USACERL Technical Report E-92/11
April 1992
T³B: FY90 BLAST Enhancements Evaluation

US Army Corps
of Engineers
Construction Engineering
Research Laboratory

TECHNOLOGY
TRANSFER
TEST BED
PROGRAM

Field Evaluation of the Building Loads Analysis and Thermodynamics (BLAST) Program Enhancements

by
Robert J. Nemeth

The Building Loads Analysis and Thermodynamics (BLAST) computer program models energy consumption and comfort parameters of new or existing facilities to help U.S. Army Corps of Engineers (USACE) District designers create more comfortable and energy efficient buildings. In response to users' requests, 11 new modeling options have recently been added to the program, including the ability to run BLAST on a microcomputer (286 or 386 IBM-compatible) platform

Technology Transfer Test Bed (T^3B) funds were provided to determine whether the recent BLAST enhancements were convenient, and applicable to the needs of Corps districts. Five districts were asked to select any of BLAST's new options, to evaluate the options, and to compare them with a second, comparable program of their choice.

Most respondents found the enhancements satisfied their needs for building energy analysis. Participants' responses were found to depend somewhat on previous experiences and attitudes toward BLAST. Some surveys revealed several minor bugs in the program, and most respondents recommended expanding the prc

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ERRATA SHEET

for

USACERL Technical Report E-92/11, "Field Evaluation of the Building Loads Analysis and Thermodynamics (BLAST) Program Enhancements," April 1992.

1. Replace title on the cover, the User Evaluation page, the Report Documentation page, at block 4, and the first sentence, paragraph 1, on page 5 with the following: "Field Evaluation of the Building Loads Analysis and System Thermodynamics (BLAST) Program Enhancements."

2. Replace sentence 1, paragraph 1 on the cover abstract, and sentence 1 at block 13 of the Report Documentation page with the following: The Building Loads Analysis and System Thermodynamics (BLAST) computer program models energy consumption and comfort parameters of new or existing facilities to help U.S. Army Corps of Engineers (USACE) District designers create more comfortable and energy efficient buildings.

TECHNOLOGY TRANSFER TEST BED PROGRAM

FINDINGS AND RECOMMENDATIONS OF TEST/DEMONSTRATION

WORK UNIT NO./TITLE OF TEST: T^3B, BLAST Enhancements Evaluation

PERFORMING LABORATORY: USACERL **PRODUCT/SYSTEM:** Additions and improvements to the BLAST program

PERFORMING TEST SITES: The following U.S. Army Corps of Engineers (USACE) Districts: Omaha, NE; Fort Worth, TX; Louisville, KY; Sacramento, CA; and Mobile, AL.

DESCRIPTION/OBJECTIVE OF TEST/DEMONSTRATION:

The objective of this T^3B Program was to determine whether recent BLAST program enhancements were convenient, and applicable to the needs of Corps districts. The user-requested enhancements increase BLAST's modeling options and also allow BLAST to run on a microcomputer (286 or 386 IBM-compatible computer) platform. Five districts were asked to select any of BLAST's new options, to evaluate the options, and to compare them with a second, comparable program of their choice.

RESULTS OF TEST/DEMONSTRATION:

Overall, respondents found the enhancements to be very beneficial to their analytic needs. It was concluded that the enhancements will increase Corps District designers' analytic capabilities to create more comfortable and energy efficient buildings. Some surveys revealed several minor bugs in the program, and most respondents recommended expanding the program's documentation.

RECOMMENDATION FOR PRODUCT/SYSTEM:

It is recommended that some of the enhancements be modified per the respondents' feedback and that some of the users' more complex concerns be studied. It is also recommended that the documentation be made more comprehensive.

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13. ABSTRACT (Maximum 200 words)

The Building Loads Analysis and Thermodynamics (BLAST) computer program models energy consumption and comfort parameters of new or existing facilities to help U.S. Army Corps of Engineers (USACE) District designers create more comfortable and energy efficient buildings. In response to users' requests, 11 new modeling options have recently been added to the program, including the ability to run BLAST on a microcomputer (286 or 386 IBM-compatible) platform.

Technology Transfer Test Bed (T^3B) funds were provided to determine whether the recent BLAST enhancements were convenient, and applicable to the needs of Corps districts. Five districts were asked to select any of BLAST's new options, to evaluate the options, and to compare them with a second, comparable program of their choice.

Most respondents found the enhancements satisfied their needs for building energy analysis. Participants' responses were found to depend somewhat on previous experiences and attitudes toward BLAST. Some surveys revealed several minor bugs in the program, and most respondents recommended expanding the program's documentation.

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FOREWORD

This work was performed for Headquarters, U.S. Army Corps of Engineers (HQUSACE), and the U.S. Army Corps of Engineers National Energy Team (CENET) under the Technology Transfer Test Bed (T^3B) program; Work Unit EA-KA1, "Test New BLAST Enhancements." Mr. Dwight Beranek, CEMP-ET, was the HQUSACE T^3B technical monitor.

Field tests were administered by the Energy and Utility Systems Division (ES), U.S. Army Construction Engineering Laboratory (USACERL). Dr. Dave Joncich is Chief, USACERL-ES. The participation of five USACE Districts (Omaha, NE; Fort Worth, TX; Louisville, KY; Sacramento, CA; and Mobile, AL) in the test is gratefully acknowledged. The USACERL technical editor was Mr. William J. Wolfe, Information Management Office.

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

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FIELD EVALUATION OF THE BUILDING LOADS ANALYSIS AND SYSTEM THERMODYNAMICS (BLAST) PROGRAM ENHANCEMENTS

1 INTRODUCTION

Background

The Building Loads Analysis and Thermodynamics (BLAST) energy analysis computer program has undergone a multiyear enhancement effort based on feedback and priorities of the ST Users' Group (BUG). During the annual BLAST planning meeting, certain BLAST improvements, supported by the BUG, are incorporated in the ongoing BLAST development program. Several of these enhancements are completed and thought ready to be fielded. It is important at this stage to demonstrate these enhancements in the users' production environment to evaluate their ability to resolve deficiencies and other needs noted by the BUG.

The first version of BLAST, introduced in 1977, required many manhours and much computer power to use. As a result, BLAST gained a reputation as a difficult program to operate. Since then, several enhancements have made BLAST more "user friendly" and the availability of powerful personal computers (PCs) has made BLAST accessible to many platforms. An additional focus of this project is to gauge whether these changes can change users' early opinions about BLAST.

Objective

The objective of this T^3B project was to evaluate how well selected BLAST enhancements serve the general needs of the BLAST users group in ease of use, speed of execution, breadth of application, reliability, and accuracy.

