



US Army Corps
of Engineers
Construction Engineering
Research Laboratories

AD-A261 890



USACERL Technical Report FE-93/04

October 1992

Application of Advanced Computer Technologies
to Building Energy Design

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Interfacing Computer-Assisted Drafting and Design With the Building Loads Analysis and System Thermodynamics (BLAST) Program

by
Jeffrey D. Morton
Changwoo Pyo
Bob Choi

Energy efficient building design requires in-depth thermal analysis. Existing Computer Aided Design and Drafting (CADD) software packages already enhance the productivity and quality of design. Thermal analysis tools use much the same information as that contained in CADD drawings to determine the most energy efficient design configuration during the design process. To use these analysis tools, data already contained in the CADD system must be re-keyed into the analysis packages.

This project created an interface to automate the migration of data from CADD to the Building Loads Analysis and System Thermodynamics (BLAST) analysis program, which is an Army-standard system for evaluating building energy performance. Two interfaces were developed, one batch-oriented (*IN2BLAST*) and one interactive (the *Drawing Navigator*). Lessons learned from the development of *IN2BLAST* were carried into the development of the *Drawing Navigator*, and the *Drawing Navigator* was field tested. Feedback indicated that useful automation of the data migration is possible, and that proper application of such automation can increase productivity.

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REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE October 1992	3. REPORT TYPE AND DATES COVERED Final		
4. TITLE AND SUBTITLE Interfacing Computer-Assisted Drafting and Design With the Building Loads Analysis System and Thermodynamics (BLAST) Program		5. FUNDING NUMBERS PE 4A162784 PR AT45 WU EA-X52		
6. AUTHOR(S) Jeffrey D. Morton, Changwoo Pyo, and Bob Choi				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Construction Engineering Research Laboratories (USACERL) PO Box 9005 Champaign, IL 61826-9005		8. PERFORMING ORGANIZATION REPORT NUMBER TR FE-93/04		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers ATTN: CEMP-ET 20 Massachusetts Avenue, NW Washington DC 20001		10. SPONSORING/MONITORING AGENCY REPORT NUMBER		
11. SUPPLEMENTARY NOTES Copies are available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) Energy efficient building design requires in-depth thermal analysis. Existing Computer Aided Design and Drafting (CADD) software packages already enhance the productivity and quality of design. thermal analysis tools use much the same information as that contained in CADD drawings to determine the most energy efficient design configuration during the design process. To use these analysis tools, data already contained in the CADD system must be re-keyed into the analysis packages. This project created an interface to automate the migration of data from CADD to the Building Loads Analysis System and Thermodynamics (BLAST) analysis program, which is an Army-standard system for evaluating building energy performance. Two interfaces were developed, one batch-oriented (<i>IN2BLAST</i>) and one interactive (<i>the Drawing Navigator</i>). Lessons learned from the development of <i>IN2BLAST</i> were carried into the development of the <i>Drawing Navigator</i> , and the <i>Drawing Navigator</i> was field tested. Feedback indicated that useful automation of the data migration is possible, and that proper application of such automation can increase productivity.				
14. SUBJECT TERMS BLAST CADD interface IN2BLAST Drawing Navigator			15. NUMBER OF PAGES 100	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT SAR	

FOREWORD

This research was performed for Headquarters, U.S. Army Corps of Engineers (HQUSACE), under Project 4A162784AT45, "Energy and Energy Systems"; Work Unit EA-X52, "Application of Advanced Computer Technologies to Building Energy Design." The HQUSACE technical monitor was Daniel Gentil, CEMP-ET.

The work was conducted by the Energy and Utility Systems Division (FE), of the Infrastructure Laboratory (FL), of the U.S. Army Construction Engineering Research Laboratories (USACERL). The USACERL principal investigator was Jeffrey Morton. Appreciation is expressed to Mark Penton, Mechanical Design Engineer, U.S. Army Corps of Engineers' Mobile District for his participation in the field test. Appreciation is also expressed to the following USACERL personnel for their efforts on this project: Bryan Peters, William Bahnfleth, and Cynthia Barton. Dr. David Joncich is Division Chief, CECER-FE, and Dr. Michael O'Connor is Laboratory Chief, CECER-FL. The USACERL technical editor was William J. Wolfe, Information Management Office.

COL Daniel Waldo, Jr., is Commander and Director of USACERL, and Dr. L.R. Shaffer is Technical Director.

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INTERFACING COMPUTER-ASSISTED DRAFTING AND DESIGN WITH THE BUILDING LOADS ANALYSIS AND SYSTEM THERMODYNAMICS (BLAST) PROGRAM

1 INTRODUCTION

Background

The design of energy efficient buildings requires in-depth thermal analysis. While there are many simplified hand calculation methods to determine building heating and cooling loads, nonautomated methods are not precise enough to achieve optimal designs. Furthermore, even simplified hand calculations are too time-consuming to be practical. Computer programs designed to aid in building energy calculations improve both the speed and accuracy of energy calculations.

Hourly simulations, such as the Army-standard Building Loads Analysis and System Thermodynamics (BLAST) program, developed by the U.S. Army Construction Engineering Research Laboratories (USACERL), are the most accurate means for determining building loads. The accuracy of BLAST allows U.S. Army Corps of Engineers (USACE) District designers to size mechanical equipment precisely to improve the energy efficiency of buildings on Army installations. The ability to simulate buildings before they are built also allows alternative building configurations to be studied to determine the most energy efficient design. The cost associated with simulation programs is the time required to construct the inputs to the simulation.

Computer-Aided Design and Drafting (CADD) tools have already become common in the building design environment. CADD systems also offer the promise of improved accuracy and reduced time in the design environment. The premise is that as automated methods replace manual methods, the automation will handle the data for the designer, thus reducing error and increasing throughput.

However, the two design processes have not yet been integrated. CADD automates the creation of the building floor plans, and programs such as BLAST automate their analysis, but the two systems remain distinct. Each of these two automation tools focuses on only a portion of the design process, requiring the designer to actively move data from one automation tool (CADD) to the other (the analysis program). This intervention involves a manual rekeying of data already in the CADD system into the analysis package, increasing the chance for error and the time required to complete the analysis. The smooth integration of CADD with analysis tools such as BLAST would speed the process of thermal analysis and ensure that the input data are accurate.

Objectives

The objectives of this project were to devise methods to interface CADD and BLAST to implement those methodologies in a software product(s), and to field test the software.

Approach

This work progressed through the following steps:

1. A primary development platform was chosen based on the Corps-wide standard CADD purchase of Intergraph hardware and software.
2. Negotiations were conducted with Intergraph Corporation* to set details of an interface.
3. Intergraph and USACERL each developed portions of the first interface as negotiated.
4. A second development platform was chosen (in addition to the Intergraph effort) based on the widespread popularity of *AutoCAD* from Autodesk Incorporated.** Development of the two interfaces proceeded in parallel.
5. After completion of the interfaces, a field test was conducted to verify the CADD-BLAST interface concept.

Scope

This report describes the conceptual foundation for the developed interfaces, the "lessons learned" from the process of development, and results of field testing. Specifics of actual implementation and program operation are not detailed.

Mode of Technology Transfer

It is anticipated that software products developed in conjunction with this research will be made available from the BLAST Support Office (BSO), which can be contacted by phone: (800) UI-BLAST or (217) 333-3877; by U.S. mail: BLAST Support Office, 30 Mechanical Engineering Bldg., 1206 W. Green Street, Urbana, IL 61801; or by electronic mail at: Support@blast.bso.uiuc.edu. A Cooperative Research and Development Agreement (CRDA) may be used to further development of the *Drawing Navigator* interfaces by the private sector.

* Intergraph Corp., 1-T Madison Industrial Park, Huntsville, AL 35807.

** Autodesk, Inc, 2320-T Marinship Way, Sausalito, CA 94965.

2 CADD AND BLAST INTERFACES

Interfaces

The term "interface" can be applied quite broadly. In all software systems, there exist multiple opportunities for interfacing. If a software system is seen as a set of many discrete, labor-performing elements, then an interface opportunity exists at each boundary between these elements. The actual definition of these elements can be chosen as a matter of convenience. In general, each *program* in a software system would be considered an element, since it takes some set of inputs and produces some results (output) after performing some desired operation (labor). The user of the program may also be considered an element in the system, because the user also takes some input, performs labor (which, at times, the program cannot do) and produces some "output" (providing data input, for example).

The type of interface may then be described in terms of the system elements that are bridged. The most familiar interface is the *user interface*, sometimes called the *man-machine* interface. In general, user interfaces are any program facilities that promote the transfer of information between user and program. User interfaces can further be classified as either dynamic (interactive) or static (batch). For example, one user interface for the BLAST program is the *BLAST Input Deck* (Figure 1). This static interface is a file created by the user that transfers information one-way to the BLAST program. The interface follows syntactic and semantic rules that are meaningful to both the user and the program. The program converts the input deck to internal data structures through a parsing subroutine that adds value to the input deck by using data encoded within the parser and from other files. The parser itself could also be considered part of the user interface. Similarly, other subroutines produce output reports that perform another one-way transfer of information from the BLAST program to the user. BLAST also employs an interactive user interface to create input decks via the BTEXT preprocessor.* BTEXT provides an interactive, menu-driven environment as its user interface. The user may create the BLAST input deck from BTEXT, but is not (necessarily) required to use the input deck as the user interface.

Another type of interface is a *program-to-program* interface. Such interfaces move information from one program to another, such as transferring the output of one program to another program as input. A third program may provide this interface, or some data structure may facilitate the transfer, or the interface may be a combination of both. In the latter two cases, the output routines from the first program, and the input routines to the second program (which read and write the data structure for transfer) could be considered part of the interface. For example, the BLAST input deck could be considered a program-to-program interface when BTEXT is used, since it transfers user information gathered via interactions with the BTEXT menu system to BLAST.

When a separate program provides the program-to-program interface, some form of data structure generally accomplishes the transfer, and may require special routines within the host programs. Usually a separate program-to-program interface is only required when the two interfaced programs were not specifically designed to exchange data. A file translation utility that converts word processor files from one format to another is a good example of such an interface.

There are probably as many interface types as there are different boundaries for the labor-performing elements. Also, as evidenced by the prior discussion, different types of interface may be combined. The concepts of system boundaries and interface types as described here will clarify discussion of the interfaces outlined in this report.

* BTEXT is a USACERL-developed preprocessor that is part of the BLAST software package.

```

BEGIN INPUT;
  RUN CONTROL:
    NEW ZONES,
    NEW AIR SYSTEMS,
    PLANT,
    UNITS(IN=ENGLISH, OUT=ENGLISH);
    PROJECT="SAMPLE BTEXT RUN";
    LOCATION=CHANUTE ;
    DESIGN DAYS=CHANUTE SUMMER,CHANUTE WINTER;
    GROUND TEMPERATURES=(54, 55, 58, 62, 67, 74, 72, 68, 64, 62, 58,
55);
  BEGIN BUILDING DESCRIPTION;
    BUILDING="NONE ";
    NORTH AXIS=0.00;
    SOLAR DISTRIBUTION=-1;
    ZONE 1 "LEFT END UNIT ":
      ORIGIN:(0.00, 0.00, 0.00);
      NORTH AXIS=0.00;
      EXTERIOR WALLS :
        STARTING AT(0.00, 0.00, 0.00)
        FACING(180.00)
        TILTED(90.00)
        EXTERIOR (12.00 BY 8.00)
          WITH WINDOWS OF TYPE SINGLE PANE HW WINDOW (8.00 BY 4.00)
            REVEAL(0.00) AT (0.00, 0.00)
        STARTING AT(0.00, 25.00, 0.00)
        FACING(270.00)
        TILTED(90.00)
        EXTERIOR (25.00 BY 8.00);
      PARTITIONS :
        STARTING AT(12.00, 0.00, 0.00)
        FACING(90.00)
        TILTED(90.00)
        INTERIOR (25.00 BY 8.00),
      FLOORS :
        STARTING AT(0.00, 25.00, 0.00)
        FACING(180.00)
        TILTED(180.00)
        SLAB FLOOR(12.00 BY 25.00);
      ROOFS :
        STARTING AT(0.00, 0.00, 8.00)
        FACING(180.00)
        TILTED(0.00)
        ROOF04 (12.00 BY 25.00);
    CONTROLS=DEAD BAND;
    INFILTRATION=10;
  END ZONE;
END BUILDING DESCRIPTION;
END INPUT;

```

Figure 1. Sample BLAST Input Deck.

CADD Interfaces

'In a typical design and construction project today there is a lot of duplication of data and especially input of data,' says Kari Karstila, researcher, Laboratory of Urban Planning and Building Design, Technical Research Centre of Finland, Espoo. 'This is true even if most of the data is prepared using software tools such as word processors, spreadsheets, drafting systems, databases.' (Hayner 1991)

One reason for this duplication of data entry is that current design software was developed separately for each traditional building design discipline, even though the interrelationship between disciplines pre-existed computer involvement in the design process (Thomas 1991). Each discipline requires information from others to complete its part of the design function. It is expected that design analysis programs such as BLAST will need input data already contained in the CADD system. Furthermore, these analysis programs will need data that is represented both graphically and nongraphically by the CADD system. For example, architects may provide the building outline as a graphical representation comprised of symbols signifying building elements such as rooms, doors, etc. The architect may also provide nongraphical information such as surface finishes, compositions, constructions, etc. Similarly, mechanical engineers will provide air distribution system information such as thermal zones and duct layout graphically, but setpoint temperatures as nongraphical information. Electrical engineers may use the (nongraphical) surface reflectance data provided by the architects for lighting analysis and for building geometry. Energy analysis relies upon a comprehensive set of data from all disciplines (building geometry, component composition, air distribution/system requirements, electrical wattage, and so forth).

There is no doubt that the building design disciplines need analysis programs. Since much of the input data required for these programs is already contained in the CADD system as both graphic and nongraphic representations, there is a need for interfaces between these representations and the design analysis programs. Such interfaces may be seen as both user interfaces to the analysis programs, and program-to-program interfaces between the CADD system and the analysis programs.

A CADD interface is a user interface in the sense that it allows the user of the analysis program to provide the necessary input data in a new way—by using the CADD system. In fact, the combination of the CADD system and interface may be regarded as a “preprocessor” to the analysis package. The CADD system provides a high-level user interface, and the program-to-program interface code provides the muscle to move the data to the analysis package. In addition, the CADD interface program queries the user for other information, thus providing its own user interface. In this way, the CADD user who needs an analysis package can operate in a suitable (or at least familiar) environment, and the analysis package still receives required inputs.

A further advantage of using a CADD interface as a preprocessor is the graphical nature of CADD, which makes the input preparation task more visual and, ostensibly, less tedious. This visual emphasis can make the task easier, and also can help to eliminate errors such as overlapping zones, or windows larger than the wall containing them. While some error checking can be built into textual preprocessors, the use of a graphical interface can help to eliminate these errors before they occur. Historically, graphical interfaces have been less popular due to the expense of the computer hardware required to run graphics-based programs. However, the current low cost of powerful personal computers is eliminating this barrier. Another computing trend is to represent computer information as graphic objects. As these trends combine to change the computing environment, they will also influence the end users' expectations of how information should be manipulated, emphasizing the importance of the graphical preprocessor.

Difficulties

To realize this vision, however, requires that a number of difficulties be overcome. The main problem associated with automating the transfer of data from CADD to BLAST is that a great deal of information contained in the CADD files is not needed for the thermal analysis. One can think of this extra information as “noise” as far as the thermal analysis package is concerned. The difficulty the interface program must overcome is to separate the required data from this noise.

More difficult is the problem that some information exists in the graphic representation logically, but not physically. For example, BLAST needs to know the endpoints for walls. Most architectural floor plan drawings will represent a wall as two parallel lines (Figure 2). The location of point A would be the ideal endpoint to use for locating these walls. However, no graphic objects in the CADD file are directly related to this point. (Unless, of course, it were physically drawn.)

Another problem exists in that the CADD drawings are typically two-dimensional representations of a three-dimensional building. While a set of two-dimensional drawings (floor plans, elevations, etc.) can help a viewer conceptualize the three-dimensional building, it is difficult to program software to make this kind of generalization. Consequently, the user must include supplemental information for the program's benefit (zone height, for example). Similarly, other information must be provided because it does not exist in any form in the CADD drawings (construction materials information, for instance).

Perhaps one of the greatest difficulties is that no conventions yet exist for drawing building elements, so that drawings may vary according to the draftsman. If some conventions were imposed on how the drawings must be produced, then the problem of information extraction could be simplified. However, imposing such conventions would reduce the general applicability of the interface, and architects may find following such conventions impediments to their own productivity. Thus for the sake of the interface, the graphical representations found in the CADD files must be considered arbitrary, leaving the question of how to recognize them.

Approach

There are many possible approaches to creating a CADD-to-analysis interface. To determine the merit of an approach, issues regarding the information being transferred, its organization, and the "ownership" of the mechanisms for manipulation of this structure were considered. The information required for thermal analysis (with regards to CADD) falls into three categories:

1. The CADD building outline (floor plan).
2. Other graphic/nongraphic data that should be associated with the building outline (e.g., thermal zones could be described by having the user input which room numbers belong to the zones, but they are much more effectively shown by pointing out the rooms on the graphical layout).
3. Additional nongraphic data that is not pertinent to the graphic data in the CADD drawing, but that is required by the analysis program.

CADD vendors are already handling categories 1 and 2, as these are required information for their systems. The third item is the exclusive domain of the analysis package vendor, who currently also replicates items 1 and 2, usually through redundant input of the data by the user.

Three possible development approaches became apparent, given the way the data is reposed. First, the CADD vendor could develop the entire package. This approach would require the CADD vendor to either create his own analysis package or to learn an existing package well enough to acquire and properly apply all data from the third category above.

A second alternative would be for the CADD vendor to manipulate data only from the first two categories and make it available to the analysis package through some data structure. The analysis package vendor would then have the responsibility of gathering data from the third category and transferring the complete data set to the analysis package. This approach has the advantage that each

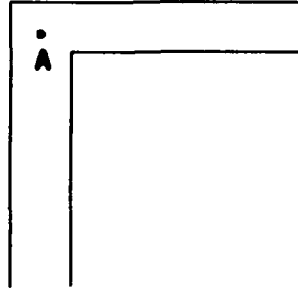


Figure 2. Endpoint for a Wall.

vendor deals primarily with familiar data. A disadvantage is that the data structure for transfer may become too specific from the CADD vendor's standpoint. (The CADD data may not be re-usable for other analysis packages.) On the other hand, the data structure may also become too generic from the analysis package vendor's standpoint. (The data may not be well matched to a specific application.)

The third development approach would be for the application developer to query the CADD vendor's database for the category 1 and 2 information needed, then fill in the category 3 information and feed the complete data set to the analysis program. This approach would allow the analysis package developer to extract only needed information. However, this method would also require the analysis package developer to learn a proprietary CADD database system.

For this project, the second approach was selected to develop a CADD-to-BLAST interface. Later, the third approach was also tried. These efforts resulted in the creation of two interfaces—*IN2BLAST* and *Drawing Navigator*. While the basic purpose of both interfaces is the same, the conceptual basis for each is quite distinct. The following two chapters will describe the conceptual basis for each interface.

3 *IN2BLAST*

Description

The developmental approach taken for the *IN2BLAST* interface was to work with a CADD vendor who provided the data available from their system in the form of a *neutral file*. USACERL researchers developed code to read the neutral file, map this information onto the data requirements for BLAST input, and query the user for missing data. The CADD vendor chosen for this effort was Intergraph Incorporated, who was selected for this project because it had already been awarded the contract for the Corps-wide standard CADD purchase. It was felt that a broad number of Corps designers could benefit from the practical interface program that would eventually be developed from this research. Determining the contents of the neutral file was a cooperative effort. Responsibility for producing the code to actually produce the neutral file was assigned to Intergraph. USACERL researchers assumed the responsibility for writing code to read the neutral file, acquire other inputs as necessary, and produce a BLAST input deck.

Specific software products were chosen to develop a prototype neutral file interface. The relationship of the various programs is best explained in terms of how they were intended to be used together. First, architectural floor plans were to be created using Intergraph's Architectural Production and Design Package (APDP). This package was designed to allow for complete creation of the architectural design. For the purposes of this project, only the floor plan drawings were critical, but this fact did not preclude using the package fully. APDP produces a set of project files to store the floor plan information. Next, the HVAC Loads Analysis program (HVLD, also from Intergraph) was used to zone the building. A digitizer or mouse was used to denote the rooms that comprised specific zones, and screen forms were used to input fan system information. For this project, HVLD was modified by Intergraph to scan the data in the project files and produce the neutral file as an output. USACERL researchers developed the *IN2BLAST* program to read the neutral file, prompt for missing data, and allow for the reviewing and/or modification of: thermal zones; activities within the zones; occupancy and lighting levels; and fan system and central plant data. *IN2BLAST* would then produce a BLAST input deck to run on an unmodified version of BLAST. The *IN2BLAST* code itself was based primarily upon BTEXT Version 6.1. Figure 3 shows the relationships of the various component programs.

Since the *IN2BLAST* code was based on BTEXT, it uses a similar menu-driven interface. One new option in the *IN2BLAST* menu structure is to load a neutral file. As the neutral file is loaded, the information contained in the file is converted to the internal BTEXT variables. In some instances, data not available in the neutral file is required to complete these conversions. When this occurs, the user is prompted for the required data. After the neutral file is read, the user may then enter other BLAST-specific information using familiar BTEXT options. Appendix A contains a menu diagram for *IN2BLAST*. Appendix B contains the data element descriptions for the neutral file.

The simplified description of *IN2BLAST* in Figure 3 is meant to relate the conceptual basis for the interface. The main program-to-program interface between CADD and BLAST is the neutral file, and the associated data structure mapping is performed within the *IN2BLAST* module. APDP, BLAST, the APDP project files, and BLAST input deck all remain unchanged. HVLD was modified to allow for creation of the neutral file, and *IN2BLAST* is essentially a new creation to effect the data transfer, but is based primarily upon BTEXT.

Some of the difficulties outlined in Chapter 2 were overcome due to the nature of APDP. By the time the energy engineer interacts with HVLD, the system has already identified the building elements represented in graphic symbols, and some of the normally nonrepresented data such as the wall height. Work already done in APDP allowed this information to be present in the project database for HVLD to

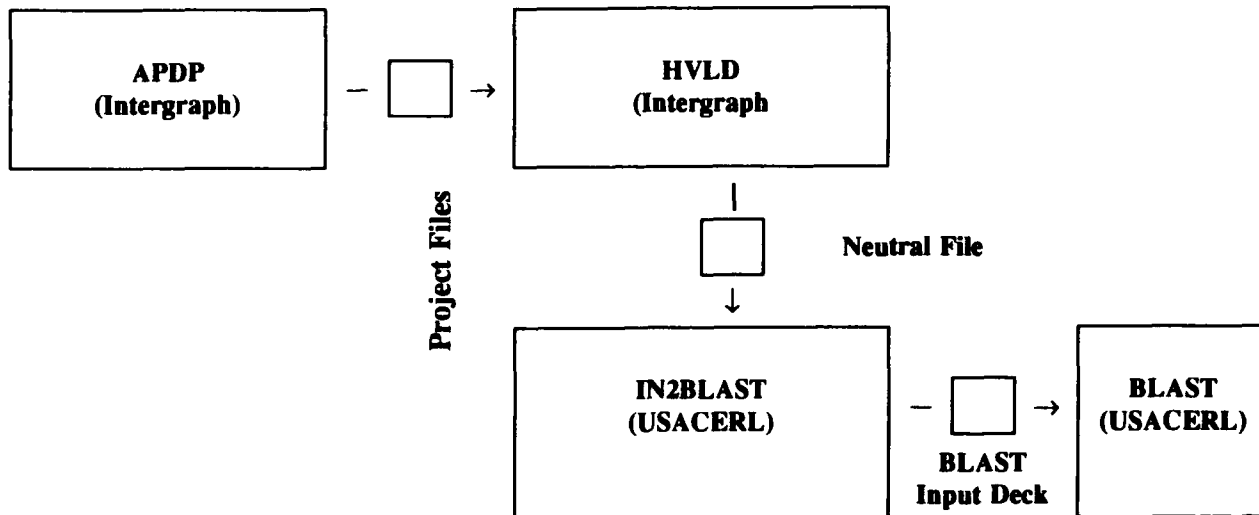


Figure 3. *IN2BLAST* Interface Programs.

access. The availability of this information also overcame some of the difficulties associated with information being logically represented but not physically available. Since the procedure for creating the floor plan in APDP was prescribed, APDP was able to “infer” this information and store it as physical entities in the project database. The one major difficulty previously discussed that was not overcome was that of sorting out only the data required for BLAST. This task was then the focus of efforts for the *IN2BLAST* code.

Lessons Learned

Several key lessons were learned while developing the *IN2BLAST* code, including the importance of filtering out “noise.” Other issues also became apparent as work progressed. Questions arose regarding user training and support, how many user interfaces would be necessary, and how user interfaces would be programmed into the system and over program boundaries.

