right** arrow keys are used to move the cursor by words, and blocks are marked with any

of the Shifted Arrow keys. Notice that blocks may also be marked using a combination of the Shift AND Ctrl arrows to jump by whole words.

Beyond the usual block operations, however, the editor also supports block operations on COLUMNS. To mark a block in sentence mode, place the cursor at the beginning of the block and press the **Shift-Right** arrow key. The marked block will be highlighted as the cursor travels over the text. Alternately, entire lines may be marked by placing the cursor at the desired starting point and pressing the **Shift-Down** arrow key. To mark a column, place the cursor at the upper left corner of the block and press the **Shift-Right** arrow key until the highlight extends to the desired right edge. Then, press **Shift-Down** until the bottom of the block has been reached. Regardless of which marking mode is used, the block will be captured as soon as any non-marking key has been pressed. If either **Del** or **Shift-Del** is pressed, the block will first be captured and then deleted. To paste the block from the buffer into the text at the current cursor location, simply press **Shift-Ins**.

- f7 VIEW** any file may be viewed from within the HIS. Press **f7** and enter the name of the file to be viewed. The arrow keys and the **Page Up** or **Page Down** keys can be used to move about the file. Pressing **esc** returns you to the HIS.
- f8 PRNT** any file may be printed from within the HIS if a printer is connected to the computer. Press **f8** and enter the name of the file to be printed.

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- f9 keys** pressing **f9** provides a pop-up screen with short definitions of the various function keys used within the HIS.
- f10 quit** pressing **f10** exits the HIS and returns to DOS. Functionally, it is equivalent to selecting the end menu bar selection.

4.2 DETACT

DETECT is a program to predict the response of thermal detectors to fires of arbitrary heat release rate. To use DETECT, select it from the shell or type

DETECT

and press **enter** at the DOS prompt. It is an interactive program where the user answers questions to input the data, and the results are presented in tabular form. Any user familiar with the calculation procedure described in Appendix C of ANSI/NFPA 72E should have no problem with this program as the procedures are similar. The questions asked are as follows:

1. HEIGHT OF CEILING ABOVE FUEL (METERS) - This is not the floor to ceiling height, but rather the distance from the top surface of the burning object to the ceiling.
2. DISTANCE OF DETECTOR FROM AXIS OF FIRE (METERS) - This is the radial distance to the detector from a point directly above the fire.
3. INITIAL ROOM TEMPERATURE (CELSIUS) - The room ambient temperature.

4. DETECTOR ACTIVATION TEMPERATURE (CELSIUS) - The temperature rating of the device. The activating of a smoke detector can be estimated by using an activation temperature of 13 °C above the initial room temperature value entered above.
5. DETECTOR RESPONSE TIME INDEX (RTI) - For sprinklers, this is now often given in the manufacturer's catalog. For fixed-temperature heat detectors, table 4-1 gives RTI values corresponding to UL spacings. For rate-of-rise detectors, table 4-2 gives RTI values for three rate-of-rise settings (NOTE: 15 °F/min is typical for U.S. commercial devices).
6. RATE OF HEAT RELEASE - The rate of heat release of the fire (which can be obtained from the FAST run with FASTplot by LISTing the variable HEAT) is entered one point at a time by answering the questions TIME (SEC) and HEAT RELEASE RATE (kw) starting with time=0. When the last desired point is entered, the user enters a -1 value for time, which stops the request for data. The results are then sent to the printer (or the screen if the user answers the question SEND OUTPUT TO PRINTER? with a N) in tabular form.

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Table 4-1. RTI values for fixed-temperature heat detectors

UL Listed Spacing	UL Listed Activation Temperature						All FM Listed Temps.
(ft/m)	128°F (53°C)	135°F (57°C)	145°F (63°C)	160°F (71°C)	170°F (77°C)	196°F (91°C)	
10/3.1	894/494	738/408	586/324	436/241	358/198	217/120	436/241
15/4.6	559/309	425/235	349/193	246/136	199/110	101/56	246/136
20/6.1	369/204	302/167	235/130	157/87	116/64	38/21	157/87
25/7.6	277/153	224/124	174/96	107/59	72/40	---	107/59
30/9.2	212/117	179/99	136/75	81/45	49/27	---	81/45
40/12.2	159/88	128/71	92/51	40/22	---	---	---
50/15.3	132/73	98/54	67/37	---	---	---	---
70/21.4	81/45	54/30	20/11	---	---	---	---
NOTE: These RTI's are based on an analysis of the Underwriters Laboratories (UL) and Factory Mutual (FM) listing test procedures. Plunge test results on the detector to be used will give a more accurate response time index.							
RTIs are shown in (ft•s) ^{1/2} /(m•s) ^{1/2} . Since the original work was in english units, the SI units are approximate.							

Table 4-2. RTI values for rate-of-rise heat detectors

Listed Spacing	UL Listed Activation Rate of Temp. Rise		
(ft/m)	15°F/min 8°C/min	20°F/min 11°C/min	25°F/min 14°C/min
10/3.1	1834/1013	1308/722	984/543
12.5/3.8	1453/802	1073/593	805/445
15/4.6	1185/654	872/482	637/352
20/6.1	872/482	581/321	425/235
30/9.2	559/309	380/210	280/155
40/12.2	447/247	291/161	206/114
50/15.3	425/235	246/136	161/89
RTIs are shown in (ft•s) ^{1/2} /(m•s) ^{1/2} . Since the original work was in english units, the SI units are approximate.			

4.3 EXITT

EXITT (version 18) is a deterministic model for simulating how people egress a building in which there is a fire. EXITT (version 18) is written in FORTRAN and is a translation of the EXITT BASIC version. It is designed to be used with a dump file from a run of FAST and provide an input file for TENAB (version 18). EXITT requires 2 input files and produces 2 output files.

To use EXITT, select it from the shell or type

EXITT

and press **enter** at the DOS prompt. To run the model, the user types appropriate file names as prompted. The user will be prompted for the names of the FAST dump file, a building-occupant set file, a user's output file, and an EXITT dump file.

4.3.1 Input from FAST

The first prompt will be for the name of the FAST dump file to be used. The user may select a test case dump file or any FAST dump file he has created. In the event that the file does not exist or the name is invalid, the user will be informed and asked to reenter the dump file name. After entering a valid file name, the user will again be prompted for a FAST dump file. If additional FAST dump files are to be used (if the FAST restart facility is used to generate multiple dump files as explained in the section on FAST in this chapter) the user enters them one at a time. When there are no more FAST dump file names to enter, the user should press the return key. If the user desires to cancel the run when prompted for a file name, a / may be entered. In the case a file specified for the FAST dump file is not a FAST dump file, the error will only be

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realized when the program attempts to read the file. When a FAST dump file is recognized as "bad," the user will be informed that the file is not a FAST dump file and the run will be stopped.

4.3.2 Input from a Building-Occupant File

The second prompt will be for the name of the file describing the building and its occupants. Examples of building-occupant files are included for each example case in the **Example Cases** volume along with a layout of the buildings used to create each file. As above the user may enter the name of a test case building-occupant file or that of a building-occupant file created by the user. If the file does not exist or the name is invalid, the user will be informed and asked to reenter the file name. If the user wishes to cancel the run at this time he may enter a /.

4.3.3 Format for a Building-Occupant File

Using a text editor the user may create his own building-occupant file. The building file contains eight sections. A sample building file is shown on the next page. It should be noted that all of the input in a building file is in "free format." That is, the placement of the input numbers in a particular format on a line or on a particular line is arbitrary as is used in the examples below for clarity. In actuality, if a particular input requires 10 numbers, the next 10 numbers in the input file will be used. In practice, this makes for easier input without the worry of placing inputs in a particular column of an input line. However, note that a missing input number on one line may lead to errors on all the following inputs.

The first section consists of a line containing two integers. The first integer indicates the number of rooms associated with the FAST dump file (which will be between 1 and 6) and the second integer represents the number of nodes (a node is a room, a location within

a room, a door or a window) in the EXITT floor plan. The maximum number of nodes allowed is 100. In the sample building file the first section is the line

6 15

indicating the associated FAST dump file was run with 6 rooms and that EXITT is run with 15 nodes.

6 15
1 2 3 4 5 6 8 7 4 3 2 2 2 2 2
1 2 3 4 5 6 4 4 4 3 2 2 2 2 2
2.4 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.1 2.3 2.3 2.3 2.3 2.3 2.3
0. 0. 0. 0. 0. 0. 0. 0. .2 0. 0. 0. 0. 0. 0.
35 35 35 35 35 35 35 35 35 35 35 35 35 35 35
1
-1.
2
83 95 83 83 83 83 83 83 83 83 83 83 83 83 83
22
1 11 2.3
2 11 4.81
2 12 1.0
2 13 4.81
2 14 4.7
2 15 4.7
3 10 4.95
4 8 4.95
4 9 4.95
5 12 2.3
6 13 2.3
9 13 4.81
9 15 4.7
10 11 4.81
10 14 4.7
11 12 4.7
11 14 1.0
12 13 4.7
12 14 4.81
12 15 4.81
13 15 1.0
3 7 4.95
4
1 7 33 30
0 1 1 0
0 0 1 1
5 6 1 1
1 0 0 0
0. 8. 0. 0.
-1. -1. -1. -1.

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The second section contains the mapping between the EXITT nodes and the FAST dump file room numbers and the EXITT nodes and the EXITT room numbers. If there are NRM rooms in FAST, then "FAST" room number NRM+1 corresponds to a door of EXITT (outside) and NRM+2 corresponds to a window of EXITT. If there are N nodes for EXITT, then the first line of this section consists of a line of N "FAST" room numbers with the first entry corresponding to node 1 of EXITT, the second entry corresponding to node 2 of EXITT, etc. In order to "cluster" nodes together into rooms, a mapping between EXITT nodes and EXITT room numbers is needed. If there are N nodes for EXITT, then the second line of this section consists of N "EXITT" room numbers with the first entry corresponding to node 1 of EXITT, the second entry corresponding to node 2 of EXITT, etc. The EXITT room numbers may not be the same as a window or door node number and window and door nodes should be assigned to the EXITT room in which they are located. The second section of the sample building file appears below.

```
1 2 3 4 5 6 8 7 4 3 2 2 2 2 2
1 2 3 4 5 6 4 4 4 3 2 2 2 2 2
```

For the sample building file the mapping between EXITT nodes and FAST rooms is that Node 1 is in room 1 of FAST, Node 2 is in room 2 of FAST, Node 3 is in room 3 of FAST, Node 4 is in room 4 of FAST, Node 5 is in room 5 of FAST, Node 6 is in room 6 of FAST, Node 7 is a window corresponding to the room of FAST in which it is located (Room 8 of FAST indicates to TENAB a window situation), Node 8 is a door corresponding to the outside for FAST (Room 7 of FAST is considered the outside to TENAB), Node 9 is in room 4 of FAST, Node 10 is in room 3 of FAST, Node 11 is in room 2 of FAST, Node 12 is in room 2 of FAST, Node 13 is in room 2 of FAST, Node 14 is in room 2 of FAST, and Node 15 is in room 2 of FAST. The mapping between EXITT nodes and EXITT

rooms is as follows: node 1 is room 1, nodes 2, 11, 12, 13, 14, and 15 are in room 2, nodes 3 and 10 are in room 3, nodes 4, 7, 8, and 9 are in room 4, node 5 is in room 5, and node 6 is in room 6. In this particular case the window (node 7) and the door (node 8) are both in room 4.

The third section consists of a line of N non-negative floating point numbers representing the node height. The node height is the distance between the floor level and the ceiling (meters) at the node. The lines corresponding to this section of the sample building file are shown below.

2.4 2.3 2.3 2.3 2.3 2.3 2.3 2.3 2.1 2.3 2.3 2.3 2.3 2.3

The first node has an associated room height of 2.4 meters and nodes 2-8 and 10-15 have an associated room height of 2.3 meters and node 9 has an associated height of 2.1 meters.

Since the FAST model is limited to a total of six rooms, several rooms of an actual building may have to be combined for the model run. If the combined rooms have different floor heights, EXITT must have that information to accurately determine the exposure conditions at each node within the building (for example, a room with a balcony where a node is "in" the balcony 2.4 meters above the floor of the room containing the balcony). The fourth section consists of a line of N non-negative floating point numbers representing the floor height of the node (in meters) above the floor of the room. The fourth section of the sample building file is shown below.

0. 0. 0. 0. 0. 0. 0. 0. .2 0. 0. 0. 0. 0. 0.

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The fourth section of the sample building file indicates that nodes 1-8 and 10-15 have an associated floor elevation of 0. meters and Node 9 has an associated floor elevation of 0.2 meters.

The fifth section is a line of NN (total number of nodes used by EXITT) integers representing the base noise level in decibels associated with each EXITT node. The section of the sample building file corresponding to the fifth section is shown below.

35 35 35 35 35 35 35 35 35 35 35 35 35 35 35

This section indicates the noise level of each room of the building is 35 decibels.

The sixth section gives the smoke detector information. The first line of this section indicates the number of smoke detectors in the building, NSD (a maximum of 10 is allowed). If there is at least one smoke detector a second, third and fourth line for this section are required. The second line consists of NSD real numbers indicating the time each alarm will sound. If an entry is non-negative the alarm will sound at that number of seconds; if an entry is negative, then the EXITT program will determine when that particular alarm will sound. The third line consists of NSD integers representing the node location associated with each detector, the first entry being associated with the location of the first detector, the second entry being associated with the location of the second detector, etc. The fourth line consists of NSD rows, one row per detector. Each row contains NN integers representing the loudness of the detector in decibels at each EXITT node when the detector is sounding. A rule of thumb for determining these levels is that for the node at which the detector is sounding the level is 95 decibels, 12 decibels are lost for nodes farther away from the detector, 12 decibels are lost in "going" through a closed door and 12 decibels are lost for a node on a different floor from that of the sounding detector's floor. The sixth section for the sample building file appears below.

```
1
-1.
2
83 95 83 83 83 83 83 83 83 83 83 83 83
```

The first line of this section indicates that there is one smoke detector. The second line, -1., indicates that the time that the alarm begins sounding will be determined by the EXITT program. The third line indicates that the smoke detector is located at node 2 and the fourth section indicates that the loudness of the alarm in rooms 1 and 3-6 will be 83 decibels and that in room 2 the loudness of the alarm will be 95 decibels.

The seventh section consists of the distances between adjacent nodes (two nodes are adjacent if one can travel from one node to the other without going through any other nodes). The first line of this section contains an integer indicating the number of edges (an edge being the path between adjacent nodes) entered, NEDGES. The second through NEDGES+1-st lines each contain 2 integers and a non-negative floating point number. The first integer represents the "from" node, the second integer represents the "to" node and the floating point number represents the distance in meters between the two nodes. If the distance between nodes x and y is d, the distance between y and x is assumed to be d unless the file specifies that the distance between y and x is otherwise. This may occur, for example, in the case of stairwell, where going up the stairs from node x to y takes longer than going down the stairs from node y to x. The seventh section of the sample building file is below.

```
22
1 11 2.3
2 11 4.81
2 12 1.0
2 13 4.81
2 14 4.7
```


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2 15 4.7
3 10 4.95
4 8 4.95
4 9 4.95
5 12 2.3
6 13 2.3
9 13 4.81
9 15 4.7
10 11 4.81
10 14 4.7
11 12 4.7
11 14 1.0
12 13 4.7
12 14 4.81
12 15 4.81
13 15 1.0
3 7 4.95

The first line of this section indicates that there are 22 edges. The next 22 lines list the pairs of adjacent nodes and their corresponding distances. The first edge, given by 1 11 2.31, indicates that the distance between nodes 1 and 11 is 2.31 meters. The second edge, 2 11 4.81, indicates the distance between nodes 2 and 11 is 4.81 meters. The remaining edges are interpreted in a similar manner.

The eighth section of the file, shown below, describes the occupants of the building.

4
1 7 33 30
0 1 1 0
0 0 1 1
5 6 1 1
1 0 0 0
0. 8. 0. 0.
-1. -1. -1. -1.

The first line of this section is an integer between 1 and 10 indicating the number of people in the building. The second line is a list of the ages of the occupants of the building. The third line is a list of 1's and 0's indicating the sex of the occupants (male=1 and female=0). The fourth line is a list of 1's and 0's indicating which occupants are awake and which are asleep (awake=1 and asleep=0). The fifth line is a list of nodes which indicate the locations of the occupants at the beginning of the simulation time. The sixth line is a list of 1's and 0's indicating which occupants require help in egressing the building (help required=1 and no help required=0). The seventh line is a list of sleeping penalties for the occupants. For occupants who are not asleep, the penalty is 0. For occupants who have difficulty waking, such as occupants who have hearing loss and young children, the penalty assigned is between 0 and 50 decibels. For occupants who wake easily, such as mothers of infants, the sleeping penalty assigned is between -15 and 0 decibels. The last line indicates the travel speed of each occupant. A non-positive number indicates that the default speed of 1.3 m/s is to be used. A positive number is interpreted as being the travel speed of the occupant in m/s.

If line 1 indicates there are N occupants, then each of lines 2 through 7 must have N entries with the first entry being associated with occupant 1, the second entry being associated with occupant 2, etc. It is noted here that if an occupant is 3 (or value of parameter BABY) years of age or less, he will be considered to require help in egressing the building regardless of what the occupant set file indicates.

In this case there are four people, ages 1, 7, 33, and 30. The 1-year old is a sleeping female at node 5 who requires help in order to leave the building. The 7-year old is a deep sleeper (sleeping penalty of 8 decibels) at node 6 who is capable of leaving the building on his own. The third person is an awake 33-year-old capable male located at node 1, and the fourth person is an awake 30-year-old

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capable female also located at node 1. In this case the default travel speed is assumed for each occupant.