Approach

Five USACE Districts (Omaha, NE; Fort Worth, TX; Louisville, KY; Sacramento, CA; and Mobile, AL) participated in the T^3B evaluation. Each district selected from a list of 11 new enhancements, those that were applicable to the types of projects administered by their offices, and that they would like to evaluate. These districts were given the enhanced version of BLAST and its draft documentation, along with a questionnaire outlining general areas of response. As in any beta-test software evaluation, questions inevitably arose. The BLAST Support Office (BSO) at the University of Illinois was instrumental in addressing problems and questions during this evaluation. The results of the surveys were compiled, compared, and analyzed to evaluate the effectiveness of the new enhancements, and to suggest new program improvements.

Mode of Technology Transfer

It is anticipated that BLAST program enhancements and documentation will be distributed with future updates and releases of the BLAST program. Future *BLASTnews* newsletters will announce the release of new enhancements and will feature articles describing their use. Information regarding the distribution of BLAST or *BLASTnews* can be obtained from the BLAST Support Office (BSO), by phone: (800) UI-BLAST or (217) 333-3877; by U.S. mail at the: BLAST Support Office, 30 Mechanical Engineering Bldg., 1206 W. Green Street, Urbana, IL 61801; or by electronic mail at: Support@blast.bso.uiuc.edu.

2 DESCRIPTION OF THE T^3B TEST

The participating Districts were requested to select enhancements that their offices were most likely to use. It was hoped that the enhancements would be tested on current in-house design projects, but where there was no applicable project, a past or simulated project would suffice. Table 1 summarizes the BLAST program enhancements (options) that each District chose to test.

The enhanced version of BLAST included user-evaluation (questionnaire) forms. The questionnaires were written specifically to pertain to the testing Districts and the options they chose. All questions and responses are included in this report.

In addition to evaluating options G and J, the Mobile District was asked to perform a side-by-side comparison of BLAST to another commercial energy analysis program of their own choice. This test was to be conducted on a building not previously analyzed by either program, and was designed to compare ease of use, input, execution, accuracy, and quality of reporting of the two programs. The Appendix includes the special questionnaire developed for this comparison.

Table 1

Options Tested by District

	Options*										
Program Participant	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
Omaha	×	×			×		×				
Fort Worth									×	×	
Louisville	×						×				
Sacramento				×		×					
Mobile							×			×	

*Options:

A - Simple Boiler/Chiller Model
B - Revised/Review Summary Report
C - Expanded Baseboard Heat Options (untested)
D - Forced Ventilation
E - High Intensity Radiant Heating
F - Comfort Reporting
G - PC 386 Version
H - PC 286 Version (untested)
I - Evaporative Cooler Model
J - Expanded Humidity Reporting
K - Ice Storage Model (untested)

3 TEST RESULTS

Each of the following sections explains the need(s) that prompted a particular enhancement, and briefly describes that enhancement. Each section concludes with a discussion of results and comments from participating Districts.

A - Simple Boiler/Chiller Model

The BLAST program has a boiler option, the operation of which depends on part-load ratio parameters. BLAST users identified the need for a constant efficiency boiler to model systems not dependent on part-load ratios.

Simple Boiler

One addition to the plant equipment types is the Simple Boiler model. The Simple Fuel Boiler equipment type models a constant efficiency boiler. BLAST can model either a simple boiler or the standard fuel boiler. Both cannot be simulated in the same central plant. The efficiency of the boiler and any parasitic electric consumption may be controlled by user-specified parameters.

The fuel consumption for the simple boiler is reported in the BUILDING / FAN / PLANT ENERGY UTILIZATION SUMMARY report under boiler fuel column for the amount of fuel used and under the appropriate electric consumption column for the parasitic electric consumption. In addition, the consumption is reported in the PLANT EQUIPMENT ENERGY INPUT BREAKDOWN report under Fuel Boiler and Fuel Boiler Electric for the fuel and electricity consumed, respectively.

A simple fuel boiler was added, but a simple electric boiler was not because the present electric boiler model in BLAST already assumes a constant efficiency; adding a simple electric boiler would have been redundant.

Simple Chiller

The simple chiller is very similar to the simple boiler, in that it operates under a constant efficiency. Chiller efficiency, also known as "coefficient of performance" (COP), is simply referred to in this report as "efficiency."

The electric consumption for the simple chiller is reported in the BUILDING / FAN / PLANT ENERGY UTILIZATION SUMMARY report under the appropriate electric consumption column. In addition, the electric consumption is reported in the PLANT EQUIPMENT ENERGY INPUT BREAKDOWN report under Electric Chiller. Noting that the chilled water pumps and cooling towers are simulated and reported, as they are for other chiller types.

Simple Boiler /Chiller Model Comments - Omaha

Comment 1. Define part load ratios. Part load ratios are shown in the input data as a major element in the boiler and chiller data; however, part load ratios are not well defined in the user's manual. Provide part load data for different types of boilers and chillers.

Response. This will partially be taken care of in the new documentation to be released in 1991. Definitions will be included and examples of some of the more common or widely used boilers and chillers will be included to give users a good feel for this type of data. However, due to the diverse range of equipment available, information regarding specific part load ratios will need to be obtained from equipment manufacturers themselves.

Comment 2. The manual should be simplified by putting equipment performance parameters instructions in a separate detailed advanced manual. Equipment performance parameters cannot be determined without part load performance curves and additional explanation of the parameters. BLAST is normally used in the design stage when the boiler and chiller manufacturer are not even known. Equipment performance parameter defaults would rarely be changed during most BLAST run preparations.

Response. Revised BLAST manuals will be released in the first quarter of fiscal year 1992 (FY92). The documentation will be separated into two manuals: (1) a quick reference manual describing program basics, and (2) a technical reference manual containing detailed program information. Also, the equipment default parameters are provided so that even during early stages of design, users may specify "generic" equipment and then go back and modify these parameters when more specific information is known. Previous studies may also serve as a source of information.

Comment 3. Guide specifications for boilers define boiler efficiency by effective radiant heating surface and capacity per cubic feet of furnace volume. Indicate in the user's manual how parameters and part load ratios would be affected by changes in effective radiant heating surface and furnace volume.

Response. Addressing questions such as this would require a detailed, in-depth study. This enhancement attempts to simplify input for the user, requiring a constant boiler efficiency that could be used for specifications. If this more complex input using effective radiant heating surface and furnace volume is truly needed, then this new enhancement request will have to be viewed by the BLAST Users' Group as well as the BLAST Sponsor (Headquarters, U.S. Army Corps of Engineers [HQUSACE)]).

Comment 4. Boiler inputs do not include induced draft or forced draft fans. Indicate how forced draft or induced draft fans would affect boiler parameters.

Response All else being equal, this has no effect on efficiency.

Comment 5. Boiler inputs do not consider whether controls are on/off, high/low/off or modulating. Indicate how control types would affect boiler parameters.

Response. Modeling boiler transients is probably beyond the scope of BLAST. There is no such thing as generic boiler "control types." Controls on each boiler are tuned to the type of fuel, the grade of fuel, and boiler design. In practice, boilers are further "tuned" to accommodate operator preference.