There were many insightful lessons pertaining to the early stages of the project, particularly the development approach. Decisions made early in the project regarding program development were vital. This interface was developed largely from existing programs, with the “newest” piece of code being the *IN2BLAST* program itself. However, *IN2BLAST* was developed primarily from BTEXT (the BLAST input pre-processor) and ENERGY (a prototype graphical pre-processor developed by USACERL for mainframe application, but never distributed). The CADD portion was a straightforward modification of HVLD to produce the neutral file. This arrangement was chosen primarily for expedience. The idea was that, since HVLD and BTEXT already had user interfaces, that portion of the work could be considered done. Therefore, the interfacing task would be reduced to mapping the HVLD data onto the BTEXT data structures.

Most of the problems in creating this interface centered on the fact that all of the programs comprising the system had implicit paradigms in data structures they used to represent the building. Each section of code being drawn together into the interface system was based on certain viewpoints and assumptions used in the original programs to determine what data was important to encode, and how to encode it. The perceived task was to map the HVLD data structure onto its *IN2BLAST* counterpart. This task proved more complex than anticipated. Instead of a relatively straightforward mapping of one data

structure onto another, the true task at hand was one of resolving completely different building representations. There was a great disparity between HVLD and BLAST in the terminology and intended use of the data elements.

This task was further complicated by a distinction in the *IN2BLAST* code between graphic and nongraphic data. Graphic data was represented by ENERGY data structures, and nongraphic data was represented by BTEXT data structures. Taken together with the HVLD/neutral file representations, there were actually three types of building representations to resolve. A few of these problems were addressed during negotiations over the content of the neutral file.

Most problems had to be resolved with programming techniques. For example, there were differences in representation of walls in the neutral file and in the ENERGY-based data structures that were used in *IN2BLAST*. Since the *IN2BLAST* data structures were list-based, representations of walls were formed from beginning and end points for the walls, which were assigned based on the order they were encountered (juxtaposition in the list). Later in the neutral file scanning process, coordinate data was used to actually locate those walls. However, there was no information inherent in either the neutral file or *IN2BLAST* structures that allowed for correlation of the two sets for beginning/endpoint data. This problem also affected *IN2BLAST*'s ability to tell which zones were on which side of an interior wall. This information must have been represented in the original CADD drawing, but was not explicitly included as data elements. The solution to this problem was to perform a vector analysis on the data points provided to reconstruct the information.

The pertinent lesson is that the required representation may include information that is not an explicit data element in any data structure. The proper approach would then be to negotiate what representation needs to be used, that is, to find a suitable data abstraction that represents the physical system that needs to be described, and base actual data structures on that abstraction. This abstract data type then becomes the program-to-program interface. Developing the abstraction then becomes the encompassing task, requiring considerable patience and cooperation on the part of both developers.

Another issue with the *IN2BLAST* interface approach is that of the distribution of the user interaction. While individual user tasks are interactive, they are spread across program boundaries. The user first interactively zones the building in HVLD, and chooses the menu option to create a neutral file. Next, he boots *IN2BLAST* and chooses the option to load the neutral file. While loading the neutral file, interaction is required to provide data needed to complete the scan. A third interactive session requires BLAST-specific information to be entered using the *IN2BLAST* menu system. Even though these last two interactions occur within the same program, they are significantly different activities and, therefore, are identifiable as distinct tasks.

This separation of the interactive portions of the system give it the look and feel of a batch, rather than an interactive system. Many users perceive batch processing as an antiquated, "user un-friendly" system. As it is setup, the system gives the feeling that the analysis input creation job must be done three times (based on the three distinct interactive sessions), so there may be no perceived labor savings compared to manually rekeying the data. User interaction needs to be centralized to eliminate these inefficiencies.

Another issue related to the distribution of the user's labor within the system becomes apparent when one considers support and training issues. The user must know how to use the CADD package (HVLD in this case), the user interface to the program-to-program interface code (*IN2BLAST*), and the analysis package (BLAST). Even if the programs involved were straightforward to use, the user would need to read three manuals. If a problem is encountered in transferring the data, the source of the problem

could be unknown, and it could be unclear whom to call for support. One party needs to take responsibility for supporting the user through the entire interface process.

Another significant problem was the amount of unneeded CADD data (noise) in the neutral file. The neutral file is organized into collections of related data elements called "entities." Of the individual data items available in the neutral file, *IN2BLAST* only used 32 percent. On average, only 39 percent of any given entity was used, with 31 (72 percent) of the entities having 50 percent or less of their items used, 17 entities (40 percent) having less than 25 percent used, and 12 entities (28 percent) not being used at all. Interestingly, the 12 entities that are not used at all account for 33 percent of the total data in the neutral file—1 percent more than the total number of data items that were used.

Disposition of Interface

The *IN2BLAST* interface actually operates on a distributed computing platform. The APDP and HVLD programs run on a minicomputer networked with a graphics workstation. The *IN2BLAST* code runs entirely on the workstation. Intergraph has decided to consolidate their software products onto the workstations and eliminate the minicomputer portion of the platform. Therefore, APDP and HVLD are no longer supported products. Given these facts, the *IN2BLAST* interface was not released to the field. However, the lessons learned in this work were carried forward into the development of the *Drawing Navigator*.

4 DRAWING NAVIGATOR

Description

A second approach that attempted to solve some of the problems encountered with *IN2BLAST* resulted in the development of the *Drawing Navigator* concept. In particular, this interface was designed to be more interactive, and to rely almost solely on BLAST to define the data abstractions. Furthermore, the development of this interface was done completely by USACERL researchers, relying only upon publicly available information about CADD products. This approach solved several problems in a single stroke: it allowed *Drawing Navigator* to concentrate the user interaction in one place, to develop a data abstraction of the CADD information that was tailored to BLAST, and to provide a single point of contact for user support. The development of a prototype *Drawing Navigator* concentrated on the user interface, and was able to use the BLAST input deck as its program to program interface.

The particular CADD package chosen for the *Drawing Navigator* prototype was *AutoCAD* Version 10 by Autodesk. *AutoCAD* was chosen for its popularity within the architectural engineering community, its status as a de facto standard CADD package, and its extensibility via AutoLISP (Autodesk's proprietary subset of LISP). Another consideration for choosing *AutoCAD* was that it would complement the *IN2BLAST* effort by providing a CADD-BLAST interface on a different manufacturer's platform. The *Drawing Navigator* was actually written as an embedded program to be run from within *AutoCAD*. Once architectural floor plan drawings are created and BLAST analysis is desired, the *Drawing Navigator* is booted with the floor plan drawing file name. Booting *Drawing Navigator* actually invokes *AutoCAD* and the AutoLISP program portion of *Drawing Navigator*. By using a pointing device such as a mouse, the user interacts with on-screen instructions and a system of menus to zone the building. By reading the *AutoCAD* database and reacting to user interactions, *Drawing Navigator* can extract the pertinent data from the CADD drawing for input to BLAST. Other menus allow the user to enter inherently textual information about the project and create a complete BLAST input deck. Figure 4 outlines the relationships between the various *Drawing Navigator* components.

The intent of this research was to develop the concept of the *Drawing Navigator* such that it could be implemented on any number of CADD platforms. The CADD System shown in Figure 4 (for the developed prototype) is *AutoCAD*. The *Drawing Navigator* box shows three subcomponents. The embedded code is the AutoLISP portion of the interface, which extracts the usable data from the CADD drawing via an interactive session with the user. A data file is then used to transfer this information to an external code portion, which is based upon BTEXT for the prototype implementation. This code allows the user to input the BLAST-specific data. The arrangement shown was chosen for the prototype as a programming convenience. A batch file couples the two sections of code and launches them sequentially for the prototype. In full implementations of *Drawing Navigator*, this external code would be replaced by additional embedded code to collect this data. The *Drawing Navigator* would then be a single block in this diagram. Once all the pertinent data is entered, a BLAST input deck is produced and BLAST can be run in the normal fashion. The release note and user's manual for the prototype *Drawing Navigator* for *AutoCAD* (Version 0.9) is included in Appendix C. Refer to this appendix for a more specific description of the operation of the prototype.

The *Drawing Navigator* overcomes most of the difficulties outlined in Chapter 2 by properly applying user input. Much of the noise in the CADD data is eliminated from consideration by the user's selection of graphic elements that restrict the size of searches required to find the appropriate information. The user can easily recognize information that exists logically, but not physically, in the drawing. The interface gathers this information from interaction with the user. Similarly, the user can easily recognize the many variations of representations of common elements such as doors, windows, etc. Once the user

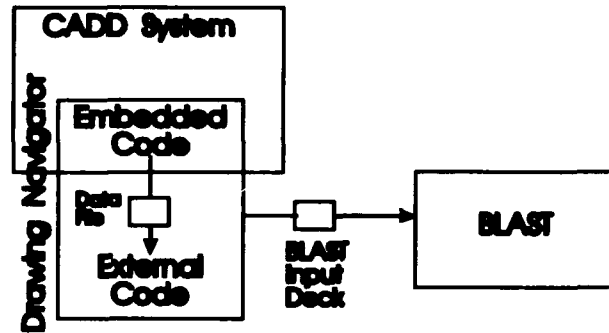


Figure 4. Drawing Navigator Interface.

selects one such item, others identically defined in *AutoCAD* blocks can then be automatically retrieved by *Drawing Navigator* without further user intervention. Other information that is readily available to the user but not easily found in the CADD database (such as zone height, wall constructions, etc.) is entered as part of the interactive process.

Development of the *Drawing Navigator* for *AutoCAD* focused on the creation of AutoLISP functions known as *browsing tools*. These tools were designed to handle specific aspects of retrieving geometric information about the building from the drawing file. For example, one tool allowed for the magnification of a specific area on a drawing to pinpoint a specific coordinate location more accurately. Another browsing tool could compute the facing direction for a surface, given its endpoints. Yet another such tool was developed to count the number of occurrences of a pattern and the corresponding locations within a user-specified region. (This tool is useful for capturing window and door descriptions.) Still other tools were responsible for producing on-line help, screen management, reporting to the user what information had been retrieved from the CADD database, etc.

The prototype *Drawing Navigator* for *AutoCAD* was developed by combining these tools through a programming technique known as *meta-interpretation*. Using this technique, the browsing tools are first organized according to a set of tasks. The meta-interpreter then controls the execution of the tools to perform various tasks based on user input. The meta-interpreter is also responsible for *backtracking* or *undoing* operations during the interactive session. The development of meta-interpreters is facilitated by AutoLISP because programs and data are represented by the same structure (i.e., there is little distinction between data and code). Other control programs can also be used to link the basic tools that are not meta-interpreters. One primary advantage of using this modular programming approach is that functionality can be changed or expanded without rewriting the browsing tools. Simply changing the controlling program allows for the behavior of the interface to be significantly altered, and can also accommodate the addition of new browsing tools late in the development cycle.

Lessons Learned

After tests at USACERL and at the BLAST Support Office, the *Drawing Navigator* for *AutoCAD* was taken to Mobile District in Mobile, AL for field testing. A mechanical design engineer for Mobile District performed the field test. This section will outline the lessons learned as a result of this testing. A copy of the beta test plan and the test report can be found in Appendix D. (Note: *Drawing Navigator* is referred to in the appendix as BCAD, an acronym used to describe the interface during the beta test.)

The primary question to be answered by the field test was whether or not a CADD to BLAST interface could really save the mechanical designer time. To test this premise, a sample project was selected for input using *Drawing Navigator*. Appendix D contains a plot of the sample building. Completion of the BLAST input task took 20 minutes. The input process was repeated using only the BTEXT pre-processor. The time required using BTEXT alone was recorded as 35 minutes. For this particular case, there was a time savings of 43 percent. A design engineer (the field test subject) estimated that a 50 to 75 percent time savings is plausible, based on his experience and observations. In other words, the field tester believed that the interface did improve productivity.

Another question to be answered by the field test was whether or not the accuracy of the BLAST simulation was adversely affected by the use of the interface. The test subject reported no significant difference between the input decks generated by *Drawing Navigator* and those generated by BTEXT. The *Drawing Navigator* for AutoCAD produces a BTEXT database file that can be loaded by any version of BTEXT subsequent to Version 1.0 Level 61 (the version which the BTEXT-based portion of *Drawing Navigator* is based on). The BTEXT database files generated using *Drawing Navigator* and by using BTEXT alone were loaded into BTEXT Version 1.0 Level 112, from which BLAST input decks were produced. This procedure eliminated differences in the two decks due to differences in the BTEXT levels, thus facilitating comparison of the input provided by each approach. Printouts of these input decks may be found in Appendix D. Each of these printouts has highlighted portions showing where one deck differs from another. Minor numerical differences due to the precision of *Drawing Navigator* were not highlighted (e.g., the difference between -26.63, 15.67, 0.00 and -26.67, 16.00, 0.00), and differences in the order of appearance of surfaces were ignored. The comparison offered here will be based upon these printouts.

The first two differences are minor. The BTEXT-produced deck has an additional design day specified (BIRM WINTER), and the two decks have different names for the building (HANGER versus FT RUCKER HANGER). These are simply differences in how the text labels were input, and do not indicate any inherent difference between the methods.

The first significant difference comes in the ZONE 1 description under SLAB ON GRADE FLOORS. The starting points for the floors are different. The same is true for the ROOFS starting point. This difference is also apparent in ZONE 2 and ZONE 3. Choosing the proper coordinates for the lower left corner for a floor or roof surface is one of the most confusing aspects of creating a BLAST input file. The starting point for the roofs are consistently correct in the *Drawing Navigator*-generated input deck, and incorrect for the BTEXT-generated deck. The starting point for the floors is consistently incorrect in both decks. This problem with the floor starting point indicates that a better explanation of what is meant by "lower left corner" for floors should be included in the *Drawing Navigator* documentation. These errors are minor, and will not change the simulation results unless the solar distribution is being considered (which, in this case, it was not).

Another recurring difference had to do with the LIGHTS statement in all three zones. The value in the BTEXT-generated deck was consistently 1000 times larger than that in the *Drawing Navigator* deck. This difference likely can be attributed to a misunderstanding of the input units when the BTEXT deck was generated. During the field test, these numbers were corrected to match those used in the *Drawing Navigator* generated deck by manually editing them in the BLAST input file. Again, no inherent difference in the programs was indicated.

Similarly, in ZONE 2 an internal mass was entered in the BTEXT version that was not entered for the *Drawing Navigator* version. *Drawing Navigator* allows for the entry of internal mass, so the difference was attributable to user choice. Several differences were apparent in the ZONE 3 description as well. First of all, different exterior wall constructions were used (EXTWALL01 versus EXTWALL02).

Secondly, on two of the walls, the BTEXT version used starting points with vertical elevations of 10 ft (3.05 m) and wall heights of 30 (9.14 m) ft, versus zero elevations and heights of 40 ft (12.2 m) for the *Drawing Navigator* version. This difference placed the top of these walls at a height of 40 ft (12.2 m) in both instances, but reduced the area of the two surfaces by ten times their respective lengths in the BTEXT generated deck. Also the length of one west-facing wall was 88 ft (26.8 m) in the BTEXT deck and 104 (103.75) ft (31.7 m) in the *Drawing Navigator* deck. Again, the BTEXT deck appeared to omit some of the surface area. Finally, different floor constructions were used in each deck (SLAB FLOOR versus FLOOR34). None of these differences were inherent to using one program or the other. The differences simply reflected different choices made by the user as to how to model the building given the two different work environments. However, the differences would change the results of the simulation.

A final minor difference is that two different names were used to describe the first central plant—"PLANT 1" versus "CHILLER." Since this item was simply a user-defined text label, there was no difference in the simulation.

After the two input decks had been produced under Level 112 of BTEXT and the factor of 1000 error was corrected in the BTEXT-generated input deck, both decks were used to run BLAST. There were no problems loading and executing either deck. The zone plots of both decks revealed the misplacement of the floor starting coordinates, and those of the BTEXT-generated deck also showed the misplacement of the roof. (Both of these errors were inconsequential.) Zone 1 had an exterior surface area of 4347.08 sq ft (403.84 m²), floor area of 2773.68 sq ft (257.68 m²), and approximate zone volume of 20716.1 cu ft (586.61 m³) in the BTEXT version. The values were 4317.07 sq ft (401.06 m²), 2749.97 sq ft (255.47 m²), and 20544.7 cu ft (581.76 m³), respectively, in the *Drawing Navigator* version. These values for the two versions all vary less than 1 percent from their counterparts. The areas of the individual surfaces/subsurfaces are also very nearly the same between versions. These relations are also true for Zone 2, with the exception of the internal mass that was added in the BTEXT version and not in the *Drawing Navigator* version. The different modeling techniques used for Zone 3 significantly altered the exterior surface area and approximate zone volume figures. (Appendix D also includes the Zone reports for both of these runs.) Since there were differences in the zone descriptions and no CONTROLS statements were included in the input decks as provided, no loads were calculated for the two models. This examination serves to support the contention that the use of the *Drawing Navigator* had no adverse affect on the accuracy of the input deck. In fact, the *Drawing Navigator* deck was more accurate.

The field tester indicated that he would prefer to use the *Drawing Navigator* over BTEXT. Reasons cited for this preference were that the *Drawing Navigator* took less effort and was less tedious than BTEXT. Overall, the tester was impressed with the interface and strongly recommended its further development.

The field test also exposed the expected program anomalies that required correction, and some aspects of the interface design that could use further attention. Although phrased as specific suggestions in the test report, most of the design issues on user control of the program function as a unit. Deficiencies existed in the prototype that made it difficult to correct omissions once a certain menu level had been exited. Also, while the interface code is running, the user cannot directly access *AutoCAD* features that may be beneficial in handling the input process. These issues can be addressed by restructuring the control code, and possibly by adding a few new tools to the system. Appendix B also contains specific comments relating to the items mentioned in the Beta Test Report. The important lesson is to allow the user, rather than the program, to control the sequence of interaction as much as possible. With such a free-format input process, the designer may then chose the work method he finds most productive.

By capitalizing on lessons learned in the *IN2BLAST* effort, the *Drawing Navigator* for *AutoCAD* was able to achieve the goal of increasing designer productivity by reducing the time required to move input

data from a CADD system to BLAST. In addition, it was learned that the form of the interface should afford the user as much control over the work process as is practicable. By relying on the user's expertise to handle recognition tasks, and on the untiring repeatability of the computer to handle the more tedious counting and calculation tasks, the *Drawing Navigator* has proven to be a useful concept for implementing a CADD-to-analysis interface.

Disposition of Interface

After correction of the operating anomalies reported during the field test, the prototype *Drawing Navigator* for *AutoCAD* was released through the BLAST Support Office as Version 0.9. Restructuring of the controlling mechanism to address the user interface issues raised by the field test was in progress at this writing. Also under development is a *Drawing Navigator* for Intergraph's Microstation CADD software (*Drawing Navigator* for Microstation). If there is sufficient demand from the field for these programs, they will remain as supported members of the BLAST software family. A Cooperative Research and Development Agreement (CRDA) may be used to further development of these interfaces by the private sector.

5 CONCLUSIONS AND RECOMMENDATIONS

The field test of the *Drawing Navigator* indicates that CADD-to-analysis interfaces can save significant time, especially for data intensive programs such as BLAST. The interface frees the designer to apply time otherwise spent in data entry to other jobs, or to do additional energy studies to determine the most energy efficient configuration for the building being studied.

The key to achieving a successful interface with current computing technology is the proper application of the skills of the human user and the computer's ability to handle repetitive tasks quickly and accurately. The *Drawing Navigator* concept capitalizes on the user's recognition abilities and the automation's search and calculation facilities. This combination speeds the BLAST input preparation process, while still leaving the designer in control of decisionmaking.

The *Drawing Navigator* concept has potential for further application. Another CADD-to-BLAST *Drawing Navigator* is currently under development. The *Drawing Navigator* methodology may be applicable to other types of analysis. By using a modular development approach, the parts of the *Drawing Navigator* are easily refined.

It is recommended that the *Drawing Navigator* be further refined. It is anticipated that a tighter coupling between the user and program-to-program interfaces will improve user acceptance and further boost efficiency. Improvements to the user interface as indicated by the field test need to be completed. The program-to-program interface could also be improved by adding the capability to transfer information from the analysis back to the CADD drawing.

Such two-way data migration should be investigated as a tool for improving communication of energy-related data between disciplines. Decisions made by different disciplines at varying times in the design process affect energy consumption. Providing two-way communication between CADD and energy analysis may allow for the CADD drawing and related data structures to become useful as repositories for the data required for interdisciplinary design.

It is also recommended that the BLAST data abstraction be further improved. Further development of the data model for BLAST input could promote interdisciplinary energy design efforts. The division of labor between the BLAST family programs (and possibly other analysis programs) could be redefined based upon a more robust abstract building model. Such efforts should seek to improve both computational efficiency and promote energy design integration.

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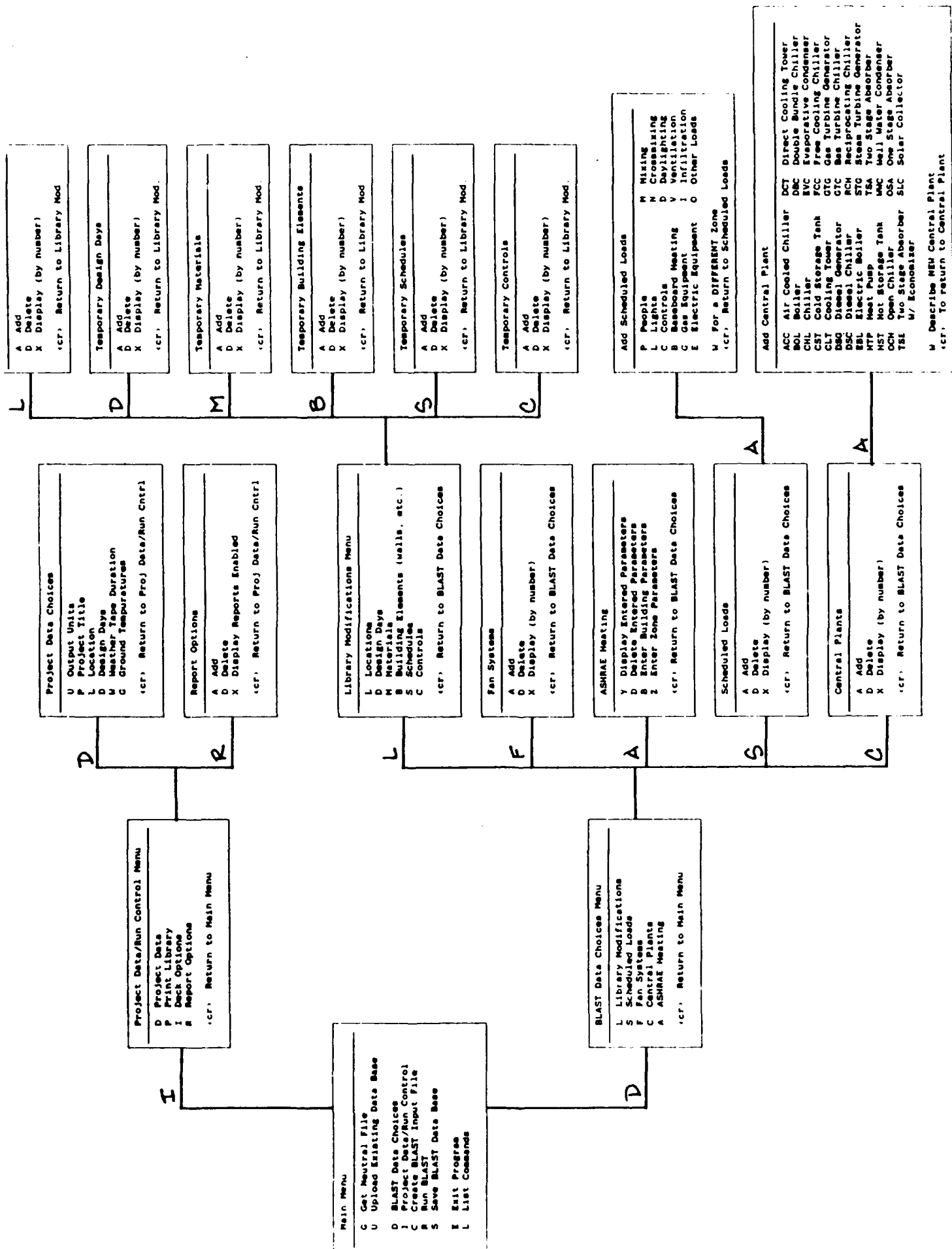
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APPENDIX A: *IN2BLAST* Menu Map



APPENDIX B: HVLD Neutral File Format

*** HVLD OUTPUT FORMATS ***

ROOM WALL (entity 120)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
13	1	2	Room Number	CHARACTER	A5	1	5			
111	1	6	Zone Number	INT*4	I11	7	17	-2147483648	2147483648	
110	1	6	System Number	INT*4	I11	19	29	-2147483648	2147483648	
16	1	1	Drawing Number	CHARACTER	A9	31	39			
120	1	6	Total_Below_Grade_Heat_Loss	REAL*8	F20.3	41	60	9.9999999	9.99X10(16)	
120	2	9	Length	REAL*8	F20.3	1	20	9.9999999	9.99X10(16)	
120	2	10	Area	REAL*8	F20.3	22	41	9.9999999	9.99X10(16)	
120	2	11	Plenum_Wall_Height	REAL*8	F20.3	43	62	9.9999999	9.99X10(16)	
120	3	12	Plenum_Wall_Area	REAL*8	F20.3	1	20	9.9999999	9.99X10(16)	
120	3	22	Wall_Description	CHARACTER	A20	22	41			
10	3	1	Class_code	CHARACTER	A12	43	54			
10	4	2	Type	CHARACTER	A50	1	50			
10	4	4	Width	REAL*8	F20.3	52	71	9.9999999	9.99X10(16)	1=exterior, 2=interior, 3=interior structural wall thickness
10	5	5	Height interior	REAL*8	F20.3	1	20	9.9999999	9.99X10(16)	
10	5	6	Base_offset	REAL*8	F20.3	22	41	9.9999999	9.99X10(16)	Distance from base of wall to finished floor level
16	5	1	arch wall drawing number	CHARACTER	A9	43	51			
10	5	101	AZIMUTH	REAL*8	F20.3	53	72	9.9999999	9.99X10(16)	0-360
10	6	102	TILT	REAL*8	F20.3	1	20	9.9999999	9.99X10(16)	-90 to 90
120	6	103	Wall_Thermal_Code	CHARACTER	A10	22	31			