4.3.4 User's Output from EXITT

The fourth prompt will be for the name of the user's output file. This file stores the names of files used in making the run, the building-occupant set data and the actions of the occupants as they egress the building. The file name can be a disk file name, the screen (CON on the PC), the printer (PRN on the PC) or the null file (NUL on the PC - use when the output file is not desired). If the file already exists, the user will be informed and allowed the opportunity to overwrite the file if desired. If the file name is invalid, the user will be informed and asked to reenter the file name. If the user wishes to cancel the run at this time a / may be entered. A sample output file appears below.

```
EXITT Version:  18.0 - Creation Date: 12/05/88 - Run Date: 12/08/88
FAST DUMP FILE   : \EXITT2\SCEN-5.DMP
BUILDING FILE    : SCEN-5.BLD
EXITT OUTPUT FILE: SCEN-5.OUT
EXITT DUMP FILE  : NUL
```

```
NO. OF ROOMS (RUN WITH FAST)      6
NO. OF DOORS                      3
NO. OF WINDOWS                    3
TOTAL NUMBER OF NODES             25
```

EXITT NODE NUMBER	EXITT ROOM NUMBER	FAST ROOM NUMBER	ROOM HEIGHT (M)	FLOOR HEIGHT (M)
1	1	1	2.4	0.0
2	2	1	2.4	0.0
3	3	2	2.4	0.0
4	3	4	4.9	0.0
5	5	5	2.4	0.0
6	6	6	2.4	0.0
7	7	6	2.4	0.0
8	8	5	2.4	0.0
9	9	3	2.4	0.0
10	10	5	2.4	0.0
11	3	7	2.4	0.0
12	2	7	2.4	0.0

Reference

13	1	7	2.4	0.0
14	6	8	2.4	0.0
15	7	8	2.4	0.0
16	8	8	2.4	0.0
17	5	5	2.4	0.0
18	3	2	2.4	0.0
19	1	1	2.4	0.0
20	3	2	2.4	0.0
21	2	1	2.4	0.0
22	5	4	2.4	2.5
23	2	1	2.4	0.0
24	8	5	2.4	0.0
25	8	5	2.4	0.0

NODE NUMBER	NOISE LEVEL (DECIBELS)
1	35
2	35
3	35
4	35
5	35
6	35
7	35
8	35
9	35
10	35
11	35
12	35
13	35
14	35
15	35
16	35
17	35
18	35
19	35
20	35
21	35
22	35
23	35
24	35
25	35

NUMBER OF SMOKE DETECTORS: 2

SMOKE DET NO.	NODE	ACTIVATION TIME (SEC)
1	3	TO BE DETERMINED BY EXITT
2	5	TO BE DETERMINED BY EXITT

EXITT NODE NUMBER	ALARM LEVEL (DECIBELS)	
	1	2
1	83	71
2	83	71
3	95	71

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4	83	71
5	71	95
6	59	71
7	59	71
8	59	71
9	83	71
10	59	71
11	83	71
12	83	71
13	83	71
14	59	71
15	59	71
16	59	71
17	71	95
18	95	71
19	83	71
20	95	71
21	83	71
22	71	71
23	83	71
24	59	71
25	59	71

EDGE LIST	TO NODE	DISTANCE (M)
FROM NODE		
1 -	13	2.81
-	18	2.59
-	19	2.50
2 -	19	2.13
-	21	2.61
-	23	2.93
3 -	4	2.20
-	18	2.29
-	20	2.18
4 -	3	2.20
-	20	1.71
-	22	4.56
5 -	17	1.83
-	22	1.74
-	25	1.61
6 -	14	1.37
-	17	2.07
7 -	15	1.37
-	17	3.29
8 -	16	1.95
-	24	2.33
-	25	1.90
9 -	18	1.07
10 -	24	1.22
11 -	20	1.02
12 -	21	1.70
13 -	1	2.81
-	19	3.36
14 -	6	1.37

Reference

15 -	7	1.37
16 -	8	1.95
-	24	2.85
17 -	5	1.83
-	6	2.07
-	7	3.29
-	22	1.57
18 -	1	2.59
-	3	2.29
-	9	1.07
19 -	1	2.50
-	2	2.13
-	13	3.36
20 -	3	2.18
-	4	1.71
-	11	1.02
-	23	1.45
21 -	2	2.61
-	12	1.70
-	23	1.07
22 -	4	4.56
-	5	1.74
-	17	1.57
23 -	2	2.93
-	20	1.45
-	21	1.07
24 -	8	2.33
-	10	1.22
-	16	2.85
-	25	3.14
25 -	5	1.61
-	8	1.90
-	24	3.14

TOTAL NUMBER OF DIRECTED EDGES 62

NUMBER OF PEOPLE 4

PERSON	LOCATION	AGE	SEX	STATE	SLEEP PENALTY	REQUIRE ASSISTANCE	TRAVEL SPEED
1	8	25	MALE	ASLEEP	0.0	NO	1.30
2	8	23	FEMALE	ASLEEP	0.0	NO	1.30
3	7	2	MALE	ASLEEP	0.0	YES	1.30
4	6	0	MALE	ASLEEP	0.0	YES	1.30

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ACTIONS TAKEN BY PERSON 1						
NODE	ROOM	TIME	SAV- ING	SAVED BY	DESTI- NATION	ACTION
8	5	0.0	--	--	--	INITIAL POSITION
8	5	364.0	4	--	6	GO TO RESCUE OTHER
25	5	366.4	4	--	6	ARRIVE AT NEW NODE
5	5	368.5	4	--	6	ARRIVE AT NEW NODE
17	5	370.9	4	--	6	ARRIVE AT NEW NODE
6	6	372.1	4	--	6	ARRIVE AT NEW NODE
6	6	372.1	4	--	--	PREPARE ANOTHER TO LEAVE BUILDING
6	6	374.1	4	--	--	ASSIST ANOTHER OUT OF BUILDING
14	8	374.9	4	--	14	ARRIVE AT WINDOW

ACTIONS TAKEN BY PERSON 2						
NODE	ROOM	TIME	SAV- ING	SAVED BY	DESTI- NATION	ACTION
8	5	0.0	--	--	--	INITIAL POSITION
8	5	364.0	3	--	7	GO TO RESCUE OTHER
25	5	366.4	3	--	7	ARRIVE AT NEW NODE
5	5	368.5	3	--	7	ARRIVE AT NEW NODE
17	5	370.9	3	--	7	ARRIVE AT NEW NODE
7	6	372.8	3	--	7	ARRIVE AT NEW NODE
7	6	372.8	3	--	--	PREPARE ANOTHER TO LEAVE BUILDING
7	6	375.8	3	--	--	ASSIST ANOTHER OUT OF BUILDING
15	8	376.6	3	--	15	ARRIVE AT WINDOW

ACTIONS TAKEN BY PERSON 3						
NODE	ROOM	TIME	SAV- ING	SAVED BY	DESTI- NATION	ACTION
7	6	0.0	--	--	--	INITIAL POSITION
7	6	372.8	--	2	--	RECEIVING ASSISTANCE
7	6	375.8	--	2	--	LEAVE BUILDING WITH ASSISTANCE
15	8	376.6	--	2	15	ARRIVE AT WINDOW WITH ASSISTANCE

ACTIONS TAKEN BY PERSON 4						
NODE	ROOM	TIME	SAV- ING	SAVED BY	DESTI- NATION	ACTION
6	6	0.0	--	--	--	INITIAL POSITION
6	6	372.1	--	1	--	RECEIVING ASSISTANCE
6	6	374.1	--	1	--	LEAVE BUILDING WITH ASSISTANCE
14	8	374.9	--	1	14	ARRIVE AT WINDOW WITH ASSISTANCE

4.3.5 The EXITT Dump File

The last prompt will be for the name of the EXITT dump file. This file is designed for use as input to the TENAB program. The file name can be a disk file name or the null file (NUL on the PC - use

when the output file is not desired). If the file does not exist, the user will be informed and allowed the opportunity to overwrite the file, provided the name entered is not the same as that entered for the user's output file. If the file name is invalid, the user will be informed and asked to reenter the file name. If the user wishes to cancel the run at this time, a / may be entered.

Once all the file names are entered, the user just awaits the run to finish. Any file errors (for example, a negative age) encountered which cause the program to stop are printed on the screen.

4.4 FAST

The computer model requires a description of the problem to be solved. The following description is for the input data used by the model. In general, the order of the input is not important. The one exception to this is the first line which specifies the version number and gives the data file a title.

The data are grouped as

- Version and title (5.1)
- Time step (5.2)
- Ambient conditions (5.3)
- Floor plan data (5.4)
- Connections (5.5)
- Thermophysical properties of the enclosing surfaces (5.6)
- Fire specifications (5.7)
- Species production (5.8)
- Output files (5.9)
- Graphics specification (5.10).

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The number of lines in a given data set will vary depending for example on the number of openings or the number of species tracked. A number of parameters such as heat transfer and flow coefficients have been set within the program as constants. Please refer to the **Technical Reference** volume to ascertain the values for these parameters.

Each line of the input data file begins with a key word which identifies the type of data on the line. The key words which are currently available are shown in table 3. The number in parentheses is the maximum number of entries for that line. "N" represents the number of compartments being modeled and "lfmax" is the number of time intervals used to describe the fire, detailed below in section 4.4.7.

Each line of input consists of a label followed by one or more alphanumeric parameters associated with that input label. The label must always begin in the first space of the line and be in capital letters. Following the label, the values may start in any column and all values must be separated by either a comma or a space. Values may contain decimal points if needed or desired. They are not required. Units are standard SI units. Most parameters have default values which can be utilized by omitting the appropriate line. These will be indicated in the discussion. The maximum line length is 128 characters, so all data for each key word must fit in this number of characters. For each entry which requires more than one type of data, the first entry under the column "parameter" indicates the number of data required.

Table 4-3. Keywords in a FAST input file

CEILI	specify name of ceiling descriptor(s)	(N)
CHEMI	miscellaneous parameters for kinetics	(5)
CO	co/co ₂ mass ratio	(lfmax+1)
CT	fraction of fuel which is toxic	(lfmax+1)
CVENT	opening/closing parameter	(lfmax + 4)
DEPTH	depth of compartments	(N)
DUMPR	specify a file name for saving time histories	(1)
EAMB	external ambient	(3)
FAREA	area of the base of the fire	(lfmax+1)
FHIGH	height of the base of the fire	(lfmax+1)
FLOOR	specify the name of floor property descriptor(s)	(N)
FMASS	pyrolysis rate	(lfmax+1)
FQDOT	heat release rate	(lfmax+1)
FTIME	length of time intervals	(lfmax)
HCL	hcl/pyrolysis mass ratio	(lfmax+1)
HCN	hcn/pyrolysis mass ratio	(lfmax+1)
HCR	hydrogen/carbon mass ration of the fuel	(lfmax+1)
HEIGH	interior height of a compartment	(N)
HI/F	absolute height of the floor of a compartment	(N)
HVENT	specify vent to connect compartments horizontally	(7)
INTER	initial height of the upper/lower interface	(2)
LFBO	compartment of fire origin	(1)
LFBT	type of fire	(1)
LFMAX	number of time intervals	(1)
LFPOS	position of the fire in the compartment	(1)
OD	C/CO ₂ mass ratio	(lfmax+1)
RESTR	specify a restart file	(2)
TAMB	ambient inside the structure	(3)
TIMES	time step control of the output	(5)
VERSN	version number and title	(fixed format 2)
WALLS	specify the name of wall property descriptor(s)	(N)
WIDTH	width of the compartments	(N)
WIND	scaling rule for wind effects	(3)

4.4.1 Version and Title

This line must be the first line in the file. It is the line that FAST keys on to determine whether it has a correct data file. The format is fixed, that is the data must appear in the columns specified in the text.

Parameter	Comments
Version Number	The VERSN line is a required input. The version number parameter specifies the version of FAST for which the input data file was prepared. Normally, this would be 18. It must be in columns 8-9.
Title	The title is optional and may consist of letters, numbers, and/or symbols that start in column 11 and may be up to 50 characters. It permits the user to uniquely label each run.

Example:

VERSN 18 Simulation for Building XYZ

4.4.2 Time Specification

Parameter	Comments
Simulation Time	The TIMES line is a required input. Simulation time is the length of time over which the simulation takes place. The maximum value for this input is 86400 seconds (one day). The simulation time parameter is required.

**Print
Interval**

The print interval is the time interval between each printing of the output values. If omitted or less than or equal to zero, no printing of the output values will occur.

**Dump
Interval**

The dump interval is the time interval between each writing of the output to the dump file. The dump file stores all of the output of the model at the specified interval in a format which can be efficiently retrieved for use by other programs. Section 4.4.9 provides details of the dump file. A zero must be used if no dump file is to be used. There is a maximum of 50 intervals allowed. If the choice of this parameter would yield more than 50 writes, it is adjusted so that this limit is not exceeded.

**Display
Interval**

The display interval is the time interval between each graphical display of the output as specified in the graphics specification, section 4.4.10. If omitted, no graphical display will occur. There is a limit on the display of 50 for the micro-computer versions and 100 for the mainframe versions of FAST. This parameter is not adjusted; rather, graphs will be truncated to the first 50 or 100 points, respectively.

**Copy
Count**

Copy count is the number of copies of each graphical display to be made on the selected hard copy device as specified in the graphics specification, section 4.4.10. If omitted, a value of zero (no copies) is assumed.

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Examples:

```
TIMES 360 0 0
TIMES 360 10 30
TIMES 900 30 10 10 0
```

In the first example, a simulation time of 360 s is specified. The output values will not be printed or stored in a dump file. No graphical display of the output will occur. In the second example, a 360-s simulation with printed output every 10 s and output to a dump file every 30 s is specified. No graphical display of the output values will be generated. In the third example, all parameters are specified. A 900-s simulation with printed output every 30 s, output to a dump file every 10 s and a graphical display with no copies will occur every 10 s. Note the free field format of these parameters - multiple spaces between parameters are permitted.

4.4.3 Ambient Conditions

The ambient conditions section of the input data allows the user to specify the temperature and pressure and station elevation of the ambient atmosphere, as well as the absolute wind pressure to which the structure is subjected. There is an ambient for the interior and for the exterior of the building. The key word for the interior of the building is TAMB and for the exterior of the building is EAMB. The form for EAMB and TAMB is identical:

Parameter	Comments
Ambient Temperature	Ambient temperature is the temperature of the ambient atmosphere in K. Default is 300 K.
Ambient Pressure	The ambient pressure is the pressure of the ambient atmosphere in Pascals. Default is 101300 Pa.

**Station
Elevation**

The station elevation is the elevation of the point at which the ambient pressure was measured in meters. The reference point for the elevation and the pressure must be consistent. This is the reference datum for calculating the density of the atmosphere as well as the temperature and pressure as a function of height. Default is 0 m.

The key word for the wind information is WIND. The wind modification is applied only to the vents which lead to the exterior. Pressure interior to a structure is calculated simply as a lapse rate. For the exterior, the nominal pressure is modified by

$$\delta(p) = C_w \rho V^2, \text{ where } V = V_w \left[H_i / H_w \right]^{P_w}$$

This modification is applied to the vents which lead to the exterior ambient. The pressure change calculated above is modified by the wind coefficient for each vent. This coefficient, which can vary from -1.0 to +1.0 (nominally from -0.8 to +0.8) determines whether the vent is facing way from or into the wind. The pressure change is multiplied by the vent wind coefficient and added to the external ambient for each vent which is connected to the outside.

The WIND key word is optional. If included, three parameters are required.

Wind Speed

Wind speed at the reference elevation in m/s. The default is 0 m/s.

**Reference
Height**

Height at which the reference wind speed is measured in meters. The default is 10 m.

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Lapse Rate Coefficient	The power law used to calculate the wind speed as a function of height. The default is 0.16.
-------------------------------	--

Examples:

```
TAMB 300
TAMB 288 101000 200.
```

The first example sets the ambient temperature to 300 K, but leaves the ambient pressure at 101300 and the reference elevation at 0 m. The second specifies a temperature of 15 °C at 200 m and a pressure of 101000 Pa. In both of these cases the external ambient is set to the same values. An example of different inside and outside values is a warm building in a winter setting and might be described as

```
TAMB 288 101305 0.0
EAMB 270 101315 0.0
```

4.4.4 Floor Plan Data

The floor plan data section allows the user to portray the geometry of the structure being modeled. The size and location of every room in the structure **MUST** be described. For the PC versions, a maximum of six compartments (plus the outdoors) is allowed. The structure of the data is such that the compartments are described as entities, and then connected in appropriate ways. It is thus possible to have a set of rooms which can be configured in a variety of ways. In order to specify the geometry of a building, it is necessary to give its physical characteristics. Thus the lines labelled **HI/F** (for floor height), **WIDTH** (for room width), **DEPTH** (for room depth) and **HEIGHT** (for room height) are all required. Each of these lines requires "N" data entries, that is, one for each compartment.

Parameter	Comments
Floor Height	The floor height is the height of the floor (in m) of each room with respect to station elevation specified by the TAMB parameter. The reference point must be the same for all elevations in the input data. The number of values on the line must equal the number of rooms in the simulation.
Room Width	Room width specifies the width of the room in m. The number of values on the line must equal the number of rooms in the simulation.
Room Depth	Room depth specifies the depth of the room in m. The number of values on the line must equal the number of rooms in the simulation.
Room Height	Room height specifies the height of the room in m. The number of values on the line must equal the number of rooms in the simulation.

Example:

HI/F	0.0	0.0	0.0
WIDTH	6.1	4.6	4.6
DEPTH	9.1	14.3	4.3
HEIGH	3.6	2.4	2.4

This floor plan data specifies the sizes for a three-room simulation with rooms sizes of 6.1 x 9.1 x 3.6 m, 4.6 x 14.3 x 2.4 m, and 4.6 x 4.3 x 2.4 m, respectively. All rooms are at the same elevation at a reference height of 0.0 m.

4.4.5 Connections

The connections section of the input data file describes any horizontal or vertical vents between rooms in the structure. These may include doors between rooms in the structure, windows in the rooms (between rooms or to the outdoors), or vertical openings between floors of the structure. Openings to the outside are included as openings to the room with a number one greater than the number of rooms described in the floor plan data section. Doors, windows, and the like are called horizontal vents because the direction of the vent, or vent connection, is in the horizontal direction. The key word is HVENT. Horizontal vents may be opened or closed during the fire with the use of the CVENT key word. HVENT is presented first:

Parameter	Comments
	HVENT is required to specify connections between compartments. No openings prevents flow. Each HVENT line in the input file describes one horizontal vent between rooms in the structure (or between a room and the outdoors). The first six entries on each line are required. There is an optional seventh parameter to specify a wind coefficient.
First Room	The first room is simply the first connection.
Second Room	The second room is the room number to which the first room is connected. The order has one significance. The height of the sill and soffit are with respect to the first compartment specified.

Vent Number	There can be as many as four vents between any two compartments. This number specifies which vent is being described. It can range from one to four.
Width	The width of the opening in m.
Soffit	Position of the top of the opening (in m) above the floor of the room number specified as the first room.
Sill	Sill height is the height (in m) of the bottom of the opening above the floor of the room number specified as the first room.
Wind	The wind coefficient is the cosine of the angle between the wind vector and the vent opening. This applies only to vents which connect to the outside ambient (specified with EAMB). The range of values is -1.0 to +1.0. If omitted, the value defaults to zero.

Examples:

```
HVENT 1 2 1 1.1 2.1 0.0
HVENT 1 3 1 1.1 2.1 0.0
HVENT 2 4 1 1.3 2.1 0.6
```

Assuming the three-room structure as described in the floor plan data section, the above examples describe two openings 1.1 x 2.1 m between rooms 1 and 2 and between rooms 1 and 3. A 1.3 x 2.1 m opening between room 2 and the outside (room 4 for a three-room simulation) is raised 0.6 m off the floor of room 2.

```
HVENT. 2 4 2 1.3 2.1 0.6 1.0
```


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This specifies vent 2 between compartment 2 and the outside, with a wind coefficient of 1.0, which implies that the vent is facing directly into the wind.

CVENT is a parameter which is used to open and close vents. It multiplies the width in the vent flow calculation. The default is 1.0 which is a fully open vent. A value of 0.5 would specify a vent which was halfway open.

Parameter	Comments
	Specify closing value. Each CVENT line in the input file describes one horizontal vent between rooms in the structure (or between a room and the outdoors). There should be (LFMAX+4) entries on each CVENT line.
First Room	The first compartment.
Second Room	The second room is the room number to which the first room is connected.
Vent Number	This number specifies which vent is being described. It can range from one to four. These parameters correspond to the first three parameters in HVENT.
Width	Fraction that the vent is open. This applies to the width only. The sill and soffit are not changed. A total of LFMAX+1 entries for the width parameter are included on the line.

CVENT has a form similar to HVENT but in addition contains the opening data. The additional data is in the same form as all the

time dependent specifications, namely a value for each endpoint in the heat release curve. The form is

```
CVENT C#1 C#2 V# x x x x,...
```

By way of example, the default value for CVENT for the example show above with LFMAX=5 would be

```
CVENT 1 2 1 1.0 1.0 1.0 1.0 1.0 1.0
```

and would specify that the first vent between compartments 1 and 2 would be open at all times. Another example would be

```
CVENT 1 3 1 0.01 0.01 0.01 1.0 1.0 1.0
```

and would specify that the first vent between compartments 1 and 3 would be opened at the fourth time interval. These fractions refer to the width given in the HVENT specification and for the cases above would be 1.1 meters.