Comment 6. There is no option for selecting helical rotary screw or the new scroll compressors in the allowable equipment types for chillers.

Response. A Program Modification Request Form (PMRF) has been initiated to add these names; however, performance of any chiller is determined through the coefficients calculated by the Chiller program and input into BLAST. New name additions will require further default values obtained from users' or manufacturer's data for full implementation.

Comment 7. Some options for chiller allowable equipment types include: air cooled chiller, chiller, open chiller, reciprocating chiller. Some chillers meet all four options. Clarify how the equipment options are to be selected.

Response. The new documentation will explain how to select condenser and evaporator options, and then model the compressor performance with the Chiller program.

Comment 8. In accordance with Corps of Engineers Guide Specifications, compressors over 10 tons normally are provided with capacity reduction by cycling multiple compressors or unloading compressor cylinders. Capacity reduction down to 10 percent load is normal on rotary screw compressors. The BLAST program has no input provisions for capacity reduction.

Response. A PMRF will be initiated for this request.

Comment 9. There is no input provision for refrigerant types. Indicate how refrigerant types will affect input parameters. New refrigerants will be coming into use as chlorofluorocarbons are phased out.

Response. It is still too early to include information such as this in the BLAST Manual and Program. Millions of dollars are being spent in research each year in an attempt to answer this question. This type of material will be melded into the BLAST program as more concrete answers become available. As new refrigerants are phased into the market, manufacturers will determine equipment performance with new refrigerants, and then the Chiller program will be used to determine new coefficients.

Comment 10. The input and output of boiler and chiller data do not indicate losses due to distribution piping and loads due to heating and chilled water circulation pumping equipment. These loads and losses should be part of the BLAST input data due to the variety of plant location situations that could be encountered. BLAST output data does not clearly indicate losses of the boiler/chiller plant.

Response. This is currently accounted for as a "parasitic" loss. It could be easily split out as a "distribution loss" and will be given consideration as a future program modification.

Simple Boiler/Chiller Model Comments - Louisville

Louisville District did not provide any specific comments regarding this option.

B – Revised Review Summary Report

Research was performed using the BLAST program and field users to determine the needs of energy analysis reviewers.[1] A special report was included in the BLAST program to reflect those needs and to streamline the USACE energy review process. From the BLAST Review Report, the reviewer (or designer) can determine:

- if the correct U-values have been modeled
- if the correct occupancy patterns have been modeled
- if the windows, HVAC system, and controls are correctly modeled
- the calculated energy consumption on an annual basis for all zones, mechanical systems, and equipment configurations

[1] D. Leverenz et al., *Use of the Building Loads Analysis and System Thermodynamics (BLAST) Program To Review New Army Building Designs for Energy Efficiency*, Technical Report (TR) E-190/ADA134487 (U.S. Army Construction Engineering Research Laboratory [USACERL], October 1983); J. Amber, D. Leverenz, and D. Herron, *Automated Building Design Review Using BLAST*, TR E-85/03/ADA151707 (USACERL, January 1985).

- if there are any "unmet loads" that affect the results

- the design energy target (Btu/sq ft/yr) for the building

- if the analysis has been performed reliably, and what other BLAST reports may be needed for further information.

The Review Summary Report is a default report and is created whenever a BLAST deck executes an annual simulation.

Revised Review Summary Report Comments - Omaha

Comment 1. The weakest link in the BLAST system is the inability to confidently interpret output data. Report interfaces between sections should be clearly defined with descriptions provided in the user's manual that explains what is included and excluded in determining the output of each report.

Response. This has been addressed in the new set of manuals to be released in 1991.

Comment 2. Clarify the difference between fan system overheating and heating without demand in the AIR HANDLING SYSTEM COMPONENT LOAD SUMMARY.

Response. This has been addressed in the new set of manuals to be released in 1991, and also in a February 1991 *BLASTnews* article[2]

Comment 3. Define equipment load ratios as indicated in the EQUIPMENT PARAMETERS.

Response. This has been addressed in the new set of manuals to be released in 1991.

Comment 4. Define "SOLUSE" used in special parameters data for minimum tank temperature in EQUIPMENT PARAMETERS.

Response. Hot and cold development is under development. Solar storage tanks are a future project.

Comment 5. Design day energy budget figures are specified in units of 1000 Btu/sq ft. If 1000 Btu/sq ft/day were used, this would clarify the data for users not familiar with the output format.

Response. The proper units for energy budget figures, as recognized in all USACE criteria is BTU/SF/YR, that is, BTU consumption per square foot for a year. To change these units arbitrarily to a daily basis would defeat part of the purpose of this report. A PMRF will be generated to show the units 1000 BTU/SF/YR to aid user understanding.

Comment 6. Define AVE OPER RATIO used in design day EQUIPMENT USE STATISTICS.

Response. This has been addressed in the new set of manuals to be released in 1991. There is also a PMRF for enhancing this report.

Comment 7. The heading NO HEATING OR COOLING in the data entitled SPACE TEMPERATURES DEG. F is misleading.

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[2] Richard J. Liesen, "Interactions of Loads and Systems," *BLASTnews* (February, 1991).

Response. The heading refers to times in a zone when neither heating nor cooling is to be provided. The SPACE TEMPERATURES show what the temperatures will be in those spaces for those conditions. The purpose of this element is to illustrate to the designer/reviewer the implications of not heating or cooling. A further subheading on this item shows OCCUPIED and UNOCCUPIED.

Comment 8. The sums of the loads for the hot water, chilled water, and electricity from the AIR HANDLING SYSTEM AND COMPONENT LOAD SUMMARIES are slightly larger than building/fan energy demands shown in the BUILDING/FAN/PLANT ENERGY UTILIZATION SUMMARY. How system loads for chilled water and electricity could be higher than plant loads could not be explained. Clarification of how loads are determined is needed.

Response. This is a problem and will be looked into. Anomalies such as this should be addressed immediately when they arise by calling the BSO for assistance. The BSO may require Input/Output (I/O) files for their own analysis and will respond with answers. This was more than likely an individualized problem.

Comment 9. Specify the units of value for loads due to people in the SCHEDULED LOADS output data.

Response. This has been addressed in the new set of manuals to be released in 1991.

Comment 10. The user manual needs to be updated to provide information regarding the J.B. Pierce, KSU, and Fanger reports.

Response. This has been addressed in the new set of manuals to be released in 1991.