WALL THERMAL CODE (entity 155)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
155	1	7	Percent_Ceiling_Heat_to_RA	BYTE	I4	1	4	-128	+127	0-100
155	1	8	Percent_Wall_Heat_to_RA	BYTE	I4	6	9	-128	+127	0-100
155	1	11	Plenum_Wall_Height	REAL*8	F20.3	11	30	9.9999999	9.99X10(16)	
155	1	30	Wall_Type	INT*4	I11	32	42	-2147483648	2147483648	
155	1	38	Below_Grade_Heat_Loss_Area	REAL*8	F20.3	44	63	9.9999999	9.99X10(16)	
155	2	102	Description	CHARACTER	A24	1	24			
155	2	103	Wall_Thermal_Code	CHARACTER	A10	26	35			

*** HVLID OUTPUT FORMATS ***

ROOF (entity 121)

ent	rec	attr	description	data type	format	location		units	min_value	max_value	comments
e	r	e				str	end				
131	1	2	Room Number	CHARACTER	A5	1	5				
111	1	6	Zone Number	INT*4	I11	7	17		-2147483648	2147483648	
110	1	6	System Number	INT*4	I11	19	29		-2147483648	2147483648	
161	1	1	Drawing Number	CHARACTER	A9	31	39				
121	1	6	Roof_Type	INT*4	I11	41	51		-2147483648	2147483648	
121	1	13	Length	REAL*8	F20.3	53	72	ft, m	-99999999	9.99X10(16)	
121	2	14	Width	REAL*8	F20.3	1	20	ft, m	-99999999	9.99X10(16)	
121	2	15	Azimuth	INT*4	I11	22	32	degrees	-2147483648	2147483648	0-360
121	2	16	Tilt	INT*4	I11	34	44	degrees	-2147483648	2147483648	-90 to 90
121	2	17	Percent_Heat_to_RA	INT*4	I11	46	56	%	-2147483648	2147483648	0-100
121	2	20	Height above floor	REAL*8	F20.3	58	77	ft, m	-99999999	9.99X10(16)	
121	3	82	Area	REAL*8	F20.3	1	20	sq ft, sq m	-99999999	9.99X10(16)	

*** HVLD OUTPUT FORMATS ***

PARTITION (entry 122)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
13	1	2	Room 1 Number	CHARACTER	A5	1 5				
111	1	6	Zone 1 Number	INT*4	I11	7 17		-2147483648	2147483648	
110	1	6	System 1 Number	INT*4	I11	19 29		-2147483648	2147483648	
16	1	1	Drawing Number	CHARACTER	A9	31 39				
122	1	6	Partition Type	INT*4	I11	41 51		-2147483648	2147483648	
122	1	7	Description	CHARACTER	A24	53 76				
13	2	2	Room 2 Number	CHARACTER	A5	1 5				
111	2	6	Zone 2 Number	INT*4	I11	7 17		-2147483648	2147483648	
110	2	6	System 2 Number	INT*4	I11	19 29		-2147483648	2147483648	
16	2	1	Drawing Number	CHARACTER	A9	31 39				
122	2	12	Length	REAL*8	E20.3	41 60	ft, m	-99999999	9.99X10(16)	
122	3	13	Width	REAL*8	F20.3	1 20	in, mm	-99999999	9.99X10(16)	partition thickness

*** HVLD OUTPUT FORMATS ***

ROOM_FLOOR (entity 123)

ent	rec	attr	description		data type	format	location		units	min_value	max_value	comments
0	0	0	0	0			str	end				
13	1	2	Room Number		CHARACTER	A5	1	5				
111	1	6	Zone Number		INT*4	I11	7	17		-2147483648	2147483648	
110	1	6	System Number		INT*4	I11	19	29		-2147483648	2147483648	
16	1	1	Drawing Number		CHARACTER	A9	31	39				
123	1	6	Floor_Type		INT*4	I11	41	51		-2147483648	2147483648	
123	1	13	Exposed_Net_Area		REAL*8	F20.3	53	62	sq ft	-99999999	9.99X10(16)	
123	2	17	Approx Meth Space Below Temp		CHARACTER	A12	1	12	sq m			"constant", "nine curve", "prorated OADB", "scheduled", "OutAir DB"

ROOM_CEILING (entity 124)

ent	rec	attr	description		data type	format	location		units	min_value	max_value	comments
0	0	0	0	0			str	end				
13	1	2	Room Number		CHARACTER	A5	1	5				
111	1	6	Zone Number		INT*4	I11	7	17		-2147483648	2147483648	
110	1	6	System Number		INT*4	I11	19	29		-2147483648	2147483648	
16	1	1	Drawing Number		CHARACTER	A5	31	39				
124	1	6	Ceiling_Type		INT*4	I11	41	51		-2147483648	2147483648	
124	1	77	Ceiling_Area		REAL*8	F20.3	53	72	sq ft, sq m	-99999999	9.99X10(16)	
124	2	78	Tilt		INT*4	I11	1	11	degrees	-2147483648	2147483648	
124	2	79	RA_Plenum_Flag		BYTE	I4	13	16		-128	+127	1=yes, 2=no

*** HVLD OUTPUT FORMATS ***

DOOR		(entity 11)											
ent	rec	attr	description		data type		format	location	units	min_value	max_value	comments	
#	#	#	#	#	#	#	#	str	end	#	#	#	
11	1	.1	Class_code		CHARACTER	A12	1	12					
11	1	.2	Number		CHARACTER	A5	14	18					
11	1	.3	Width		REAL*8	F20.3	20	39	in., mm	-99999999	9.99X10(16)	Door width	
11	1	.4	Height		REAL*8	F20.3	41	60	in., mm	-99999999	9.99X10(16)	Door height	
11	2	.5	Frame_width		REAL*8	F20.3	1	20	in., mm	-99999999	9.99X10(16)	Frame face width	
11	2	.6	Base_offset		REAL*8	F20.3	22	41	in., mm	-99999999	9.99X10(16)	Distance-base of door to finished floor level	
16	2	.1	Drawing Number		CHARACTER	A9	43	51					
11	2	.101	Door_Type		INT*4	I11	53	63		-2147483648	2147483648		
120	3	.22	Room_Wall Description		CHARACTER	A20	1	20					
13	3	.2	Room Number		CHARACTER	A5	22	26					
111	3	.6	Zone Number		INT*4	I11	28	38		-2147483648	2147483648		
110	3	.6	System Number		INT*4	I11	40	50		-2147483648	2147483648		
11	3	.110	Door_Description		CHARACTER	A24	52	75					

WINDOW (entry 12)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
12 1	1	1	Class_code	CHARACTER A12	1	12				
12 1	2	2	Number	CHARACTER A5	14	18				
12 1	3	3	Length	REAL*8	F20.3	20	39	-9999999	9.99X10(16)	width of window
12 1	4	4	Height	REAL*8	F20.3	41	60	-9999999	9.99X10(16)	Distance sill to window top
12 2	5	5	Sill_height	REAL*8	F20.3	1	20	-9999999	9.99X10(16)	Vertical distance-floor to sill
16 2	1	1	Drawing Number	CHARACTER A9	22	30				
12 2	101	101	Window_Thermal_Code	CHARACTER A10	32	41				
120 2	22	22	Room Wall Description	CHARACTER A20	43	62				
13 2	2	2	Room Number	CHARACTER A5	64	68				
111 3	6	6	Zone Number	INT*4	111	1	11	-2147483648	2147483648	
110 3	6	6	System Number	INT*4	111	13	23	-2147483648	2147483648	
12 3	125	125	Descript_wall_with_window	CHARACTER A24	25	48				
12 3	126	126	Window_Description	CHARACTER A24	50	73				
12 4	127	127	Quantity	INT*4	111	1	11	-2147483648	2147483648	
12 4	130	130	External_Shade_Start_Azimuth	INT*4	111	13	23	-2147483648	2147483648	0-360
12 4	131	131	External_Shade_End_Azimuth	INT*4	111	25	35	-2147483648	2147483648	0-360
12 4	132	132	External_Shade_Start_Altitude	INT*4	111	37	47	-2147483648	2147483648	0-90
12 4	133	133	External_Shade_End_Altitude	INT*4	111	49	59	-2147483648	2147483648	0-90
12 4	134	134	External_Shade_Start_Hour	CHARACTER A6	61	66				"midnit", "1 a.m.", "2 a.m.", "3 a.m.", "4 a.m.", "5 a.m.", "6 a.m.", "7 a.m.", "8 a.m.", "9 a.m.", "10 a.m.", "11 a.m.", "noon", "1 p.m.", "2 p.m.", "3 p.m.", "4 p.m.", "5 p.m.", "6 p.m.", "7 p.m.", "8 p.m.", "9 p.m.", "10 p.m.", "11 p.m.", "midnit", "1 a.m.", "2 a.m.", "3 a.m.", "4 a.m.", "5 a.m.", "6 a.m.", "7 a.m.", "8 a.m.", "9 a.m.", "10 a.m.", "11 a.m.", "noon", "1 p.m.", "2 p.m.", "3 p.m.", "4 p.m.", "5 p.m.", "6 p.m.", "7 p.m.", "8 p.m.", "9 p.m.", "10 p.m.", "11 p.m."
12 5	135	135	External_Shade_End_Hour	CHARACTER A6	68	73				

*** HVLD OUTPUT FORMATS ***

WINDOW (entry 12)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
12 1	1	1	Class_code	CHARACTER	A12	1 12				
12 1	2	2	Number	CHARACTER	A5	14 18				
12 1	3	3	Length	REAL*8	F20.3	20 39	in., mm	-99999999	9.99X10(16)	width of window
12 1	4	4	Height	REAL*8	F20.3	41 60	in., mm	-99999999	9.99X10(16)	Distance-sill to window top.
12 2	5	5	Sill_height	REAL*8	F20.3	1 20	in., mm	-99999999	9.99X10(16)	Vertical distance-floor to sill
16 2	1	1	Drawing Number	CHARACTER	A9	22 30				
12 2	101	101	Window_Thermal_Code	CHARACTER	A10	32 41				
12 2	22	22	Room Wall Description	CHARACTER	A20	43 62				
13 2	2	2	Room Number	CHARACTER	A5	64 68				
11 3	6	6	Zone Number	INT*4	I11	1 11				
11 3	6	6	System Number	INT*4	I11	13 23		-2147483648	2147483648	
12 3	125	125	Descript_wall_with_window	CHARACTER	A24	25 48		-2147483648	2147483648	
12 3	126	126	Window_Description	CHARACTER	A24	50 73				
12 4	127	127	Quantity	INT*4	I11	1 11		-2147483648	2147483648	
12 4	130	130	External_Shade_Start_Azimuth	INT*4	I11	13 23	degrees	-2147483648	2147483648	0-360
12 4	131	131	External_Shade_End_Azimuth	INT*4	I11	25 35	degrees	-2147483648	2147483648	0-360
12 4	132	132	External_Shade_Start_Altitude	INT*4	I11	37 47	degrees	-2147483648	2147483648	0-90
12 4	133	133	External_Shade_End_Altitude	INT*4	I11	49 59	degrees	-2147483648	2147483648	0-90
12 4	134	134	External_Shade_Start_Hour	CHARACTER	A6	61 66				"midnit", "1 a.m.", "2 a.m.", "3 a.m.", "4 a.m.", "5 a.m.", "6 a.m.", "7 a.m.", "8 a.m.", "9 a.m.", "10 a.m.", "11 a.m.", "noon", "1 p.m.", "2 p.m.", "3 p.m.", "4 p.m.", "5 p.m.", "6 p.m.", "7 p.m.", "8 p.m.", "9 p.m.", "10 p.m.", "11 p.m.", "midnit", "1 a.m.", "2 a.m.", "3 a.m.", "4 a.m.", "5 a.m.", "6 a.m.", "7 a.m.", "8 a.m.", "9 a.m.", "10 a.m.", "11 a.m.", "noon", "1 p.m.", "2 p.m.", "3 p.m.", "4 p.m.", "5 p.m.", "6 p.m.", "7 p.m.", "8 p.m.", "9 p.m.", "10 p.m.", "11 p.m."
12 5	135	135	External_Shade_End_Hour	CHARACTER	A6	68 73				

HVLD OUTPUT FORMATS

WINDOW THERMAL CODE (entry 156)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
156	1	7	Description	CHARACTER	A24	1 24				
156	1	.101	Window_Thermal_Code	CHARACTER	A10	26 35				
156	1	.102	Shading_Coefficient_Shaded	REAL*8	F20.3	37 56				
156	1	.105	External_Shade_Type	INT*4	I11	58 68		-9999999	9.99X10(16)	0-1.0
156	1	.107	Sunscreen_Type	INT*4	I11	70 80		-2147483648	2147483648	
156	2	.108	Window_Type	INT*4	I11	1 11		-2147483648	2147483648	
156	2	.113	Percent_Heat_to_RA	BYTE	I4	13 16	%	-128	+127	0-100
156	2	.114	Air_Outlet_Location	BYTE	I4	18 21		-128	+127	1-between glass & drapes, 2-at glass sill
156	2	.117	Height	REAL*8	F20.3	23 42	in, mm	-9999999	9.99X10(16)	
156	2	.118	Width	REAL*8	F20.3	44 63	in, mm	-9999999	9.99X10(16)	
156	2	.124	Tilt	INT*4	I11	65 75	degrees	-2147483648	2147483648	-90 to 90

SCHEDULE PROFILE (entity 105)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
105	1	6	Schedule_Number	INT4	I11	1 11		-2147483648	2147483648	" JAN", " FEB", " MAR", " APR", " MAY", " JUN", " JUL", " AUG", " SEP", " OCT", " NOV", " DEC", " JAN", " FEB", " MAR", " APR", " MAY", " JUN", " JUL", " AUG", " SEP", " OCT", " NOV", " DEC", 1-midnight,13=noon,24=11 pm 0-100
105	1	7	First_Month	CHARACTER	A5	13 17				
105	1	8	Last_Month	CHARACTER	A5	19 23				
105	1	9	Start_Hour_1st_period	BYTE	14	25 28	%	-128	+127	
105	1	10	Percent_load_1st_period	BYTE	14	30 33	%	-128	+127	
105	1	11	Start_Hour_2nd_period	BYTE	14	35 38	%	-128	+127	
105	1	12	Percent_load_2nd_period	BYTE	14	40 43	%	-128	+127	
105	1	13	Start_Hour_3rd_period	BYTE	14	45 48	%	-128	+127	
105	1	14	Percent_load_3rd_period	BYTE	14	50 53	%	-128	+127	
105	1	15	Start_Hour_4th_period	BYTE	14	55 58	%	-128	+127	
105	1	16	Percent_load_4th_period	BYTE	14	60 63	%	-128	+127	
105	1	17	Start_Hour_5th_period	BYTE	14	65 68	%	-128	+127	
105	1	18	Percent_load_5th_period	BYTE	14	70 73	%	-128	+127	
105	1	19	Start_Hour_6th_period	BYTE	14	75 78	%	-128	+127	
105	2	20	Percent_load_6th_period	BYTE	14	1 4	%	-128	+127	
105	2	21	Percent_load_12_midnight	BYTE	14	6 9	%	-128	+127	
105	2	22	Percent_load_1_a_m	BYTE	14	11 14	%	-128	+127	
105	2	23	Percent_load_2_a_m	BYTE	14	16 19	%	-128	+127	
105	2	24	Percent_load_3_a_m	BYTE	14	21 24	%	-128	+127	
105	2	25	Percent_load_4_a_m	BYTE	14	26 29	%	-128	+127	
105	2	26	Percent_load_5_a_m	BYTE	14	31 34	%	-128	+127	
105	2	27	Percent_load_6_a_m	BYTE	14	36 39	%	-128	+127	
105	2	28	Percent_load_7_a_m	BYTE	14	41 44	%	-128	+127	
105	2	29	Percent_load_8_a_m	BYTE	14	46 49	%	-128	+127	
105	2	30	Percent_load_9_a_m	BYTE	14	51 54	%	-128	+127	
105	2	31	Percent_load_10_a_m	BYTE	14	56 59	%	-128	+127	
105	2	32	Percent_load_11_a_m	BYTE	14	61 64	%	-128	+127	
105	2	33	Percent_load_12_noon	BYTE	14	66 69	%	-128	+127	
105	2	34	Percent_load_1_p_m	BYTE	14	71 74	%	-128	+127	
105	2	35	Percent_load_2_p_m	BYTE	14	76 79	%	-128	+127	
105	3	36	Percent_load_3_p_m	BYTE	14	1 4	%	-128	+127	
105	3	37	Percent_load_4_p_m	BYTE	14	6 9	%	-128	+127	
105	3	38	Percent_load_5_p_m	BYTE	14	11 14	%	-128	+127	
105	3	39	Percent_load_6_p_m	BYTE	14	16 19	%	-128	+127	

SCHEDULE PROFILE (entity 105) (continued) HVLD OUTPUT FORMATS

cat	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
105	3	A0	Percent_load_7_p_m	BYTE	I4	21 24	%	-128	+127	0-100
105	3	A1	Percent_load_8_p_m	BYTE	I4	26 29	%	-128	+127	0-100
105	3	A2	Percent_load_9_p_m	BYTE	I4	31 34	%	-128	+127	0-100
105	3	A3	Percent_load_10_p_m	BYTE	I4	36 39	%	-128	+127	0-100
105	3	A4	Percent_load_11_p_m	BYTE	I4	41 44	%	-128	+127	0-100
105	3	A5	Description	CHARACTER	A30	46 75				

*** HVLD OUTPUT FORMATS ***

WALL TYPE (entry 131)									
ent	rec	attr	description		data type	format	location str end	units	min_value max_value comments
#	#	#	#	#					
131	1	7	Description		CHARACTER A24		1 24		
131	1	30	Wall_Type		INT*4	I11	26 36		-2147483648 2147483648
131	1	31	Summer_U_Value		REAL*8	F20.3	38 57	Brub/ft2F W/eq m C	-99999999 9.99X10(16)
131	1	32	Winter_U_Value		REAL*8	F20.3	59 78	Brub/ft2F W/eq m C	-99999999 9.99X10(16)
131	2	33	Decrement_Factor		REAL*8	F20.3	1 20		-99999999 9.99X10(16)
131	2	34	Time_Lag		REAL*8	F20.3	22 41	hours	-99999999 9.99X10(16)
131	2	35	Color		CHARACTER A8		43 50		-99999999 9.99X10(16)
131	2	36	Absorptivity		REAL*8	F20.3	52 61		-99999999 9.99X10(16)
ROOF TYPE (entry 132)									
ent	rec	attr	description		data type	format	location str end	units	min_value max_value comments
#	#	#	#	#					
132	1	6	Roof_Type		INT*4	I11	1 11		-2147483648 2147483648
132	1	7	Description		CHARACTER A24		13 36		
132	1	8	Summer_U_Value		REAL*8	F20.3	38 57	Brub/ft2F W/eq m C	-99999999 9.99X10(16)
132	1	9	Winter_U_Value		REAL*8	F20.3	59 78	Brub/ft2F W/eq m C	-99999999 9.99X10(16)
132	2	10	Decrement_Factor		REAL*8	F20.3	1 20		-99999999 9.99X10(16)
132	2	11	Time_Lag		REAL*8	F20.3	22 41	hours	-99999999 9.99X10(16)
132	2	12	Absorptivity_for_Solar_Temp		REAL*8	F20.3	43 62		-99999999 9.99X10(16)
132	2	16	Color		CHARACTER A8		64 71		-99999999 9.99X10(16)

PARTITION TYPE (entity 133)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
133	1	.6	Partition_Type	INT*4	I11	1 11		-2147483648	2147483648	
133	1	.7	Description	CHARACTER A24	A24	13 36				
133	1	.8	U_Value	REAL*8	F20.3	38 57	Btub/ft2F W/eq m C	-99999999	9.99X10(16)	
133	1	.9	Summer_Adjacent_Space_Temp	REAL*8	F20.3	59 78	deg F, C	-99999999	9.99X10(16)	"constant", "sine curve",
133	2	.10	Winter_Adjacent_Space_Temp	REAL*8	F20.3	1 20	deg F, C	-99999999	9.99X10(16)	"prorated OADB", "scheduled",
133	2	.11	Aprox_Meth_Adj_Space_Temp	CHARACTER A14	A14	22 35				"OADB"

see HVLD OUTPUT FORMATS

FLOOR TYPE (entity 134)

int	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
134	1	6	Floor_Type	INT*4	I11	1 11		-2147483648	2147483648	
134	1	7	Description	CHARACTER	A24	13 36				" above space", " below grade",
134	1	8	Location_of_Floor	CHARACTER	A13	38 50				" on grade", " exposed"
134	1	9	U_Value	REAL*8	F20.3	52 71	Btu/ft2F W/mq m C	-99999999	9.99X10(16)	
134	2	10	U_value_units	CHARACTER	A23	1 23				" Btu/hr/sq.ft/deg. F", " Watts/mq.m/deg. C"
134	2	11	Heat_Loss_Rate	REAL*8	F20.3	25 44		-99999999	9.99X10(16)	units depend on heat loss rate units (134.12)
134	2	12	Heat_Loss_Rate_Units	CHARACTER	A23	46 68				" Btu/hr/sq.ft", " Btu/hr/sq.ft", " Btu/hr/lineal ft", " Watts/sq. m", " Watts/lineal m."
134	3	46	Summer_Temp_of_Space_Below	REAL*8	F20.3	1 20	deg F, C	-99999999	9.99X10(16)	
134	3	47	Winter_Temp_of_Space_Below	REAL*8	F20.3	22 41	deg F, C	-99999999	9.99X10(16)	

CEILING TYPE (entity 135)

int	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
135	1	6	Ceiling_Type	BYTE	I4	1 4		-127	127	
135	1	7	Description	CHARACTER	A24	6 29				
135	1	8	U_Value	REAL*8	F20.3	31 50	Btu/ft2F W/mq m C	-99999999	9.99X10(16)	
135	1	9	Floor_Type_of_Floor_Above	INT*4	I11	52 62		-2147483648	2147483648	
135	2	10	Summer_Temp_of_Floor_Above	REAL*8	F20.3	1 20	deg F, C	-99999999	9.99X10(16)	
135	2	11	Winter_Temp_of_Floor_Above	REAL*8	F20.3	22 41	deg F, C	-99999999	9.99X10(16)	
135	2	12	Roof_Type_Above	INT*4	I11	43 53		-2147483648	2147483648	

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DOOR TYPE (entry 136)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
136	1	.7	Description	CHARACTER	A24	1 24				
136	1	.136	Door_Type	INT*4	I11	26 36		-2147483648	2147483648	
136	1	.102	U_Value	REAL*8	F20.3	38 57	Brub/ft2F W/mq m C	-99999999	9.99X10(16)	
136	1	.103	Area	REAL*8	F20.3	59 78	sq ft, sq m	-99999999	9.99X10(16)	
136	2	.104	Infiltration_Air_Quantity	REAL*8	F20.3	1 20	cfm, l/s	-99999999	9.99X10(16)	

WINDOW TYPE (entry 137)

ent	rec	attr	description	data type	format	location str end	units	min_value	max_value	comments
137	1	.7	Description	CHARACTER	A24	1 24				
137	1	.108	Window_Type	INT*4	I11	26 36		-2147483648	2147483648	
137	1	.109	Percent_Open_Glazing	BYTE	I4	38 41	%	-128	+127	0-100
137	1	.110	Summer_Shaded_U_Value	REAL*8	F20.3	43 62	Brub/ft2F W/mq m C	-99999999	9.99X10(16)	
137	2	.111	Summer_Unshaded_U_Value	REAL*8	F20.3	1 20	Brub/ft2F W/mq m C	-99999999	9.99X10(16)	
137	2	.112	Winter_U_Value	REAL*8	F20.3	22 41	Brub/ft2F W/mq m C	-99999999	9.99X10(16)	
137	2	.115	Glass_Type	INT*4	I11	43 53				
137	2	.116	Shading_Coefficient_Unshaded	REAL*8	F20.3	55 74		-2147483648	2147483648	0-1.0