4.4.6 Thermophysical Properties of Enclosing Surfaces

The thermophysical properties of the enclosing surfaces are described by specifying the thermal conductivity, specific heat, emissivity, density, and thickness of the enclosing surfaces for each room. If the thermophysical properties of the enclosing surfaces are not included, FAST will treat them as adiabatic (no heat transfer). Since most of the heat transfer is through the ceiling and since the conduction calculation takes more than half of the computation time, it is recommended that initial calculations be made using the ceiling only. Adding the walls generally has a small effect on the results and the floor contribution is usually negligible. Clearly, there are cases where the above generalization does not hold, but it may prove to be a useful screening technique. Currently, thermal properties for

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materials are read from a thermal database file unique to FAST. The data in the file for FAST simply gives a name (such as CONCRETE) which is a pointer to the properties in the thermal database. All of these specifications are optional.

Parameter	Comments
CEILI	The label CEILI indicates that the names of thermophysical properties on this line describe the ceiling material. If this parameter is present, there must be an entry for each compartment.
WALLS	The label WALLS indicates that the names of thermophysical properties on this line describe the wall material. If this parameter is present, there must be an entry for each compartment.
FLOOR	The label FLOOR indicates that the names of thermophysical properties on this line describe the floor material. If this parameter is present, there must be an entry for each compartment.

Examples:

CEILI	OFF	REDOAK	CONCRETE
WALLS	CONCRETE	CONCRETE	CONCRETE

The corresponding thermal database might appear as

CONCRETE	1.75	1000.	2200.	0.156	0.94
BRICK	0.85	1200.	1900.	0.15	0.90
REDOAK	0.15	1300.	640.	0.025	0.90

The names of the materials can be any ASCII string up to eight characters. So a valid name is \$%#@**% although this admittedly does not convey much information. The key word "OFF" is used to tell the model not to compute the heat loss for the ceiling in compartment 1. In this case the FLOOR parameter is not present at all, so there will be no heat transfer through the floor in any room and the calculation will not be done for the ceiling in compartment 1, where the key word "off" is present. This is most useful for doing the heat transfer calculation in the burn room and adjacent rooms and then turning it off in distant compartments.

4.4.7 Fire Specifications

The fire specifications allow the user to describe the fire source in the simulation. The location and position of the fire is specified along with the chemical properties of the fuel. Finally, the fire is described with a series of mass loss rate, fuel height, and fuel area inputs. All of these specifications are optional and each line requires a single number.

Parameter	Comments
Room of Fire Origin	The label LFBO is used to specify the room of fire origin and is the room number in which the fire originates. Default is 1.
Fire Type	<p>The label LFBT specifies the fire type This is a number indicating the type of fire.</p> <p>1 Unconstrained fire 2 Constrained fire.</p> <p>The default is 1.</p>

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Fire Position The fire position (LFPOS) is the area of the room in which the fire originates and is one of the following values:

- 1 Center of the room,
- 2 Corner of the room, or
- 3 Along a wall of the room, but not near a corner of the room.

The fire position is used to account for the entrainment rate of the plume, which depends on the location of the fire plume within the compartment. Fire positions 2 and 3 should only be used when the fire is very close to the corner or wall respectively. The default is 1.

The CHEMI line specifies chemical kinetics and miscellaneous fire parameters.

Molar Weight Molecular weight of the fuel. While not currently used by FAST, this can affect the conversion into parts per million of the fuel. The default is fixed at 16.

Relative Humidity The initial relative humidity in the system. This is converted to kilograms of water per cubic meter from the table from "Dynamical and Physical Meteorology" by Haltiner and Martin (1957).

Limiting Oxygen Index The limit on the ratio of oxygen to other gases in the system below which a flame will not burn. This is applicable only to type (LFBT) 2 or later fires. The default is 10.

Heat of Combustion	Heat of combustion of the fuel in J/kg. Default is 50000000 J/kg.
Initial Fuel Temperature	Typically, the initial fuel temperature is the same as the ambient temperature as specified in the ambient conditions section. Units are in K.
Gaseous Ignition Temperature	Minimum temperature for ignition of the fuel as it flows from a compartment through a vent into another compartment. The default is the initial fuel temperature.

The **LFMAX** line specifies the the number of time intervals for the mass loss rate, fuel height, and species inputs. The mass loss rate, fuel height, and species are entered as series of points with respect to time. This is referred to in this document as a specified fire. The program performs a linear interpolation between these points to determine the values at all times. A sufficient number of intervals should be selected to provide a reasonable approximation (using straight line segments) for the input variables which specify the fire.

Number of Intervals	The number of points specified must be one greater than the number of time intervals. For example, if there are six mass loss points there should be a total of five time intervals (or one interval between every two consecutive points). The maximum number of intervals allowed in version 18 of FAST is 21.
----------------------------	--

The line **FTIME** specifies the time intervals of the fire growth specification.

Time Interval	A total of LFMAX entries should be placed on the line. Time interval is the time (in s) bet-
----------------------	---

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ween each point (mass loss rate, fuel height, and species) specified for the fire. The total duration of the fire is the sum of the time intervals. This time is independent of the simulation time which is specified for the TIMES label. If the simulation time is longer than the total duration of the fire, the final values specified for the fire (mass loss rate, fuel height, fuel area, and species) will be continued until the end of the simulation. The number of values on the line must equal the number of time intervals specified by LFMAX, above.

FMASS Mass Loss Rate	The FMASS line specifies the rate at which fuel is pyrolyzed at times corresponding to each point of the specified fire in kg/s. A total of (LFMAX+1) entries must be placed on the line.
FHIGH Fuel Height	The height of the base of the flames above the floor of the room of fire origin for each point of the specified fire in m.
FQDOT Heat Release Rate	The heat release rate of the specified fire in W.

With the three parameters, the heat of combustion (HOC) from CHEMI, FMASS and FQDOT, the pyrolysis and heat release rate are over specified. The model uses the last two of the three to obtain the third parameter. That is, if the three were specified in the order HOC, FMASS and FQDOT, then FQDOT would be divided by FMASS to obtain the HOC for each time interval. If the order were FMASS, FQDOT and HOC, then the pyrolysis rate would be determined by dividing the heat release rate by the heat of combustion. If only two of the three are given, then those two will

determine the third, and finally, if none or only one of the parameters is present, the defaults shown will be used.

Example:

```
LFBO      1
LFBT      1
LFPOS     1
CHEMI     0.0  0.0 10.  18100000. 300.
LFMAX     7
FMASS     .014 .0014 .025 .045 .050 .0153 .0068 .0041
FAREA     .5   .5   .5   .5   .5   .5   .5   .5
FHIGH     .25  .25  .25  .25  .25  .25  .25  .25
FTIME     20.  20.  50.  50. 100. 100. 400.
```

In the example, a specified fire (LFBT 1) originates in room number 1 (LFBO 1) in the center of the room (LFPOS 1). A seven-segment (LFMAX) fire is specified. The fuel burns with a heat of combustion of 18100000 J/kg. The initial relative humidity is 0%, the molecular weight is 16 (zero is not allowed, so the default is used) and the limiting oxygen index is 10%. Since the type of fire is 1, an unconstrained fire, this latter parameter has no meaning in this context.

```
LFBT      2
LFMAX     7
FMASS     .014 .0014 .025 .045 .050 .0153 .0068 .0041
FAREA     .5   .5   .5   .5   .5   .5   .5   .5
FHIGH     .25  .25  .25  .25  .25  .25  .25  .25
FTIME     20.  20.  50.  50. 100. 100. 400.
```

In this example, the specified fire is constrained with a limiting oxygen index of 1%. Since LFBO is not given, the default compartment (1) is used, and the position of the fire is in the center of the room. The default heat of combustion of 50000000 kJ/kg is used.

4.4.8 Species Production

Species production rates are specified in the manner similar to the fire, entering the rates as a series of points with respect to time. The species which are followed by FAST are

- Carbon Dioxide
- Carbon Monoxide
- Concentration-Time Product
- Hydrogen Cyanide
- Hydrogen Chloride
- Nitrogen
- Oxygen
- Soot (Smoke Density)
- Total Unburned Hydrocarbons
- Water

For a type one (LFBT=1) fire, only the concentration-time product, hydrogen cyanide and hydrogen chloride can be specified. No other species are followed. For a type two (LFBT=2) fire, nitrogen, oxygen, carbon dioxide, carbon monoxide, Soot, unburned fuel and water are followed. In all cases, the unit of the production rates is kg/kg. However, the meaning of the production rates is different for the several types of species. For either fire, the production rates for the first three are with respect to the pyrolysis rate of the fuel. For the latter, the production rate of hydrogen and other materials is specified with respect to the basic carbon production. Thus we can not consider a pure hydrogen flame, but this is unlikely in the situations of interest.

Parameter	Comments
	For each species desired a series of production rates are specified for each of the time points input for the specified fire. The program

	performs a linear interpolation between these points to determine the time of interest. A total of (LFMAX+1) entries must be included on each SPECIES line.
HCN, HCL, and CT	Production rates for HCN, HCl, and CT are specified kilogram of species produced per kilogram of fuel burned. The input for CT is the kilograms of "toxic" combustion products produced per kilogram of fuel burned.
HCR	The production rate of the fuel is the mass ratio (kg/kg) of hydrogen to carbon <i>as it becomes available from the fuel</i> . This parameter affects primarily the rate of production of water.
OD	The ratio (in kg/kg) of the mass of carbon to carbon dioxide produced by the oxidation of the fuel.
CO	The ratio of the mass of carbon monoxide to carbon dioxide produced by the oxidation of the fuel.

4.4.9 Output Files

There are several files which FAST uses to communicate with its environment. They are 1) a configuration file, 2) the thermal database, 3) a "dump" file, and 4) a restart file. The output of the simulation may be written to a disk file for further processing by programs such as FASTplot or to restart FAST. At each interval of time as specified by the dump interval in the TIMES label, the output is written to the file specified. For efficient disk storage and optimum speed, the data is stored in an internal format and cannot be read directly with a text editor.

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Parameter	Comments
DUMPR	The Dump file name specifies a file (up to 17 characters) to which the program outputs for plotting are written. Dump file is an optional input. If omitted, the file will not be generated. Note that in order to obtain a history of the variables, this parameter must be specified and also the dumper interval (under TIMES) must be set to a nonzero value.
RESTR	The Restart file name specifies a file (up to 17 characters) from which the program reads data to restart the model. This data must have been generated (written) previously with the dump parameter discussed earlier. A time step is given after the name of the file and specifies at what time the restart should occur.
THRMF	The name specifies a file (up to 20 characters) from which the program reads thermophysical data. If this parameter is not specified, then either the default (THERMAL.TPF) is used, or the name is read from the configuration file.
DEFCG	The name specifies a file (up to 20 characters) from which the program reads configuration information data.

Example:

```
DUMPR FAST1.DMP
RESTR filename n
THRMF thermal.2
```

where "filename" was created in a previous run using the DUMP parameter. "n" specifies the starting time and must be one of the times at which a dump was generated. As an example, if a data set were run with

```
VERSN    18 title...
TIMES    360 60 10 0 0
.
.
DUMPR    MYFILE
```

then every 10 seconds a snapshot of the time histories of all variables would be generated. So a restart might be done at 300 seconds with the following

```
VERSN    18 new title
TIMES    900 60 0 0 0
.
.
RESTRT   MYFILE 300
```

with no requirement that the restart must be at the last dump point. The only caveat is to check the listings to be sure that a dump was generated at the desired point. For those cases where too many dump intervals are requested, the interval is recalculated.

4.4.10 Graphics Specification

A graphics specification can be added to the data file. Details of the meaning of some of the parameters are best left to the discussion of the device independent graphics software used by FAST [2]. However, the information necessary to use it is straightforward. The general structure is similar to that used for the building and fire specification. One must tell the program "what to plot," "how it should appear" and "where to plot it." Please peruse the examples. They should clarify most of the usage of the key words.

The key words for "where to put it" are

DEVICE	where to plot it
BAR	bar charts
GRAPH	specify an x-y plot
TABLE	put the data into a table
PALETTE	specify the legend for CAD views
VIEW	show a picture of the structure in three dimensional perspective
WINDOW	the size of the window in "user" space.

The complete key word is required. That is, for the "where to put it" terms, no abbreviations are allowed. Then one must specify the variables to be plotted. They are VENT, HEAT, PRESSUR, WALL, TEMPERA, INTERFA, N₂, O₂, CO₂, CO, HCN, HCL, TUHC, H₂O, OD, and CT. As might be expected, these are a subset of the key words used in the plotting program, FASTplot. For each key word there are some parameters to specify the location of the graph, some for the colors, and finally, titles as appropriate. For the variables, there is a corresponding pointer to the graph of interest.

The form of each "where to put it" variable is described below.

Parameter	Comments
DEVICE	The line specifies the hardware device where the graphics is to be displayed. For the PC version, this key word should be omitted. If it must be included for compatibility reasons, set it to 3. For other computers, it is installation dependent. In general it specifies which device will receive the output.
WINDOW	<p>The window label specifies the user space for placement of graphs, views, and tables. Six variables should be placed on the line as follows: Xl is the left hand side of the graph in any user desired units. Yb is the bottom of the graph in any user desired units. Zf is the forward edge of the 3-D block in any user desired units. Xr is the right hand side of the graph in any user desired units. Yt is the top of the graph in any user desired units. Zb is the rear edge of the 3-D block in any user desired units. These definitions refer to the 3-D plotting block that can be seen. The most common values (which are also the default) are</p> <p style="margin-left: 40px;">Xl = 0. Yb = 0. Zf = 0. Xr = 1279. Yt = 1023. Zb = 10.</p>

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This is not a required parameter; however, it is often convenient to define graphs in terms of the units that are used. For example, if one wished to display a house in terms of a blueprint, the more natural units might be feet. In that case, the parameters might have the values

$$Xl = 0.$$

$$Yb = 0.$$

$$Zf = 0.$$

$$Xr = 50.$$

$$Yt = 25.$$

$$Zb = 30.$$

GRAPH

Up to five graphs may be displayed at one time on the graphics display. Each graph is identified by a unique number (1-5) and placed in the window at a specified location. Xl , Yb , Zf , Xr , Yt and Zb have a meaning similar to WINDOW. However, here they specify where in the window to put the graph. A total of 10 entries are placed on the line. **Graph number** is the number to identify the graph. Allowable values are from 1 to 5. The graphs must be numbered consecutively, although they do not have to be given in order. It is acceptable to define graph 4 before graph 2 but if graph 4 is to be used, then graphs 1 through 3 must also be defined. Xl is the left hand side of the graph within the window in the same units as that of the window. Yb is the bottom of the graph within the window in the same units as that of the window. Zf is the forward edge of the 3-D block within the window in the same units as that of the window. Xr is the right hand side of the graph within the window in the same units as that of

the window. **Yt** is the top of the graph within the window in the same units as that of the window. **Zb** is the back edge of the 3-D block within the window in the same units as that of the window. **Color** specifies the color of the graph and labels as an integer from 1 to 15. **Abcissa Title** specifies the title for the horizontal axis. To have blanks in the title, use the underscore character "_" where the blanks are to appear. **Ordinate Title** specifies the title for the vertical axis. To have blanks in the title, use the underscore character "_" where the blanks are to appear.

TABLE

The **TABLE** line describes tabular outputs to be displayed. Up to five tables may be displayed at one time on the graphics display. Each table is identified by a unique number and placed in the window at a specified location. **Xl,Yb,Zf,Xr,Yt** and **Zb** have a meaning similar to **WINDOW**. However, here they specify where in the window to put the table. The **Table Number** is the number to identify the table. Allowable values are from 1 to 5. The tables must be numbered consecutively, although they do not have to be given in order. It is acceptable to define table 4 before table 2 but if table 4 is to be used, then tables 1 through 3 must also be defined. **Xl** is the left hand side of the table within the window in the same units as that of the window. **Yb** is the bottom of the table within the window in the same units as that of the window. **Zf** is the forward edge of the 3-D block within the window in the same units as that of the window. **Xr** is the right hand side of the table within the window in the same units as that of

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the window. **Yt** is the top of the table within the window in the same units as that of the window. **Zb** is the back edge of the 3-D block within the window in the same units as that of the window.

VIEW

A **VIEW** presents a 2- or 3-D display of a structure. Up to five views may be displayed at one time on the graphics display. Each view is identified by a unique number and placed in the window at a specified location. **Xl**, **Yb**, **Zf**, **Xr**, **Yt** and **Zb** have a meaning similar to **WINDOW**. However, here they specify where in the window to put the view. View number is the number to identify the view. Allowable values are from 1 to 5. The views must be numbered consecutively, although they do not have to be given in order. It is acceptable to define view 4 before view 2 but if view 4 is to be used, then views 1 through 3 must also be defined. **Xl** is the left hand side of the view within the window in the same units as that of the window. **Yb** is the bottom of the view within the window in the same units as that of the window. **Zf** is the forward edge of the 3-D block within the window in the same units as that of the window. **Xr** is the right hand side of the view within the window in the same units as that of the window. **Yt** is the top of the view within the window in the same units as that of the window. **Zb** is the back edge of the 3-D block within the window in the same units as that of the window. **File** is the filename of a compatible "BUILD" file, as discussed later. The **Transform Matrix** is a 16-number matrix which allows dynamic positioning of the view within the window. The matrix

(1 0 0 0 0 1 0 0 0 0 1 0 0 0 0 1) would show the image as it would appear in a display from BUILD.

PALETTE

The PALETTE label performs a specialized function for showing colors on the views. A four-entry table is created and used for each type of filling polygon used in a view. Up to five palettes may be defined. Each palette is identified by a unique number and placed in the window at a specified location. **Xl**, **Yb**, **Zf**, **Xr**, **Yt** and **Zb** have a meaning similar to WINDOW. However, here they specify where in the window to put the palette. The **Palette Number** is the number to identify the palette. Allowable values are from 1 to 5. **Xl** is the left hand side of the palette within the window in the same units as that of the window. **Yb** is the bottom of the palette within the window in the same units as that of the window. **Zf** is the forward edge of the 3-D block within the window in the same units as that of the window. **Xr** is the right hand side of the palette within the window in the same units as that of the window. **Yt** is the top of the palette within the window in the same units as that of the window. **Zb** is the back edge of the 3-D block within the window in the same units as that of the window. **Color and Label** describes four pairs of color/text combinations, each corresponding to an entry in the palette. The color number is an integer from 1 to 15 and the text can be up to 50 characters (but remember the 128-character maximum). As before, spaces are indicated with an underscore character "_".

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BAR

Up to five bar charts may be displayed at one time on the graphics display. Each bar chart is identified by a unique number and placed in the window at a specified location. **Xl**, **Yb**, **Zf**, **Xr**, **Yt** and **Zb** have a meaning similar to **WINDOW**. However, here they specify where in the window to put the bar chart. The **Bar Chart Number** specifies the number to identify the bar chart. Allowable values are from 1 to 5. **Xl** is the left hand side of the bar chart within the window in the same units as that of the window. **Yb** is the bottom of the bar chart within the window in the same units as that of the window. **Zf** is the forward edge of the 3-D block within the window in the same units as that of the window. **Xr** is the right hand side of the bar chart within the window in the same units as that of the window. **Yt** is the top of the bar chart within the window in the same units as that of the window. **Zb** is the back edge of the 3-D block within the window in the same units as that of the window. **Abcissa Title** specifies the title for the horizontal axis. To have blanks in the title, use the underscore character "_" where the blanks are to appear. **Ordinate Title** specifies the title for the vertical axis. To have blanks in the title, use the underscore character "_" where the blanks are to appear.

LABEL

Up to five labels may be displayed at one time on the graphics display. Each label is identified by a unique number and placed in the window at a specified location. **Xl**, **Yb**, **Zf**, **Xr**, **Yt**, and **Zb** have a meaning similar to **WINDOW**. However, here they specify where in the window to put the label. It is assumed that time is

always to be displayed if any labels are present. To this end, label 1 is always used for the time in the units HH:MM:SS. The **Label Number** is the number to identify the label. Allowable values are from 1 to 5. **Xl** is the left hand side of the label within the window in the same units as that of the window. **Yb** is the bottom of the label within the window in the same units as that of the window. **Zf** is the forward edge of the 3-D block within the window in the same units as that of the window. **Xr** is the right hand side of the label within the window in the same units as that of the window. **Yt** is the top of the label within the window in the same units as that of the window. **Zb** is the back edge of the 3-D block within the window in the same units as that of the window. **Text** is the text to be displayed within the label. To have blanks in the title, use the underscore character "_". **Angle1** and **Angle2** describe the placement of the label. Angles for display of the label in a right cylindrical coordinate space. At present only the first angle is used and represents a positive counterclockwise rotation; set the second angle to zero. Both angles are in radians.