Comment 11. Energy Budget and Floor Area:

a. Energy Budget and Total Area: Energy Budget and Total Area are presented in various reports with all the values different. This is confusing to the experienced and especially the inexperienced BLAST user as to what the "bottom line" facility Energy Budget is. [For example:]

Building/Fan/Plant Energy Utilization Summary
Energy = 5.19E+03
Total Floor Areas = 3.78E+02

Review Summary Report
Total Floor Area (Adding all zones) = 3.672+04

Building Envelope Data
Floor Area of Building = 36720 sq ft

Zones Energy Budget
Energy Budget = 1.090+01
Zone Energy = 4.001+05

System Loads
System Energy = 7.031+05

Response. One of the specific reasons that the review summary report was created was to provide a means for a designer or reviewer to determine that the proper building had been analyzed. Therefore, seemingly redundant material may appear in the review summary report that would not be redundant if somehow something had been missed in the analysis. For example, not all zones may be conditioned and therefore zone loads would appear that are not included in system loads. What is probably needed to satisfy this comment is better documentation on the contents of the review summary report; as stated previously, this documentation is forthcoming.

b. [Budget Definition and Usage:] These differences in values and the usage of Energy Budget values [appear] in three reports, but all differently. [This] is very confusing and creates lack of confidence in report interpretation. [We] recommend [that the] Energy Budget only be used once in all reports, in the last report, and that the Energy Budget value be . . . defined [as] in Air Force ETL 87-4 and in the OCE Architectural and Engineering Instructions (AEI).

Response. Again, the purposes of the several budget information displays in the review summary report is to provide, at a glance, a chance for the designers or reviewers to be assured that the proper analysis has been done. The energy budget value, in each instance, is calculated as specified in the Air Force or Army criteria. However, the "bottom line" energy budget is usually assumed to be the TOTAL BUILDING ENERGY BUDGET that appears on approximately the last line of the report. Because BLAST is quite flexible and allows a user to study several options such as different equipment to meet the fan system and other loads, a user may choose to study several PLANT options in a single BLAST run. In that case, one of the PLANT ENERGY BUDGET lines would truly be the proper BUILDING ENERGY BUDGET. The user can control this by formulating the simulation so that the bottom line energy budget figure represents the building in its entirety or can save some simulation time by checking out several plant options before deciding on the final building configuration. It does not seem effective to require BLAST to try to guess what the user is intending in the simulation nor does it seem effective to restrict users to entering just a single building configuration in BLAST.

Comment 12. Building/Fan/Plant Energy Utilization Summary. Recommend changing heading over report from BUILDING/FAN ENERGY DEMAND to BUILDING/FAN ENERGY CONSUMPTION. Values are in 1000 Btu and would appear to be total energy consumed. Use of the word "demand" implies the peak value.

Response. DEMAND is not meant to imply peak value; however, a PMRF can be initiated to make this change. It should be clarified that CONSUMPTION includes system efficiencies, and DEMAND does not.

C - Expanded Baseboard Heat Options

The Thermostatic baseboard heat option has been changed to increase the flexibility and usefulness of the model. The baseboard heat option in the fan specifications data block can now be used with any of the BLAST fan systems. Additionally, the new model allows the baseboard heater to provide heat to a zone without turning on the system fans.

Where available, the baseboard heater will supply heat to reduce or eliminate any unmet load or overcooling load generated by the system. When used in conjunction with a heating or reheat coil, baseboard heat acts as a supplementary heat source that is independent of air flow, hot deck temperature, or reheat temperature limit. It can also be used as a zone's sole heat source. If baseboard heat is available and the system is off, a heating load will not turn the system on. The baseboard heater will attempt to meet the load without operating the system. If the baseboard heater capacity is insufficient to meet the load, an unmet heating load will be recorded.

No District selected this option for evaluation.

D – Forced Ventilation

Description

The Forced Ventilation option is a modification of the Ventilation statement. Forced Ventilation allows for the modeling of electrically powered ventilation fans. When there is forced ventilation in a zone, the electrical load due to the fan blowing air in or out of the zone is accounted for. Parameters associated with the fan equipment may be specified. This option can be used with the new thermal comfort models to examine the effect of forced ventilation on comfort, as an alternative to mechanical cooling.

Forced Ventilation Comments - Sacramento

Comment. Problems were encountered in trying to use the Forced Ventilation enhancement. The Sacramento District attempted to model a building that uses forced ventilation (i.e., exterior air) as its primary source of cooling, but mixes it with return air. It was impossible to control an interior space to a specific temperature with exterior ambient conditions and return air. Although exterior air may afford cooling potential, it was impossible to specify the exact cooling capacity of an indeterminate cooling source. The deficiency of the program to model this type of system is something that should be examined. Cooling with exterior air is a viable option in many climates and one energy conservation strategy.

Response. BLAST 3.0 does not have a feedback mechanism between fan systems and the loads modules of the program; thus it is impossible to represent an indeterminate cooling source. However, this will be possible with the new version of BLAST presently being developed as part of the Research, Development, Test and Evaluation (RDT&E) project "Integrate and Standardize Energy Analysis Programs."

E – High Intensity Radiant Heating

Description

One new mechanical system type incorporated into BLAST is a high intensity radiant heating system. The radiant heaters that can be modeled are high-temperature gas or electric heaters that give off a component of directional infrared radiant heat. These heaters are not to be confused with low-temperature radiant heaters, which include heated floor slabs, old-fashioned radiators, and any other warm source that does not give off a directional component of radiant energy and heats primarily by convection to the air. The BLAST syntax can be written to model many types of high-intensity radiant heating systems. Heaters can be described as either scheduled or temperature-controlled.

High Intensity Radiant Heating Comments - Omaha

Comment 1. A programming problem was encountered when defining a scheduled gas-fired radiant heater using the radiant equipment schedule. A severe error indicating "key name not found" and "percent not allowed for rad. equip." appeared in the printout of the input file. The BSO indicated the word "heat" must be inserted after "percent radiant gas" in the percent total capacity statement of the input file. This was done and the program worked correctly.

Response. This was a BTEXT problem and has since been corrected.

Comment 2. The BLAST High Temperature Radiant Heater Model Users Guide was reviewed. Recommended clarification comments are as follows:*

1. In the paragraph "Specifying and Controlling Radiant Heaters in BLAST," the second sentence should be clarified. The Other Equipment file is shown as an Other Loads file in the program being used. The radiant equipment selection is made in the Scheduled Loads file and not in the building description as implied. The last part of the sentence between "specified" and "by" the following should

Response. The second sentence does need clarification; the suggested addition to the sentence will be included.

2. In the paragraph "BLAST Syntax for Specifying Scheduling Radiant Heaters," the USN1 description should be clarified by adding the statement "kW units shall be used when using the SI System."

Response. The BLAST documents are currently being updated and the new text should clarify issues such as this.

3. In the paragraph "BLAST Syntax for Specifying Temperature Controlled Radiant Heaters," the second sentence could be clarified by adding "in the scheduled loads file" after "CONTROLS statement."

Response. This addition may serve to confuse users, since there is no "scheduled loads file." However, this section will be reviewed to assure clarity.