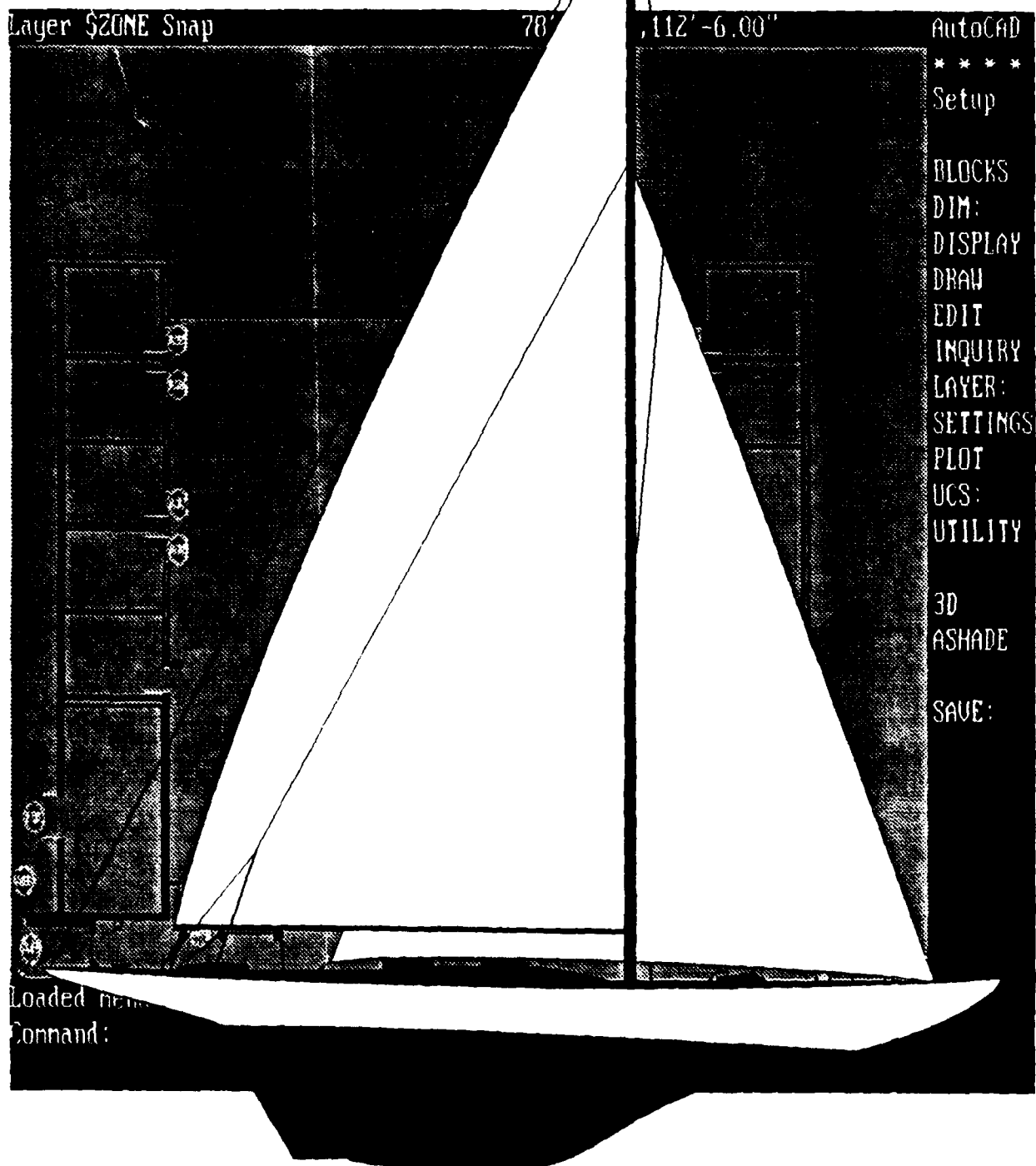
*** HVLD OUTPUT FORMATS ***

GLASS TYPE (entity 138)

ent	rec	attr	description		data type	format	location		units	min_value	max_value	comments
e	e	e	e	e			str	end				
138	1	.12	absorp_coef_outside_glass_j_0		REAL*8	F20.3	1	20		-99999999	9.99X10(16)	
138	1	.13	absorp_coef_outside_glass_j_1		REAL*8	F20.3	22	41		-99999999	9.99X10(16)	
138	1	.14	absorp_coef_outside_glass_j_2		REAL*8	F20.3	43	62		-99999999	9.99X10(16)	
138	2	.15	absorp_coef_outside_glass_j_3		REAL*8	F20.3	1	20		-99999999	9.99X10(16)	
138	2	.16	absorp_coef_outside_glass_j_4		REAL*8	F20.3	22	41		-99999999	9.99X10(16)	
138	2	.17	absorp_coef_outside_glass_j_5		REAL*8	F20.3	43	62		-99999999	9.99X10(16)	
138	3	.18	absorp_coef_inside_glass_j_0		REAL*8	F20.3	1	20		-99999999	9.99X10(16)	
138	3	.19	absorp_coef_inside_glass_j_1		REAL*8	F20.3	22	41		-99999999	9.99X10(16)	
138	3	.20	absorp_coef_inside_glass_j_2		REAL*8	F20.3	43	62		-99999999	9.99X10(16)	
138	4	.21	absorp_coef_inside_glass_j_3		REAL*8	F20.3	1	20		-99999999	9.99X10(16)	
138	4	.22	absorp_coef_inside_glass_j_4		REAL*8	F20.3	22	41		-99999999	9.99X10(16)	
138	4	.23	absorp_coef_inside_glass_j_5		REAL*8	F20.3	43	62		-99999999	9.99X10(16)	
138	5	.24	transmittance_coef_j_0		REAL*8	F20.3	1	20		-99999999	9.99X10(16)	
138	5	.25	transmittance_coef_j_1		REAL*8	F20.3	22	41		-99999999	9.99X10(16)	
138	5	.26	transmittance_coef_j_2		REAL*8	F20.3	43	62		-99999999	9.99X10(16)	
138	6	.27	transmittance_coef_j_3		REAL*8	F20.3	1	20		-99999999	9.99X10(16)	
138	6	.28	transmittance_coef_j_4		REAL*8	F20.3	22	41		-99999999	9.99X10(16)	
138	6	.29	transmittance_coef_j_5		REAL*8	F20.3	43	62		-99999999	9.99X10(16)	
138	6	.115	Glass_Type		BYTE	I4	64	67		-128	+127	
138	7	.119	Summer_U_value		REAL*8	F20.3	1	20	Brub/ft2F	-99999999	9.99X10(16)	
138	7	.120	Winter_U_value		REAL*8	F20.3	22	41	W/mq m C	-99999999	9.99X10(16)	
138	7	.121	Summer_Convection_coef		REAL*8	F20.3	43	62	Brub/ft2F	-99999999	9.99X10(16)	
138	8	.122	Winter_Convection_coef		REAL*8	F20.3	1	20	W/mq m C	-99999999	9.99X10(16)	
138	8	.123	Description		CHARACTER A40		22	61		-99999999	9.99X10(16)	
138	8	.125	Number_of_Glazings		BYTE	I4	63	67		-128	+127	

APPENDIX C: *Drawing Navigator* for AutoCAD Manual

Drawing



Navigator

**Drawing Navigator for AutoCAD
Version 0.9
Release Note and User's Manual
September 1991**

1. Introduction

Drawing Navigator is a graphical user interface to the Building Loads Analysis and System Thermodynamics (BLAST) program. Executed from within AutoCAD, *Drawing Navigator* initiates an interactive session between you and AutoCAD. During this session, you navigate an AutoCAD drawing file of an architectural (floor plan) design. *Drawing Navigator* collects information from your responses and organizes it to construct input decks for BLAST. When possible, data retrieval is automatic to reduce the number of inputs you will have to make.

Drawing Navigator was designed to facilitate utilization of BLAST during building design. BLAST is an hourly simulation for thermodynamic building analysis capable of not only calculating design loads, but also predicting annual energy consumption and peak demands, thermal comfort analysis, and performing many other sophisticated analyses. Use of BLAST at each stage of building design can significantly improve the quality of the design with respect to energy performance. In particular, analyzing building architecture at early stages of building design would save the cost of later design modifications needed to improve energy efficiency.

Historically, the major obstacle to using BLAST has been the task of preparing the BLAST input deck. The input language for BLAST is complex enough to intimidate some users, and the amount of data to be coded is non-trivial. The input process requires reading drawings and referring to other information which is not present in the architectural drawings. For instance, geometric information can be retrieved from architectural drawings, but information regarding weather, occupancy, and thermal properties of construction materials is not present in architectural drawings. Therefore, it is desirable to have a user interface which provides a unified access root to such information and automatically produces the input deck for BLAST. As a result, the turn-around time for preparing an input deck for BLAST would be reduced, and the utilization of BLAST during building design would be enhanced. *Drawing Navigator*, was developed to serve as such a user interface.

Technically, *Drawing Navigator* covers some of the same functions related to producing BLAST building descriptions as does the menu-driven BLAST textual pre-processor, BTEXT (for more information on BTEXT, see the BTEXT manual or Chapter 4 of the BLAST manual). Since some desired functionality of the graphical interface (such as displaying zone descriptions and producing the BLAST input deck) are not yet implemented in *Drawing Navigator*, these functionalities were borrowed from a modified version of BTEXT. The modified BTEXT is included as part of the *Drawing Navigator* distribution package. Output from *Drawing Navigator* is an ASCII file which BTEXT reads to generate the geometric portions of the building description as a BTEXT database. The modified BTEXT is then used to add project, system, plant and all other non-geometric information and to generate the input deck.

Since *Drawing Navigator* is an interactive program with on-line help facilities, we suggest that you get acquainted with *Drawing Navigator* through a couple of practice sessions. Previous experience with BLAST and BTEXT is of great help in using *Drawing Navigator*, but is not required. If you are unfamiliar with BLAST and the terminology used by BLAST, it is strongly suggested that you review Chapter 4 of the BLAST User's Manual.

2. Development, Technical support, and Problem Reports

Drawing Navigator was developed by the Energy Design and Management team of the Energy and Utility Systems Division at USACERL. Technical support and distribution responsibilities were transferred at the time of release to the BLAST Support Office (BSO) at the University of Illinois at

Urbana-Champaign. Technical questions, bug reports, suggestions, and any comments may be directed to:

US-mail	BLAST Support Office 30 Mechanical Engineering Building 1206 West Green Street Urbana, IL 61801
Phone	(217) 333-3977 or 800 UIBLAST
FAX	(217) 244-6534
Email	support@blast.bso.uiuc.edu

When you report problems with *Drawing Navigator*, it is helpful to the technical staff if you include printed records of problematic *Drawing Navigator* sessions. *Drawing Navigator* sessions can be recorded using the printer echoing facility in AutoCAD. Use CONTROL-Q to toggle the printer on and off while in Autocad (*Drawing Navigator*). If the printer echo is on, any input/output to and from *Drawing Navigator* will be printed on your printer. Referring to these printouts can help the BSO staff more quickly and accurately answer your questions. In addition, this printer echo feature is useful for recording your dialogue with *Drawing Navigator* for later reference as well.

Be sure to check the READ.ME file on the *Drawing Navigator* disk for additional information about *Drawing Navigator* that may not be included in this manual.

3. System requirements

System requirements for *Drawing Navigator* are somewhat hefty, in that a fair amount of hardware and software is required to run *Drawing Navigator*, as follows:

Software:	AutoCAD with AutoLISP (Version 10 is recommended but higher versions may also work), extended AutoLISP, DOS Version 3.3 or later, and a modified version of BTEXT (included in the distribution diskette).
Hardware:	To run <i>Drawing Navigator</i> you will need a 386 (or higher) PC with at least 640K of conventional and 512K of extended memory, EGA or VGA display adapter, math coprocessor (80287 or 80387), and a digitizer or mouse.

Also see sections 7.1 "Environment variables" and 7.2 "Extended AutoLISP" for further information about machine and memory configuration.

4. Installation

Drawing Navigator is distributed on a single high density diskette. The distribution diskette has three subdirectories. One is DN, which contains AutoLISP source code, AutoCAD menu files, and AutoCAD script files which form the main portion of the *Drawing Navigator* program. The second directory, MBTEXT, has a modified version of BTEXT that can read input from a file that *Drawing Navigator* produces. A third directory called SAMPLE contains a sample AutoCAD drawing file you can

manually copy to your hard disk and use to test the installation of *Drawing Navigator*. Note that the install program does not copy this program for you. To install *Drawing Navigator*:

1. Place the *Drawing Navigator* diskette in one of your disk drives and type <drivename>:dninstal. For example, if you were installing from drive A:

```
C:\>a:dninstal
```

2. Answer the questions asked by the install program about which drive you are installing the *Drawing Navigator* on, and from which floppy drive you are installing from.
3. Make sure the path to the directory for AutoCAD is included in the environment variable PATH. Otherwise, modify the PATH variable. You may wish to change the PATH statement in your AUTOEXEC.BAT file to ensure that the AutoCAD directory will be included in your path every time your machine is booted.

```
PATH=c:\acad; ...
```

4. Modify the environment variable PATH so that it includes the directory for *Drawing Navigator*. Again, you could modify the statement in AUTOEXEC.BAT to be sure the DN directory is always included.

```
PATH=c:\dn; c:\acad; ...
```

An alternative way of achieving the same effect is to copy DN.BAT and MBTEXT.BAT into a directory included already on the PATH. For example, if you have a directory called BAT for batch files which resides on the PATH, then

```
copy c:\dn\dn.bat c:\bat
copy c:\dn\mbtext.bat c:\bat
```

5. See Section 7.1 for a discussion of environment space and how to increase it. You may wish to make the described modification to CONFIG.SYS now.
6. For better screen formatting, add the following line to the file CONFIG.SYS which resides in the root directory of drive C.

```
device=directory\ansi.sys
```

where *directory* is a path to the directory containing the file ANSI.SYS.

7. Reconfigure AutoCAD to enable Extended AutoLISP. To enable AutoLISP:
NOTE: This discussion is based on AutoCAD Release 10--later releases may differ.

(a) Start AutoCAD. The main menu of AutoCAD is then displayed on the screen.

(b) Select the fifth menu item, "Configure AutoCAD." The configuration menu is displayed on the screen.

(c) From the configuration menu, select item 8, "Configure operating parameters." The operating parameter menu is displayed.

(d) From the operating parameter menu, select the seventh item, "AutoLISP feature." AutoCAD will ask if AutoLISP should be used and if extended AutoLISP should be enabled. Answer "Y" to both of these questions. Exit all of the menus. When exiting, AutoCAD you will be asked if the changes in configuration should be saved. Answer "Y" to this question.

The installation routine leaves a directory called DN on the specified target drive that contains the *Drawing Navigator* LISP code. Under this directory is another directory called MBTEXT which contains the modified BTEXT code.

5. Using *Drawing Navigator* and the modified BTEXT

To initiate a *Drawing Navigator* session,

1. Move to the directory where the concerned drawing file is:

```
cd c:\dwg
```

2. Type

```
DN file
```

where *file* is a name of a AutoCAD drawing file. NOTE: The initialization of the *Drawing Navigator* takes some time. When initialization is complete you will see the message:

```
<DN> Initialization complete, System is now ready for use.
```

When you finish the AutoCAD portion of a *Drawing Navigator* session, a file file.ZIN is created in the same directory as the drawing file. This file is also copied to the MBTEXT directory where it is read by the modified BTEXT program, thus allowing you to save what you did in *Drawing Navigator* as a BTEXT database file or BLAST input deck. DN.BAT will automatically copy the file, change the active directory and boot MBTEXT after you exit the AutoCAD portion of *Drawing Navigator*. If no ZIN file was saved, MBTEXT will not be executed. To import the ZIN file into MBTEXT:

- (a) Choose the menu item "Building and zone description."
- (b) Choose "AutoCAD interface" by entering "T." The menu item "T" reads data from the ZIN file which *Drawing Navigator* created, and the BTEXT database is constructed. The menu item "T" has the same functionality as the menu item "Z" except that input is taken from the ZIN file, rather than from the keyboard.
- (c) Use the rest of BTEXT to modify/complete an input deck. The rest of BTEXT remains the same as before.

6. Overview of *Drawing Navigator*

You can understand *Drawing Navigator* in terms of data objects and some program units managing these objects. Data objects represent physical building components such as buildings, zones,

surfaces, and *subsurfaces*. Each data object has a set of attributes, or properties. Real-world building components are represented by associating a proper value with each attribute.

Around the data objects representing building components, there are a set of functions or program units working on these data objects. The primary responsibility of these program units is reading and writing values for attributes of the data objects. Other responsibilities include providing communication channels and interfacing with BTEXT.

The outer appearance of *Drawing Navigator* or its behavior is characterized by the interfacing functions. Thus, this section mainly describes communication between you and *Drawing Navigator*. Section 6.1 will explain the four communication channels between you and *Drawing Navigator*, which are called logical devices. Two of the logical devices are in charge of manipulating and navigating architectural drawing files. The other two logical devices are control messages and menu-driven communications. Section 6.2 shows how the video screen is shared among these devices. Section 6.3 deals with messages from *Drawing Navigator*. Menus are described in section 6.4. The last section (Section 6.5) covers some keywords used in this document and *Drawing Navigator* messages which are not discussed elsewhere.

6.1 Logical devices

As *Drawing Navigator* guides you through a series of user-*Drawing Navigator* interactions, it is helpful to use the notion of logical devices. Devices, here, are communication channels between you and *Drawing Navigator*. The logical devices are defined to precisely represent basic input/output operations which *Drawing Navigator* should perform, while physical devices refer to such hardware and signals as the video screen, keyboard, mouse, and cursor keys.

A logical device may consist of a physical device, but not necessarily. For example, we may regard the video screen -- a physical device -- as being shared by 3 or 4 logical devices. On the other hand, two or more physical devices may make up a logical device. It is possible for a logical device to be defined in terms of other logical devices. For example, pointing (logical) device refers to any combination of physical devices that can be used to indicate a location on the video screen. The mouse and cross hair in AutoCAD is an example of a pointing device. The arrow keys and high-lighting cursor also compose a pointing device. A pointing device and some part of the video screen define a logical device through which we can communicate with *Drawing Navigator*. *Drawing Navigator* has the following logical devices:

Pointing Device

Made up of a mouse and a cursor, or the arrow keys and a cursor. AutoCAD has two kinds of cursors. One is a pair of vertical and horizontal lines intersecting each other (cross hairs). The other is a highlighted rectangular block. The cross hair cursor is used in the graphic display area, while the highlighted block cursor is used in the menu display. During our implementation, a Microsoft mouse and mouse driver were used. The Microsoft mouse has two buttons. The left button is used for pointing and selection of graphic entities. The right button is the same as the ENTER key in some functions. For example, when you enter input through keyboard, you can use the right button instead of the ENTER key. Also, some prompts from *Drawing Navigator* show default values and the corresponding action to accept the default values (hitting the ENTER key). In this case, the right button can be used instead of the ENTER key.

- Main** The major portion of the video screen and a pointing device. Shows a building or a zone of the building. The video sub-screen of main is referred to as the *main-display*.
- Work** Made up of a part of the video screen and a pointing device. Shows the detail of a part displayed in the device **main**. The video sub-screen of *work* is referred to as the *work-display*. When this device is needed, part of the screen occupied by the main-display is used temporarily. The main-display is divided in two vertically or horizontally (depending on the situation), and the right or lower division becomes the work device. The left or upper portion of the display becomes the main-display.
- Menu** Composed of the 8 rightmost columns of the screen and a pointing device. Shows a set of choices comprised of possible actions or data. The video sub-screen of *menu* is referred to as *menu-display*. This device is furnished to avoid keyboard typing. From the viewpoint of functionality, the following device *key* subsumes menu.
- Key** Made up of the 3 bottom rows of the video screen and the keyboard. Particularly, the video part will be called the *keyboard-display*. The *keyboard-display* shows messages from *Drawing Navigator*, and reads and echoes user input. Inputs read from the menu are also echoed in the keyboard-display. The function key F1 will flip (toggle) the video screen between the graphic and text screens, as furnished by AutoCAD. In this context, the keyboard-display can be regarded as being made of the entire video screen (when flipped to the text screen).

6.2 Screen configuration

The video screen is shared by 3 or 4 logical devices. When 3 devices are sharing the screen, we say the screen is in 3-device configuration, and when 4 devices are being used, *4-device configuration*.

The 3-device configuration is the same as the default screen configuration of AutoCAD (Figure 1). When the screen is used in 4-device configuration, it can have two formats, vertical split or horizontal split. A 4-device configuration in vertical split is normally used to display a zone (Figure 2). If the shape of a zone is wide, then the 4-device configuration in horizontal split is used (Figure 3).

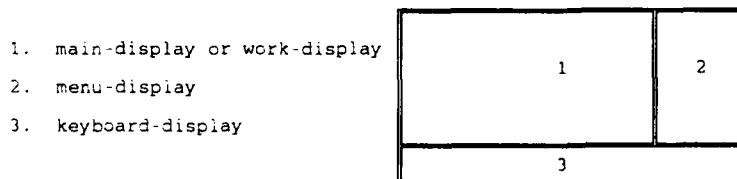


Figure 1. 3-device configuration of video screen.

1. main-display
2. work-display
3. menu-display
4. keyboard-display

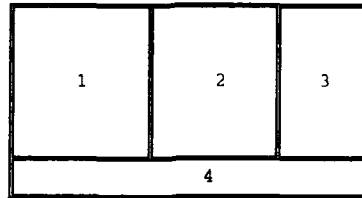


Figure 2. 4-device configuration of video screen, vertical split.

1. main-display
2. work-display
3. menu-display
4. keyboard-display

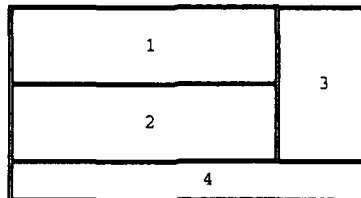


Figure 3. 4-device configuration of video screen, horizontal split.

6.3 Messages from *Drawing Navigator*

There are two kinds of messages *Drawing Navigator* gives: One is prompting messages and the other is *reporting messages*. After giving a prompting message (or prompt), *Drawing Navigator* waits for your response. Reporting messages display constructed descriptions and help information in response to your request for help. Messages from *Drawing Navigator* are displayed in the keyboard-display. Section 7.3 in the appendix lists messages from *Drawing Navigator*.

6.3.1 Structure of prompting message

Prompting messages from *Drawing Navigator* have the following syntax:

`<class - device> attribute:`

Class specifies the generic group name of the data object currently being described. It can be one of **building**, **zone**, **surface** or one of its more specific group names, and **subsurface** or one of its more specific group names. *Device* specifies the logical device through which *Drawing Navigator* is expecting a response. Device can be one of: **main**, **work**, **menu**, and **key**. *Attribute* may be a name of an attribute or a description of an action for getting a value for some attribute. For example, the following message

`<surface - menu> Select a surface group:`

specifies that *Drawing Navigator* is expecting a description for a surface object. It asks you to respond through the device **menu**, i.e., to select an item from the menu-display of a more specific surface group. Prompting messages may provide a default value and the corresponding action necessary for accepting that value. Prompting messages for this case have the following syntax:

`<class - device[response]> attribute[value]:`

If you take the action specified by response, the value specified by value would be accepted as the value for the attribute specified by attribute. For example, given the following prompting message

<building - key[hit ENTER]> North axis (degree)[0]:,

if you hit the ENTER key, 0 is accepted as the direction of the north axis for the building. More than one logical device can be used for some type of inputs. For example, when asked to enter a name of a surface, if you cannot find a proper name for the surface on the menu-display, you can input one via the keyboard. In such cases, the *Drawing Navigator* prompting message would look like:

<surface-menu or key> Enter the surface name:

6.3.2 Reporting message

Reporting messages from *Drawing Navigator* show descriptions of objects, their summary, or some explanation when help is requested. Usually *Drawing Navigator* sends reporting messages when you choose the actions Report and Help. It has the following syntax

<DN> message

where *message* is usually a listing of attributes and their values. In most instances, reporting messages are displayed through the keyboard-display logical device. After displaying a reporting message, *Drawing Navigator* will wait for you to hit the ENTER key before continuing.

6.4 Menu

We use the term "menu" to refer to a set of items appearing in a menu-display as well as the logical device menu. Menus are a convenient method for communication: they save keyboard typing and thus reduce input errors. There are two kinds of menus in *Drawing Navigator*: static and *dynamic*. The contents of static menus do not change, while that of dynamic menus normally grow as the *Drawing Navigator* session proceeds. Figures 4 through 8 show selection items displayed in static menu-display. Dynamic menus show choices of possible (sub)surface names. When you do not see the proper name for a surface (e.g. external walls) in the menu-display, you can reply by typing in the appropriate name. When *Drawing Navigator* asks for the name of another surface of the same kind, the menu-display will contain the item entered earlier. The discussion in the rest of this section pertains to the static menus of *Drawing Navigator*.

Building	Zone	Surface	Subsurfa
Describe Report Save Done Break Revert Help	Describe Report Discard Done Break Help	Describe Report Discard Done Break Help	Describe Report Discard Done Break Help

Figure 4. Menus requesting an action.

For managing the descriptions of objects (building elements), we provide a set of actions. Figure 4 shows the allowed actions for each thermal object.

- Describe** Initiates the process of describing an object. See section "6.5 Keywords" for an important caveat regarding the Describe action.
- Report** Selection of this action flips the screen to text mode. The most recently produced description of an object is then displayed.
- Done** Normally terminates the process of producing descriptions of objects of the same type. For example, when surfaces are completely described, you may choose **Done** if you have no more surfaces to describe in the current zone. See section "6.5 Keywords" for an important caveat regarding use of Done.
- Break** Abandons all the descriptions produced and returns you to some previous level for an object of a higher class. Suppose the descriptions of five surfaces have been completed. Choosing this action would remove all the descriptions of the five surfaces. The *Drawing Navigator* session is then resumed at some point of description of the super-object, in this case the building.
- Discard** Removes the most recently produced description. For example, if five surfaces are described followed by this action, the description of the first four surfaces would remain.
- Revert** Marks made by *Drawing Navigator* in the drawing files, such as boxes around objects and origins of building and zones, are removed. The original contents of the drawing file is restored by this action.