In order to see the variables, they must be assigned to one of the above displays. This is accomplished with the variable pointers as

(Variable) (nmopq) (Compartment) (Layer).
12345

Variable is one of the available variables VENT, HEAT, PRESSUR, WALL, TEMPERA, INTERFA, N₂, O₂, CO₂, CO, HCN, HCL,

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TUHC, H₂O, OD, CT used as a label for the line. The species listed correspond to the variable "SPECIES" in FASTplot. In the variable list of FAST, all are contained in the variable TOXICT. (nmopqr) is a vector which points to

index	display in
(1) n	-> bar chart
(2) m	-> table
(3) o	-> view
(4) p	-> label
(5) q	-> graph

respectively. These numbers vary from 1 to 5 and correspond to the value of "n" in the "where to put it" specification. **Compartment** is the compartment number of the variable and **Layer** is "U" or "L" for upper and lower layer, respectively.

Examples:

```
WINDOW      0   0 -100 1280 1024 1100
GRAPH 1  250. 170.  0. 1220. 900.  10.  5 TIME  CELSIUS
LABEL 1  970. 960.  0. 1231. 1005.  10. 15 00:00:00          0.  0.
LABEL 2  690. 960.  0.  987. 1005.  10. 13 TIME [S]          0.  0.
LABEL 3   90.  920.  0.  730. 1020.  10.  4 Single_Compartment_demo 0.  0.
LABEL 4  400.  610.  0.  687.  660.  10.  1 U_layer_temperature .1  0.
LABEL 5  400.  270.  0.  687.  320.  10.  1 l_layer_temperature  .0  0.
TEMPERA 0 0 0 0 1 1 U
TEMPERA 0 0 0 0 1 1 L
```

In this case, a new window is defined, along with one graph and five labels. Both temperature variables are assigned to graph 1. One quirk is not obvious. It is assumed that time is always to be displayed if any labels are present. To this end, label 1 is always used for the time in the units HH:MM:SS. Graph 1 has the label "TIME" on the abscissa and "CELSIUS" on the ordinate.


```

WINDOW      0      0 -100 1280 1024 1100
GRAPH 1 120. 300. 0. 600. 920. 10. 3 TIME PPM
GRAPH 2 740. 300. 0. 1220. 920. 10. 3 TIME CELSIUS
LABEL 1 970. 960. 0. 1231. 1005. 10. 15 00:00:00 0. 0.
LABEL 2 690. 960. 0. 987. 1005. 10. 13 TIME [S] 0. 0.
LABEL 3 200. 050. 0. 520. 125. 10. 14 CO2 O2 CONCENTRATION 0. 0.
CO 0 0 0 0 1 1 U
TEMPERA 0 0 0 0 2 1 U
TEMPERA 0 0 0 0 2 1 L

```

This file sets up two graphs with the CO data from the upper layer of compartment 1 in the first graph and both the upper and lower layer temperatures displayed on the second graph.

```

WINDOW      0      0 -100 1280 1024 1100
GRAPH 1 150. 300. 0. 620. 920. 10. 3 TIME PPM
LABEL 1 390. 960. 0. 651. 1005. 10. 15 00:00:00 0. 0.
LABEL 2 110. 960. 0. 407. 1005. 10. 13 TIME [S] 0. 0.
LABEL 3 200. 050. 0. 520. 125. 10. 14 O2 O2 CONCENTRATION 0. 0.
TABLE 1 700. 300. 0. 1200. 920. 10.
HEAT 0 1 0 0 0 1 U
O2 0 1 0 0 1 1 U
TEMPERA 0 1 0 0 0 1 U
TEMPERA 0 1 0 0 0 1 L

```

Here the four variables HEAT, O₂, and TEMPERATURE are displayed in table 1 and O₂ is shown in graph 1.

```

WINDOW      0      0 -100 1280 1024 1100
VIEW 1 800. 390. 150. 1200. 900. 200. DEMOFA.DAT 1.41 .48 1.33 0....
VIEW 2 420. 200. 50. 720. 500. 100. DEMOFA.DAT 1.53 -.46 1.21 0. ...
GRAPH 1 50. 290. 0. 300. 490. 10. 13 TIME PPM
GRAPH 2 150. 650. 0. 500. 850. 10. 13 TIME m3/U-1
GRAPH 3 510. 690. 0. 740. 890. 10. 13 TIME CELSIUS
GRAPH 4 810. 120. 0. 1160. 320. 10. 13 TIME HEIGHT
LABEL 1 760. 960. 0. 1021. 1005. 10. 14 00:00:00 0. 0.
LABEL 2 50. 10. 0. 250. 70. 10. 2 TEST_IN ONE_ROOM 0.57079 0.
LABEL 3 70. 960. 0. 367. 1005. 10. 13 FIRE [W] 0. 0.
LABEL 4 480. 960. 0. 777. 1005. 10. 13 TIME [S] 0. 0.
LABEL 5 300. 960. 0. 475. 1005. 10. 14 _____ 0. 0.
TABLE 1 220. 50. 0. 520. 250. 10.
HEAT 0 0 0 5 0 1 U
CO 0 1 1 0 0 1 U
CO 0 0 2 0 2 1 U
CO 0 1 1 0 1 1 U
CO 0 0 2 0 0 1 U
TEMPERA 0 1 1 0 3 1 U
TEMPERA 0 0 2 0 0 1 U
INTERFA 0 1 1 0 4 1 U
INTERFA 0 0 2 0 0 1 U

```

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Two views are specified, both emanating from the file "demofa.dat" with different transforms. Four graphs, three labels and one table will be displayed. All variables will be taken from the upper layer in compartment 1, and they will go to both views, in determining the hazard calculation. The variables will also be shown in table 1 and in the four graphs, respectively.

4.5 FAST_in

FAST_in is a highly interactive, user-friendly program used to generate most data files for input to the FAST model. As such, it is difficult to describe all the functions of the program in a reference guide. Rather, it is best learned through use. Chapters 2 and 3 provide such a learning guide. This section will describe the types of information entered on each of the screens of FAST_in and relate those to the specific sections which describe the FAST input file generated by FAST_in.

The user interface is organized into a series of screens, each of which addresses a general area of the process of modeling a fire. FAST_in may be started by selecting it from the shell or by typing

```
FAST_IN [/log]
```

and pressing enter as the DOS prompt. The command line directive in brackets is optional. If the option is given, a file named "FAST_IN.LOG" will be generated which contains a record of every keystroke during the session, for use in resolving problems. If help is requested, this "log" file should be supplied.

FAST_in is presented as a series of "screens" of associated data. General and key word help is always available except within the key word help section. The top of each screen shows the active screen

and today's date. The names are shown below and are roughly descriptive of the area which is covered. These correspond to sections in the data file discussed in the section describing the FAST input format. The bottom of the screen shows what special keys are active, or indicates what action is expected. If data can be entered, the range and units will be shown if appropriate. Room width will be in units of length, whereas a title has no dimensions.

The "screens" are

0	Initialization	only at the beginning
1	Overview	} primary sections
2	Ambient Conditions	
3	Geometry	
4	Thermal Properties	
5	Thermal Database	
6	Fire Specification	}
7	Calculations,...	
8	Results - temp,...	show results of calculation
9	Flow Field	

Note that the Initialization screen (screen 0) and the output screens (screens 7-9) do not correspond to sections of the data file. Rather, they are used to retrieve and save the data file created with FAST_in or to run the model with the present data set. Refer to section 4.4 for the details of the data entered on each screen.

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1. Overview	Title and time specifications from section 4.4.1 and 4.4.2
2. Ambient Conditions	Ambient conditions from section 4.4.3
3. Geometry	Floor plan data and connections from sections 4.4.4 and 4.4.5
4. Thermal Properties	Thermophysical properties of enclosing surfaces from section 4.4.6
5. Thermal Database	
6. Fire Specification	Fire specifications from section 4.4.6

In general, the program requests either data from the keyboard, or selection information from the function keys (or mouse if present). Any active function keys will be shown at the bottom of the screen. If the meaning is not clear, the **show keys** function key, **f9**, will give further explanation. Otherwise, there will be directions as to what further actions are possible. If alphanumeric input (data) is being requested, the entry must always be completed by pressing the **enter** key. For function keys, only a single keystroke is required. Some of the function keys are active throughout **FAST_in**; others are specific to certain screens. Those specific to individual screens are described in more detail on the following pages. Those active throughout the program are presented below.

key	key label	function
f1	go to page	Allows you to move directly from one screen to another within FAST_in . From any screen, pressing f1 brings up a menu listing all the screens in FAST_in . Using the mouse or the arrow keys, select the screen of interest and press enter or the left mouse button.
f2	return	Allows you to move directly from the current screen to the previous screen within FAST_in . As an example, if you are on the thermal properties screen and press Page

Down to move to the thermal database screen, pressing **f2** will return you to the thermal properties screen. Pressing **f2** again will take you again to the thermal database screen. This switching may be continued as long as desired.

f3 help

You may press the help key, **f3**, at any time to receive context sensitive help describing the current screen or current quantity being entered. Pressing **f3** a second time brings up a list of keywords for which more detailed help is available.

f8 change units

You may temporarily change the working engineering units displayed by FAST_in and used for data entry at any time by pressing **f8** and selecting the quantity to be changed with the up and down arrow keys. Pressing the right or left arrow keys changes the working units of the currently selected quantity. To change the units permanently, you must modify the installation parameters for HAZARD I as described in sections 2.2.3 and 2.2.4 of this **Software User's Guide**.

f9 show keys

provides a brief description of the function keys currently active and can be used to provide a quick reference of the current function of each of the keys.

f10 quit

is used to end the program.

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FAST_in v 2.3 Initialization

04/10/89

FILE: DATA.DAT

|file| |help| | 1R | 3R | | |keys|unit|quit| input=>

On the Initialization screen, the FAST input file to be edited with FAST_in is selected. The name of any DOS file may be entered by typing in the name of the file or the user may press the select file key, **f1**, to see a list of files in the current working directory. By default, all files with an extension of **.DAT** are presented in the list, consistent with the file extension conventions presented in chapter 3. If desired, the user may type a file matching pattern (such as ***.*** to see all files in the subdirectory) before pressing **f1**.

If a completely new data file is to be created, two generic data sets are built into the program. Key **f5** may be pressed to use a single-room case and key **f6** may be pressed to use a three-room case.

FAST_in v 2.3 Overview				04/10/89	
File: DATA.DAT		Title: demo #1 a single compartment			
Geometry		Time		Ambient Conditions	
Compartments	1	Simulation	180	Temperature	26.9
Vents...	1	Print	0	Pressure	1.0E+05
HVAC connect	0	Dump	5	Station elv.	0.0
		Display	5	Wind speed	0.0
				Scale height	10.0
				Power law	0.1600
Fire Specification					
Type Specified fire(constrained)					
Species tracked	O2	CO2	CO	TUHC	H2O
	CD		CT		
Range: Alphanumeric (50)			Units: Name or Title		
goto	rtrn	help		unit	keys
quit					input=> single compartment

The Overview screen presents a summary of the FAST data file. The title, simulation time, print interval, dump interval, and display interval may be changed on the screen. See sections 4.4.1 and 4.4.2 for detailed information on the parameters. All other information presented is changed on other screens of the program and is included here (in the "protected text" color) to provide a summary of the data set.

Only the permanent functions are operative on this screen.

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FAST_in v 2.3 Ambient conditions

04/10/89

	(internal)	(external)	
Temperature	26.9	26.9	
Pressure	1.0E+05	1.0E+05	
Station elv.	0.0	0.0	
Wind speed		0.0	
Scale height		10.0	
Power law		0.1600	
Compartments	1	Maximum pressure differential	0.0
Vents...	1	Maximum elevation change	2.30
HVAC connect	0	Total internal volume	32.6

Range: -73.1 to 76.9 Units: Temperature in CELSIUS

|goto|rtm|help| | | |unit|keys|quit| input=>

On the Ambient Conditions screen, the internal and external ambient temperature, pressure, and station elevation along with information on external wind may be changed. Ambient conditions are detailed in section 4.4.3. The wind speed, scale height, and power law are used to calculate the wind coefficient for each vent connected to the outside. The wind velocity is specified at some reference height. The power law then provides a lapse rate for the wind speed. An assumption is that the wind velocity vanishes at the surface. The formula used to calculate the wind speed at the height of any vent is $(\text{wind speed}) \cdot ((\text{vent height})/(\text{scale height}))^{(\text{power law})}$. The wind is applied to each external opening as a change in pressure outside of the vent. It is further modified by the wind coefficient used for the openings.

Only the permanent functions are operative on this screen.

FAST_in v 2.3 Geometry

04/10/89

Dimensions

Compartment Number: 1
Width: 3.30
Depth: 4.30
Height: 2.30
Floor elevation: 0.0

Vents(doors...)

with respect to first room					wrt second room			- absolute -		
#	width	sill	soffit	wind	#	sill	soffit	a sil	a sof	Vent(1->4)
1	1.07	0.0	2.0	0.0	2	0.0	2.0	0.0	2.0	1

Range: 0.0 to 150.0 Units: Distance in METER
|goto|rtm|help|ADD |DEL |O/C |SWPG|unit|keys|quit| input=>

On the Geometry screen, information on the sizes of all of the rooms and vents are entered. Sections 4.4.4 and 4.4.5 provide details. The screen is divided into an upper and lower "page" - one for the room dimensions and one for the vent information. The SWITCH PAGE key, **f7**, toggles between the two pages. A room or vent may be added or deleted using the ADD key (**f4**) or the DELETE key (**f5**). The OPEN/CLOSE key, **f6**, allows specification of vent position over the course of the fire as detailed by the CVENT parameter in FAST.

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FAST_in v 2.3 Thermal properties

04/10/89

Compartment Number

1

Ceiling properties:

OFF

Floor properties:

OFF

Wall properties:

OFF

Range: Alphanumeric (8)

Units: Name or Title

| go |rtrn|help|ADD |DEL |

| |unit|keys|quit| input=>

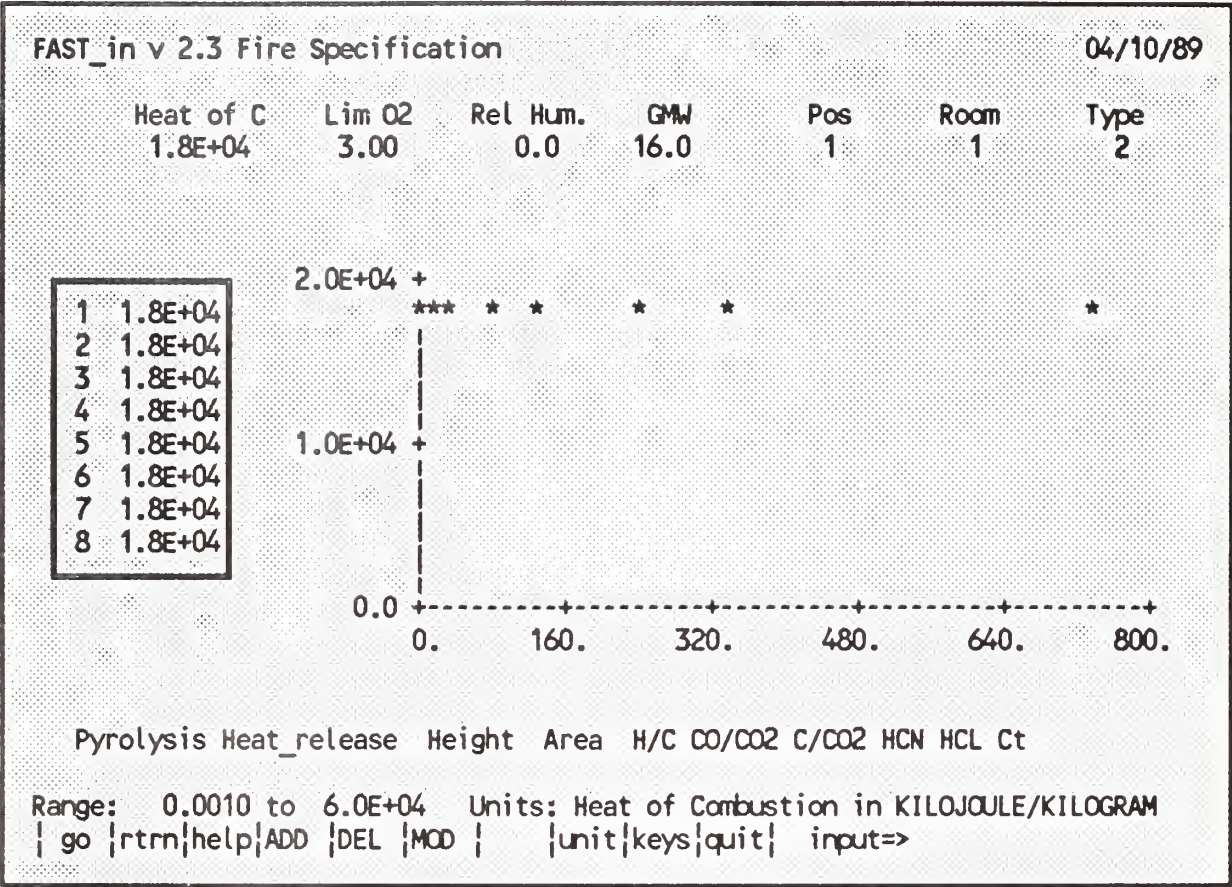
The Thermal Properties screen details the materials used for the ceilings, walls, and floors of all of the rooms as detailed in section 4.4.6. The name of a material contained in the FAST Thermal Database may be entered by first positioning the highlighted selection bar over the entry of interest and typing the material name exactly as it appears in the FAST thermal database. To make the process easier, a material name may be selected on the Thermal Database screen below, and designated for the currently selected surface by pressing the ADD PICKED key, f4. To specify an adiabatic surface, press the DELETE key, f5, to turn OFF the heat transfer calculation for that surface. If the word NONE appears, it means that the name entered does not appear in the Thermal Database.

FAST_in v 2.3 Thermal Database						04/10/89	
	Conduct	Specifi	Density	Thickne	Emissiv	* CODES *	
DFIR30	0.0002	0.9000	790.0	0.0160	0.9000		
PINEWOOD	0.0001	2.50	540.0	0.0160	0.8000		
CONCRETE	0.0018	1.00	2200.0	0.1500	0.9400		
REDOAK	0.0002	1.30	640.0	0.0160	0.9000		
FIBER	0.0	1.25	240.0	0.0160	0.9000		
GYPSUM	0.0002	0.9000	800.0	0.0160	0.9000		
WOOD	0.0	1.00	250.0	0.0160	0.9800		
DFIRO	0.0001	1.40	510.0	0.0127	1.00		
DFIR10	0.0002	1.50	560.0	0.0160	0.9000		
GLASS	0.0014	0.7600	2500.0	0.0160	0.9500		
GLASFIBR	0.0	0.7200	32.0	0.0160	0.9000		
KAOWOOL	0.0002	1.05	128.0	0.1160	0.9700		
GYP1	0.0001	0.9000	800.0	0.0250	0.9000		
GYP2	0.0001	0.9000	800.0	0.0500	0.9000		
BRICK1	0.0002	0.9000	790.0	0.0160	0.9000		
REDOAK	0.0002	1.30	640.0	0.0250	0.9900		D
GLASS	0.0014	0.7600	2500.0	0.0020	0.1000		D
WB	0.0001	1.17	4050.0	0.0250	0.8000		
Range: 0.0 to 0.0900 Units: Conductivity in KILOJOULE/SECOND/METER/CELS go rtrn help ADD DEL PICK unit keys quit input=>							

The contents of the FAST thermal database may be examined or changed on the Thermal Database screen. A new material may be added by pressing the ADD key (f4), or an existing one deleted by pressing the DELETE key (f5). A material can be chosen (and later added in the Thermal Properties screen) by positioning the highlighted selection bar over the material and pressing the PICK MATERIAL key, f6.