Comment 3. USN2 of the scheduled radiant heater definition (USN4 of the controlled radiant heater) is a concern. Radiation generation ratios needed to determine the percent capacity radiated are not available from manufacturers' literature. Typical figures for percent of total capacity for different types of equipment should be provided.

Response. The ASHRAE Equipment Handbook[3] contains this information and will be referenced in the revised documentation.

Comment 4. "Latent Loads" need better definition. Latent loads in HVAC work usually mean loads due to moisture changes. Clarify the definition of latent and provide guidance for determining the latent load loss when using radiant heat.

Response. Latent load loss is not determined by the user but is rather a characteristic of the radiant system being modeled. The BLAST user should use manufacturer's specifications for these parameters.

Comment 5. Clarify and provide guidance for determining the percent of total capacity that is lost. This could be interpreted as heat lost through flues; however, a 10 percent loss is shown for electrical radiant heating in examples.

Response. Again, this information is a characteristic of the system being modeled and will change from one manufacturer to another. This type of data should be obtained from the manufacturer and not the BLAST manual.

* Since the submission of these comments by the Omaha District, the Radiant Heat manual has been updated.

[3] *ASHRAE Equipment Handbook* (ASHRAE, 1988).

Comment 6. Provide examples of when the radiant flux factor should vary from 0.0005 or provide more information for calculating radiant flux factors such as how view factor Frh-p is determined and the units of value for Aeff.

Response. These parameters are completely dependent on users' zone geometry; therefore, more examples, information, and guidance will be provided in the new release of the BLAST program user's guide to help users calculate these values for themselves.

Comment 7. The USN3 description of the controlled radiant heater input needs revision. It is not clear whether input is to be comfort mean radiant temperature, effective temperature, or mean air temperature. Clarify whether effective temperature is an input or calculated by BLAST. The input file printout indicates a percent MRT. Percent MRT is not defined except in the discussion of the temperature controlled radiant heater example.

Response. Percent MRT is only defined in the discussion regarding temperature controlled radiant heaters because this is the only type of radiant heater that it applies to. The scheduled radiant heater is controlled by a schedule; thus MRT is irrelevant to a scheduled radiant heater.

Comment 8. The "view from person" parameter should be further reviewed to determine if it is a useful input. Radiation energy from people would be low in energy and not usually directed towards any surface.

Response. View Factors allow energy to flow in both directions. They thus define radiant exchange from surfaces to person and person to surfaces.

Comment 9. There should be an indication of view factors in the printout of input or output data.

Response. The printout of the input deck does contain this information assuming the user supplied it. Output reports will be reviewed to see about clarifying this information.

Comment 10. Indicate that zero to 1 used in view factors indicates zero to 100 percent of the radiant heat energy directed at a surface or change input using the form of zero to 100 percent.

Response. The standard format for specifying View Factors is zero to 1. The new documentation will clarify that this refers to zero to 100 percent.

Comment 11. When specifying radiant equipment the basic zone load report does not specify any loads for total radiant heater load and peak radiant heater load. Clarify what these columns signify if not for radiant heaters.

Response. A PMRF has been initiated to clarify this.

F – Comfort Reporting

Description

The BLAST program was recently enhanced to include three popular thermal comfort models. These models were developed by P.O. Fanger, the J.B. Pierce Foundation, and the researchers at Kansas State University.[4] All three apply an energy balance to a fictitious person in the space being modeled.

[4] For a discussion of these three models, see: ASHRAE Standard 55-81, "Thermal Environmental Conditions for Human Occupance" (ASHRAE, 1981).

The energy exchanged between the zone and its occupants is used, along with empirically derived physiological parameters, to predict the thermal sensation and the physiological response (or satisfaction) of a person due to environmental conditions. This is a powerful tool in that it appraises numerous parameters that affect occupant satisfaction with their surroundings rather than focusing only on air temperature. Furthermore, it allows the designer to model various design options and mechanical operational strategies to assess how these would affect occupant comfort without ever having to dedicate anything more than computer time and effort.

Comfort Reporting Comments - Sacramento

The Sacramento District attempted to model the comfort conditions inside a building that uses forced ventilation as its primary source of cooling but mixes it with return air. Problems were encountered however in trying to use this model for such a situation. It was impossible to control an interior space to a specific temperature with exterior ambient conditions and return air. The present program's inability to model the mechanical system of the building makes it impossible to perform an effective comfort analysis of the interior spaces. BLAST 3.0 does not have a feedback mechanism between fan systems and the loads modules of the program; thus it is impossible to represent an indeterminate cooling source. This will be possible with the new version of BLAST presently being developed as part of the RDT&E project "Integrate and Standardize Energy Analysis Programs."

The comfort reporting enhancements were used successfully for a study conducted at USACERL that analyzed the comfort conditions in a new facility that was experiencing problems. This facility had a much simpler mechanical system than the Sacramento facility and could be effectively modeled in BLAST. In this instance, the comfort reporting enhancements allowed the researcher to evaluate various building modification options and determine their effect on occupant thermal comfort.[5]

G - PC 386 Version

Description

In April 1989, a version of BLAST and its associated programs that ran on 286 and 386 PCs was released. This was a full implementation of BLAST, which was identical to the mainframe and workstation versions. This new version of BLAST has a menu-driven interface that helps users run BLAST and other programs included in the BLAST family of software. The interface also includes its own editor. The intent was to make BLAST available and easy enough to use for individuals unfamiliar with DOS. There is no longer a need to learn a complex operating system just to run BLAST.

In general, every participating district that used BLAST on a 386 PC was pleased with its performance on this new platform. There were also many suggestions for improvement on the user/program interface, the program itself, and the output.

Many aspects of the new PC 386 versions of BLAST and BTEXT were opened to evaluation. The Appendix contains the questionnaire provided to the Mobile District as guideline to evaluate the PC 386 version and to perform a side-by-side comparison with another commercially available energy analysis program.

Note that the respondents' prior experience with BLAST is reflected in the tone of the responses. Respondent No. 1 is an avid BLAST user and provided constructive suggestions for perceived deficiencies. Respondent No. 2 appeared to be a novice to computers who maintained a critical tone

[5] R. Nemeth, L. Lawrie, *Thermal Comfort Modelling Using BLAST—A Case Study*, Draft TR E-91/12 (USACERL, September 1991).

throughout the comments and responses; this actually limited the number of positive suggestions that could be drawn from the second commentary. A summary of the questionnaire responses follows.

PC 386 Version Comments - Mobile

Question #1. Was installation simple; what problems were encountered; and what suggestions can you make for improvement?

Answer #1. Installation was simple and straightforward and took approximately 15 minutes, including customizing initialization files. Installation instructions were clear and concise. No suggestions for improvement. Problems were encountered when trying to load BLAST onto a MicroExpress 386. For some unknown reason the BLAST program was never able to run on this particular brand of computer.