For convenience, surfaces are grouped in four categories (Figure 5). Each of the four surface groups is further refined into a set of "surface types" as shown in Figure 6. Each surface entry is based upon the familiar scheme employed by BLAST.

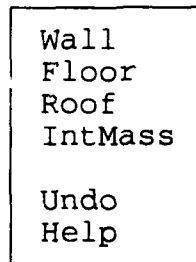


Figure 5. Menu for Surface group.

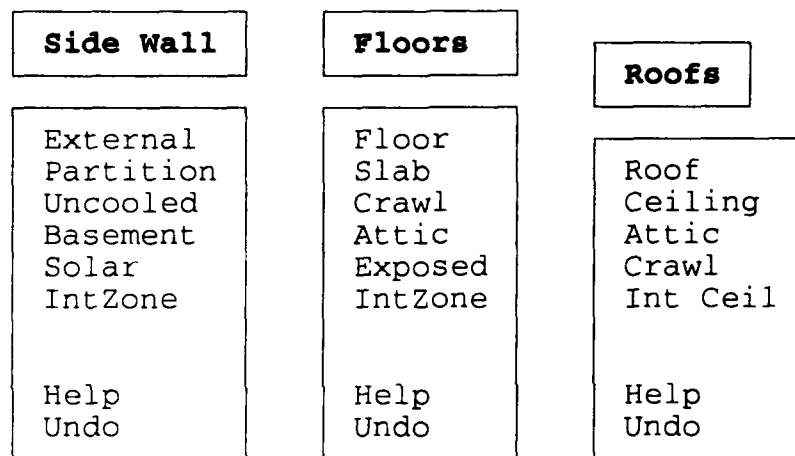


Figure 6. Menus for Surface types.

There are four subsurface types: **window**, **door**, **wing**, and **overhang**. Each surface type has a set of allowable subsurfaces, therefore the three menus for the subsurfaces. See Figure 7 for sample menus for each subsurface type.

Yes/No answers are required for *Drawing Navigator* to confirm that some action, such as discarding a description of an object, is truly what you intended to do. **Undo** "undoes" the last logically meaningful *Drawing Navigator* operation, removing any drawing marks involved in that operation and resetting values for data objects to the values before the operation. For example, after zooming in on an area to select a point, you decide to use a different point before selecting the exact location. You can then select **undo** and magnify the other area of interest. See Figure 8 for sample menus of these two miscellaneous responses.

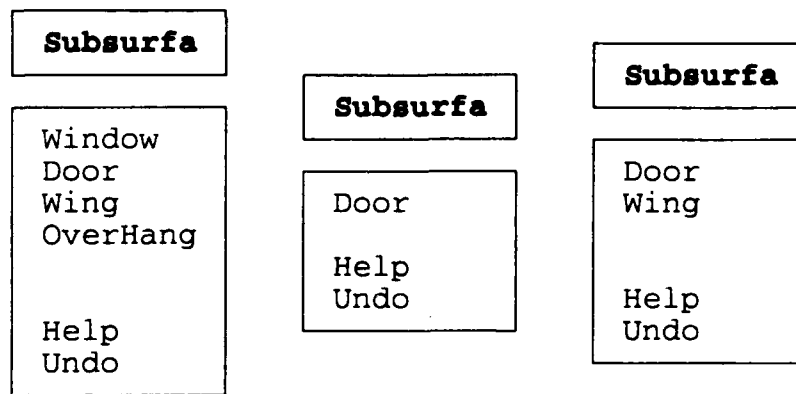


Figure 7. Menus for Subsurfaces.

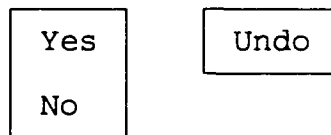


Figure 8. Miscellaneous menus.

6.5 Keywords

The following keywords are used by *Drawing Navigator*. They may appear in the keyboard-display or menu-display device areas of the screen. Some of these explanations are also available from the online help facility of *Drawing Navigator*.

Box means a rectangle defined by two diagonal points. As a verb, box means indicating two diagonal points defining a rectangle. Boxing is used to designate an area of interest to be magnified in the work-display. It is also used to limit the area of the drawing in which searches will be made for automatically finding subsurfaces. Make sure when you box a zone or wall that all graphic blocks denoting subsurfaces are completely enclosed within the box. Move the mouse and click the selection button when the cursor is at the desired location (e.g. left button is pushed if Microsoft mouse is used). The point that the cursor indicates is the first corner of the rectangle being defined. Then the cursor is moved to another location representing the second (diagonal) corner of the box. Clicking the selection button completes the box.

Point Clicking the left button of the mouse or entering the x-y coordinate so that the desired location is input to *Drawing Navigator*.

Undo brings you back to the last step. Under some circumstances, the Undo function may be repeated to back up more than one step. To undo more than a very few operations the Break and Discard menu actions are better.

Action *Drawing Navigator* requests you to take some actions. Possible actions are **Describe**, **Report**, **Discard**, **Done**, **Break**, and **Revert**. Depending on what object is described, the set of possible actions varies.

Describe see Section 6.4. An important limitation of this interim release of drawing navigator is that once a description has been completed, there is no provision to re-enter that description for editing. For example, if you describe a zone and select **Done** and then realize that you forgot to define a floor for the zone, there is no provision in the current code to go back into that zone and just enter the floor. Be very careful that you have entered all surfaces for a zone, and all subsurfaces for a surface, and so on before choosing **Done**. The *Drawing Navigator* code is being restructured to eliminate this problem.

Report see Section 6.4.

Done see Section 6.4 and **Describe**, above.

Discard see Section 6.4.

Break see Section 6.4.

Revert see Section 6.4.

7. Appendix

7.1 Environment variables

The use of environment variables required by DN may necessitate additional environment space for the DOS command interpreter COMMAND.COM. If additional space is required, DOS will give the following error message:

Out of environment space.

This message indicates it is necessary to increase the environment space. Increasing environment space is accomplished by placing the command SHELL= in your CONFIG.SYS file. The specific syntax is:

```
SHELL=c:\command.com /e:nnnn
```

where nnnn is a number of bytes reserved for environment space. The minimum number of bytes required will likely be determined via experimentation. Using an excessively large number will reduce the amount of your computer's memory that is available for applications. The exact number to use with this command will vary with the demands other software packages put on this space. The value 1024 should be sufficient for most users, and can serve as a good starting point for experimentation if environment space is a problem. **REMEMBER:** You must reboot your machine for changes in CONFIG.SYS to take effect.

The following environment variables may need to be set for Autocad and *Drawing Navigator* to function properly.

AutoCAD specific variables (see your AutoCAD manual for detailed information):

ACAD: normally the directory where AutoCAD is located. DN.BAT sets this environment variable to the directory for *Drawing Navigator* during execution and resets it to its original value upon exit.

ACADCFG: directory where AutoCAD hardware configuration files are.

ACADFREERAM: size of reserved working memory for AutoCAD.

ACADXMEN: specification of part of extended memory for extended I/O paging.

ACADLIMEN: restrict usage of expanded memory to run other programs.

LISPHEAP: specification of heap storage for AutoLISP.

LISPSTACK: specification of stack space for AutoLISP, set by DN.BAT.

LISPMEM: specification of location of Extended AutoLISP in extended memory.

Drawing Navigator specific variables:

DN: directory where the *Drawing Navigator*-related programs are, set by DN.BAT.

DWGFILE: name of the drawing file you are working on, set by DN.BAT.

7.2 Extended AutoLISP

Extended AutoLISP is compatible with extended memory management software conforming to the Virtual Control Program Interface (VCPI). Thus, Extended AutoLISP would have no problem with memory managers conforming to this standard such as QEMM386 or 386MAX, but may have problems with HIMEM.SYS. If you are Microsoft Windows 3.0 user, beware the difficulties of using HIMEM.SYS. Sometimes the Windows expanded memory manager EMM.SYS may be used to alleviate problems with HIMEM. For further discussion of memory management issues, see your AutoCAD manuals and README files.

7.3 *Drawing Navigator* messages

The following is a list of messages which *Drawing Navigator* may give. Note that this list is not complete, but covers most messages.

<building - main> Box the origin:

You are about to enter data pertaining to the entire building. You are expected to enter two diagonal points defining a rectangle using a pointing device. *Drawing Navigator* is expecting you to supply the two points using the main-display. *Drawing Navigator* zooms in on the area contained in the rectangular box in order to increase the accuracy of pointing to a location (building origin in this case).

<building - work> Point the origin:

Using a pointing device, point to a location in work-display, which will be recorded as the building origin.

<zone - main> Box a zone:

You are supposed to enter a box (a pair of points) through the main-display. Only the area enclosed by the box will be considered in describing a zone. That is, only graphic blocks enclosed entirely within the box will be considered as part of the zone.

<zone - key> Name:

Drawing Navigator is waiting for you to type in the name of the current zone.

<zone - key[hit ENTER]> North axis (degree)[0]:

Drawing Navigator is describing a zone. *Drawing Navigator* expecting your response through the keyboard to be the value for the north axis of the current zone. If you want 0 degrees as the north axis of the current zone, just hit the ENTER key. If you are using a two-button mouse, pressing the right button of mouse gives the same effect.

<zone - key[hit ENTER]> Elevation (ft)[0]:

Drawing Navigator is describing a zone. *Drawing Navigator* is expecting your response through the keyboard to be the value for the elevation of the current zone. If the elevation is 0 ft, just hit the ENTER key. If a two-button mouse is used, the right mouse button can be used for instead of the ENTER key.

<zone - key> Height (ft):

Drawing Navigator is describing a zone. It is expecting your response through the keyboard to be the value for the height of the current zone. There are no default values for the height. You should enter a real number upon seeing this message.

<zone - main> Box the origin:

Drawing Navigator is describing a zone. It wants to focus on an area where the origin of the zone is. You should enter a box (by giving two diagonal points) using the main-display.

<zone - work> Point the origin:

Drawing Navigator is describing a zone. It is expecting your response on the work-display to get the location of the origin of the current zone.

<side wall - main> Box a wall:

Drawing Navigator is describing a side wall. *Drawing Navigator* wants to focus on the area where the side wall is. You are to enter a box enclosing the side wall in the main-display.

<side wall - main> Box the left end (As viewed from the outside of the zone):

Drawing Navigator is describing a side wall. *Drawing Navigator* wants to magnify the area where the left end of the side wall is. You are to enter a box enclosing the left end in the main-display. "Left" and "right" is determined by viewing the side wall from outside of the current zone.

<side wall - work> Point to the left end:

Drawing Navigator is describing a side wall. *Drawing Navigator* is expecting your response through work-display to point to the location of the left end of the side wall.

<surface - menu> Select a surface group:

Drawing Navigator is describing a surface. *Drawing Navigator* is expecting your response through the menu-display to be the group code to which the surface belongs. It can be one of side wall, floor, roof, and internal mass.

<side wall - key[hit ENTER]> Tilt (degree)[90]:

Drawing Navigator is describing a side wall. *Drawing Navigator* is expecting your response through keyboard to get the value for the tilt of the side wall. If the tilt is 0 degrees, just hit ENTER (or the right button of the mouse).

<subsurface - menu> Type:

Drawing Navigator is describing a subsurface. *Drawing Navigator* is expecting your response through menu-display to be the value for subsurface type. Valid responses are: window, door, wing, and overhang.

<subsurface - menu or tty> Name:

Drawing Navigator is describing a subsurface. *Drawing Navigator* needs the name for the subsurface. You may respond through the menu. If there is no proper entry in the menu, you may enter the name through keyboard.

<door - main> Box a door:

Drawing Navigator is describing a door. It wants to focus on a sample of a door. You are to enter a box enclosing the door on the main-display. Then a magnified view of the door is displayed in the work-display.

<door - work> Select a door:

Drawing Navigator is describing a door. It wants to get the graphic representation of a door so that it can understand how a door is drawn. You are to point to a door on the work-display.

<window - main> Box a window:

Drawing Navigator is describing a window. It wants to focus on a sample of a window. You are to enter a box enclosing the window on the main-display. Then a magnified view of the window is displayed in the work-display.

<window - work> Select a window:

Drawing Navigator is describing a window. It wants to get the graphic representation of a window so that it can understand how a window is drawn. You are to grab a window on the work-display.

<door - work> Point to the left end (As viewed from outside of the zone):

Drawing Navigator is describing a door. It expects your response through work-display to be the location for the left end of the door.

<door - work> Point to the right end:

Drawing Navigator is describing a door. It expects your response through work-display to be the location of the right end of the door.

<window - work> Point to the left end (As viewed from outside of the zone):

Drawing Navigator is describing a window. It expects your response through work-display to be the location for the left end of the window.

<window - work> Point to the right end:

Drawing Navigator is describing a window. It expects your response through work-display to be the location of the right end of the window.

<door - key> Height (ft):

Drawing Navigator is describing a door. It needs the value for height of the door. You are to enter a value through the keyboard.

<window - key> Height (ft):

Drawing Navigator is describing a window. It needs the value for height of the window. You are to enter a value through the keyboard.

<door - key> Elevation:

Drawing Navigator is describing a door. It needs the value for the elevation of the door. You are to enter a value through the keyboard.

<window - key> Elevation:

Drawing Navigator is describing a window. It needs the value for the elevation of the window. You are to enter a value through the keyboard.

<window - key[hit ENTER]> Reveal (degree)[0]:

Drawing Navigator is describing a window. It needs the value for the reveal of the window. You are to enter a real number value through the keyboard. If the reveal is 0 degrees, just hit the ENTER key (or the right button of the mouse).

<wing - main> Box the location:

Drawing Navigator is describing a wing. *Drawing Navigator* will show a magnified view of the vicinity of the location of the wing. You are to enter a box in the main-display.

<wing - work> Point to the location:

Drawing Navigator is describing a wing. *Drawing Navigator* needs the coordinates of the location of the wing. You are to enter a point on work-display.

<wing - main> Box the end:

Drawing Navigator is also describing a wing here. *Drawing Navigator* will show a magnified view of the vicinity of the end of the wing. You are to enter a point on work-display.

<wing - work> Point to the end:

Drawing Navigator is describing a wing as well. *Drawing Navigator* needs the coordinate of the end of the wing. You are to enter a point on work-display.

<wing - key[hit ENTER]> Elevation[n]:

Drawing Navigator is describing a wing. It needs the value for the elevation of the wing. The default value for the elevation is the elevation of the zone. You are supposed to enter a real number through the keyboard. You may use the default action to enter the supplied default value.

<wing - key[hit ENTER]> Height (ft)[n]:

Drawing Navigator is describing a wing. It needs the value for the height of the wing. The default value for the height is the height of the zone. You are supposed to enter a real number through the keyboard. You may use the default action to enter the supplied default value.

7.4 An Example Session of *Drawing Navigator*

The following is an example of a typical *Drawing Navigator* session.

<building - main> Box the origin:

You: Using the mouse, supply two points which are the two diagonal points of a window - i.e. rectangle.

Drawing Navigator: *Drawing Navigator* zooms in on the area enclosed by the window.

<building - work> Point the origin:

You: Move the mouse to the desired location in the drawing and click the selection button of the mouse.

Drawing Navigator: Leaves a mark for the building origin on the drawing.

<zone - main> Box a zone:

You: Draw a window using the two diagonal points around the zone to be defined. The smaller, the better. However, the window should be large enough to show all of the surfaces and subsurfaces in the intended zone.

Up to now, there has been no distinction between the "main" screen and "work" screen.

Drawing Navigator: Divides the screen in two either horizontally or vertically depending on the shape of the window enclosing the zone.

Comment: If the screen is divided vertically, the left screen will be referred to as the "main" screen and the right screen as the "work"ing screen. If the division were horizontal, the top screen is the main screen and the one below is the work screen.

<zone - main> Box the origin:

You: Enclose the area where the zone origin is using two diagonal points.

Drawing Navigator: Zoom the area enclosed by the window.

<zone - work> Point the origin:

You: Indicate the location to be defined as the origin of the zone in the drawing using a pointing device.

<zone - key> Name:

You: Type in the name of the zone using the keyboard. Typed string is displayed in the keyboard-display.

<surface-menu> Select a surface group:

Drawing Navigator: Displays the following menu in the menu-display.

Wall

Roof

Floor

IntMass

Help

Undo

You: Suppose Wall is chosen.

<side wall - main> Box a wall:

You: Box a side wall using two diagonal points.

<side wall - main> Box the left end (As viewed from outside of the zone):

You: Box the end of the wall that would be on your left if you were standing outside the zone looking at the wall.

Drawing Navigator: Zooms in the box in the work screen.

<side wall - work> Point to the left end:

You respond...

...and so forth.

APPENDIX D: Drawing Navigator Field Test

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US ARMY CONSTRUCTION ENGINEERING RESEARCH LABORATORY
BLAST-Autocad Interface (BCAD)
BETA TEST PLAN

I. OBJECTIVES: As part of the FY91 work unit entitled "Micro-based Computer Aided Energy Systems Design", software developed at USACERL will be beta tested. The results of this beta test will be used in decisions regarding further development of this and similar products in the future. The objective of this test is proof-of-concept for this type of interface. In addition, program bugs and deficiencies will be reported. This test will help determine if this type of graphic input pre-processor to BLAST is desirable. More specifically, this test will provide insight into interfaces with CADD systems whereby data transfer is accomplished by means of an interactive process. The term Drawing Navigator has been coined to describe a class of applications which perform such data transfers. Procedural aspects of such interfaces, such as ease of use, potential productivity gains, and program interactions will also be better understood as a result of this test.

II. BACKGROUND - BLAST and other analysis programs used during design have need of geometric input data such as that represented graphically on CADD systems. They also have need for other graphic and non-graphic data that is typically the responsibility of a single engineering discipline. The engineering disciplines have a demonstrated need for design analysis software tools, such as energy analysis, heat/cooling loads determination, lighting analysis, etc. Thus, the need was seen for an interface between the graphic/non-graphic representations of the building contained within the CADD system and the design analysis programs.

With this need recognized, an interface between a defacto-standard CADD system and BLAST was chosen as a suitable prototype for such efforts. Development of an interface to Autocad began in FY89 with the prototype becoming *substantially complete* in FY90. Development of this interface and other such front-end programs to BLAST complements other enhancement programs to improve the "user friendliness" of BLAST. Successful development of CADD interfaces and other graphic pre-processors could significantly increase the BLAST user base, and improve the productivity of those already using BLAST.

III. INTERFACE TO BE TESTED - This test is specifically concerned with the Autocad to BLAST interface, commonly known as Drawing Navigator for Autocad (DN). Once the input deck is created it may be run on any BLAST platform (Intergraph, 386PC, Apollo, or other).

IV. APPROACH - BLAST users from the Mobile district will be involved with the test. Each user will conduct a BLAST energy analysis on one or more in house design projects at the district. A BLAST energy analysis will be conducted for the projects using BTEXT. The users will keep track of the time required to perform this analysis. The analysis will then be repeated using DN. Again, time to perform the analysis will be recorded--however, documentation of this time will be sufficiently detailed such that it may be determined how much time was actually spent doing the analysis as opposed to "learning curve" time, problem reporting and resolution, etc. Additional data will be collected throughout the test to measure parameters related to the test objectives. The data collected will be analyzed by the Principal Investigator. Results and recommendations will be prepared by the Principal Investigator for the review of the test sites and BLAST proponent.

V. TEST PROCEDURE - The following procedure will be used to accomplish the beta test.

A. SETUP - CERL will provide copies of the DN interface and 386PC BLAST (if needed) to each user. CERL will provide training for the use of the DN software. The Sample studies will be provided to verify system operation after installation. Actual design projects to be used in the test will

be selected by the districts according to guidance of the Principal Investigator. Weather data for the project sites will be obtained through the BLAST Support Office, if needed.

B. STEP #1 - Each user will generate a BLAST input deck from one or more of the sample projects as verification of correct installation.

C. STEP #2 - Each user will evaluate the selected design project with regard to its energy analysis requirements. Information regarding the energy model (number of thermal zones, number of systems, types and efficiencies of equipment) will be recorded.

D. STEP #3 - The BLAST input data will be gathered. Time required to collect the data will be recorded.

E. STEP #4 - Each user will enter the BLAST input data using BTEXT. Time to create the complete input deck will be recorded. Time devoted to any use of a text editor to directly manipulate the deck outside of BTEXT should also be included.

F. STEP #5 - Execute the BLAST run for the model generated by BTEXT.

G. STEP #6 - Repeat the study process using DN: I.e. zone the building and create a BLAST input deck using DN and a text editor. Elapsed time for this entire process should be recorded. In addition to total time, time spent referring to DN documentation, obtaining DN support from CERL, and any repetition of component steps in the DN procedure should be recorded.

H. STEP #7 - Execute the BLAST run for the model using the DN input deck.

I. STEP #8 - Compare the results of the two runs and document.

J. STEP #9 - If feasible, repeat Steps #2-#8 for a different design project.

K. STEP #10 - All documentation of the test including all recorded data will be forwarded to the Principal Investigator. This documentation should include a narrative report outlining the users' general impressions of and recommendations for the DN system. Further questions will be answered in telephone interviews by the Principal Investigator (or designee) with the users (and supervisors) upon the conclusion of this phase of the demonstration.

VI. ANALYSIS - The Principal Investigator will review all the data collected from the demonstration. The analysis should consider items such as the following:

A. Did the DN program improve productivity? If not: Was it due to the inexperience of the users? Was it due to problems with program anomalies? If the problems were solved, is there a likelihood of a productivity increase?

B. How did the results compare? Do the differences indicate any inaccuracies in either of the models? Is one deck clearly a better model than the other? Are the results essentially the same, as one would expect?

C. Does one method allow alternative designs to be modeled more easily or accurately? Does DN help the designer visualize the model better than BTEXT? If so, in what way and if not, why not?

D. Did the projects selected give an unfair advantage to either method of generating the input? That is, were they peculiarly better suited for one of the methods more so than the other? Were the projects overly simplified or complex?

E. What is the relative difference in level of effort to use each method? Did the users find one method particularly more "friendly" than the other?

F. What were the opinions and experiences of the users? What attitude did they have toward DN at the end of the test?

G. What recommendations were made by the users that should be considered in future efforts to develop or refine such interfaces? Is type of interface worth pursuing for other software/hardware platforms? What platforms? What are the potential benefits?

H. What are the PI's recommendations based upon this test?

VII. TEST REPORT - A narrative report will be generated from the above analysis. Draft copies will be provided to the test sites and the project proponent. This draft will be modified to incorporate comments as necessary. This report will then be used for inclusion in a CERL Technical Report and/or other reports documenting the entire AT45 project of which this BETA test is part.

BCAD TEST REPORT *(verbatim, from Mark Penton, Mobile District)*

1. The current UCS was set to *no name* in lieu of *world*. This confused some of my custom lisp routines by creating an x,y translation where delta-x=1051 and delta-y=835. Is this a problem? What about resetting this back to its original state when leaving BCAD?

2. What do you think about a "utility" menu item ? This would contain some miscellaneous commands that can be accessed from inside BCAD. Some suggested commands are status, time, snap setting, pickbox size, dwgname (read system variable "dwgname"), and a print option. (Although hard copy of BCAD reports can be obtained by the printer toggle ctrl + q and then selecting the "REPORT" menu item).

3. During a subsurface description the user is prompted for the window height by the familiar "<window - key> Height (ft):" prompt. What about prompting in this manner; "<window - key> Height (ft) <0>:". The user may hit return for a default value of 0, or enter a value, say 4 in this instance. During a subsequent window description the user is prompted in this manner; "<window - key> Height (ft) <4>:". The user could accept this current default value of 4 by hitting return (either on the keyboard or the button on the mouse as currently configured).

This concept could be applied liberally throughout the program particularly in the subsurface descriptions. Perhaps this could be somewhat modeled after the prompt for reveal information contained in the window input routine.

4. When describing subsurfaces such as a window, and you are at this point "<window - work> Point the left end (as viewed from outside of the zone):", it would be helpful to add to the screen menu area, a couple of spaces below the "undo" menu item, the autocad snap modes "int" and "endp". These would be used when "pointing" the left and right end of windows, doors, etc. This aids in maintaining a consistent door or window width in lieu of the varying widths that are a result of "eyeing" the left and right ends when pointing. (I added this to the BCAD menu myself to try it.)

5. After describing a zone and one wall in a zone I proceeded to describe some subsurfaces (windows in this case). There were six windows in this particular exterior wall. After describing five windows I selected "DONE" from the screen menu. Upon jumping back up to the surface menu I selected "DONE" once again from the screen menu. Now I was sitting idly in the zone menu when I suddenly realized that I had forgot to define the sixth window in my zone.

How do we re-enter this zone to pick-up the remaining window without going back through the entire zone description?

6. Similar to item 5, after describing some surfaces you leave the surface menu by selecting "DONE" and jump up to the zone menu. If you advertantly omitted the roof or floor how do you re-enter the surface menu to pick-up the floor or roof without going back through re-describing the entire zone? This can be a problem, particularly if a zone description is quite lengthy.