Caution: If the database file contains data on layered assemblies, do not add materials to the file with the ADD key on this screen. This will result in the deletion of the middle and outer layers. Such files may be changed with the editor built into the HIS.

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All data pertaining to the combustion properties are entered on this screen. The heat of combustion, mass loss rate, and species yields computed by MLTFUEL are entered, along with selection of the fire room and fire type as described in the chapter on FAST. Note that fire chemistry is only allowed for constrained (type 2) fires.

A species may be added or deleted from the calculation using the ADD key (f4) or the DELETE key (f5). The time intervals may be modified by pressing the MODIFY TIME key, f6.

FAST_in v 2.3 Calculate,...

04/10/89

run this data set <f4> time 0 maximum 180 (seconds)
 quick estimates <f5> asks for a time interval
 run time graphics (FAST) <f6> no
 save data file(s) <f7>
 write to log file <f8> no

| go |rtrn|help| | | | | |quit|

Once data for a test case has been entered or modified using FAST_in, you may run the data set using a version of the FAST model, or save the data to disk to run with the complete version of FAST. To run the model, press **f4**. To save the data to a disk file, press **f7**. You may also append a simple graphics descriptor to the FAST data file by pressing **f6**. The resulting display will show selected variables in a simple X-Y plot on the screen as the model calculates the results. If problems are encountered with FAST_in, you can document the problem by generating a log file with the **f8** function key and repeating the sequence of commands which generates the problem. This file will allow technical experts to duplicate, evaluate, and correct the problem more easily.

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FAST_in v 2.3 Results - temp..

04/10/89

Time:0.0

Compartment Number:1

Upper layer temp:26.9

Lower layer temp:26.9

Upper volume:0.0326

Layer depth:0.0023

Ceiling temp:26.9

Upper wall temp:26.9

Floor temp:26.9

Plume flow rate:0.0

Pyrolysis rate:0.0

Fire size:0.0

Vent fire:0.00.0

Pressure:0.0

Units: Temperature in CELSIUS

| go |rtrn|help| FF | | |unit|keys|quit|

If you decide to run the data set from within FAST_in (by pressing the **f4** key on the Calculate screen), the Results screen displays the calculation as it proceeds. The screen is updated for each print interval specified on the Overview screen. You may suspend the calculation at any time by pressing the **esc** key, change the data and resume the calculation with the modified input by pressing **f4** on the Calculate screen.

The permanent function keys are active only when the calculation has been suspended. Pressing the FLOW FIELD key, **f4**, on the Results screen, displays the vent flows at the time the calculation was suspended.

4.6 FASTplot

The FAST model provides 3-D pictorial results and graphs while the model is executing. The model predicts the environment produced by a fire in one of several compartments, or rooms, and follows smoke and toxic gases from one compartment to another, separately predicting values for each of the variables in both the upper and lower layers. The results for "FAST" are written to a special data file (the "dump" file) after each prescribed time step. FASTplot is intended to provide a visual interface to generate graphs and tables from the time histories saved by the model. FASTplot has the capability to form a list of variables, read in their values at each time interval, list the values in tabular form, plot the values, and save the variables in a formatted file for use with other software. In addition, it has the capability to read dump files created by other programs to plot along with FAST data.

To use FASTplot, select it from the shell or type the following command from the DOS prompt:

```
FASTPLOT <input> <,output > </N> </monitor type>
```

followed by an **enter**. All of the command line arguments and options are optional and are defined as

- | | |
|-----------------------|---|
| <input> | specifies the name of the DOS file or device from which the commands for FASTplot will be read. Normally (and by default if the argument is omitted) the keyboard will be used for input. |
| <output> | specifies the name of the DOS file or device which will receive the printed output and command prompts from FASTplot. Normally |

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(and by default if the argument is omitted) the screen will be used for output.

</N> including a **/N** on the command line will suppress the extended sign-on message issued by FASTplot.

</monitor type> Fastplot can usually recognize the type of graphics monitor attached to your comuter system automatically. If graphics output is garbled or not of the highest resolution possible for your system, you may include an option on the command line to force the graphics monitor to an appropriate type. The supported monitors are described in detail in section 4.5.

For the FAST dump files, the variables currently available are

boundary surface temperature (ceiling, floor)	WALL	C
entrained mass flow in the plume	ENTRAIN	kg/s
hcl wall surface concentration	HCL	kg/m ²
heat release in lower layer	LPLUME	kW
heat release in upper layer	UPLUME	kW
heat release in flame out a vent	VFIRE	kW
heat release rate of the fire	HEAT	kW
layer height	INTE	m
layer temperature	TEMP	C
layer mass density	MASS	kg/m ³
mass flux from the plume into the upper layer	PLUME	kg/s
pyrolysis rate of the fuel	PYROL	kg/s
pressure	PRES	Pa
radiation field to a target	TARGET	W/m ²

species density ¹	SPECIES	
total radiative heat flux into the layer	RAD	W
total convective heat flux into the layer	CONVEC	W
vent flow	VENT	kg/s
vent entrainment	JET	kg/s
volume of the upper layer	VOLUME	m ³

After identifying information, a "command prompt" appears and commands to direct the generation of the tables and graphs may be entered. Commands available at the "command prompt" are

ADD	LIST
ASCII	PLOT
AGAIN	RAPID
CLEAR	READ
DEFAULT	REVIEW
DELETE	SAVE
END	SHIFT
HELP	TENAB
FILE	VARIABLE

These commands can be broken into five major groups that describe the process used to generate tabular or graphical output with FASTplot. The following is a description of each of the commands. At least three characters must be used to identify a command.

¹ For nitrogen, oxygen, carbon dioxide, fuel (tuhc) and water, the units are volume percent. For carbon monoxide and hydrogen cyanide, the units are parts per million. For optical depth the unit is inverse meters, and CT is dimensionless.

4.6.1 Entering Data Into FASTplot

FASTplot can currently read three types of data files:

- data created by the FAST model (FAST dump files),
- data created by the TENAB model (TENAB dump files), and
- data created in specially formatted ASCII text files from other programs including RAPID, a program developed by CFR for analysis of large-scale fire tests.

Several commands are available within FASTplot to read these data files. They are FILE, AGAIN, and ADD (for FAST files), ASCII and RAPID (for ASCII text files), and TENAB (for TENAB files). In addition, several commands provide ancillary functions to support data entry.

ADD

This command is used to build a list of FAST variables to be read into the active list. When an option is requested, ADD may be entered by itself or together with a list of variables that are to be added. If it is entered alone, there will be a request for the variables that are to be added to the list. For example:

```
> ADD
- INPUT VARIABLES TO BE ADDED>
or
> ADD TEMP,PRES,.....
```

For each variable selected there is a series of questions that will be asked to identify the type of that variable wanted. A question asked about all variables is:

WHICH COMPARTMENT? ->

For layer dependent variables, the user is asked to input the layer (U for upper or L for lower):

WHICH LAYER? ->

If VENTFLOW is chosen the compartment origin and destination will be requested as will the vent number; if SPECIES is selected the species name (O₂, CO₂,...) will be requested.

The maximum number of variables allowed in the active list at any one time is 20. If the list is full or the variable is presently in the active list the addition will be disallowed and another option requested.

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ASCII	Read a file in columnar ASCII format. The next query will be for the columns to read. In order for this to work, there must be a column which corresponds to the default column as selected by the "DEFAULT" command. Normally this will be time, but can be any other column as desired.
FILE	The FILE command allows the user to specify the FAST dump file name for subsequent ADD commands. FILE applies only to FAST dump files.
RAPID	Read a file in the RAPID format. The next query will be for the channels to read. In order for this to work, there must be a channel which corresponds to the default channel as selected by the "DEFAULT" command. Normally this will be the time channel, but can be any other channel as desired.

TENAB

Read a file in the TENAB format. The TENAB program produces estimates for a number of tenability criteria for persons exposed to a fire environment predicted by the FAST model. The user must enter the "person number" and the desired criteria to be read from the file. The possibilities are:

Tenab Variable List

1. Fractional Effective Dose Due to Gases - Bukowski
2. Fractional Effective Dose Due to Gases - Purser
3. Fractional Effective Dose Due to CO2 - Purser
4. Temperature - Deg C
5. Fractional Effective Dose Due to Convective Heat
6. CT (G-MIN/M3)
7. Flux (KW-MIN/M2)
8. Derksen Curve

The AGAIN, CLEAR, DELETE, READ, and REVIEW commands allow the user to view and manipulate the list of variables read with the data entry commands.

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AGAIN

This will repeat the input of a list of variables for a new file. The program maintains a list of the most recently acquired FAST variables. First, get a file with "FILE," then get a set of variables. Once again using "FILE," get a new file and then use AGAIN to get the same list of variables on this new file. This function simplifies direct comparisons between runs of FAST.

CLEAR

This command empties the current variable list.

DELETE

When this option is entered the present list of variables will be printed to the screen and the user will be asked to input the variables to delete by the number associated with them on the list. They must be entered on a single line separated by commas or blanks. If the variable number that is input does not correspond to one that is currently on the list it will be skipped. After the deletions have been processed a new list is presented and another option requested. If the list is presently empty then that fact will be stated in an error message. One caution is in order. The variables are deleted by the number in the list, rather than by rank ordering within a group. This is important in conjunction with use of the AGAIN command.

READ READ is used to force a read of the data files. This is most useful for script files which can be processed automatically to display data. It is equivalent to pressing an <enter> at the "read prompt" in the interactive mode.

REVIEW At times the user may wish to see what is presently on his list before entering a command. This may be done with the REVIEW command. It will print out the current list along with the compartment number, species, and layer of each of the variables. After the printing of the entire list, the option request is again displayed.

4.6.2 Generating Tables and Graphs With FASTplot

The commands LIST and PLOT allow the user to generate a table of values of selected variables or a graph of selected variables. The SHIFT command allows the user to shift the abscissa or ordinate axis of a variable.

LIST List the values of any of the variables on the list to the screen. The variables to be listed and the time range of the list are entered. After the list appears on the screen, it can be printed with the PRINT SCREEN key.

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PLOT

After entering the PLOT command, the current list of variables will be displayed along with their numbers. They should be entered in a string separated by commas or blank spaces. For example:

Select 1->4 graphs by grouping variables
with parentheses followed by a <return> >1,2,3,4

or

Select 1->4 graphs by grouping variables
with parentheses followed by a <return> >1 2 3 4

Variables to be plotted together on a single graph are grouped in parentheses. For example:

Select 1->4 graphs by grouping variables
with parentheses followed by a <return> >(1 2 3 4)

Normally, the program will scale the axes automatically. However, if the automatic formatting option has been turned off, then before the graph is drawn, the user is given the opportunity to change the range of the X and Y axes and the graph legends. The maximum and minimum value of the X and Y axes will be displayed, followed by a request for a change in each, which will be of the form. If no change is desired simply enter an <enter> and the next axis change will be displayed:

The Min/Max for Temperature are
X = 0.00 TO 2000.00
Y = 0.00 TO 1000.00

<ENTER> If no changes are desired.
Xmin = 0.00, Change to =
Xmax = 2000.00, Change to =
Ymin = 0.00, Change to =
Ymax = 1000.00, Change to =

Similar prompts are made for the legends for each graph. The user is allowed to change the text for each curve label and the position. If no changes are desired, the <ENTER> key may be pressed to accept the suggested values for the legend text and position:

```
Legend for 1 (Temperature 1 U ) is |R 1 U|. :  
<ENTER> For no change:  
Legend for 2 (Temperature 2 U ) is |R 2 U|. :  
<ENTER> For no change:
```

```
Legend for graph 1 is at X=    40.00, Y=    945.49  
<ENTER> If no changes are desired.  
      X =    40.00, Change to =  
      Y =    945.49, Change to =
```

When all the changes have been made (if any) the graph of that particular variable will be plotted. After the graph has been completed the option request will be displayed and a new option may be entered.

SHIFT

SHIFT is used to adjust the variable axes. Typically, it is used only when plotting variables from different files to normalize the data to a common ignition time, initial temperature, or the like. The required input is a selection of the axis to shift, the amount of shift, and a list of channels. Please note that shifting the time axis for a single variable will shift the time axis for all variables associated with that particular file. Such an effect occurs because only one vector of values is kept for the time line for each file.

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4.6.3 Printing Copies of FASTplot Graphs

A utility program called **METAPRNT** is provided with the HAZARD I software to allow you to print copies of the graphs on the screen on several dot-matrix printers. **METAPRNT** operates with most popular graphics adapter cards and can be used with the following printers: IBM Dot Matrix, IBM ProPrinter, Epson MX-80/100 or FX-80/100.

To use the screen copy facility, you must first execute the program **METAPRNT** *prior to starting HAZARD I* to install a resident driver. Subsequent presses of the **SHIFT-PRTS** key will activate the **METAPRNT** utility to freeze the graphics screen and copy it to the dot matrix printer. To install the print utility, type the following command at the DOS prompt *prior to starting HAZARD I* :

METAPRNT <options>

The **<options>** allow you to control the output display format:

- /R --** Rotate picture 90°
- /I --** Inverse print
- /F --** Form feed after printing
- /2 --** Use printer attached to LPT2 instead of LPT1
- /H --** Help
- /K --** Kill. Removes **METAPRNT** from memory

For higher quality output, an output file compatible with Hewlett-Packard HPGL plotters can be generated and subsequently copied to the plotter. Section 4.6.5 provides details of specifying the HPGL output format.

4.6.4 Saving Data With FASTplot

The save command allows the user to create an ASCII text file in one of two formats. These files may be used for future FASTplot runs or for exporting FAST or TENAB data to other programs.

SAVE

A command to save the values of the variables in the list into a file. The format used will depend on the option chosen in "DEFAULT," columnar data for spreadsheet and charting programs, or row data for making the data directly compatible with our data processing program (RAPID) designed for the reduction of experimental data in the Center for Fire Research.

The user will be asked for the name to be used for the file. A check will be made to see whether that file presently exists or not. If it does, the user will be asked if he wants to write over the old file with this new data. If his answer is NO, nothing will be placed in the file and other option requested. If, however, he does want the file rewritten, or the file does not already exist, the new file will be created and the data stored in it.

Columnar data is straightforward, with each variable listed. The time channel will be the first column. For files in the row format, each variable in the list will be saved with the following line at the beginning of each block of data:

I6,I6,A6,*-----COMMENT-----

The first I6 will be for the number of data points for that variable, the next I6 is for the number given to that variable on the list, and the A6 is the actual variable name. Everything after the * is a comment block and will be filled with information relevant to that particular variable, such as species number, compartment number, layer, etc. The actual numerical data will be written using the format 7E11.5.

4.6.5 Changing the Default Parameters in FASTplot

The default command allows the user to change a number of default parameters within FASTplot. These defaults specify the format of the graphical output and assumed values for some of the input parameters (ones where the user may simply press the ENTER key).

DEFAULT

This enables the user to set default parameters for the following:

Default compartment specifies the compartment number to be used whenever the user presses an enter in response to a question requesting a compartment number. **Ventflow destination** specifies the compartment number for the "to compartment" for vent flows. **Default species** and **default layer** specifies the species and layer to be used whenever the user presses an enter in response to a question requesting a species or a layer, respectively. **Character set** is a number from 1 to 25 which specifies a different typeface to be used. Only character sets 4, 7, 24, and 25 are supplied with HAZARD I.

Graphics device specifies where the graphic output will be placed. Allowable outputs are type 4 or SCREEN for output to the screen and type 6 or HPGL for output to a file formatted in format for Hewlett-Packard format devices. **Automatic plot formatting** allows the user to customize the format of the graphical output. A response of Yes tells the program to format the axes and legends automatically, or No to allow the user to select the axis limits and legend text manually for each plot. **Channel for abscissa** specifies the channel number to be used for the horizontal axis for data read from RAPID format data files with the RAPID command. **Factor for abscissa** specifies the number of the column of data to be used for the horizontal axis for data read in ASCII format. **Type of save file** specifies the format of the file written by the SAVE command. Finally, **Draw curves in color (Y/N)** and **Draw curves with dashed lines (Y/N)** allow the user to specify the lines to be drawn for each variable in a plot.

The defaults are saved in a permanent file on the disk so the next execution of FASTplot will use whatever defaults were most recently selected.

4.6.6 Getting Online Help in FASTplot

The HELP and VARIABLES command provides some simple online help for using FASTplot.

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HELP

This command may be entered at any time that the user is asked for an option. Its purpose is to list to the screen, the available commands and a brief explanation, after which another option will be asked for.

VARIABLES

Show the list of variables which are available. This list is identical to the one shown at the beginning of section 7.

4.6.7 Exiting FASTplot

The END command terminates the execution of FASTplot. IF desired, any data which has been read into FASTplot should be saved prior to entering this command. Any data not saved will be lost upon exiting the program and must be re-entered if it is to be used again.

4.7 FIREDATA

4.7.1 Introduction

The material properties database for the Hazard Assessment Method was created using DbaseIII Plus. (DbaseIII Plus will hereafter be referred to simply as Dbase.) To facilitate the use of the data base, a set of procedures was written to enter, edit, and retrieve data for use as input to HAZARD I. The procedures were written to give the casual Dbase user access to the information contained within the databases as well as update them without understanding the databases, their structure, or their relationship to each other.

4.7.2 Database Structure

The material properties database is composed of five interlocked (not indexed) databases. This was done to reduce the search time for specific pieces of information. The five databases are:

- Material Directory (MATDIR.DBF);
- Material Property (PHYSICAL.DBF);
- Cone Calorimeter (DECOMCC.DBF);
- Furniture Calorimeter (DECOMFC.DBF);
- Toxicity (TOXICITY.DBF).

The databases have two fields in common; the material code (Mcode) and the material identification or description (Mid). The databases, however, are not indexed. For special applications, this will allow one or several of the databases to be accessed by a user written retrieval program outside of the Dbase environment.

The material directory (MATDIR.DBF) contains information about the presence of data in the other four databases for a given material code or material description. For example, if toxicity data is necessary, the procedures will first check the material directory database to ascertain if the material of interest has been entered into the databases and, in particular, if data exists in the toxicity database. When data are entered into the databases, a record for each material code is added to the material directory indicating the material code, material description and four TRUE/FALSE fields showing where data has been placed in the other four databases.

The material property database (PHYSICAL.DBF) contains information on the thermophysical properties of a material. It is composed of a single input form, figure 4-1, that provides conductivity, specific heat, and emissivity values for a given material as a function of temperature. Up to six temperatures can be entered or

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Thermophysical Data			
Material Code: RDO001			
Material ID: RED OAK			
Form:		Volume Density:	640.00 kg/m3
		Areal Density:	0.000 kg/m2
Temperature	Conductivity	Specific Heat	Emissivity
(C)	(kW/(mzk))	(kJ/(kgzK))	
20.0	0.000150	1.3000	0.900
100.0	0.000190	1.8200	0.900
0.0	0.000000	0.0000	0.000
0.0	0.000000	0.0000	0.000
0.0	0.000000	0.0000	0.000
0.0	0.000000	0.0000	0.000

Figure 4-1. Material property database.

retrieved. These values relate to a specific form and density of material. For other densities or forms, additional records must be entered. This database contains records relating to combustible and noncombustible materials which serve as interior finish (walls, floor, ceiling) or as furnishings. For example, the thermophysical properties of firebrick as well as carpeting will be found in the database.