Response. This installation snag was later diagnosed as a hardware problem. An older series Intel 80386 "B" series chip was replaced with a "D" Series chip and the program ran successfully.

Answer #2. Instructions were not as clear as they could be. Installation took approximately 4 hours to get BLAST system set up so that the test files could be run without having to reconfigure. Suggest that the installation setup be revised to: (1) prompt for each disk insertion by number, (2) automatically load the program configured to run the test files, and (3) go straight from installation to test runs, and allow for custom configuration after the program is installed and tested. Had problems understanding what was meant by "working directory" during the installation. The Trane Trace 600 design simulation program was used as a comparable program and installation took approximately 2 hours.

Response. Note that respondent No. 1 considered himself an "expert" BLAST user while respondent number 2 considered himself a "trained" user. Respondent No. 1's extensive prior knowledge of the inner workings of BLAST could have contributed to the apparent ease of installation. Moreover, any program installation depends on a good working knowledge of the disk operating system (DOS), its directory structure, and its conventions.

Question #2. Mobile participants were asked (1) to use BTEXT, the BLAST Text Preprocessor, to construct an input deck for a building of their choice, and to analyze the building using BLAST; (2) following the BLAST analysis, to input the same building with another commercially available energy analysis program to compare the two programs for ease and speed of input, flexibility, and preference; and (3) to form suggestions for improvement.

Answer #1. [Respondent No. 1 modeled a 13-story Aircraft control tower. The response was:]

1. The input process for a 13-story aircraft control tower took approximately 1 hour, 35 minutes, and problems were encountered. However, these problems may have been a result of the computer [platform] being used and not the program itself. Problems were:

a. BTEXT did not create a "bin" file until both an annual and design day were selected from the BTEXT menu.

b. BTEXT locked up and the computer had to be rebooted. A "bin" was created; however, the file was empty.

c. On a second attempt, a "bin" input file was created, but the system and central plant portions of the input were missing, even though the information was contained in the database. A third attempt created a complete BLAST input deck.

[In reference to the] BLAST Library, . . . most of the construction assemblies required for the facility were contained in the BLAST library, and those assemblies that weren't, were easily created.

2. The Carrier HAP program[6] was used as a comparable energy analysis program and input of the same building required approximately 1 hour and 15 minutes. No problems were encountered. I prefer using BTEXT for the following reasons:

a. I find the menu structure on Carrier HAP to be "clunky" in its flow. For example, before a new space is input, the previously defined space must be saved to the hard disk before you can proceed with the next space.

b. The level of detail that can be entered in Carrier HAP is very limited (probably a lot of simplistic assumptions being made).

c. The level of detail option in BTEXT is useful, enabling the user to match input complexity to building complexity.

d. I like the ASCII format of the input file created by BTEXT. This enables the designer to see the input file and modify it as necessary.

e. The information required for input to HAP differed little from that required for the BLAST input.

3. [Suggestions for improving BTEXT are:]

a. Have the capability to save the BLAST input file at any time and at any point inside the BTEXT program.

b. Have the capability to pop up a window at any time to view the actual BLAST input deck at that point in time and then return to BTEXT.

c. Have pop-down windows that contain the various menus. Inside each menu window the user could make choices by moving a highlight bar over the choice or by hitting a highlighted key in a short descriptive phrase for selection.

d. Have full mouse support for running BTEXT.

e. Show areas in the zone description/ surface definition as "gross area" in lieu of "area" as is currently shown.

f. [Have the] ability to retrieve, or save and exit the database at any point inside BTEXT.

g. Allow BTEXT to take any first entry in response to a menu question and retain this value for all subsequent entries until changed by user.

h. When selecting a wall code show on the screen something like "Wall code <EW> (Esc to exit)". By hitting Esc key the user would jump back to the surfaces menu. <EW> [would be] the default value until changed by the user.

[6] The *Hourly Analysis Program* (HAP) is a product of Carrier International, 1133 Avenue of the Americas, 19th Floor, New York, NY 10036.

i. Improve the way BTEXT creates hourly schedules. The 07 to 16-1.0, 16 to 07-0.0 format [is] much better.

j. Give users the capability to configure BTEXT with various color options instead of the black and white as currently done.

k. The BTEXT program should be . . . [updated] to provide enhanced capabilities for on-line database file storage and retrieval, default value capabilities, and the ability to see more menus on the screen at one time and to . . . step back to any previous menu.

Response. An effort is underway to completely redesign the BTEXT input preprocessor. The "Smart Editor" will address all of the following issues. For this reason, they are not commented on individually.

Answer #2. [Respondent No. 2 modeled a one-story, training/telecommunications facility. It was a rectangular building that was described as having nine zones. The response was:]

1. It took approximately 36 hours to get a BLAST input deck that gave me the correct building load.* There are two main problems with the input process:

a. First, BTEXT is the most frustrating method I have ever encountered for input of data into a design program. I was expecting an improved method to the one I learned approximately 3 years ago. I was very disappointed. There has been little improvement. The scrolling menu entry is very time consuming and lends itself to data entry errors. The fact that a user has to stop displaying of entered data with "control S" is archaic. In addition, to simply change some wall types from exterior to partition, you must find out which exterior wall it is, then delete it and add a new partition. This is very time consuming. Commercial programs today use the spreadsheet entry format. This allows the user to see and change all the data in logical groups at one time.

Response. There is currently a new version of BTEXT in developmental stages which will address all of the above complaints.

b. Most commercial programs will not allow you to create an input deck if there is insufficient or conflicting information. And once you finish a BTEXT input you still have to edit the input deck with a text processor. For this project I used BLAST library assemblies to reduce time spent.

2. As a comparable program, I used the new Trane Trace 600 design/simulation program. My training and experience with this program is equivalent to the BLAST program. I felt using this instead of the Carrier HAP program, which I have used extensively for 3 years, would provide a fair evaluation. It took approximately 3 hours to input the building data.

3. My suggestion is not to try to improve BTEXT, but to replace it with a modern, user-friendly, manual input interface.

Response. BTEXT is currently being replaced.

Question #3. Following the input process for describing the buildings to their respective programs, respondents were asked to perform a design day and annual simulation with each program, record the amount of time that these took to execute, and report any problems encountered.

* Note that a 36-hour input time for a nine-zone, single-story building is highly unusual, and may indicate basic procedural problems external to the program itself. A misunderstanding of how to use BTEXT could be the cause of this greatly extended input time.

Answer #1. My BLAST design day run took about 1 minute and 15 seconds (on the Dell). I encountered no significant problems in executing the design day run. However, with the Carrier HAP program there is no clear-cut option for a design day run due to the program configuration. Most users accept a range of default time and date values for calculating maximum heating and cooling loads and maximum system demands. I encountered no problems during this run.