7. The following sequence, as illustrated below, was initiated.

--> <zone - main> Box a zone: --> <zone - key> Name:

--> <zone - key [hit ENTER]> North axis (degree) [0]:>

--> <zone - key [hit ENTER]> Elevation (ft) [0]:>

--> <zone - key> Height (ft): --> <zone - main> Box the origin:

--> <surface - menu> Select a surface group:

--> <side wall - main> Box a wall:

--> <side wall - main> Box the left end (As viewed from outside of the zone):

--> <side wall - work> Point to the left end:

--> <side wall - main> Box the right end (As viewed from outside of the zone):

--> <side wall - work> Point to the right end:

--> <side wall - menu> Wall code:

--> <side wall - key [hit ENTER]> Tilt (degree) [90]:

--> <subsurface - menu> Action (Select "Done" if none):
(at this point I selected "DONE")

--> <surface - menu> Action:
(at this point I selected "DONE")

--> <zone - menu> Action:
(at this point I selected "DISCARD")

BCAD then deleted the fence that was drawn around the zone. The zone origin that was previously placed and the fence that was drawn around the previously described exterior wall re-appear on the screen. This is an apparent bug in the program.

8. It would be beneficial to have the "SAVE" command at more than one level in the program. As another option what about including a timed interval for automatic saving of the program without exiting?

9. Normally a BCAD session is initiated by typing BCAD "filename" in the directory where the drawing file resides. The environment variable "dwgfile" is saved for later use by the BCAD "DONE" and "SAVE" commands. In one BCAD session I started BCAD via my front end menuing program. After completing some input I selected "DONE" at the main menu. The program then aborted because the environment variable "dwgfile" was not set to anything. What about modifying bcad.bat or init.lsp or both, if required, to allow, as an option, startup of BCAD from a menu program. The autocad system variables "dwgname" and "dwgprefix" can be read and utilized to initialize the variable "dwgfile".

10. After starting a BCAD session normally, i.e. going to the drawing directory and typing BCAD "filename", I ended the session a short time later by selecting "DONE" from the main menu. Program input was saved in the file "hanger.zin". BCAD was then re-started. I next selected "REPORT" from the main menu and the response was "<BCAD> No available information to report". What about the idea of the "REPORT" command being able to report on previous information stored on the hard drive, from the previous session, in addition to 'fresh' information that would be subsequently input? Currently the only information that gets reported comes from a current active BCAD session.

11. A new BCAD session was initiated and the sample test project was selected for inputting. Upon

conclusion of the inputting, the time required for the session was recorded. About 20 minutes was needed to complete this task. Conversely, the time required to manually input the same data utilizing BTEXT was recorded. This effort took about 35 minutes. Even though the input was rather minimal and simplified it is apparent to this casual user that the labor savings are significant, perhaps a 50% to 75% time savings. Additionally, I also think that any user would feel more at ease with the graphical approach of BCAD. The concept of BTEXT is an "old" idea, and in my opinion, in its current configuration, past its prime. The process of extracting building geometry from a blue print and inputting this data into BTEXT is at best, tedious.

12. What about giving some thought to having parts of the BLAST library, (i.e. walls, floors, roofs, windows, etc.) available on-line while in a BCAD session? Perhaps you could have a user-definable library, on a smaller scale, that could be accessed from inside BCAD. Another idea, which may be more practical, would be for the user to fill-in the (sub)surface sub-menus, using an ascii editor, with the (sub)surface names of their choice. This is an idea I tried as illustrated in the attached sheet. When I ran BCAD and got to the point where I picked a wall code from the screen menu I selected "NEXT" to page to the next screen menu that would contain "EXWALL25". Instead of the next screen menu appearing with the remaining exterior wall choices the "Undo" command appeared. This is an apparent bug in the program. Additionally, AutoCad limits the number of nested menu calls to eight, so this would put some upper limit to the number of (sub)surface items (but still over a hundred items) that could be placed in any one (sub)surface screen menus by the user.

13. The on-line help in BCAD should be further expanded and clarified for more clearer explanations. I find some of the help statements to be a little hazy in exactly what they are trying to say. Perhaps some of the key commands should be changed to more directly communicate to the user as to their intended use. Although this would be a topic better discussed then written about.

14. Upon entering a zone description the user is eventually prompted by "<zone - key [hit ENTER]> Elevation (ft) [0]:>". This fixes the z-coordinate for all surfaces described thereafter. Let us assume a zone has an elevation of 0 feet. If during the course of a surface description an exterior wall has a z-coordinate of say 10 feet, the BCAD user has no option to enter this data. It must be done later in a BTEXT session. What about an additional input in an exterior wall description following the "Tilt" prompt asking for a wall elevation that would override the zone elevation input? Such as "<side wall - key [hit ENTER]> Wall elevation (ft) [0]:". The default value in the brackets would be the zone elevation entered earlier and would stay that value no matter what value a user would enter at this point. This would let the BCAD user enter a new wall elevation on the fly.

15. The BLAST input files (the building descriptions) from BCAD and BTEXT look alike except zero values from the BCAD generated input file are reported as ".00" in lieu of "0.00" as per BTEXT.

16. As an individual who strives to make full use of an AutoCad drawing database in as many ways as can be done, and also having a better than average knowledge of lisp programming, I can appreciate this beta version of BCAD. I highly recommend that BCAD refinement and development be pursued. It is, in my opinion, a valuable tool to hvac and energy engineers to use as a front end to PC-BLAST (or if you're a real hacker a front end to some other program).

COMMENTS ON BETA TEST REPORT

The following text is comment on the points made in the Beta Test Report. The numbers correspond to those in the Beta Test Report.

1. This change was made before Version 0.9 was released.
2. Some "utility" commands or shell capability are being investigated for Version 1.0.
3. This suggestion is being used for Version 1.0.
4. This suggestion is also being used for Version 1.0.
5. The problem described is inherent in the design of Version 0.9. The re-design effort for Version 1.0 will address this problem.
6. Same comment as item 5.
7. This was a program anomaly, which has been corrected.
8. The new menu layout of Version 1.0 should alleviate this problem.
9. This idea is being explored for implementation in Version 1.0.
10. Version 1.0 will have this capability.
11. This comment relays the verification desired in the field test--Drawing Navigator can save time creating the geometric input to BLAST when the AutoCAD drawing file is available.
12. The menu lists are managed dynamically, such that any input from the keyboard is added to the menu the next time it is presented. There is nothing to stop the full library from being put into the menu files. In this particular case, a program problem stopped the menus from paginating properly. Correction of that problem should allow for the desired functionality.
13. On-line help will be improved in subsequent versions, as will the written documentation.
14. This enhancement will be included in Version 1.0.
- 15 & 16. These comments further affirm that Drawing Navigator decreases the effort required for BLAST input.

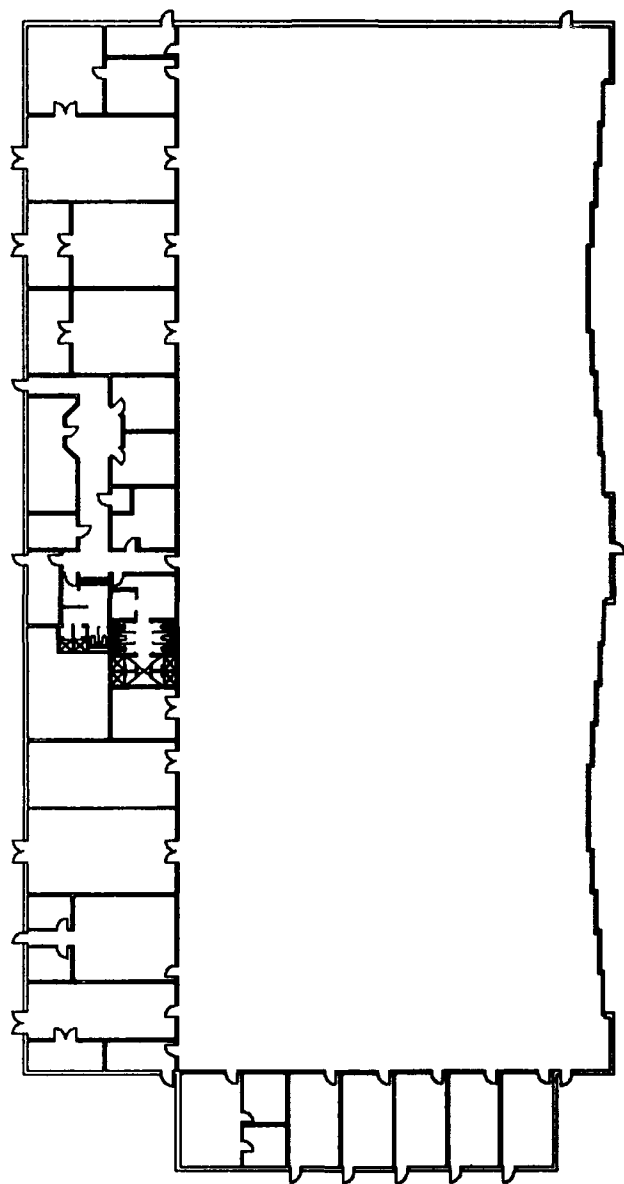


Figure D1. Sample Building Drawing Used in Test

BLAST Input Deck Created by Drawing Navigator

```
BEGIN INPUT;
RUN CONTROL:
  NEW ZONES,
  NEW AIR SYSTEMS,
  PLANT,
  REPORTS(ZONE,ZONE LOADS,SYSTEM LOADS,PLANT LOADS),
  UNITS(IN=ENGLISH, OUT=ENGLISH);
TEMPORARY LOCATION:
  FT RUCKER
    = (LAT=31.00, LONG=85.00, TZ=5);
END;
TEMPORARY DESIGN DAYS:
  FT RUCKER SUMMER
    = (HIGH=95.00, LOW=75.00, WB=78.00, DATE=21JUL, PRES=405.00,
      WS=660.00, DIR=270.00, CLEARNESS=1.00, WEEKDAY);
  FT RUCKER WINTER
    = (HIGH=47.00, LOW=27.00, WB=23.00, DATE=21JAN, PRES=405.00,
      WS=660.00, DIR=270.00, CLEARNESS=1.00, WEEKDAY);
END;
TEMPORARY SCHEDULE (CONSTANT):
  MONDAY THRU FRIDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SATURDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SUNDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  HOLIDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL1=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL2=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL3=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL4=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00);
END;
TEMPORARY CONTROLS (DB):
  PROFILES:
    PROFILE=(0.0000 AT 68.00, 0.0000 AT 68.00, 0.0000 AT 78.00,
      -1.0000 AT 78.00);
  SCHEDULES:
    MONDAY THRU FRIDAY=(0 TO 24-PROFILE),
    SATURDAY=(0 TO 24-PROFILE),
    SUNDAY=(0 TO 24-PROFILE),
    HOLIDAY=(0 TO 24-PROFILE),
    SPECIAL1=(0 TO 24-PROFILE),
    SPECIAL2=(0 TO 24-PROFILE),
    SPECIAL3=(0 TO 24-PROFILE),
    SPECIAL4=(0 TO 24-PROFILE);
END;
PROJECT="FT RUCKER HANGER";
LOCATION=FT RUCKER ;
```

BLAST Input Deck Created by Drawing Navigator

DESIGN DAYS=FT RUCKER SUMMER ,
FT RUCKER WINTER ;
GROUND TEMPERATURES=(55, 55, 55, 55, 55, 55, 55, 55, 55, 55, 55);
BEGIN BUILDING DESCRIPTION;
BUILDING="FT RUCKER HANGER ";
NORTH AXIS=0.00;
SOLAR DISTRIBUTION=-1;
ZONE 1 "ZONE 1 ":
ORIGIN:(-26.63, 15.67, 0.00);
NORTH AXIS=0.00;
EXTERIOR WALLS :
STARTING AT(0.00, 0.00, 0.00)
FACING(180.00)
TILTED(90.00)
EXTWALL01 (26.58 BY 10.00),
STARTING AT(26.58, 103.46, 0.00)
FACING(0.00)
TILTED(90.00)
EXTWALL01 (26.67 BY 10.00),
STARTING AT(-0.08, 103.46, 0.00)
FACING(270.00)
TILTED(90.00)
EXTWALL01 (103.46 BY 10.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (6.41, 3.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (36.51, 3.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (51.18, 3.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (65.84, 3.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (80.51, 3.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (95.18, 3.00);
SLAB ON GRADE FLOORS :
STARTING AT(0.00, 0.00, 0.00)
FACING(180.00)
TILTED(180.00)
SLAB FLOOR (26.58 BY 103.46);
ROOFS :

BLAST Input Deck Created by Drawing Navigator

STARTING AT(0.00, 0.00, 10.00)
FACING(180.00)
TILTED(0.00)
ROOF01 (26.58 BY 103.46);
PEOPLE=10,CONSTANT ,
AT ACTIVITY LEVEL 0.45, 70.00 PERCENT RADIANT,
FROM 01JAN THRU 31DEC;
LIGHTS=25.00,CONSTANT ,
0.00 PERCENT RETURN AIR, 20.00 PERCENT RADIANT,
20.00 PERCENT VISIBLE, 0.00 PERCENT REPLACEABLE,
FROM 01JAN THRU 31DEC;
END ZONE;
ZONE 2 "ZONE 2 ":
ORIGIN:(-0.04, 119.38, 0.00);
NORTH AXIS=0.00;
EXTERIOR WALLS :
STARTING AT(290.17, 0.00, 0.00)
FACING(90.00)
TILTED(90.00)
EXTWALL01 (41.75 BY 10.00),
STARTING AT(290.13, 41.71, 0.00)
FACING(0.00)
TILTED(90.00)
EXTWALL01 (290.13 BY 10.00),
STARTING AT(0.04, 41.67, 0.00)
FACING(270.00)
TILTED(90.00)
EXTWALL01 (41.67 BY 10.00);
SLAB ON GRADE FLOORS :
STARTING AT(0.00, 0.00, 0.00)
FACING(180.00)
TILTED(180.00)
SLAB FLOOR (290.13 BY 41.79);
ROOFS :
STARTING AT(0.00, 0.00, 10.00)
FACING(180.00)
TILTED(0.00)
ROOF01 (290.17 BY 41.75);
PEOPLE=25,CONSTANT ,
AT ACTIVITY LEVEL 0.45, 70.00 PERCENT RADIANT,
FROM 01JAN THRU 31DEC;
LIGHTS=30.00,CONSTANT ,
0.00 PERCENT RETURN AIR, 20.00 PERCENT RADIANT,
20.00 PERCENT VISIBLE, 0.00 PERCENT REPLACEABLE,
FROM 01JAN THRU 31DEC;
END ZONE;
ZONE 3 "ZONE 3 ":
ORIGIN:(0.00, 0.08, 0.00);
NORTH AXIS=0.00;
EXTERIOR WALLS :
STARTING AT(0.00, 0.04, 0.00)
FACING(180.00)
TILTED(90.00)

BLAST Input Deck Created by Drawing Navigator

EXTWALL01 (290.08 BY 40.00),
STARTING AT(290.13, 0.08, 0.00)
FACING(90.00)
TILTED(90.00)
EXTWALL01 (119.21 BY 40.00),
STARTING AT(290.13, 119.33, 0.00)
FACING(0.00)
TILTED(90.00)
EXTWALL01 (289.88 BY 40.00),
STARTING AT(0.21, 119.21, 0.00)
FACING(270.00)
TILTED(90.00)
EXTWALL01 (103.75 BY 40.00),
STARTING AT(-0.08, 15.42, 0.00)
FACING(270.00)
TILTED(90.00)
EXTWALL01 (15.42 BY 40.00);
FLOORS :
STARTING AT(0.04, 0.00, 0.00)
FACING(180.00)
TILTED(180.00)
FLOOR04 (290.08 BY 119.25);
ROOFS :
STARTING AT(-0.04, 0.00, 40.00)
FACING(180.00)
TILTED(0.00)
ROOF02 (290.17 BY 119.33);
PEOPLE=15,CONSTANT ,
AT ACTIVITY LEVEL 0.45, 70.00 PERCENT RADIANT,
FROM 01JAN THRU 31DEC;
LIGHTS=100.00,CONSTANT ,
0.00 PERCENT RETURN AIR, 20.00 PERCENT RADIANT,
20.00 PERCENT VISIBLE, 0.00 PERCENT REPLACEABLE,
FROM 01JAN THRU 31DEC;
END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
VARIABLE VOLUME SYSTEM 1
"AHU-1 " SERVING ZONES
1, 2;
FOR ZONE 1:
SUPPLY AIR VOLUME=5000;
EXHAUST AIR VOLUME=0;
MINIMUM AIR FRACTION=0.1;
REHEAT CAPACITY=0;
REHEAT ENERGY SUPPLY=HOT WATER;
BASEBOARD HEAT CAPACITY=0.0;
BASEBOARD HEAT ENERGY SUPPLY=HOT WATER;
ZONE MULTIPLIER=1;
END ZONE;
FOR ZONE 2:
SUPPLY AIR VOLUME=7500;
EXHAUST AIR VOLUME=0;

BLAST Input Deck Created by Drawing Navigator

MINIMUM AIR FRACTION=0.1;
REHEAT CAPACITY=0;
REHEAT ENERGY SUPPLY=HOT WATER;
BASEBOARD HEAT CAPACITY=0.0;
BASEBOARD HEAT ENERGY SUPPLY=HOT WATER;
ZONE MULTIPLIER=1;
END ZONE;
OTHER SYSTEM PARAMETERS:
SUPPLY FAN PRESSURE=2.48914;
SUPPLY FAN EFFICIENCY=0.7;
RETURN FAN PRESSURE=0.0;
RETURN FAN EFFICIENCY=0.7;
EXHAUST FAN PRESSURE=1.00396;
EXHAUST FAN EFFICIENCY=0.7;
COLD DECK CONTROL=FIXED SET POINT;
COLD DECK TEMPERATURE=55.04;
COLD DECK THROTTLING RANGE=7.2;
COLD DECK CONTROL SCHEDULE=(55 AT 90,65 AT 70);
MIXED AIR CONTROL=FIXED PERCENT;
DESIRED MIXED AIR TEMPERATURE=COLD DECK TEMPERATURE;
OUTSIDE AIR VOLUME=0.0;
PREHEAT COIL LOCATION=NONE;
PREHEAT TEMPERATURE=46.4;
PREHEAT ENERGY SUPPLY=HOT WATER;
PREHEAT COIL CAPACITY=0;
GAS BURNER EFFICIENCY=0.8;
VAV MINIMUM AIR FRACTION=0.1;
VAV VOLUME CONTROL TYPE=INLET VANES;
** FAN POWER COEFFICIENTS=(0,0,0,0,0);
HUMIDIFIER TYPE=NONE;
HUMIDISTAT LOCATION=1;
HUMIDISTAT SET POINT=50;
SYSTEM ELECTRICAL DEMAND=0.0;
REHEAT TEMPERATURE CONTROL=FIXED SET POINT;
REHEAT TEMPERATURE LIMIT=140;
REHEAT CONTROL SCHEDULE=(140 AT 0,70 AT 70);
END OTHER SYSTEM PARAMETERS;
COOLING COIL DESIGN PARAMETERS:
COIL TYPE=CHILLED WATER;
END COOLING COIL DESIGN PARAMETERS;
EQUIPMENT SCHEDULES:
SYSTEM OPERATION=ON, FROM 01JAN THRU 31DEC;
EXHAUST FAN OPERATION=ON, FROM 01JAN THRU 31DEC;
PREHEAT COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
HUMIDIFIER OPERATION=ON, FROM 01JAN THRU 31DEC;
REHEAT COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
TSTAT BASEBOARD HEAT OPERATION=ON, FROM 01JAN THRU 31DEC;
HEAT RECOVERY OPERATION=OFF, FROM 01JAN THRU 31DEC;
MINIMUM VENTILATION SCHEDULE=MINOA, FROM 01JAN THRU 31DEC;
MAXIMUM VENTILATION SCHEDULE=MAXOA, FROM 01JAN THRU 31DEC;
SYSTEM ELECTRICAL DEMAND SCHEDULE=ON, FROM 01JAN THRU 31DEC;
END EQUIPMENT SCHEDULES;
END SYSTEM;

BLAST Input Deck Created by Drawing Navigator

SINGLE ZONE DRAW THRU SYSTEM 2

"AHU-2 " SERVING ZONES

3;

FOR ZONE 3:

SUPPLY AIR VOLUME=35000;

EXHAUST AIR VOLUME=0;

BASEBOARD HEAT CAPACITY=0.0;

BASEBOARD HEAT ENERGY SUPPLY=HOT WATER;

ZONE MULTIPLIER=1;

END ZONE;

OTHER SYSTEM PARAMETERS:

SUPPLY FAN PRESSURE=2.48914;

SUPPLY FAN EFFICIENCY=0.7;

RETURN FAN PRESSURE=0.0;

RETURN FAN EFFICIENCY=0.7;

EXHAUST FAN PRESSURE=1.00396;

EXHAUST FAN EFFICIENCY=0.7;

HEATING COIL ENERGY SUPPLY=HOT WATER;

HEATING COIL CAPACITY=3412000;

MIXED AIR CONTROL=FIXED PERCENT;

DESIRED MIXED AIR TEMPERATURE=COLD DECK TEMPERATURE;

OUTSIDE AIR VOLUME=0.0;

PREHEAT COIL LOCATION=NONE;

PREHEAT TEMPERATURE=46.4;

PREHEAT ENERGY SUPPLY=HOT WATER;

PREHEAT COIL CAPACITY=0;

GAS BURNER EFFICIENCY=0.8;

HUMIDIFIER TYPE=NONE;

HUMIDISTAT LOCATION=3;

HUMIDISTAT SET POINT=50;

SYSTEM ELECTRICAL DEMAND=0.0;

END OTHER SYSTEM PARAMETERS;

COOLING COIL DESIGN PARAMETERS:

COIL TYPE=CHILLED WATER;

END COOLING COIL DESIGN PARAMETERS;

EQUIPMENT SCHEDULES:

SYSTEM OPERATION=ON, FROM 01JAN THRU 31DEC;

EXHAUST FAN OPERATION=ON, FROM 01JAN THRU 31DEC;

PREHEAT COIL OPERATION=ON, FROM 01JAN THRU 31DEC;

HEATING COIL OPERATION=ON, FROM 01JAN THRU 31DEC;

COOLING COIL OPERATION=ON, FROM 01JAN THRU 31DEC;

HUMIDIFIER OPERATION=ON, FROM 01JAN THRU 31DEC;

TSTAT BASEBOARD HEAT OPERATION=ON, FROM 01JAN THRU 31DEC;

HEAT RECOVERY OPERATION=OFF, FROM 01JAN THRU 31DEC;

MINIMUM VENTILATION SCHEDULE=MINOA, FROM 01JAN THRU 31DEC;

MAXIMUM VENTILATION SCHEDULE=MAXOA, FROM 01JAN THRU 31DEC;

SYSTEM ELECTRICAL DEMAND SCHEDULE=ON, FROM 01JAN THRU 31DEC;

END EQUIPMENT SCHEDULES;

END SYSTEM;

END FAN SYSTEM DESCRIPTION;

BEGIN CENTRAL PLANT DESCRIPTION;

PLANT 1 "CHILLER " SERVING ALL SYSTEMS;

EQUIPMENT SELECTION:

BLAST Input Deck Created by Drawing Navigator

```
RECIPROCATING CHILLER :  
  1 OF SIZE 750;  
END EQUIPMENT SELECTION;  
PART LOAD RATIOS:  
  RECIPROCATING CHILLER(MIN=.10,MAX=1.05,BEST=.65,ELECTRICAL=.2275);  
END PART LOAD RATIOS;  
FOR SYSTEM 1:  
  SYSTEM MULTIPLIER=1;  
END SYSTEM;  
FOR SYSTEM 2:  
  SYSTEM MULTIPLIER=1;  
END SYSTEM;  
END PLANT;  
PLANT 2 "BOILER " SERVING ALL SYSTEMS;  
EQUIPMENT SELECTION:  
  BOILER :  
    1 OF SIZE 1200;  
END EQUIPMENT SELECTION;  
PART LOAD RATIOS:  
  BOILER(MIN=.0100,MAX=1.0000,BEST=.8700,ELECTRICAL=0.0000);  
END PART LOAD RATIOS;  
SCHEDULE:  
  HOT WATER=0.0,CONSTANT,FROM 1JAN THRU 31DEC,  
    AT 125.0 SUPPLIED BY BOILER;  
END SCHEDULE;  
FOR SYSTEM 1:  
  SYSTEM MULTIPLIER=1;  
END SYSTEM;  
FOR SYSTEM 2:  
  SYSTEM MULTIPLIER=1;  
END SYSTEM;  
END PLANT;  
END CENTRAL PLANT DESCRIPTION;  
END INPUT;
```