Three databases exist that contain fire response or fire property data. Small-scale heat release and species yield data (grams of the species produced by each gram of fuel lost) are contained in the Cone Calorimeter database (DECOMCC.DBF), while medium- and large-scale heat release and species yield data are contained in the Furniture Calorimeter database (DECOMFC.DBF). Toxic potency data can be found in the toxicity database (TOXICITY.DBF).

The Cone Calorimeter database (DECOMCC.DBF) consists of a two screen forms, figures 4-2 and 4-3. The first screen contains basic information about the test sample and exposure conditions (i.e., initial and final sample weight, orientation, ignition mode, incident energy, time to ignition). A summary of the test results,

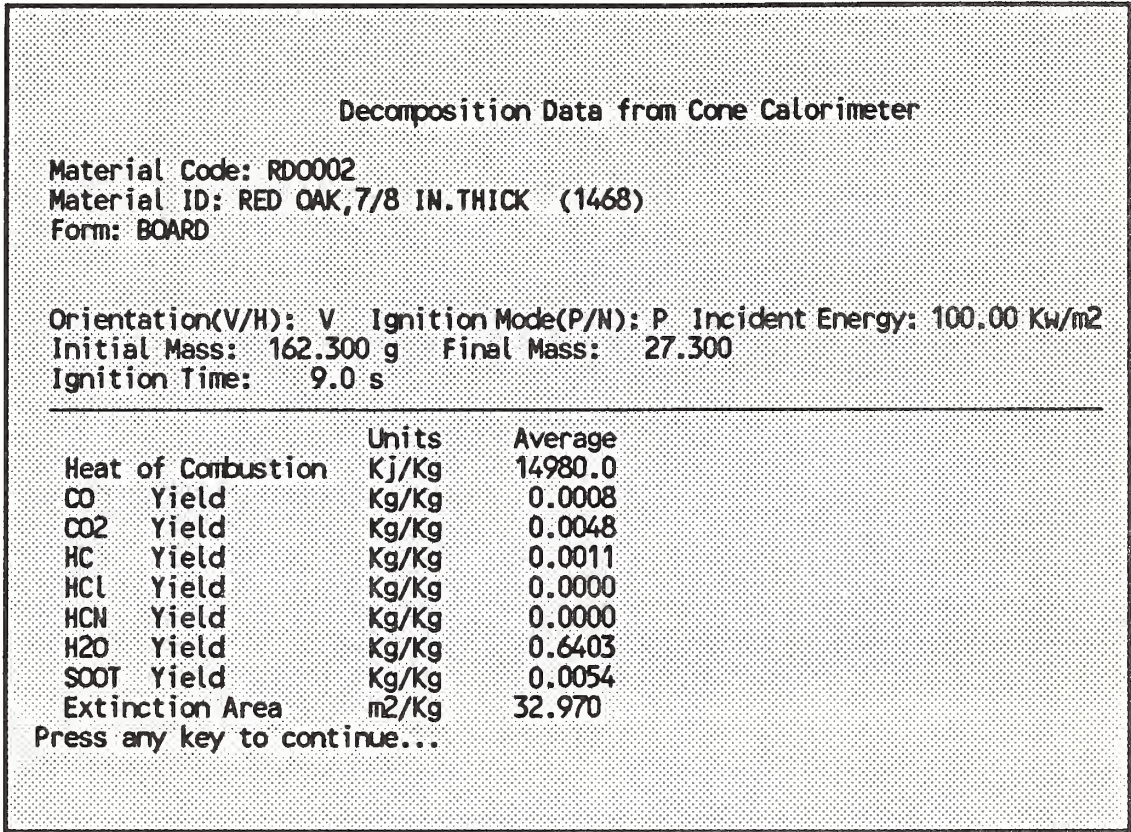


Figure 4-2. First screen of the Cone Calorimeter database.

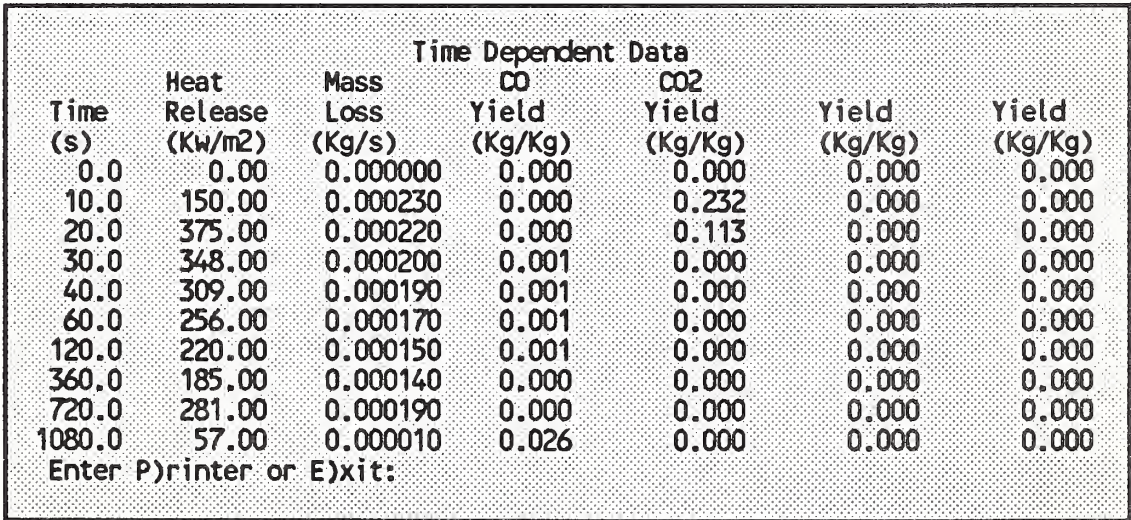


Figure 4-3. Second screen of the Cone Calorimeter database.

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where available, can also be found on this screen. This is presented in the form of average and maximum values and the time for the maximum value (from either ignition or start of exposure for non-flaming exposures). The second screen contains time dependent data for heat release rate, mass loss rate, CO yield, and CO₂ yield. Two additional time dependent fields are provided for user defined yields of other combustion products (e.g. soot, HCN, etc.).

The Furniture Calorimeter database (DECOMFC.DBF) is similar to the Cone Calorimeter database. It is also divided into two screens, figures 4-4 and 4-5. The first presents test sample and exposure information as well as average and maximum values. The second screen represents time dependent information for the same properties as described for the second screen of the Cone Calorimeter database. Data from furniture items tested in large-scale compartments are also included in this database.

Decomposition Data from Furniture Calorimeter			
Material Code: UPC001			
Material ID: UPHOLSTERED CHAIR,F21,WOOD FRAME,PU FOAM-FR,OLEFIN			
Configuration: CENTER			
Ignition Source: GAS BURNER,50KW,200S			
Initial Mass:		28.300 kg	Final Mass: 0.000 kg
Ignition Time:		0.0 s	
		Units	Average
Heat of Combustion		kJ/kg	18100.0
CO	Yield	kg/kg	0.0000
CO2	Yield	kg/kg	0.0000
HC	Yield	kg/kg	0.0000
HCl	Yield	kg/kg	0.0000
HCN	Yield	kg/kg	0.0000
H2O	Yield	kg/kg	0.0000
SOOT	Yield	kg/kg	0.0000
Extinction Area		m2/kg	0.000
Press any key to continue...			

Figure 4-4. First screen of the Furniture Calorimeter database.

Time Dependent Data						
Time	Heat	Mass	CO	CO2	SMOKE	
(s)	Release	Loss	Yield	Yield	Yield	Yield
	(kW)	(kg/s)	(kg/kg)	(kg/kg)	(kg/kg)	(kg/kg)
0.0	0.00	0.000000	0.000	0.000	0.000	0.000
60.0	0.00	0.000000	0.000	0.000	0.000	0.000
150.0	90.00	0.005000	0.030	0.670	0.008	0.000
200.0	450.00	0.025000	0.024	0.760	0.015	0.000
260.0	2100.00	0.116000	0.016	1.070	0.020	0.000
325.0	600.00	0.033000	0.000	0.710	0.022	0.000
450.0	150.00	0.008000	0.016	0.590	0.001	0.000
600.0	150.00	0.008000	0.000	0.540	0.000	0.000
900.0	90.00	0.005000	0.000	0.750	0.000	0.000
2000.0	0.00	0.000000	0.000	0.000	0.000	0.000
Enter P)rinter or E)xit:						

Figure 4-5. Second screen of the furniture calorimeter database.

The toxicity database (TOXICITY.DBF) is composed of two screens of LC_{50} data. The first screen, figure 4-6, provides data from the cup furnace toxicity screening protocol (NBS), while the second, figure 4-7, provides data on material tests performed according to the University of Pittsburgh Protocol. For the NBS Toxicity Protocol, auto-ignition temperatures are listed. Provisions for several different LC_{50} endpoint times are made. This is intended to accommodate the input of pure gas data as well as possible future alterations in the protocol. The University of Pittsburgh screen also allows for variations in data reported by small alterations in the protocol. Here provisions are made for different heating rates of the sample and different endpoint times for the determination of LC_{50} values (in grams).

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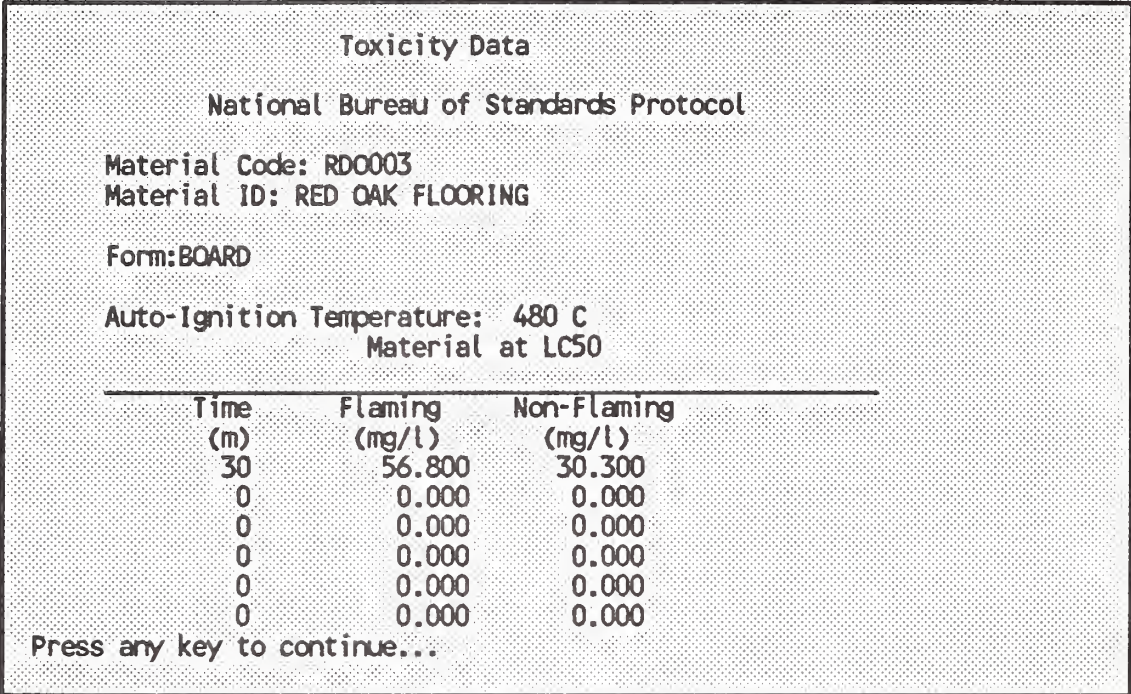


Figure 4-6. First screen of the toxicity database.

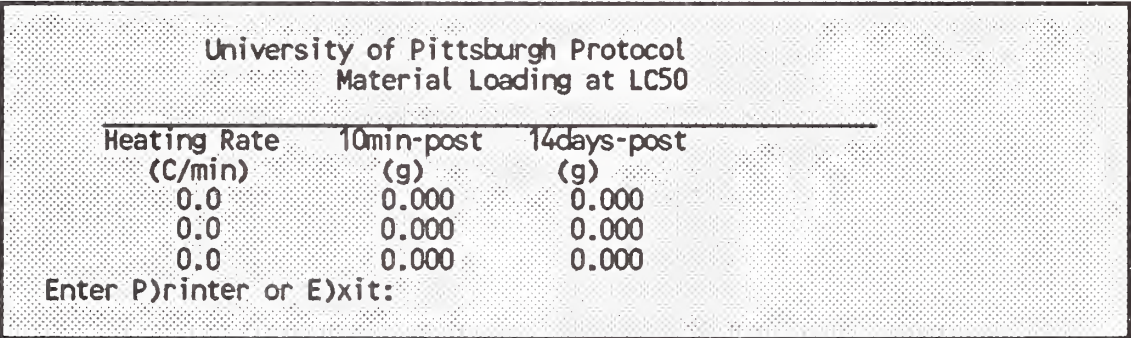


Figure 4-7. Second screen of the toxicity database.

4.7.3 Program Structure

FIREDATA is a program that operates as a DOS program. It is actually the main program of a series of subprograms that give the user the capabilities to add, edit, and retrieve data from a collection of databases with only a casual familiarity with Dbase. There are two levels to FIREDATA. The first level is FIREDATA.PRG. At

this level the user is able to move to the second command level by selecting a specific operation (i.e., appending, editing, searching).

The group of subprograms are dedicated to perform a specific operation on a specific database. There are four programs for adding data, one for each database, and four programs for editing data, one for each database. Associated with each database, there is a format file that contains the input form that is used to enter data into each database. These format files are shared by the ADD and EDIT options. They have files names of TOXFORM.FMT, CONFORM.FMT, FURNFORM.FMT, and PHYFORM.FMT.

Data can be recalled in one of two ways. One approach is to search for a specific data record. The other approach is to list blocks of data records. The FIND and LIST options implement these two approaches. Both options share the same print programs. These appear as TOXFMT.PRG, CONEFMT.PRG, PHYFMT.PRG, or FURNFMT.PRG.

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Figure 4-8 is an overview of the FIREDATA program structure showing the relationship between the various parts. As can be seen, it is not possible to move between second level commands without first returning to the first level commands. This is done to ensure that databases are properly closed before moving on to the next operation.

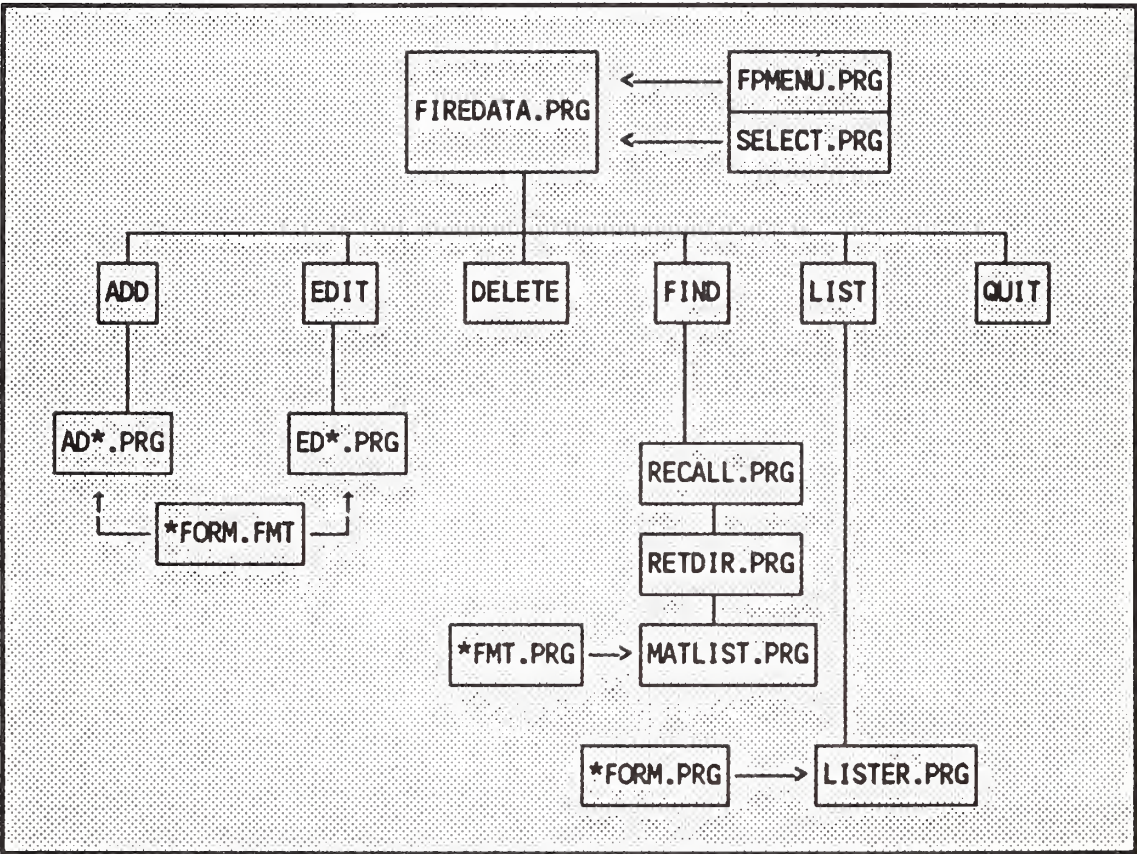


Figure 4-8. FIREDATA program structure.

4.7.4 Starting FIREDATA

FIREDATA is started by selecting it from the shell or by typing
FIREDATA

and pressing **enter** at the DOS prompt.

A main menu screen is presented to the user that requests a character be entered from the list of six possible choices:

A)dd	E)dit	D)eleete
F)ind	L)ist	
Q)uit		

followed by pressing **enter**. Any other entry will be ignored. If the user selects **Q**, the program will close all files, reset screen parameters, and end **FIREDATA** returning to the shell or to **DOS**.

4.7.5 Adding Data

If the user selects **A**, a secondary menu is placed on the screen. This menu requires that the user select the database to which the data will be appended. There are six selections at this point as well.

M)aterial property	C)one calorimeter
T)oxicity	F)urniture calorimeter
A)ll	E)xit

If the user selects **E**, the program returns to the previous menu. If the user selects **A**, the program will sequentially request information for each database beginning with material property (i.e., thermophysical properties), Cone Calorimeter, Furniture Calorimeter, and, finally, toxicity. Any other selection, moves the user directly to entering data for that particular database.

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The selection of a particular database for data addition results in one of four forms being presented to the user. The forms that are presented to the user are those shown in: figure 4-1 for material property data; figures 4-2 and 4-3 for Cone Calorimeter data; figures 4-4 and 4-5 for Furniture Calorimeter data; and figures 4-6 and 4-7 for toxicity data. Each form is to be completed by the user in as complete a fashion as possible. Errors on a given field can be corrected by backspacing and typing over the incorrect information. If one has left the field, the cursor control keys (i.e., arrow keys) can be used to return to a previous field and type over the error. On a multi-screen form, either screen can be reviewed by using the "Page Down" key to move forward or the "Page Up" key to move backward. At the completion of each form, the user is required to depress the "End" key while holding down the "Ctrl" key. This ensures that the data are properly appended to the database. The program prompts the user to determine if another record will be appended to the same database.

"Do you want to exit this operation?(Y/N)"

If the user responds "Y", then the program returns to the previous menu. If the user responds "N", then the program presents the user with a blank form. This enables the user to append information to a given database on several materials without returning to the selection menu.

For the A)ll option, the forms that are presented to the user are those shown in: figure 4-1 for material property data; figures 4-2 and 4-3 for Cone Calorimeter data; figures 4-4 and 4-5 for Furniture Calorimeter data; and figures 4-6 and 4-7 for toxicity data. As each screen of a multi-screen form is completed, the program automatically presents the user with the second screen. Prior to completing the second screen the user may use the cursor control keys (i.e., arrow keys) to move about each screen and move from screen to screen with the "Page Up" and "Page Down" keys. The "Enter" key may be used to leave every field except the last field on the entire form.