The annual BLAST simulation took approximately 11 minutes. I had some syntax errors that were the result of using my external editor on the input file. Additionally, I had some overlapping heating and cooling with a two-pipe fan-coil system I had modeled. The annual simulation with the Carrier HAP program took about 20 minutes to execute all of the required subprograms to produce an annual simulation, and I encountered no problems with this procedure.

Answer #2. It took approximately 8 design day runs before I was able to get a BLAST input deck [that] gave a cooling load at approximately the correct tonnage. It took approximately 2-1/2 minutes to execute a design day run. Problems were resolved by repeating runs and searching through the BLAST documentation for needed corrections. The resolution to input problems is to keep working on the input deck until you get a reasonable answer. The BLAST annual simulation took approximately 30 minutes to execute. The main problem was not being able to run the annual simulation while networked.

The Trane Trace program took approximately 2-1/2 minutes to execute a design day run. I entered an incorrect amount of outside air for one zone, revised it and ran the program again. The input then required 1 additional hour to add information for the annual simulation. The annual simulation calculations took 1 hour and 40 minutes. No problems were encountered with the annual simulation. Without question, the Trane Trace program was the best program.

Response. Most network problems have been overcome. What remains unclear after this answer is how this user already knew the correct answer before running both programs. If he ran the commercial program first and assumed that its answer was "correct," there could be no objective comparison between the two programs. In other words, a simple difference in output between the two programs cannot show which program is correct.

Question #4. Following the execution of the design day and annual runs, participants were asked to analyze the output from each run and provide an assessment of program output.

Answer #1. I have found the design day and annual outputs provide an abundance of information that allows the user to make intelligent decisions, with a high degree of confidence, regarding design choices associated with Army and Air Force in-house design projects. The annual and design day outputs provide many detailed reports which, as an experienced BLAST user, I like to see. At this time I feel that both of the Design Day and Annual reports are quite adequate for design purposes.

The output of the Carrier HAP program in my opinion barely meets what I would consider useful for design purposes. Additional supplemental reports on system components, such as annual usage of fan energy, chilled water, hot water, and steam coils would be an improvement.

Once I became familiar with the output reports, I found the BLAST output easier to interpret. Due to the specificity and multiplicity of reports in the output, an interpretation of one report can usually be verified by an interpretation of a different one.

Answer #2. The design day BLAST output is too hard to read. A designer wants bottom line [information,] peak sensible load for each space, and a recap of room and coil loads for each coil. BLAST output is just not structured for design. Simple output as given in typical ASHRAE load calculations. For annual simulation, again, a simple short output is all that is needed. The use of scientific notation must be abandoned to become a design tool.

The Trane Trace 600 output for design gives all the information required. Please note I requested all the reports the program could give. The lack of bulk helps to find the information needed. I don't have to wade through 20 times the information to find what I need. A simple review of both outputs is all that is needed to verify that Trace output is easier to interpret.

Question #5. Participants were asked which program they would select given the choice and why.

Answer #1. Given a choice, I would select the BLAST program. The BLAST program allows for very complex building geometry; HAP does not. BLAST allows complex scheduling of fans, coils, and central plant seasonally, hourly, or by temperature; HAP does not. BLAST provides zone minimum and maximum temperatures; HAP does not. BLAST provides monthly data on all coils specified; HAP does not.

Carrier HAP has placed more emphasis on detailed breakdowns of cooling and heating loads in lieu of detailed system or plant loads. For an "energy analysis" program I think this is the wrong emphasis. I think that one of the best advantages BLAST has to offer over HAP is flexibility. Flexibility with scheduling, building description, systems definition, and plant definition. I think that "ease of use" usually compromises quality of output, particularly if "ease of use" means as "soon as possible." While I think that Carrier HAP is easier to use, the difference is not great enough for me to use HAP on a consistent basis. Comparing one to the other, my effort is better justified when BLAST is utilized.

Answer #2. I would select the Trane Trace program. I believe a designer is less likely to make a sizing error due to complex and difficult input. I can find what I need for design much easier in the Trace output. I don't trust the results obtained from a BLAST run for design. The program is so difficult and time-consuming to use that the chance for error is too great. Which is better, to get a result that is always in the ball park or one that is exactly right to 6 decimal places if you can (or most probably happen) [to] get all the inputs correct.

Question #6. Participants were asked if the new interface to BLAST (DoBLAST) was convenient and user-friendly.

Answer #1. I find the interface to BLAST to be convenient and user friendly. There are two improvements I would suggest. I would like to start the interface and execute any of the programs from some of the various menu programs that are commercially available such as "Direct Access," to name one. Secondly, I would like the capability to allow DoBLAST users the option to specify an external editor of their choice in lieu of the canned editor available with DoBLAST (Norton™ *Commander* contains this feature).

Response. Currently, BLAST and its associated programs are executable from many commercially available menu programs, and many external editors can now be used with DoBLAST. The BSO should be contacted if there are any questions or problems regarding this.

Answer #2. Actually no. The DOBLAST interface is the only program I have which does not work with my main menu program "DIRECT ACCESS."

Response. DOBLAST has been changed to accommodate menu programs. It has been tested with several of the popular menu programs: *Automenu,*™ *WordPerfect* Office, and others as could be found. Hopefully, "DIRECT ACCESS" has been addressed by this change.

Tables 2 to 5 show responses taken directly from the two questionnaires returned from Mobile District. The significant difference in how these two participates responded to these questions discloses their personal attitudes towards the BLAST program. The expert user is a strong advocate of BLAST, and the trained user dislikes the program.

Table 2

Program Selections of "Expert" Users

For what reason do you currently use:	BLAST	Other Program
1. Determine peak heating and cooling loads		XXXX
2. Determine energy budgets	XXXX	
3. Study building/site orientation	XXXX	
4. Study envelope alternatives		XXXX
5. Study mechanical system alternatives	XXXX	
6. Study equipment alternatives	XXXX	
7. Study boiler/chiller alternatives	XXXX	
8. Other - describe*		

Table 3

Program Selection of "Trained" Users

For what reason do you currently use:	BLAST	Other Program
1. Determine peak heating and cooling loads		XXXX
2. Determine energy budgets		XXXX
3. Study building/site orientation		
4. Study envelope alternatives		XXXX
5. Study mechanical system alternatives		XXXX
6. Study equipment alternatives		XXXX
7. Study boiler/chiller alternatives		XXXX
8. Other - Describe*	XXXX	

* Model building we have had problems with.

Table 4

Program Ratings of "Expert" Users

Selection	Program	Easy				Hard
User/Program interface	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Time Requirements	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Level of detail required	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to correct mistakes	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to input building geometry	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to input mechanical systems	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Support	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
User Manual/Documentation	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Other - Describe*	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5

*"Fine Tuning" (Equipment scheduling, etc.)

PC 386 Version Comments - Louisville

Question #1. Was the effort to use the PC-Workstation environment more or less expensive and manpower intensive than the normal usage of BLAST on the Harris environment?