BLAST Input Deck Created by BTEXT

```
BEGIN INPUT;
RUN CONTROL:
  NEW ZONES,
  NEW AIR SYSTEMS,
  PLANT,
  REPORTS(ZONE,ZONE LOADS,SYSTEM LOADS,PLANT LOADS),
  UNITS(IN=ENGLISH, OUT=ENGLISH);
TEMPORARY LOCATION:
  FT. RUCKER
  = (LAT=31.00, LONG=85.00, TZ=5);
END;
TEMPORARY DESIGN DAYS:
  FT RUCKER SUMMER
  = (HIGH=95.00, LOW=75.00, WB=78.00, DATE=21JUL, PRES=405.00,
    WS=660.00, DIR=270.00, CLEARNESS=1.00, WEEKDAY);
  FT RUCKER WINTER
  = (HIGH=47.00, LOW=27.00, WB=23.00, DATE=21JAN, PRES=405.00,
    WS=660.00, DIR=270.00, CLEARNESS=1.00, WEEKDAY);
END;
TEMPORARY SCHEDULE (CONSTANT):
  MONDAY THRU FRIDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SATURDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SUNDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  HOLIDAY=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL1=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL2=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL3=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00),
  SPECIAL4=(1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,
    1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00,1.00);
END;
TEMPORARY CONTROLS (DB):
  PROFILES:
    PROFILE=(1.0000 AT 68.00, 0.0000 AT 68.00, 0.0000 AT 78.00,
      -1.0000 AT 78.00);
  SCHEDULES:
    MONDAY THRU FRIDAY=(0 TO 24-PROFILE),
    SATURDAY=(0 TO 24-PROFILE),
    SUNDAY=(0 TO 24-PROFILE),
    HOLIDAY=(0 TO 24-PROFILE),
    SPECIAL1=(0 TO 24-PROFILE),
    SPECIAL2=(0 TO 24-PROFILE),
    SPECIAL3=(0 TO 24-PROFILE),
    SPECIAL4=(0 TO 24-PROFILE);
END;
PROJECT="FT RUCKER HANGER";
LOCATION=FT. RUCKER ;
```

BLAST Input Deck Created by BTEXT

DESIGN DAYS=DORM WINTER ,
FT RUCKER SUMMER ,
FT RUCKER WINTER ;
GROUND TEMPERATURES=(55, 55, 55, 55, 55, 55, 55, 55, 55, 55, 55, 55);
BEGIN BUILDING DESCRIPTION;
BUILDING="HANGER";
NORTH AXIS=0.00;
SOLAR DISTRIBUTION=-1;
ZONE 1 "ZONE 1";
ORIGIN:(-26.67, 16.00, 0.00);
NORTH AXIS=0.00;
EXTERIOR WALLS :
STARTING AT(0.00, 104.00, 0.00)
FACING(270.00)
TILTED(90.00)
EXTWALL01 (104.00 BY 10.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (0.00, 0.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (0.00, 0.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (0.00, 0.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (0.00, 0.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (0.00, 0.00)
WITH WINDOWS OF TYPE
DPTW (5.00 BY 5.00)
REVEAL(0.00)
AT (0.00, 0.00),
STARTING AT(26.67, 104.00, 0.00)
FACING(0.00)
TILTED(90.00)
EXTWALL01 (26.67 BY 10.00),
STARTING AT(0.00, 0.00, 0.00)
FACING(180.00)
TILTED(90.00)
EXTWALL01 (26.67 BY 10.00);
SLAB ON GRADE FLOORS :
STARTING AT(0.00, 104.00, 0.00)
FACING(180.00)
TILTED(180.00)
SLAB FLOOR (26.67 BY 104.00);

BLAST Input Deck Created by BTEXT

ROOFS :

STARTING AT(0.00, 104.00, 10.00)

FACING(180.00)

TILTED(0.00)

ROOF01 (26.67 BY 104.00);

PEOPLE=10,CONSTANT ,

AT ACTIVITY LEVEL 0.45, 70.00 PERCENT RADIANT,

FROM 01JAN THRU 31DEC;

LIGHTS=(25000.00),CONSTANT ,

0.00 PERCENT RETURN AIR, 20.00 PERCENT RADIANT,

20.00 PERCENT VISIBLE, 0.00 PERCENT REPLACEABLE,

FROM 01JAN THRU 31DEC;

END ZONE;

ZONE 2 "ZONE 2 ";

ORIGIN:(0.00, 120.00, 0.00);

NORTH AXIS=0.00;

EXTERIOR WALLS :

STARTING AT(0.00, 42.00, 0.00)

FACING(270.00)

TILTED(90.00)

EXTWALL01 (42.00 BY 10.00),

STARTING AT(288.00, 42.00, 0.00)

FACING(0.00)

TILTED(90.00)

EXTWALL01 (288.00 BY 10.00),

STARTING AT(288.00, 0.00, 0.00)

FACING(90.00)

TILTED(90.00)

EXTWALL01 (42.00 BY 10.00);

SLAB ON GRADE FLOORS :

STARTING AT(0.00, 42.00, 0.00)

FACING(180.00)

TILTED(180.00)

SLAB FLOOR (288.00 BY 42.00);

ROOFS :

STARTING AT(0.00, 42.00, 0.00)

FACING(180.00)

TILTED(0.00)

ROOF01 (288.00 BY 42.00);

EXTERNAL MASS: (T)

(126.00 BY 10.00);

PEOPLE=25,CONSTANT ,

AT ACTIVITY LEVEL 0.45, 70.00 PERCENT RADIANT,

FROM 01JAN THRU 31DEC;

LIGHTS=(25000.00),CONSTANT ,

0.00 PERCENT RETURN AIR, 20.00 PERCENT RADIANT,

20.00 PERCENT VISIBLE, 0.00 PERCENT REPLACEABLE,

FROM 01JAN THRU 31DEC;

END ZONE;

ZONE 3 "ZONE 3 ";

ORIGIN:(0.00, 0.00, 0.00);

NORTH AXIS= 0.00;

EXTERIOR WALLS :

BLAST Input Deck Created by BTEXT

STARTING AT(0.00, 16.00, 0.00)
FACING(270.00)
TILTED(90.00)
EXTWALL02 (16.00 BY 40.00),
STARTING AT(0.00, 120.00, 10.00)
FACING(270.00)
TILTED(90.00)
EXTWALL02 (28.00 BY 30.00),
STARTING AT(288.00, 120.00, 10.00)
FACING(0.00)
TILTED(90.00)
EXTWALL02 (288.00 BY 30.00),
STARTING AT(288.00, 0.00, 0.00)
FACING(90.00)
TILTED(90.00)
EXTWALL02 (120.00 BY 40.00),
STARTING AT(0.00, 0.00, 0.00)
FACING(180.00)
TILTED(90.00)
EXTWALL02 (288.00 BY 40.00);
SLAB ON GRADE FLOORS :
STARTING AT(0.00, -120.00, 0.00)
FACING(180.00)
TILTED(180.00)
SLAB FLOOR (288.00 BY 120.00);
ROOFS :
STARTING AT(0.00, 120.00, 0.00)
FACING(180.00)
TILTED(0.00)
ROOF01 (288.00 BY 120.00);
PEOPLE=15,CONSTANT ,
AT ACTIVITY LEVEL 0.45, 70.00 PERCENT RADIANT,
FROM 01JAN THRU 31DEC;
LIGHTS=100000.00,CONSTANT ,
0.00 PERCENT RETURN AIR, 20.00 PERCENT RADIANT,
20.00 PERCENT VISIBLE, 0.00 PERCENT REPLACEABLE,
FROM 01JAN THRU 31DEC;
END ZONE;
END BUILDING DESCRIPTION;
BEGIN FAN SYSTEM DESCRIPTION;
VARIABLE VOLUME SYSTEM 1
"AHU-1 " SERVING ZONES
1, 2;
FOR ZONE 1:
SUPPLY AIR VOLUME=5000;
EXHAUST AIR VOLUME=0;
MINIMUM AIR FRACTION=0.1;
REHEAT CAPACITY=0;
REHEAT ENERGY SUPPLY=HOT WATER;
BASEBOARD HEAT CAPACITY=0.0;
BASEBOARD HEAT ENERGY SUPPLY=HOT WATER;
ZONE MULTIPLIER=1;
END ZONE;

BLAST Input Deck Created by BTEXT

FOR ZONE 2:

SUPPLY AIR VOLUME=7500;
EXHAUST AIR VOLUME=0;
MINIMUM AIR FRACTION=0.1;
REHEAT CAPACITY=0;
REHEAT ENERGY SUPPLY=HOT WATER;
BASEBOARD HEAT CAPACITY=0.0;
BASEBOARD HEAT ENERGY SUPPLY=HOT WATER;
ZONE MULTIPLIER=1;

END ZONE;

OTHER SYSTEM PARAMETERS:

SUPPLY FAN PRESSURE=2.48914;
SUPPLY FAN EFFICIENCY=0.7;
RETURN FAN PRESSURE=0.0;
RETURN FAN EFFICIENCY=0.7;
EXHAUST FAN PRESSURE=1.00396;
EXHAUST FAN EFFICIENCY=0.7;
COLD DECK CONTROL=FIXED SET POINT;
COLD DECK TEMPERATURE=55.04;
COLD DECK THROTTLING RANGE=7.2;
COLD DECK CONTROL SCHEDULE=(55 AT 90,65 AT 70);
MIXED AIR CONTROL=FIXED PERCENT;
DESIRED MIXED AIR TEMPERATURE=COLD DECK TEMPERATURE;
OUTSIDE AIR VOLUME=0.0;
PREHEAT COIL LOCATION=NONE;
PREHEAT TEMPERATURE=46.4;
PREHEAT ENERGY SUPPLY=HOT WATER;
PREHEAT COIL CAPACITY=0;
GAS BURNER EFFICIENCY=0.8;
VAV MINIMUM AIR FRACTION=0.1;
VAV VOLUME CONTROL TYPE=INLET VANES;
** FAN POWER COEFFICIENTS=(0.0,0.0,0.0);
HUMIDIFIER TYPE=NONE;
HUMIDISTAT LOCATION=1;
HUMIDISTAT SET POINT=50;
SYSTEM ELECTRICAL DEMAND=0.0;
REHEAT TEMPERATURE CONTROL=FIXED SET POINT;
REHEAT TEMPERATURE LIMIT=140;
REHEAT CONTROL SCHEDULE=(140 AT 0,70 AT 70);

END OTHER SYSTEM PARAMETERS;

COOLING COIL DESIGN PARAMETERS:

COIL TYPE=CHILLED WATER;

END COOLING COIL DESIGN PARAMETERS;

EQUIPMENT SCHEDULES:

SYSTEM OPERATION=ON, FROM 01JAN THRU 31DEC;
EXHAUST FAN OPERATION=ON, FROM 01JAN THRU 31DEC;
PREHEAT COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
HUMIDIFIER OPERATION=ON, FROM 01JAN THRU 31DEC;
REHEAT COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
TSTAT BASEBOARD HEAT OPERATION=ON, FROM 01JAN THRU 31DEC;
HEAT RECOVERY OPERATION=OFF, FROM 01JAN THRU 31DEC;
MINIMUM VENTILATION SCHEDULE=MINOA, FROM 01JAN THRU 31DEC;
MAXIMUM VENTILATION SCHEDULE=MAXOA, FROM 01JAN THRU 31DEC;

BLAST Input Deck Created by BTEXT

```
SYSTEM ELECTRICAL DEMAND SCHEDULE=ON, FROM 01JAN THRU 31DEC;
END EQUIPMENT SCHEDULES;
END SYSTEM;
SINGLE ZONE DRAW THRU SYSTEM 2
"AHU-2 " SERVING ZONES
3;
FOR ZONE 3:
  SUPPLY AIR VOLUME=35000;
  EXHAUST AIR VOLUME=0;
  BASEBOARD HEAT CAPACITY=0.0;
  BASEBOARD HEAT ENERGY SUPPLY=HOT WATER;
  ZONE MULTIPLIER=1;
END ZONE;
OTHER SYSTEM PARAMETERS:
  SUPPLY FAN PRESSURE=2.48914;
  SUPPLY FAN EFFICIENCY=0.7;
  RETURN FAN PRESSURE=0.0;
  RETURN FAN EFFICIENCY=0.7;
  EXHAUST FAN PRESSURE=1.00396;
  EXHAUST FAN EFFICIENCY=0.7;
  HEATING COIL ENERGY SUPPLY=HOT WATER;
  HEATING COIL CAPACITY=3412000;
  MIXED AIR CONTROL=FIXED PERCENT;
  DESIRED MIXED AIR TEMPERATURE=COLD DECK TEMPERATURE;
  OUTSIDE AIR VOLUME=0.0;
  PREHEAT COIL LOCATION=NONE;
  PREHEAT TEMPERATURE=46.4;
  PREHEAT ENERGY SUPPLY=HOT WATER;
  PREHEAT COIL CAPACITY=0;
  GAS BURNER EFFICIENCY=0.8;
  HUMIDIFIER TYPE=NONE;
  HUMIDISTAT LOCATION=3;
  HUMIDISTAT SET POINT=50;
  SYSTEM ELECTRICAL DEMAND=0.0;
END OTHER SYSTEM PARAMETERS;
COOLING COIL DESIGN PARAMETERS:
  COIL TYPE=CHILLED WATER;
END COOLING COIL DESIGN PARAMETERS;
EQUIPMENT SCHEDULES:
  SYSTEM OPERATION=ON, FROM 01JAN THRU 31DEC;
  EXHAUST FAN OPERATION=ON, FROM 01JAN THRU 31DEC;
  PREHEAT COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
  HEATING COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
  COOLING COIL OPERATION=ON, FROM 01JAN THRU 31DEC;
  HUMIDIFIER OPERATION=ON, FROM 01JAN THRU 31DEC;
  TSTAT BASEBOARD HEAT OPERATION=ON, FROM 01JAN THRU 31DEC;
  HEAT RECOVERY OPERATION=OFF, FROM 01JAN THRU 31DEC;
  MINIMUM VENTILATION SCHEDULE=MINOA, FROM 01JAN THRU 31DEC;
  MAXIMUM VENTILATION SCHEDULE=MAXOA, FROM 01JAN THRU 31DEC;
  SYSTEM ELECTRICAL DEMAND SCHEDULE=ON, FROM 01JAN THRU 31DEC;
END EQUIPMENT SCHEDULES;
END SYSTEM;
END FAN SYSTEM DESCRIPTION;
```

BLAST Input Deck Created by BTEXT

```
BEGIN CENTRAL PLANT DESCRIPTION;
  PLANT 1 "PLANT 1 " SERVING ALL SYSTEMS;
    EQUIPMENT SELECTION;
      RECIPROCATING CHILLER :
        1 OF SIZE 750;
      END EQUIPMENT SELECTION;
    PART LOAD RATIOS;
      RECIPROCATING CHILLER(MIN=.10,MAX=1.05,BEST=.65,ELECTRICAL=.2275);
    END PART LOAD RATIOS;
    FOR SYSTEM 1:
      SYSTEM MULTIPLIER=1;
    END SYSTEM;
    FOR SYSTEM 2:
      SYSTEM MULTIPLIER=1;
    END SYSTEM;
  END PLANT;
  PLANT 2 "BOILER " SERVING ALL SYSTEMS;
    EQUIPMENT SELECTION;
      BOILER :
        1 OF SIZE 1200;
      END EQUIPMENT SELECTION;
    PART LOAD RATIOS;
      BOILER(MIN=.0100,MAX=1.0000,BEST=.8700,ELECTRICAL=0.0000);
    END PART LOAD RATIOS;
    SCHEDULE;
      HOT WATER=0.0,CONSTANT,FROM 1JAN THRU 31DEC,
        AT 125.0 SUPPLIED BY BOILER;
    END SCHEDULE;
    FOR SYSTEM 1:
      SYSTEM MULTIPLIER=1;
    END SYSTEM;
    FOR SYSTEM 2:
      SYSTEM MULTIPLIER=1;
    END SYSTEM;
  END PLANT;
END CENTRAL PLANT DESCRIPTION;
END INPUT;
```

Zone Report of Drawing Navigator Deck

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DESCRIPTION OF ZONE 1: ZONE 1 FT RUCKER HANGER

SURF HTS TYPE OF SURFACE AREA U AZM TILT CONSTRUCTION

NUMBER NUMBER TYPE OF SUBSURFACE

1	1	EXTERIOR WALL	265.8	0.104	180.0	90.0	EXTWALL01
2	2	EXTERIOR WALL	266.7	0.104	0.0	90.0	EXTWALL01
3	3	EXTERIOR WALL	884.6	0.104	270.0	90.0	EXTWALL01
4	4	WINDOW	25.0	0.526			DOUBLE PANE TINTED WINDOW
5	5	WINDOW	25.0	0.526			DOUBLE PANE TINTED WINDOW
6	6	WINDOW	25.0	0.526			DOUBLE PANE TINTED WINDOW
7	7	WINDOW	25.0	0.526			DOUBLE PANE TINTED WINDOW
8	8	WINDOW	25.0	0.526			DOUBLE PANE TINTED WINDOW
9	9	WINDOW	25.0	0.526			DOUBLE PANE TINTED WINDOW
10	10	SLAB ON GRADE FLOOR	2750.0	0.091	180.0	180.0	SLAB FLOOR
11	11	ROOF	2750.0	0.083	180.0	0.0	ROOF01
EXTERIOR SURFACE AREA =			4317.07	AVERAGE U-VALUE = 0.105			

ZONE FLOOR AREA= 2749.97 FT**2

APPROXIMATE ZONE VOLUME = 20544.7 FT**3 AIR HEAT CAPACITY = 395.650 BTU/DEG F

GENERAL SCHEDULES DATA:

PEOPLE: 1.000E+01 FROM 1JAN THRU 31DEC 1 1 1 1 1 1 1 1 1 1 1 1

LIGHTS: 4.500E+02 BTUH ACTIVITY LEVEL, 70.0% RADIANT FROM 1JAN THRU 31DEC 1 1 1 1 1 1 1 1 1 1 1 1

SURFACE VERTICES OF ZONE 1 0.0% RETURN AIR, 20.0% RADIANT, 20.0% VISIBLE, 0.0% REPLACEABLE

NS ORG DIRECTION COSINES COORDINATES

1	ABS	0.000	-1.000	0.000	(-26.6,	15.7,	10.0)	(-26.6,	15.7,	10.0)
2	ABS	0.000	1.000	0.000	(-0.1,	119.1,	10.0)	(-26.7,	119.1,	10.0)
3	ABS	-1.000	0.000	0.000	(-26.7,	119.1,	10.0)	(-26.7,	119.1,	10.0)
4	REL	-1.000	0.000	0.000	(6.4,	8.0,	0.0)	(11.4,	8.0,	0.0)
5	REL	-1.000	0.000	0.000	(36.5,	8.0,	0.0)	(41.5,	8.0,	0.0)
6	REL	-1.000	0.000	0.000	(51.2,	8.0,	0.0)	(56.2,	8.0,	0.0)
7	REL	-1.000	0.000	0.000	(65.8,	8.0,	0.0)	(70.8,	8.0,	0.0)
8	REL	-1.000	0.000	0.000	(80.5,	8.0,	0.0)	(85.5,	8.0,	0.0)
9	REL	-1.000	0.000	0.000	(95.2,	8.0,	0.0)	(100.2,	8.0,	0.0)
10	ABS	0.000	0.000	-1.000	(-26.6,	-87.8,	0.0)	(-0.1,	-87.8,	0.0)
11	ABS	0.000	0.000	1.000	(-26.6,	119.1,	10.0)	(-0.1,	119.1,	10.0)

Zone Report of Drawing Navigator Deck

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6 APR 92

LEVEL 193

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77)

PLAN VIEW OF ZONE HEAT TRANSFER SURFACES.

MIN X = -26.72
MAX X = -0.05
MIN Y = -87.79
MAX Y = 119.13

* - ZONE SURFACE
ZONE :

+Y
1
-X---+X
1
-Y
N
1
W---E
1
S



US ARMY CORPS OF ENGINEERS --- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 6 APR 92 17:21:36 PAGE 19

FT RUCKER HANGER

SURF	HTS	TYPE OF SURFACE	AREA	U	AZM	TILT	CONSTRUCTION
NUMBER	NUMBER	TYPE OF SUBSURFACE					
12	12	EXTERIOR WALL	417.5	0.104	90.0	90.0	EXTWALLO1
13	13	EXTERIOR WALL	2901.3	0.104	0.0	90.0	EXTWALLO1
14	14	EXTERIOR WALL	416.7	0.104	270.0	90.0	EXTWALLO1
15	15	SLAB ON GRADE FLOOR	12124.5	0.091	180.0	180.0	SLAB FLOOR
16	16	ROOF	12114.6	0.083	180.0	0.0	ROOF01
EXTERIOR SURFACE AREA =		15850.10	AVERAGE U-VALUE = 0.088				

ZONE FLOOR AREA= 12124.53 FT**2

APPROXIMATE ZONE VOLUME = 102556.9 FT**3 AIR HEAT CAPACITY = 1975.039 BTU/DEG F

GENERAL SCHEDULES DATA:

[illegible]

4.500E+02 BTUH ACTIVITY LEVEL, 70.0% RADIANT FROM 1JAN THRU 31DEC
LIGHTS: 1 1 1 1 1 1 1 1 1 1 1 1

0.0% RETURN AIR, 20.0% RADIANT, 20.0% VISIBLE, 0.0% REPLACEABLE
SURFACE VERTICES OF ZONE 2% ZONE 2

NS	ORG	DIRECTION	COSINES	COORDINATES
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9
10	10	10	10	10
11	11	11	11	11
12	12	12	12	12
13	13	13	13	13
14	14	14	14	14
15	15	15	15	15
16	16	16	16	16
17	17	17	17	17
18	18	18	18	18
19	19	19	19	19
20	20	20	20	20
21	21	21	21	21
22	22	22	22	22
23	23	23	23	23
24	24	24	24	24
25	25	25	25	25
26	26	26	26	26
27	27	27	27	27
28	28	28	28	28
29	29	29	29	29
30	30	30	30	30
31	31	31	31	31
32	32	32	32	32
33	33	33	33	33
34	34	34	34	34
35	35	35	35	35
36	36	36	36	36
37	37	37	37	37
38	38	38	38	38
39	39	39	39	39
40	40	40	40	40
41	41	41	41	41
42	42	42	42	42
43	43	43	43	43
44	44	44	44	44
45	45	45	45	45
46	46	46	46	46
47	47	47	47	47
48	48	48	48	48
49	49	49	49	49
50	50	50	50	50
51	51	51	51	51
52	52	52	52	52
53	53	53	53	53
54	54	54	54	54
55	55	55	55	55
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57	57	57	57	57
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70	70	70	70	70
71	71	71	71	71
72	72	72	72	72
73	73	73	73	73
74	74	74	74	74
75	75	75	75	75
76	76	76	76	76
77	77	77	77	77
78	78	78	78	78
79	79	79	79	79
80	80	80	80	80
81	81	81	81	81
82	82	82	82	82
83	83	83	83	83
84	84	84	84	84
85	85	85	85	85
86	86	86	86	86
87	87	87	87	8

12 ABS	1.000	0.000	0.000	(290.1,	119.4,	10.0)	(290.1,	161.1,	0.0)	(290.1,	161.1,
13 ABS	0.000	1.000	0.000	(290.1,	161.1,	10.0)	(290.1,	161.1,	0.0)	(0.0,	161.1,
14 ABS	-1.000	0.000	0.000	(0.0,	161.0,	10.0)	(0.0,	119.4,	0.0)	(0.0,	119.4,
15 ABS	0.000	0.000-1.000	(0.0,	77.6,	0.0)	(0.0,	290.1,	119.4,	0.0)	(290.1,	77.6,
16 ABS	0.000	0.000	1.000	(0.0,	161.1,	10.0)	(290.1,	119.4,	10.0)	(290.1,	161.1,

Zone Report of Drawing Navigator Deck

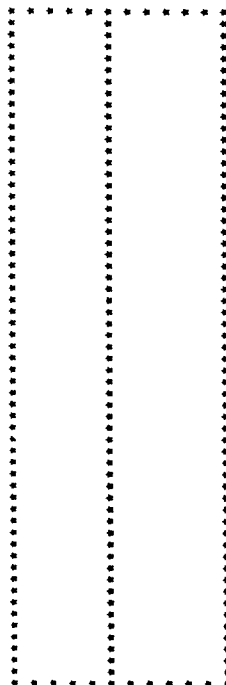
US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 6 APR 92 17:21:36 PAGE 20

PLAN VIEW OF ZONE HEAT TRANSFER SURFACES.