(That is, for multi-screen forms the last entry on the last screen.) It is preferable to use the cursor keys to leave each field. *In order to actually append the data to the end of a database, the user must depress the "End" key while holding down the "Ctrl" key. Once data has been appended to a database, changes in a field must be accomplished by using the Edit option in the main menu.*

4.7.6 Editing Data

If the user selects E, a secondary menu is displayed on the screen. This secondary menu is identical to that used in adding data to a database.

M)aterial property	C)one calorimeter
T)oxicity	F)urniture calorimeter
A)ll	E)xit

However, the A)ll option is not functional under this selection choice. If the user selects E, the program returns to the previous menu. Upon selecting a database, the program requests that you

"Enter MATERIAL CODE of record to be edited:".

This is the Mcode previously discussed. For the selected database, the program searches for a match between the Mcode entered by the user and the Mcodes stored in the database. If a match is not found, the program informs the user of that fact. The program responds in one of two ways. It either says

"Not found in {name of} database"

or

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"NO data in {name of} database",

where {name of} is the name of one of the four databases. The first response indicates that the database may have been corrupted. This problem may be beyond the capabilities of the casual user to correct, because it indicates that the data should be present in the database but is not. *(The only protection from a corrupted database is to keep regular back-up copies of the files and go back to the last good copy if a corruption occurs.)* The second response simply means that the data has never been entered for this Mcode into this particular database.

If a match is found, the program presents the information in the selected record using the original screen forms. Thus, for material property data, figure 4-1 is used; for Cone Calorimeter data, figures 4-2 and 4-3 are used; for Furniture Calorimeter data, figures 4-4 and 4-5 are used; for toxicity data, figures 4-6 and 4-7 are used. Corrections and additions on a given field can be accomplished by using the arrow keys to position the cursor in the desired field and type over existing data or type in missing data. Corrections within a field are done by backspacing and typing over the incorrect information. If one has left the field, the cursor control keys can be used to return to the offending field and type over the error. On a multi-screen form, either screen can be reviewed by using the **Page Down** key to move forward or the **Page Up** key to move backward. At the completion of each form, the user is required to depress the "End" key while holding down the "Ctrl" key. This ensures that the data are properly replaced in the database. The program prompts the user to determine if another record with the same Mcode and database will be edited. A response of "N" to the question,

"Search for next record?(Y/N)"

will return the program to the secondary menu, while a response of "Y" will continue searching the database for additional records with matching Mcodes. If any are found the appropriate screen forms are

used and the user is permitted to alter the data in these records as well.

4.7.7 Retrieving Data

Data can be retrieved from specific databases in two ways. Specific records can be found and displayed or groups of records can be automatically found and displayed. In either case the data can be displayed on the screen or printed on a printer. The output format is similar to the forms used for entering data.

If the user selects **F**, the program clears the screen and presents a short description of the procedure used for finding and displaying a specific record. Data are retrieved from the various databases by an interactive procedure that utilizes the user's requirements to define the specific record of interest. Since the exact name of a material may not be known or may be ambiguously entered into the databases, the program requests that the user enter a key word(s) {At this point, the user can enter the word **EXIT** to return to the main menu screen.} and select the database to be searched. For example, **gypsum**, an acceptable key word, can modify many words such as **gypsum wallboard** or **gypsum walls**. Another example would be **polyurethane** which could be entered as **polyurethane foam seat cushions** or **polyurethane foam insulation**. This information is used to display **MATERIAL CODE** and **MATERIAL IDENTIFICATION** fields containing the specified key word(s) for the selected database. Then, the user is required to enter the **MATERIAL CODE** (letters must be all caps.) so that a listing of records with the selected **MATERIAL CODE** can be displayed. This latter display presents the information contained in each record as it was entered into the database. The user can print each screen of information to a printer for later use.

If the user selects **L**, he will be presented with a short description of the listing process. This option has been implemented to provide the user with a rapid means for determining the contents of

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the various databases composing FIREDATA. [A word of warning. This procedure does not search each database but instead searches the master directory. The programs provided automatically update the master directory when new entries are made to a file. If other means are used to add data, this will not be the case.] The listing procedure provides the user with the material code and material identification fields in addition to showing which of the four databases contain entries for the listed materials. The listing can be performed based on record numbers or material codes. One leaves the listing program by selecting the E)xit option. This returns the user to the main menu.

The listing by record number requires that the user provide the numbers of the first record to be printed and of the last record to be printed. If the user leaves out the number of the first record, the system assumes that the first record in the database is intended. Similarly, for the last record to be printed, the system assumes that if one is not entered the listing process continues to the end of the file. If a printer is connected to the system, the listing process can be directed to the printer instead of the screen.

Listing by material codes is primarily intended for the development of tables of materials. It functions in an analogous manner as the listing by record numbers. The absence of an entry implies that the listing is to proceed to the extremes of the database.

4.8 MLTFUEL

The fire model FAST requires that the fire be input as a single heat of combustion, plus a time series of mass loss rates and yields of the species of interest. When there are multiple items burning simultaneously, this input requires that a composite of all of the items be used, where each separate burning item will generally have a different set of values for each of these parameters. The purpose of the program MLTFUEL is to convert these values for each

burning item into the required composite fire. To start the program, select the module from the HIS or type

MLTFUEL

and press **enter** at the DOS prompt. While the units of the results will be the same as the units input (everything is multiplied by dimensionless parameters), it is suggested that SI units be used to avoid confusion later.

Like `FAST_in`, `MLTFUEL` is a user-friendly and highly interactive module and is best mastered by following the example presented in chapter 3. For other fire simulations, the process is similar to that presented in the example and follows several steps.

For each item which burns simultaneously:

- 1) Enter the name of the item and heat of combustion
- 2) Enter the times, mass loss rates, and species yields for the item acquired from `FIREDATA` or from other sources.

Once all of the data for the items have been entered

- 3) a combined timeline, effective mass loss rates, and effective species yields are calculated for the composite fuel.
- 4) The data calculated above is printed for later manual entry into the fire specification in `FAST_in`.

At any point in the process, the data for any entry can be modified or deleted. Additional items can be added or deleted and the composite fuel results viewed as desired until the fire specification appropriate for a given scenario is obtained.

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The program assumes that the burning characteristics of multiple items burning together are the same as those measured for each item burning individually - that is, that there are no interactions. This is obviously not the case. Each item will be affected by the radiation and convection from the others, increasing the burning (mass loss) rates; thus making this assumption nonconservative. These interactions are, however, beyond the scope of the present model, but will be included in future versions. For the present, the user should keep this limitation in mind and may choose to make an arbitrary adjustment in mass loss rates as a safety factor.

4.9 TENAB

TENAB (version 18) is a FORTRAN program which follows a person's escape route through a building containing a fire as determined by the program EXITT (version 18), and for each occupant, accumulates fractional effective doses due to gases, FED (a variation of FED used in Hazard I), FEDP (Purser) and FEDCO2, the exposure to radiant energy which might cause burns on exposed skin (FLUX), the integrated concentration-time product (CT), and exposure to convective heat (TEMPA and FEDTEMP) from the data generated by FAST (version 18) in terms of their estimated effect on that person along his escape route. The program is interactive and requires a minimum of four pieces of information. To start the program, select the module from the shell or type

TENAB

and press **enter** at the DOS prompt.

4.9.1 Input from FAST

TENAB requires a "dump" file from a FAST run. Upon executing TENAB, the user will be prompted for the name of the dump file. If a file name corresponding to a nonexistent file is input, the user will be informed that no such file exists and will be prompted for another file name. After entering a valid file name, the user will again be prompted for a Fast dump file. If additional Fast dump files are to be used (as in the case the FAST restart facility is used) the user enters them one at a time. When there are no more Fast dump file names to enter, the user should press the return key. If, for some reason, the user wants to abort the run, a / may be entered instead of a file name.

4.9.2 Input from EXITT

TENAB requires input from an EXITT run corresponding to the FAST dump file. The data may be entered from the terminal, in which case TENAB prompts the user for the necessary information, or the data may be read from a disk file created by the user or the EXITT program.

After being prompted for the FAST file name, the user will be prompted for the name of the EXITT output file. If the user wishes to enter the data at the terminal the user should enter the device name corresponding to the keyboard/terminal (CON on the PC). If a file name corresponding to a nonexistent file is entered, the user will be informed that no such file exists and will then be prompted for another file name. If it is then desired to halt TENAB, the user may enter a / for a file name, which aborts the run and returns to the system.

4.9.3 Format for an EXITT Data File

The EXITT data file consists of four sections of which three are required and one is optional. The first section, which is required, is a single entry consisting of the number of nodes in the floor plan (a node refers to a location in the building (a room or a point in a room), a door or a window) upon which the EXITT run was made. The second section, which is also required, consists of the data corresponding to the escape routes taken by the occupants. The third section, which is required, consists of the mapping between the "FAST" rooms and the "EXITT" nodes. (Since FAST is limited to at most six rooms on the PC, some nodes for EXITT may refer to the same room for FAST.) The fourth and last section, which is optional, contains data on the threshold values for incapacitation due to FED, FEDP (Purser), FEDCO2, FEDTEMP, TEMPA, and CT. If this section is omitted, default values will be used.

The format for the EXITT data file is as follows:

The first section is just a single integer denoting the total number of nodes, NR, in the floor plan.

The second section, describing the escape routes taken by the occupants, is entered as ordered-integer quadruplets as follows:

Occupant No., Node No., Time arrived at node, Height

where: Occupant No. must be a positive integer,
Node No. must be a positive number between 1 and the
number of nodes in the building,
Time arrived must be non-negative and in seconds.
Height entered is the distance in meters the occupant is
from the base floor (when a room has a loft or
balcony). It is a non-negative floating point number
(usually 0.0).

Reference

The maximum number of nodes visited by an occupant is 100. A zero entry for time denotes the location of the occupant at the start of the simulation.

The third section consists of N_R integers, separated by commas or spaces, which lie between 1 and $2 +$ the number of rooms with which FAST was run (N_F). The row(s) would appear as follows:

$N_1, N_2, N_3, \dots, N_{N_R}$ where: N_i represents to which FAST room the i -th room of EXITT corresponds.
Note FAST room N_F+1 refers to the outside via a door and N_F+2 refers to a window.

The last section of the file (optional) indicates whether the user wants to specify his own critical levels for incapacitation due to FED, TEMPA (in $^{\circ}\text{C}$), CT (in g-min/m^2), FEDP, FEDTEMP, and FEDCO₂ and for lethality due to FED, TEMPA, and CT. The critical levels for incapacitation and lethality are entered in the order given above. An entry of -1. indicates that the user wishes to use the default value. The default values for incapacitation are .5, 65., 450., 1., 1., 1. and for lethality, 1., 100., 900.

In order for TENAB to know if the optional section is present one of the following rows of data must immediately follow the second section.

1. The fourth section is not present.
0,0,0,0.
or
2. The fourth section is present.
-1,0,0,0.

A commented sample data file is shown below (EXITT assumes six rooms and FAST assumes five rooms):

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- 6 (EXITT run with a floor plan of six rooms)
- 1,1,0,0. (person 1 in room 1 at time 0 seconds on base floor level)
- 2,2,0,0. (person 2 in room 2 at time 0 seconds on base floor level)
- 1,2,120,0. (person 1 in room 2 at time 120 seconds on base floor level)
- 1,3,600,0. (person 1 in room 3 at time 600 seconds on base floor level)
- 1,6,500,0. (person 1 in room 6 at time 500 seconds on base floor level)
- 2,3,720,0. (person 2 in room 3 at time 720 seconds on base floor level)
- 1,0,0,0. (indicates the fourth section is present)
- 1,2,2,3,4,5 (indicates room 1 of EXITT corresponds to room 1 of FAST, room 2 of EXITT corresponds to room 2 of FAST, room 3 of EXITT corresponds to room 2 of FAST, room 4 of EXITT corresponds to room 3 of FAST, room 5 of EXITT corresponds to room 4 of FAST, room 6 of EXITT corresponds to room 5 of FAST)
- 1.,-1.,400.,-1.,-1.,-1 (default for FED(CO₂,CO,HCN,O₂), TEMPERATURE, FED(CO₂,CO,HCN,O₂, Purser's equations), FED(convective heat), and FED(CO₂) and 400. for Ct incapacitation)
- 1.,-1.,800. (default for FED(CO₂,CO,HCN,O₂), TEMPERATURE, and 800. for Ct for lethality)

4.9.4 Entering EXITT Data from the Terminal

To enter the EXITT data from the terminal when running TENAB the user needs to respond to the prompts. When prompted for the number of nodes, the user keys in an integer value denoting the total number of nodes in the floor plan upon which the escape routes are determined and hits the return key.

When prompted for the Occupant No., Node No., Time Entered & Height, the user keys in the data as follows

Occupant No.,Node No.,Time (seconds),Height
where entries are separated by spaces and/or commas and the line is ended with a return

The occupant number must be a positive integer. The node number must be an integer between 1 and the number of nodes in the building. The time must be a non-negative integer in seconds. The height from base floor level (as occurs when there is a room with a loft or balcony) is a non-negative floating point number (usually 0.0).

To end the input of occupant information, the user simply presses the enter key.

After the occupant and the room information are entered, the current incapacitation and lethality critical values will appear on the screen and the user may opt to change any of the values appearing on the screen. This is done by selecting the appropriate option number (each measure is associated with a unique option number) and entering the new value. When no more changes are desired the user simply presses the enter key.

4.9.5 Output from TENAB

After the user is prompted for the input FAST and EXITT file names, the user is prompted for the name to be given to the output file. The user may have the output written to disk by entering a valid file name or he may have the output routed directly to the printer by entering the printer device name (PRN on the PC), or to the screen by entering the screen device name (CON on the PC). In the case the file already exists the user will be allowed to

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overwrite the file (provided it is not a file already in use by TENAB) or to enter a different file name.

The output from TENAB begins by listing the FAST and EXITT file names used. Then TENAB writes out the EXITT data and the incapacitation critical levels for FED, TEMP, CT, FEDP, FEDTEMP, and FEDCO2 and the lethality critical levels for FED, TEMP and CT.

The last part of the output is in tabular form. For each person, TENAB outputs in time order the pertinent information corresponding to when a person's FED, TEMP, CT, FLUX, FEDP, FEDTEMP, or FEDCO2 exceeds a critical level or when a person is able to exit the building or arrives at a window. The pertinent information consists of the time of the occurrence, the node number (according to EXITT) of occurrence, the condition of the person (dead or incapacitated) due to the occurrence, the factor cause, and the values of FED, TEMP, CT, FLUX, FEDP, FEDTEMP, and FEDCO2 at that time. Information related to the final time (the occupant's condition at the end of the simulation) is also recorded. A sample of the output is shown on the next page.

Reference

FAST Version: 18.3
TENAB Version: 18.0 - Creation Date: 10/31/88 - Run Date: 11/01/88

INPUT FAST FILE : SHAR6.DMP
INPUT EXITT FILE : C:
TENABS OUTPUT FILE: SHAR6.TEN

OCCUPANT	ROOM	NUMBER	NODE	NUMBER	FLOOR	ELEVATION	ENTER TIME (S)
1	1	1	1	0.	0.		
	3	3	0.	60.			
	5	5	0.	120.			
2	2	2	0.	0.			
	4	4	0.	180.			

FACTORS	INCAPACITATION LEVEL	LETHAL LEVEL
FED1	0.5	1.0
TEMP1 DEG C	65.0	100.0
CT (G-MIN/M3)	450.0	900.0
FED2	1.0	
TEMP2	1.0	
FED3	1.0	

PERSON 1								
TIME	ROOM	CONDITION	CAUSE	FED1 FED2 FED3	TEMP1 TEMP2	CT	FLUX	
(SEC)						(G-MIN/M3)	(KW-MIN/M2)	
160.	5	INCAPACITATED	TEMP1	0.219E-02 0.105E-02 0.586E-02	0.729E+02 0.378E-01	0.000E+00	0.112E+00	
190.	5	DEAD	TEMP1	0.307E-02 0.125E-02 0.686E-02	0.108E+03 0.590E-01	0.000E+00	0.113E+00	
310.	5	INCAPACITATED	TEMP2	0.314E-01 0.415E-01 0.889E-01	0.145E+03 0.101E+01	0.000E+00	0.151E+00	
450.	5	INCAPACITATED	FED2	0.128E+00 0.102E+01 0.635E+00	0.666E+02 0.130E+01	0.000E+00	0.157E+00	
600.	5	FINAL TIME		0.176E+00 0.187E+01 0.913E+00	0.601E+02 0.135E+01	0.000E+00	0.157E+00	

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PERSON	2							
TIME	ROOM	CONDITION	CAUSE	FED1 FED2 FED3	TEMP1 TEMP2	CT	FLUX	
(SEC)						(G-MIN/M3)	(KW-MIN/M2)	
310.	4	INCAPACITATED	TEMP1	0.997E-02 0.429E+00 0.940E-01	0.204E+03 0.351E+00	0.000E+00	0.368E+01	
310.	4	DEAD	TEMP1	0.997E-02 0.429E+00 0.940E-01	0.204E+03 0.351E+00	0.000E+00	0.368E+01	
320.	4	INCAPACITATED	FED2	0.247E-01 0.159E+01 0.254E+00	0.164E+03 0.593E+00	0.000E+00	0.369E+01	
450.	4	INCAPACITATED	TEMP2	0.103E+00 0.632E+01 0.896E+00	0.104E+03 0.101E+01	0.000E+00	0.371E+01	
460.	4	INCAPACITATED	FED3	0.123E+00 0.728E+01 0.102E+01	0.988E+02 0.106E+01	0.000E+00	0.371E+01	
600.	4	FINAL TIME		0.185E+00 0.101E+02 0.131E+01	0.922E+02 0.120E+01	0.000E+00	0.371E+01	

- FED1 - THE FRACTIONAL EFFECTIVE DOSE DUE TO CO,CO2,HCN AND O2 BASED ON THE HAZARD I TENAB FED PLUS AN OXYGEN TERM
- FED2 - THE FRACTIONAL EFFECTIVE DOSE DUE TO CO,CO2,HCN AND O2 BASED ON PURSER'S EQUATIONS
- FED3 - THE FRACTIONAL EFFECTIVE DOSE DUE TO CO2 BASED ON PURSER'S EQUATIONS
- TEMP1 - THE AVERAGE TEMPERATURE OF THE LAYER OF THE ROOM TO WHICH THE PERSON IS EXPOSED - IT IS THE SAME AS TEMP USED IN THE HAZARD I TENAB
- TEMP2 - THE FRACTIONAL EFFECTIVE DOSE DUE TO CONVECTIVE HEAT BASED ON PURSER'S EQUATIONS

* IF PERSON IS WAITING AT A WINDOW, HE IS CONSIDERED TO BE AT THE NODE (ROOM) FROM WHICH HE CAME PRIOR TO REACHING THE WINDOW THIS ALLOWS HIM TO CONTINUE TO BE EXPOSED TO THE ROOM FIRE CONDITIONS

4.9.6 The TENAB Dump File

After entering the output file name, the user will be prompted for the TENAB dump file name. The TENAB dump file name can be any valid file name, provided the file does not already exist, but cannot be a device name other than NUL. In the case the file already exists and was not given the same name as a file currently being used by TENAB, the user may select to overwrite the file or reenter a different name. The TENAB dump file will contain the tenability measures for each person as a function of time and its primary purpose is to serve as an input file to FASTplot, a plotting program, so that the tenability measures can be plotted.

CHAPTER 5. ERROR MESSAGES

5.1 EXITT Runtime Errors

*** ERROR: Bad room height line in BUILDING /
OCCUPANT file
Program stopped

(The line of the building / occupant file which specifies the floor height could not be read correctly. Typically, either a line is out of sequence in the file or the line contains non-numeric data.)