MIN X = -0.04
 MAX X = 290.13
 MIN Y = 77.59
 MAX Y = 161.13

* = ZONE SURFACE ZONE 2

+Y 1 N
 -X--+---X W--+---E
 -Y 1 S



Zone Report of Drawing Navigator Deck

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 6 APR 92 17:21:36 PAGE 21

DESCRIPTION OF ZONE	3: ZONE 3	FT RUCKER HANGER

SURF	HTS	TYPE OF SURFACE	AREA	U	AZM	TILT	CONSTRUCTION
------	-----	-----------------	------	---	-----	------	--------------

NUMBER	NUMBER	TYPE OF SURFACE	TYPE OF SUBSURFACE
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
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28	28	28	28
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46	46	46	46
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51	51	51	51
52	52	52	52
53	53	53	53
54	54	54	54
55	55	55	55
56	56	56	56
57	57	57	57
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64	64	64	64
65	65	65	65
66	66	66	66
67	67	67	67
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69	69	69	69
70	70	70	70
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72	72	72	72
73	73	73	73
74	74	74	74
75	75	75	75
76	76	76	76
77	77	77	77
78	78	78	78
79	79	79	79
80	80	80	80
81	81	81	81
82	82	82	82
83	83	83	83
84	84	84	84
85	85	85	85
86	86	86	86
87	87	87	87
88	88	88	88
89	89	89	89
90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

	17	EXTERIOR WALL	11603.2	0.104	180.0	90.0	EXTWALL01
	18	EXTERIOR WALL	4768.4	0.104	90.0	90.0	EXTWALL01
	19	EXTERIOR WALL	11595.2	0.104	0.0	90.0	EXTWALL01
	20	EXTERIOR WALL	4150.0	0.104	270.0	90.0	EXTWALL01
	21	EXTERIOR WALL	616.8	0.104	270.0	90.0	EXTWALL01
	22	FLOOR	34592.0	0.493	180.0	180.0	FLOOR34
	23	ROOF	34626.0	0.065	180.0	0.0	ROOF02
EXTERIOR SURFACE AREA =			67359.59	AVERAGE U-VALUE =			0.084

ZONE FLOOR AREA= 34592.04 FT**2

APPROXIMATE ZONE VOLUME = 1523603.9 FT**3 AIR HEAT CAPACITY = 29341.553 BTU/DEG F

GENERAL SCHEDULES DATA:

[illegible]

4.500E+02 BTUH ACTIVITY I

FIGURE 1. **PROBABILITY OF A PERSON BEING A MEMBER OF A PARTY**

0.00 RETURN AIR, 20.00 NOISE, 0.00 REFRACTABLE;
SURFACE VERTICES OF ZONE 30 ZONE 3

NS ORG	DIRECTION	COSINES	COORDINATES
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9
10	10	10	10
11	11	11	11
12	12	12	12
13	13	13	13
14	14	14	14
15	15	15	15
16	16	16	16
17	17	17	17
18	18	18	18
19	19	19	19
20	20	20	20
21	21	21	21
22	22	22	22
23	23	23	23
24	24	24	24
25	25	25	25
26	26	26	26
27	27	27	27
28	28	28	28
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90	90	90	90
91	91	91	91
92	92	92	92
93	93	93	93
94	94	94	94
95	95	95	95
96	96	96	96
97	97	97	97
98	98	98	98
99	99	99	99
100	100	100	100

17 ABS	0.000-1.000	0.000	(0.0,	0.1,	40.0)	(290.1,	0.0)	(290.1,	0.1,	40.0)
18 ABS	1.000-1.000	0.000	(290.1,	0.2,	40.0)	(290.1,	119.4,	(290.1,	119.4,	40.0)
19 ABS	0.000-1.000	0.000	(290.1,	119.4,	40.0)	(290.1,	0.0)	(290.1,	0.2,	40.0)
20 ABS	1.000-1.000	0.000	(0.2,	119.3,	40.0)	(0.2,	15.5,	(0.2,	15.5,	40.0)
21 ABS	-1.000-1.000	0.000	(-0.1,	15.5,	40.0)	(-0.1,	0.0)	(-0.1,	0.1,	40.0)
22 ABS	0.000-1.000	1.000	(0.0,	119.2,	40.0)	(0.0,	0.0)	(290.1,	119.2,	40.0)
23 ABS	0.000-1.000	1.000	(0.0,	119.4,	40.0)	(0.0,	0.1,	(290.1,	119.4,	40.0)

Zone Report of Drawing Navigator Deck

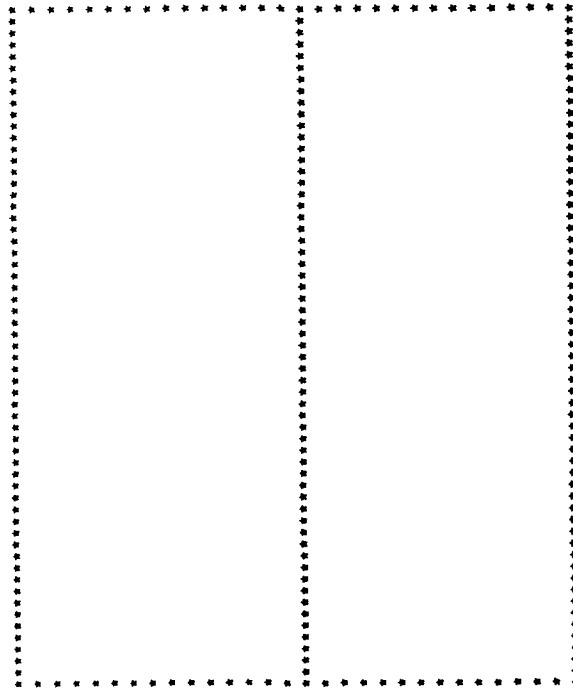
US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 6 APR 92 17:21:36 PAGE 22

PLAN VIEW OF ZONE HEAT TRANSFER SURFACES.

MIN X = -0.08
 MAX X = 290.13
 MIN Y = -119.17
 MAX Y = 119.41

* - ZONE SURFACE ZONE 3

+Y 1
 -X---+---X
 -Y
 N 1
 W---+---E
 1 1
 S



Zone Report of Drawing Navigator Deck

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77); LEVEL 193 6 APR 92 17:21:36 PAGE 23

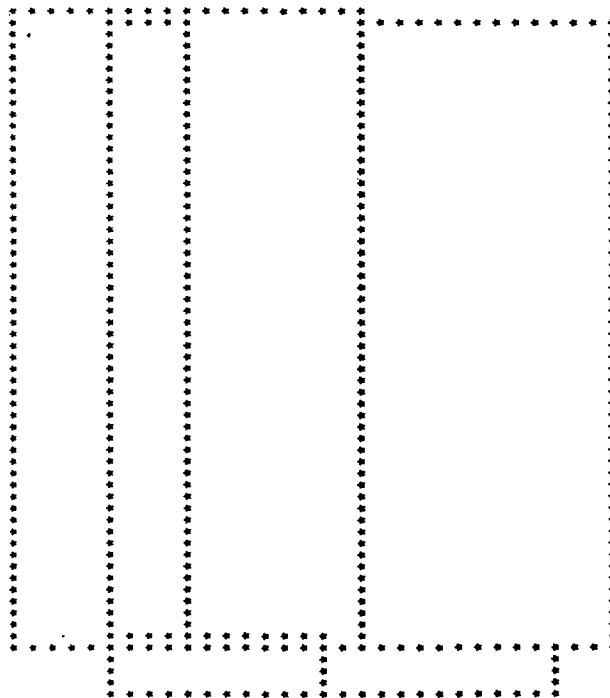
PLAN VIEW OF BUILDING SURFACES.

MIN X = -26.72
 MAX X = 290.13
 MIN Y = -119.17
 MAX Y = 161.13

+Y 1 N 1
 -X---+X W---E
 1 1 1
 -Y S

* = BUILDING SURFACE, + = SHADOWING SURFACE

FT RUCKER HANGER



Zone Report of BTEXT Generated Deck

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 7 APR 92 8:59:53 PAGE 17

DESCRIPTION OF ZONE	1: ZONE 1	HANGER
1.00	1.00	1.00
1.01	1.01	1.01
1.02	1.02	1.02
1.03	1.03	1.03
1.04	1.04	1.04
1.05	1.05	1.05
1.06	1.06	1.06
1.07	1.07	1.07
1.08	1.08	1.08
1.09	1.09	1.09
1.10	1.10	1.10
1.11	1.11	1.11
1.12	1.12	1.12
1.13	1.13	1.13
1.14	1.14	1.14
1.15	1.15	1.15
1.16	1.16	1.16
1.17	1.17	1.17
1.18	1.18	1.18
1.19	1.19	1.19
1.20	1.20	1.20
1.21	1.21	1.21
1.22	1.22	1.22
1.23	1.23	1.23
1.24	1.24	1.24
1.25	1.25	1.25
1.26	1.26	1.26
1.27	1.27	1.27
1.28	1.28	1.28
1.29	1.29	1.29
1.30	1.30	1.30
1.31	1.31	1.31
1.32	1.32	1.32
1.33	1.33	1.33
1.34	1.34	1.34
1.35	1.35	1.35
1.36	1.36	1.36
1.37	1.37	1.37
1.38	1.38	1.38
1.39	1.39	1.39
1.40	1.40	1.40
1.41	1.41	1.41
1.42	1.42	1.42
1.43	1.43	1.43
1.44	1.44	1.44
1.45	1.45	1.45
1.46	1.46	1.46
1.47	1.47	1.47
1.48	1.48	1.48
1.49	1.49	1.49
1.50	1.50	1.50
1.51	1.51	1.51
1.52	1.52	1.52
1.53	1.53	1.53
1.54	1.54	1.54
1.55	1.55	1.55
1.56	1.56	1.56
1.57	1.57	1.57
1.58	1.58	1.58
1.59	1.59	1.59
1.60	1.60	1.60
1.61	1.61	1.61
1.62	1.62	1.62
1.63	1.63	1.63
1.64	1.64	1.64
1.65	1.65	1.65
1.66	1.66	1.66
1.67	1.67	1.67
1.68	1.68	1.68
1.69	1.69	1.69
1.70	1.70	1.70
1.71	1.71	1.71
1.72	1.72	1.72
1.73	1.73	1.73
1.74	1.74	1.74
1.75	1.75	1.75
1.76	1.76	1.76
1.77	1.77	1.77
1.78	1.78	1.78
1.79	1.79	1.79
1.80	1.80	1.80
1.81	1.81	1.81
1.82	1.82	1.82
1.83	1.83	1.83
1.84	1.84	1.84
1.85	1.85	1.85
1.86	1.86	1.86
1.87	1.87	1.87
1.88	1.88	1.88
1.89	1.89	1.89
1.90	1.90	1.90
1.91	1.91	1.91
1.92	1.92	1.92
1.93	1.93	1.93
1.94	1.94	1.94
1.95	1.95	1.95
1.96	1.96	1.96
1.97	1.97	1.97
1.98	1.98	1.98
1.99	1.99	1.99
2.00	2.00	2.00
2.01	2.01	2.01
2.02	2.02	2.02
2.03	2.03	2.03
2.04	2.04	2.04
2.05	2.05	2.05
2.06	2.06	2.06
2.07	2.07	2.07
2.08	2.08	2.08
2.09		

[illegible]

SURE	HTS	TYPE OF SURFACE	AREA	U	AZM	TILT	CONSTRUCTION
1	1	1	1	1	1	1	1

NUMBER	NUMBER	TYPE OF SUBSURFACE
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	9	9
10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
21	21	21
22	22	22
23	23	23
24	24	24
25	25	25
26	26	26
27	27	27
28	28	28
29	29	29
30	30	30
31	31	31
32	32	32
33	33	33
34	34	34
35	35	35
36	36	36
37	37	37
38	38	38
39	39	39
40	40	40
41	41	41
42	42	42
43	43	43
44	44	44
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47	47	47
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52	52	52
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54	54	54
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58	58	58
59	59	59
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62	62	62
63	63	63
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65	65	65
66	66	66
67	67	67
68	68	68
69	69	69
70	70	70
71	71	71
72	72	72
73	73	73
74	74	74
75	75	75
76	76	76
77	77	77
78	78	78
79	79	79
80	80	80
81	81	81
82	82	82
83	83	83
84	84	84
85	85	85
86	86	86
87	87	87
88	88	88
89	89	89
90	90	90
91	91	91
92	92	92
93	93	93
94	94	94
95	95	95
96	96	96
97	97	97
98	98	98
99	99	99
100	100	100

1	2	3	4	5	6	7	8	9	10	11
1	EXTERIOR WALL	890.0	0.104	270.0	90.0	EXTWALL01	DOUBLE PANE	TINTED WINDOW		
2	WINDOW	25.0	0.526			DOUBLE PANE	TINTED WINDOW			
3	WINDOW	25.0	0.526			DOUBLE PANE	TINTED WINDOW			
4	WINDOW	25.0	0.526			DOUBLE PANE	TINTED WINDOW			
5	WINDOW	25.0	0.526			DOUBLE PANE	TINTED WINDOW			
6	WINDOW	25.0	0.526			DOUBLE PANE	TINTED WINDOW			
7	WINDOW	25.0	0.526			DOUBLE PANE	TINTED WINDOW			
8	EXTERIOR WALL	266.7	0.104	0.0	90.0	EXTWALL01	DOUBLE PANE	TINTED WINDOW		
9	EXTERIOR WALL	266.7	0.104	180.0	90.0	EXTWALL01	DOUBLE PANE	TINTED WINDOW		
10	SLAB ON GRADE FLOOR	2773.7	0.091	180.0	180.0	SLAB FLOOR				
11	ROOF	2773.7	0.083	180.0	0.0	ROOF01				

11 ROOF
11 EXTERIOR SURFACE AREA = 4347.08
27.57 0.000 100.0
AVERAGE U-VALUE = 0.105

ZONE FLOOR AREA= 2773.68 FT**2

APPROXIMATE ZONE VOLUME - 20716.1 FT**3 AIR HEAT CAPACITY - 398.950 BTU/DEG F

GENERAL SCHEDULES DATA:

	FROM	1JAN	THRU	31DEC	
PEOPLE:	1.000E+01				1
	1.000E+01				1

4.500E+02 BTUH ACTIVITY LEVEL, 70.0% RADIANT

4.500E+02 BION ACTIVITY LEVEL, 10.00 GEDHAT
 HIGHLIGHTS: 2.500E+04 BTUH FROM 1JAN THRU 31DEC

0.0% RETURN AIR,	20.0% RADIANT,	20.0% VISIBLE,	0.0% REPLACEABLE
------------------	----------------	----------------	------------------

SURFACE VERTICES OF ZONE 18 ZONE 1
0:00 RETURN AIR, 20:00 RETURN

NS	ORG	DIRECTION	COSINES	COORDINATES
1	1	1	1	1
2	2	2	2	2
3	3	3	3	3
4	4	4	4	4
5	5	5	5	5
6	6	6	6	6
7	7	7	7	7
8	8	8	8	8
9	9	9	9	9
10	10	10	10	10
11	11	11	11	11
12	12	12	12	12
13	13	13	13	13
14	14	14	14	14
15	15	15	15	15
16	16	16	16	16
17	17	17	17	17
18	18	18	18	18
19	19	19	19	19
20	20	20	20	20
21	21	21	21	21
22	22	22	22	22
23	23	23	23	23
24	24	24	24	24
25	25	25	25	25
26	26	26	26	26
27	27	27	27	27
28	28	28	28	28
29	29	29	29	29
30	30	30	30	30
31	31	31	31	31
32	32	32	32	32
33	33	33	33	33
34	34	34	34	34
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36	36	36	36	36
37	37	37	37	37
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71	71	71	71	71
72	72	72	72	72
73	73	73	73	73
74	74	74	74	74
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76	76	76	76	76
77	77	77	77	77
78	78	78	78	78
79	79	79	79	79
80	80	80	80	80
81	81	81	81	81
82	82	82	82	82
83	83	83	83	83
84	84	84	84	84
85	85	85	85	85
86	86	86	86	86
87	87	87	87	8

1	ABS	-1.000	0.000	0.000	(-26.7,	120.0,	10.0)	(-26.7,	16.0,	10.0)
2	REL	-1.000	0.000	0.000	(0.0,	5.0,	0.0)	(5.0,	5.0,	0.0)
3	REL	-1.000	0.000	0.000	(0.0,	5.0,	0.0)	(5.0,	5.0,	0.0)
4	REL	-1.000	0.000	0.000	(0.0,	5.0,	0.0)	(5.0,	5.0,	0.0)
5	REL	-1.000	0.000	0.000	(0.0,	5.0,	0.0)	(5.0,	5.0,	0.0)
6	REL	-1.000	0.000	0.000	(0.0,	5.0,	0.0)	(5.0,	5.0,	0.0)
7	REL	-1.000	0.000	0.000	(0.0,	5.0,	0.0)	(5.0,	5.0,	0.0)
8	ABS	0.000	1.000	0.000	(0.0,	120.0,	10.0)	(-26.7,	120.0,	10.0)
9	ABS	0.000	-1.000	0.000	(-26.7,	16.0,	10.0)	(0.0,	16.0,	10.0)
10	ABS	0.000	0.000	-1.000	(-26.7,	-88.0,	0.0)	(-26.7,	-192.0,	0.0)
11	ABS	0.000	0.000	1.000	(-26.7,	120.0,	10.0)	(0.0,	120.0,	10.0)
12	ABS	0.000	0.000	0.000	(-26.7,	120.0,	10.0)	(0.0,	224.0,	10.0)

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 7 APR 92 8:59:53 PAGE 18

PLAN VIEW OF ZONE HEAT TRANSFER SURFACES.

MIN X =	-26.67
MAX X =	0.00
MIN Y =	-192.00
MAX Y =	224.00

• - ZONE SURFACE
ZONE 1

$$\begin{array}{c} \begin{array}{c} +Y \\ 1 \\ -X \end{array} \begin{array}{c} 1 \\ + \\ - \end{array} \begin{array}{c} X \\ 1 \\ -Y \end{array} \\ \begin{array}{c} N \\ 1 \\ W \end{array} \begin{array}{c} 1 \\ + \\ - \end{array} \begin{array}{c} E \\ 1 \\ S \end{array} \end{array}$$

Zone Report of BTEXT Generated Deck

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 7 APR 92 8:59:53 PAGE 19

DESCRIPTION OF ZONE	2: ZONE 2	HANGER
1		
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100		

DESCRIPTION OF ZONE	2: ZONE 2

SURE	HTS	TYPE OF SURFACE	AREA	U	AZM	TILT	CONSTRUCTION
------	-----	-----------------	------	---	-----	------	--------------

NUMBER	NUMBER	TYPE OF SUBSURFACE
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
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7	7	7
8	8	8
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10	10	10
11	11	11
12	12	12
13	13	13
14	14	14
15	15	15
16	16	16
17	17	17
18	18	18
19	19	19
20	20	20
21	21	21
22	22	22
23	23	23
24	24	24
25	25	25
26	26	26
27	27	27
28	28	28
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31	31	31
32	32	32
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36	36	36
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43	43	43
44	44	44
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52	52	52
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84	84	84
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88	88	88
89	89	89
90	90	90
91	91	91
92	92	92
93	93	93
94	94	94
95	95	95
96	96	96
97	97	97
98	98	98
99	99	99
100	100	100

[illegible]

ZONE FLOOR AREA= 12096.00 FT**2

```
APPROXIMATE ZONE VOLUME = 102283.1 FT**3
AIR HEAT CAPACITY = 2636.946 BTU/DEG F
```

APPROXIMATE ZONE VOLUME = 102283.1 FT**3

GENERAL SCHEDULES DATA:

PEOPLE:
2.500E+01 FROM 1JAN THRU 31DEC
1 1 1 1 1 1 1 1 1 1 1

LIGHTS:

4.500E+02 BTUH	ACTIVITY LEVEL,	70.0% RADIANT			
3.000E+04 BTUH	FROM	1JAN THRU 31DEC	1	1	1

0.0% RETURN AIR, 20.0% RADIANT, 20.0% VISIBLE, 0.0% REPLACEABLE

SURFACE VERTICES OF ZONE 2

NS	ORG	DIRECTION	COSINES	COORDINATES
----	-----	-----------	---------	-------------

12	ABS	-1.000	0.000	0.000	(	0.0,	162.0,	0.0)	(	0.0,	120.0,	0.0)
13	ABS	0.000	1.000	0.000	(	288.0,	162.0,	0.0)	(	0.0,	162.0,	0.0)
14	ABS	1.000	0.000	0.000	(	288.0,	120.0,	0.0)	(	288.0,	162.0,	0.0)
15	ABS	0.000	0.000	-1.000	(	0.0,	78.0,	0.0)	(	288.0,	36.0,	0.0)
16	ABS	0.000	0.000	1.000	(	0.0,	130.0,	0.0)	(	288.0,	172.0,	0.0)
17	ABS	0.000	1.000	0.000	(	0.0,	120.0,	0.0)	(	-126.0,	120.0,	0.0)

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7 APR 92

LEVEL 193

U S ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77)

PLAN VIEW OF ZONE HEAT TRANSFER SURFACES.

MIN X	=	0.00
MAX X	=	288.00
MIN Y	=	36.00
MAX Y	=	172.00

$$\begin{array}{c} \text{N} \\ | \\ \text{W} - + - \text{E} \\ | \\ \text{S} \end{array} \quad \begin{array}{c} +\text{Y} \\ | \\ \text{X} - + - \text{X} \\ | \\ -\text{Y} \end{array}$$

* - ZONE SURFACE
ZONE 2

[illegible]

Zone Report of BTEXT Generated Deck

US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77) LEVEL 193 7 APR 92 8:59:53 PAGE 21

DESCRIPTION OF ZONE 3: ZONE 3 HANGER

SURF HTS TYPE OF SURFACE AREA U AZM TILT CONSTRUCTION

NUMBER NUMBER TYPE OF SUBSURFACE

18	18	EXTERIOR WALL	640.0	0.231	270.0	90.0	EXTWALLO2
19	19	EXTERIOR WALL	2640.0	0.231	270.0	90.0	EXTWALLO2
20	20	EXTERIOR WALL	8640.0	0.231	0.0	90.0	EXTWALLO2
21	21	EXTERIOR WALL	4800.0	0.231	90.0	90.0	EXTWALLO2
22	22	EXTERIOR WALL	11520.0	0.231	180.0	90.0	EXTWALLO2
23	23	SLAB ON GRADE FLOOR	34560.0	0.091	180.0	180.0	SLAB FLOOR
24	24	ROOF	34560.0	0.083	180.0	0.0	ROOF01
EXTERIOR SURFACE AREA =			62800.00	AVERAGE U-VALUE = 0.150			

ZONE FLOOR AREA= 34560.00 FT**2

APPROXIMATE ZONE VOLUME = 1312476.6 FT**3 AIR HEAT CAPACITY = 25275.666 BTU/DEG F

GENERAL SCHEDULES DATA:

PEOPLE: 1.500E+01 FROM 1JAN THRU 31DEC

LIGHTS: 4.500E+02 BTUH ACTIVITY LEVEL, 70.0% RADIANT FROM 1JAN THRU 31DEC

0.0% RETURN AIR, 20.0% RADIANT, 20.0% VISIBLE, 0.0% REPLACEABLE

SURFACE VERTICES OF ZONE 3 ZONE 3

NS ORG DIRECTION COSINES COORDINATES

18	ABS	-1.000	0.000	0.000	(	0.0,	16.0,	40.0)	(	0.0,	16.0,	0.0)	(	0.0,	0.0,	40.0)
19	ABS	-1.000	0.000	0.000	(	0.0,	120.0,	40.0)	(	0.0,	120.0,	32.0,	(	0.0,	32.0,	40.0)
20	ABS	0.000	1.000	0.000	(	288.0,	120.0,	40.0)	(	288.0,	120.0,	10.0)	(	0.0,	120.0,	40.0)
21	ABS	1.000	0.000	0.000	(	288.0,	0.0,	40.0)	(	288.0,	0.0,	0.0)	(	288.0,	120.0,	40.0)
22	ABS	0.000	-1.000	0.000	(	0.0,	-120.0,	40.0)	(	0.0,	-120.0,	0.0)	(	288.0,	0.0,	40.0)
23	ABS	0.000	0.000	-1.000	(	0.0,	-240.0,	0.0)	(	0.0,	-240.0,	0.0)	(	288.0,	-240.0,	0.0)
24	ABS	0.000	0.000	1.000	(	0.0,	160.0,	0.0)	(	0.0,	40.0,	40.0)	(	288.0,	160.0,	0.0)

Zone Report of BTEXT Generated Deck

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7 APR 92

LEVEL 193

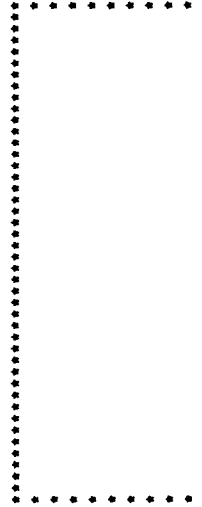
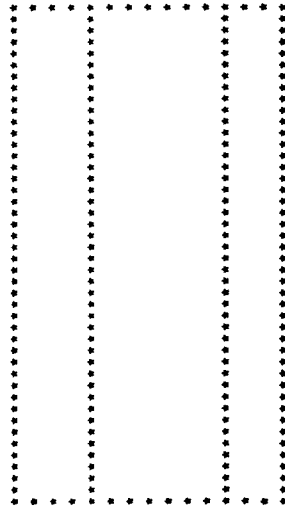
US ARMY CORPS OF ENGINEERS -- BLAST VERSION 3.0 (ANSI FORTRAN 77)

PLAN VIEW OF ZONE HEAT TRANSFER SURFACES.

MIN X = 0.00
MAX X = 288.00
MIN Y = -240.00
MAX Y = 160.00

+Y 1
-X 1
-Y 1
N 1
W 1
E 1
S 1

* - ZONE SURFACE
ZONE 3



Zone Report of BTEXT Generated Deck

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LEVEL 193

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PLAN VIEW OF BUILDING SURFACES.

MIN X =	-26.67	$\begin{array}{c} +1 \\ 1 \\ -X \end{array} \begin{array}{c} + \\ + \\ - \end{array} \begin{array}{c} X \\ \\ \end{array}$	$\begin{array}{c} N \\ 1 \\ W \end{array} \begin{array}{c} 1 \\ 1 \\ 1 \end{array} \begin{array}{c} + \\ - \\ + \end{array} \begin{array}{c} E \\ S \\ S \end{array}$
MAX X =	288.00		
MIN Y =	-240.00		
MAX Y =	224.00	$-Y$	

• - BUILDING SURFACE, + - SHADOWING SURFACE

HANGER

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