*** ERROR: Bad floor elevation line in BUILDING /
OCCUPANT file
Program stopped

(The line of the building / occupant file which specifies the floor elevation could not be read correctly. Typically, either a line is out of sequence in the file or the line contains non-numeric data.)

*** ERROR: BUILDING/OCCUPANT and FAST files
disagree on the number of rooms
Program stopped

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(The number of rooms is specified in the building / occupant file and is checked against the data in the FAST dump file. The two numbers must agree.)

*** ERROR: Cannot have an EXITT room number be a door or window node number
Program stopped

(EXITT room numbers must be assigned only to interior nodes.)

*** ERROR: Cannot group nodes to a room number outside of 1-N
Program stopped

(For rescue or notification in EXITT, nodes are grouped into sets representing individual rooms within the building. The groups of nodes must be assigned a number corresponding to one of the existing nodes. N will be defined when the program gives the error message.)

*** ERROR: Cannot start a person at door or window
Invalid node assignment
Program stopped

(Since the evacuation process takes a person from their beginning location to the nearest accessible door or window, starting at a window or a door is pointless and is not allowed in the model.)

*** ERROR: Distance between nodes must be non-negative
Program stopped

(Every pair of adjacent nodes in the EXITT mapping is assigned a travel distance which is the walking distance

Error Messages

between the nodes. Obviously, this quantity must be greater than zero.)

***** ERROR: Dump file from version Y
Expecting version X
Program stopped**

(Exit program requires a FAST version X dump file in order to read the file. The programs supplied with HAZARD I are compatible.)

***** ERROR: Error or End of file encountered in
BUILDING / OCCUPANT File
Program stopped**

(Data could not be read from the building / occupant file. Either invalid data in the file (e.g., character instead of numeric data) or an incomplete BUILDING/OCCUPANT file can cause this message.)

***** ERROR: File already exists**

(Can occur when trying to create an output file. In order to not overwrite an existing file the user is warned and allowed an opportunity to select another file name.)

***** ERROR: File cannot be CON**

(The device CON (PC keyboard for input and screen for output) cannot be used as the input / output file in this instance. Some of the files read by EXITT are specially formatted files which can only be read or created by the modules of HAZARD I. It is not possible to type them in from the keyboard or view them intelligibly on the screen.)

***** ERROR: File cannot be inquired**

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(Before overwriting output files, EXITT will check to see if the file exists. If an error occurs trying to make this determination, you will be asked to enter another file name.)

*** ERROR: File cannot be NUL

(The device NUL (a scratch file that is deleted after program execution) cannot be used as the input/output file.)

*** ERROR: File cannot be PRN

(The device PRN (printer) cannot be used as the input / output file.)

*** ERROR: File does not exist or is not local

(Can occur when trying to open an input file. If the file does not exist or is not in the current directory (when no path name given) there will be no data to read.)

*** ERROR: File is already opened

(The file is already being used by the program.)

*** ERROR: File is not formatted

(The file is not formatted but is expected to be formatted. Some of the files read by EXITT are specially formatted files which can only be read or created by the modules of HAZARD I. Trying to use one of these files for a normal text file will result in this message.)

*** ERROR: File is not sequential

Error Messages

(The file is not sequential but is expected to be sequential. Some of the files read by EXITT are specially formatted files which can only be read or created by the modules of HAZARD I. Trying to use one of these files for a normal text file will result in this message.)

***** ERROR: Input file cannot be NUL**

(The device NUL (a scratch file) cannot be used as an input file.)

***** ERROR: Input file cannot be PRN**

(The device PRN (printer) cannot be used as an input file.)

***** ERROR: Invalid action indicator - Must be a 0
or a 1
Program stopped**

(In BUILDING/OCCUPANT file, the occupant section, the action indicator line contained an entry which was not 0 or 1. A value of zero indicates the occupant can escape unaided or a 1 if the occupant requires assistance to exit the building. No other numbers are allowed.)

***** ERROR: Invalid age - Must be between 0 and 120
Program stopped**

(In BUILDING/OCCUPANT file, the occupant section, an occupant's age was not between 0 and 120.)

***** ERROR: Invalid detector location
Program stopped**

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(In BUILDING/OCCUPANT file, the building section, the detector was specified as being at an invalid node number or at a door or window node number.)

*** ERROR: Invalid edge node
Program stopped

(In BUILDING/OCCUPANT file, the building section, an invalid node number was given.)

*** ERROR: Invalid file name FNAME

(The file name, FNAME, is not a valid file name. You will be asked to enter another file name.)

*** ERROR: Invalid mapping between EXITT nodes and
FAST room numbers
Program stopped

(The entries on the two lines of the BUILDING/OCCUPANT file are incorrect. An EXITT node may be assigned to more than one FAST room or an invalid number may have been entered for a FAST room or on EXITT node.)

*** ERROR: Invalid node assignment - must be
between 1 and N
Program stopped

(N will be given the appropriate value which is the number of nodes specified in the BUILDING/OCCUPANT file.)

*** ERROR: Invalid sex indicator - Must be a 0 or
a 1
Program stopped

Error Messages

(In BUILDING/OCCUPANT file, the occupant section, the sex indicator line contains an entry which is not a 0 or a 1. An entry of zero indicates a female and a one indicates a male. No other numbers are allowed.)

*** ERROR: Invalid sleep indicator - Must be a 0
or a 1
Program stopped

(In BUILDING/OCCUPANT file, the occupant section, the sleep indicator line contains an entry which is not a 0 or a 1. A zero indicates the occupant is asleep and a one indicates the occupant is awake.)

*** ERROR: Invalid sleep penalty - Must be between
-15 and 50
Program stopped

(In BUILDING/OCCUPANT file, the occupant section, the sleep penalty indicator line contains an entry outside the range of -15 to 50.)

*** ERROR: Last time of fname1.dmp was K seconds
First time of fname2.dmp was N seconds
The two files do not follow each other
Program stopped

(When two or more FAST dump files are used sequentially, the last time of the previous file is expected to be the same as the first time of the next file.)

*** ERROR: Must have at least N-1 edges
Program stopped

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(In BUILDING/OCCUPANT file, the building section, the minimum number of edges must be greater than or equal to the number of nodes-1.)

*** ERROR: Noise level must be non-negative
Program stopped

(In BUILDING/OCCUPANT file, the building section, the node noise level was given a negative value.)

*** ERROR: Number of people must be between 1 and 10
Program stopped

(In BUILDING/OCCUPANT file, the occupant section, the number of occupants was given as less than 1 or greater than 10.)

*** ERROR: Number of smoke detectors must be between 0 and 10
Program stopped

(In BUILDING/OCCUPANT file, the building section, the number of smoke detectors was given as greater than 10.)

*** ERROR: Number of rooms must be between 1 and 10
Program stopped

*** ERROR: Room alarm noise level must be non-negative
Program stopped

(In BUILDING/OCCUPANT file, the building section, a room alarm noise level was given a negative value.)

Error Messages

*** ERROR: The nodes are not all connected together. Node 1 cannot reach node I
Program stopped

(In BUILDING/OCCUPANT file, the building section, there exist nodes from which you cannot reach other nodes. The program expects that any node can be reached from any other node through some path.)

*** ERROR: There are no doors or windows
No one can escape
Program stopped

(At least one exit must be available.)

*** ERROR: Too many dump files - Program stopped
Allow 10 FAST, 1 BUILDING/OCCUPANT, 1
OUTPUT, AND 1 TENAB FILE

*** ERROR: Total number of nodes must be at least
N
Program stopped

(Here N will be given as the number of FAST rooms. There must at least as many EXITT nodes as FAST rooms.)

*** ERROR: Trouble with FAST dump file
Program stopped

(The first FAST dump file given is not a FAST compatible file. If the first file cannot be read, the program is stopped.)

*** ERROR: Trouble with FAST dump file

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(A subsequent FAST dump file given is not compatible. Further data is simply ignored and data from the files processed up to this point are processed.)

*** WARNING: IN RMVBLK, Truncation has occurred
 removing blanks from:
 FNAME1
 FNAME2

(Typically occurs when path\filename exceeds 63 characters or an invalid file name has been specified for an input or output file.)

*** WARNING: Travel speed of X is excessive

(In BUILDING/OCCUPANT file, the occupant section, a travel speed was specified as greater than 5 m/s. The message is just a warning and the value will still be accepted and used.)

5.2 FAST Runtime Errors

A pointer to a compartment must be a number
Non numeric Token for display pointer
A layer must be specified
Invalid string for Palette label
Non numeric for label color
Invalid label
Invalid first angle
Invalid second angle
Invalid filename for view
Non numeric window entry
Non numeric for graph color
Invalid string for graph title

Error Messages

Over indexing in gas list
Non numeric value for index
Invalid number in loadup

(An error has been found in reading the graphics specification. Check the syntax of the specification as detailed in chapter 4.)

*** At least one thermal name is not defined
nnnnnnnn ***
QUIT WHILE READING THERMAL DATABASE

*** The name nnnnnnnn does not exist in the thermal database ***

(One of the materials specified as a ceiling, wall, or floor material could not be found in the thermal database. All specified materials must be defined in the thermal database. The label nnnnnnnn shows the undefined name.)

Display area overwritten

(An error has occurred preparing the graphical display output. Check the graphics specification for correct syntax as described in chapter 4.

ERROR IN ACCESSING DUMP FILE, ERR = N
STOP 697

(An error has occurred trying to write the model outputs to the dump file. The error code N provides greater detail of the error. Usually, there is insufficient room on the output disk to write the information.)

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ERROR OPENING RESTART FILE

(The file specified by the RESTRT key word could not be read or is not a valid FAST dump file.)

EXCEEDED ARRAY BOUNDS FOR GRAPHS

(An error has occurred preparing the graphical display output. Check the graphics specification for correct syntax as described in chapter 4.)

FILE NOT FAST COMPATIBLE

(The first line of the input file does not specify a FAST version 18 input.)

Illegal device for graphics output

(Only device number 4 (for screen output) or number 6 (for HPGL output) may be specified in a graphics specification. No other numbers may be entered.)

NOT AN ALLOWED FIRE TYPE

(Only fire types 1 (for an unconstrained fire) or 2 (for a constrained fire) are allowed. No other numbers may be entered.)

STOP 69

(An internal error has occurred in the differential equation solver. This error should never occur. If it does, notify NIST and have available the model inputs.)

**** WARNING - MISMATCH IN DUMP FILE SPECIFICATION

(A dump file name has been found with a DUMPR keyword specification but no dump file was specified on the files line of the input. No dump file output will be generated.)

**** WARNING - EXCEEDED MAXIMUM DUMP INTERVALS

(A maximum of 50 dump intervals are allowed. If more are specified, the dump interval is adjusted to produce a total of 50 dump intervals.)

5.3 FASTplot Runtime Errors

List is empty; need variables before obtaining their values.

Must create a list before plotting graphs.

No data to save!

No variables to read

No variables to duplicate.

No list to duplicate

No variables on the list.

Nothing to plot

(The working list of variable is empty. You must use the FILE command and the ADD command to read data from a FAST or TENAB input file prior to plotting, listing, or saving data.)

Duplicate of list will exceed allowable size.

Too many variables - RAPID list reduced.

Too many variables - TENAB list reduced.

Variable list is full. No more additions allowed.

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(A total of 25 variables may be on the working list at one time. Use the CLEAR command and read in the additional data to create separate graphs.)

No file open for reading.

A FILE command must be executed prior to the ADD command

(Prior to reading data in from a FAST dump file, the name of the file must be specified with the FILE command.)

Error opening RAPID dump file, error = n

Error opening TENAB dump file, error = n

Error in opening FAST dump file n, File =

(An error has occurred trying to read an input data file. The error number n gives more detail. Usually, the specified file is not in the proper format for reading. Some of the files read or written by FASTplot are specially formatted files which can only be read or created by the modules of HAZARD I.)

No new variables were added.

Time channel not found.

None of the selected channels were found.

Information not found.

(The information you selected to read from the input file could not be located in the file. Check the input file and try again.)

Parenthesis Error, Check Input!

The plot descriptor contains an error.

Variable numbers must be from 1 to

Error Messages

(The plot command specifying the variable to be plotted contained an error. Usually either a missing parenthesis or an invalid variable number results in these errors.)

All variables must be from the same file.

(Data to be saved with the save command must have originated in the same type of file - a FAST file, a TENAB file or an ASCII text file.)

Error in opening new file.

(The file name specified for a SAVE could not be opened. Either the file name was typed incorrectly or the disk file already exists.)

Units do not match, try again.

(On a single graph, the physical units of the curves must be the same. Temperature cannot be plotted on the same graph with interface height, for instance.)

Compartment number must be between 1 and n

(The number of rooms in a FAST dump file is determined automatically from the file. Only numbers corresponding to a valid room may be entered.)

n Is not on the current list of species

(FAST models a limited set of species production rates. The key word entered for a species is not one modelled by FAST.)

On the list already!

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That ventflow on list already, try again.

(FASTplot checks to make sure only one copy of a single variable is maintained on the working list of variables.)

Syntax error in option, try again.

Possible Variable Match, More Characters Are Required, Try Again.

Syntax error in variable input.

(An error was found on the ADD command. Additional variables are ignored. You may reenter the additional variables with another add command or read in the data up to the invalid entry by issuing a READ command.)

5.4 TENAB Runtime Errors

*** ERROR: Bad input line - Please try again

(The line could not be read. You are allowed to reenter the line. The prompt for the line should tell you what information should be entered.)

*** ERROR: Cannot have more than 10 people - new person ignored

(A maximum of 10 people can be simulated in a single execution of TENAB.)

*** ERROR: Error in reading EXITT file
Program stopped

Error Messages

***** ERROR: Error in reading EXITT file in section relating EXITT nodes with FAST rooms
Program stopped**

(The specified EXITT dump file could not be read. Typically, the wrong name was specified for the file.)

***** ERROR: Expecting a data file produced by EXITT version X
EXITT dump file is from version Y
Program stopped**

(TENAB and EXITT versions must be compatible. The versions supplied with HAZARD I are compatible.)

***** ERROR: FAST Version: X
TENAB Version: Y-Creation Date:mm/dd/yy
- Run Date: mm/dd/yy
Incompatible versions
Program stopped**

(TENAB and FAST versions must be compatible. When the FAST dump file is created by version X of FAST and the TENAB version is Y, TENAB will not be able to read the dump file.)

***** ERROR: File already exists**

(Can occur when trying to create an output file. In order to not overwrite an existing file the user is warned and allowed an opportunity to select another file name.)

***** ERROR: File cannot be CON**

(The device CON (PC keyboard for input and screen for output) cannot be used as the input / output file.)

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***** ERROR: File cannot be inquired**

(Before overwriting output files, TENAB will check to see if the file exists. If an error occurs trying to make this determination, you will be asked to enter another file name.)

***** ERROR: File cannot be NUL**

(The device NUL (a scratch file that is deleted after program execution) cannot be used as the input/output file.)

***** ERROR: File cannot be PRN**

(The device PRN (printer) cannot be used as the input / output file.)

***** ERROR: File does not exist or is not local**

(Can occur when trying to open an input file. The file does not exist or is not in the current directory (when no path name given).)

***** ERROR: File entered for EXITT file is not an EXITT file
Program stopped**

(An EXITT file created by EXITT will have an identifier line which the TENAB program checks. Typically, a wrong file name has been specified.)

***** ERROR: File is already opened**

(The file is already being used by TENAB for another purpose.)

Error Messages

***** ERROR: File is not formatted**

(The file is not formatted but is expected to be formatted. Some of the files read by EXITT are specially formatted files which can only be read or created by the modules of HAZARD I. Trying to use one of these files for a normal text file will result in this message.)

***** ERROR: File is not sequential**

(The file is not sequential but is expected to be sequential. Some of the files read by EXITT are specially formatted files which can only be read or created by the modules of HAZARD I. Trying to use one of these files for a normal text file will result in this message.)

***** ERROR: In FAST dump file FNAME**

(File empty, error on read, or wrong version of dump file.)

***** ERROR: Input file cannot be NUL**

(The device NUL (a scratch file that is deleted after program execution) cannot be used as the input file.)

***** ERROR: Input file cannot be PRN**

(The device PRN (printer) cannot be used as the input file.)

***** ERROR: Invalid critical values - entries must be floating point numbers**

(When user supplied values are used to override the default values for tenability limits, the values for incapacitation and lethality must be entered as real numbers with decimal points.)

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***** ERROR: Invalid file name FNAME**

(The file name FNAME is not a valid path\name.)

***** ERROR: Last time of FNAME1.DMP was X seconds
First time of FNAME2.DMP was Y seconds
The 2 files do not follow each other
Program stopped**

(Can occur when using more than one FAST dump file in sequence. TENAB expects that the last time of the previous file be the first time of the next file. If not, then the files are considered not to be in sequence.)

***** ERROR: No people in EXITT data or trouble
reading input file**

(The output file from EXITT does not contain any information on the egress of people from the building. Check your input and printed output from the EXITT run to insure the correct simulation.)

***** ERROR: No people were entered from EXITT**

***** ERROR: Node numbers must be between 1 and N
Please try again**

(N is the number of nodes in the EXITT file.)

***** ERROR: Node numbers must be between 1 and N
Program stopped**

(N is the number of nodes in the EXITT file.)

Error Messages

*** ERROR: Number of nodes cannot exceed 100
Program stopped

*** ERROR: Room number out of range in section
relating EXITT nodes with FAST rooms in
EXITT file
Program stopped

(An EXITT node was mapped onto a nonexistent FAST
room number.)

*** ERROR: Time must be ≥ 0 seconds
Program stopped

(The enter time must be non-negative.)

*** ERROR: Cannot have more than 10 distinct
occupants so occupant K cannot be
entered

*** ERROR: TENAB dump file cannot be CON

(The device CON (keyboard for input and screen for output)
cannot be used as the output file. Some of the files read or
written by TENAB are specially formatted files which can
only be read or created by the modules of HAZARD I.)

*** ERROR: TENAB dump file cannot be NUL

(The device NUL (a scratch file that is deleted after pro-
gram execution) cannot be used as the input file. Some of
the files read or written by TENAB are specially formatted
files which can only be read or created by the modules of
HAZARD I.)

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*** ERROR: TENAB dump file cannot be PRN

(The device PRN (printer) cannot be used as the output file. Some of the files read or written by TENAB are specially formatted files which can only be read or created by the modules of HAZARD I.)

*** ERROR: Time must be ≥ 0 seconds - Please try again

*** ERROR: Too many dump files 10 FAST, 1 EXITT, 1 OUTPUT and 1 TENAB file allowed
Program stopped

*** WARNING: IN RMVBLK, Truncation has occurred removing blanks from:
FNAME1
FNAME2

(Typically occurs when path\filename exceeds 63 characters or an invalid file name has been specified for an input or output file.)

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10. SUPPLEMENTARY NOTES Library of Congress Catalog Card Number: 89-600740 <input type="checkbox"/> Document describes a computer program; SF-185, FIPS Software Summary, is attached.			
11. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here) <p>This report describes the first version of a method for predicting the hazards to occupants involved in a building fire. To implement the method, a personal computer software package called HAZARD I is provided. The software consists of modules which can predict the time varying environment within a building resulting from a specified fire; the locations and actions of a specified group of occupants as they interact with the building, the fire, and each other; and the impact of the exposure of each of the occupants to the fire products in terms of whether the occupants successfully escape, are incapacitated, or are killed. The documentation includes the <i>Software User's Guide</i>, and a <i>Reference Guide</i> consisting of the <i>Technical Reference Guide</i> and <i>Example Cases</i>.</p> <p>NIST Handbook 146 is a set consisting of the three volumes described above plus computer software supplied on seven (7) 5¼" and four (4) 3½" disks.</p>			
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