Answer. The effort in using the PC environment is less due to response time using the equipment, [than to] the added cost in storage and processing time, which is added to the labor. When the Harris is significantly utilized, data entry is definitely slowed. Of course, when you have complete control over both the computer and the printer, then entry and utilization become more cost effective, and no additional costs are added to the labor. No actual costs were obtained.

Question #2. Was the time necessary to learn the PC - Workstation BLAST operation justified by the benefits received? For example, was better information obtained from the BLAST studies or was the control of the hardware environment more reliable?

Answer. The obvious answer is yes. Time spent in learning the system and the operation of BLAST definitely enhances the use and speed of the operator. Control of the hardware allows a faster response to the design questions because there are no other priorities for the equipment, so solutions and output can be rapidly obtained.

Table 5

Program Ratings of "Trained" Users

Selection	Program	Easy				Hard
User/Program interface	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Time Requirements	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Level of detail required	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to correct mistakes	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to input building geometry	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to input mechanical systems	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Support	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
User Manual/Documentation	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Other - Describe*	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5

*Desire to use

<u>Question #3.</u> List features you liked and disliked.

<u>Answer.</u>

<u>Likes:</u>

Input real conditions
(Actual construction)
(Actual weather data)
Can vary construction materials
Can standardize inputs
Control of program
Control of computer
Summary reports

<u>Dislikes:</u>

Input time required
Unfamiliar with library
Need modified library
Many variables
Making architectural changes
Present massive output

<u>Response.</u> A PMRF will be initiated to reduce the number of default reports.

<u>Question #4.</u> Is special training required to assist the user in learning this environment? What form should it take?

<u>Answer.</u> No special training should be required for a person with some computer literacy, or for someone who has some knowledge of HVAC systems.

Question #5. Was the users manual documentation of the environment sufficient to describe how the environment should be used? What improvements should be made?

Answer. The users manual is adequate.

Question #6. Can A/E designers easily pick up on this environment?

Answer. A/E designers should have no problem in using BLAST. Some minor assistance may be required, but it really is relatively easy to use.

Question #7. Would there be a better way to represent the results of the BLAST study for this new environment? For example, should we retain the current BLAST output reports or should a new kind of result output be formulated?

Answer. There is a much better way to handle the output. Unlock the standard reports and allow each user to determine which reports are needed. With all of the file viewing programs available now, there is really no need of such a massive printing job for each run. The paper savings alone would be significant and could justify the change. It would appear that if a shorter output report like some of the commercial packages have, there would be a greater degree of acceptability for the BLAST program.

Response. A PMRF has been initiated to unlock the standard reports to allow the user the option to specify which reports to print.

Question #8. Should less extensive output reports be used in hard copy in the future and should greater dependence on the graphic capabilities of the PC - Workstation environment be used for BLAST?

Answer. Hard copy reporting is a difficult problem. Data is wonderful and yet is a curse depending on whether you want it or have it or not. In a production situation such as the CORPS is going towards, massive output is not really desired. However, if there is a problem in that you have to have the information to correct the situation. The easiest answer seems to be as described above.

Question #9. Is this environment ready for general release or must further work be done?

Answer. Even though PC BLAST is obviously considered by USACERL to be ready for release, it could be made better with some of the modifications suggested above and it could be improved even more with local modifications and changes input which will be implemented in the near future. BLAST is a wonderful tool to use for HVAC, without question. There is no other HVAC program that will allow the input of actual materials as they appear in the existing structure. Therefore no other program can be used for retrofitting existing structures. There is only one other program that can perform an hour by hour heat transfer analysis without using the BIN method. There is only one other program that uses an energy balance to perform heat transfer calculations. These factors alone put BLAST in a relatively exclusive category. However, in a production environment, BLAST is somewhat more difficult and time consuming to use than some of the commercial programs available. There have been great strides made in the ease of use in just the last four years.

Question #10. Do you feel it will be worthwhile for your FOA* to use this new environment?

Answer. In order to participate in some of the military programs, this FOA must use BLAST. As mentioned above, BLAST alone is necessary for retrofitting. BLAST is the only program that can be used for passive solar studies, which is required on military housing projects. Without a doubt, there are

* U.S. Army Corps of Engineers Field Operating Agency.

other situations on the horizon that will require the use of BLAST. Yes, this FOA must continue to use BLAST, but maintain proficiency in other programs also.

PC 386 Version Comments - Omaha

One difficulty experienced was the inability to scan through a BLAST output file without first printing out a hard copy of the entire file. It is possible to scan back and forth through small output files with the use of the BLAST editing program; however, this program has insufficient memory capacity for most output files. If specific reports or specific sections of a file could be printed out, this would save a lot of time and paper during the phase of BLAST use when input files are being edited and revised.

H - PC 286 Version

This is simply a version of BLAST that has been compiled to run on a 286 instead of a 386 PC. There is no difference except that it is slower than the 386 version.

No District selected this option for evaluation.

I - Evaporative Cooler Model

Description

An evaporative cooler model has been developed for BLAST. This model presently has three configurations:

1. Single-stage direct evaporative cooler
2. Single-stage indirect evaporative cooler
3. Two-stage evaporative cooler, indirect/direct.

The model will allow evaporative cooling to be specified alone or as part of all fan systems except the 2- and 4-pipe fan coils and the unit heaters. The evaporative system needs a fan system that has a mixed air box to function. To use the evaporative cooler model, flow and geometry information are needed. The output reports that can be used to analyze the performance of the evaporative coolers are: (1) the Evaporative Report, and (2) the Humidity Report. They can be added to the Reports statement in the BLAST input file and the reports will appear in the Fans System Section of the output file. The output reports can be used for both design day and annual runs. The humidity report can be run for any fan system and can also be used without an evaporative cooler specified.

Evaporative Cooler Model Comments - Fort Worth

Question #1. On what type of computer did you run this program on?

Answer. PC-BLAST 386 Level 129E on ALR FlexCache 25386 and 3COM LAN

Question #2. What is your experience level with using BLAST? Was this your first time to try the enhancement? If no, how many times (approximately) had you used the enhancement before?

Answer. I have used BLAST for 13 years. This was my first experience with the BLAST evaporative cooling model.

Question #3. Project description?

Answer. Administration Building, Fort Bliss, TX.

Question #4. Did you need to call the BLAST Support Office (800-UI-BLAST) for further clarification before or during using this enhancement? Was the call beneficial?

Answer. I did need to call the BLAST Support Office for clarification on several items. All questions were answered promptly.

Question #5. Explain any problems you encountered:

Answer. Mirrored zones change convective to radiant heating resulting in consumption of natural gas instead of boiler fuel. The Humidity Report Chilled Water Demand column title is confusing (demand or consumption?). Annual Plant Loads Not Met report format [is] used for design day runs. [There is] no detail[ed] documentation as to relationship between typical design values (peak sensible zone cooling, air volume flow rate, etc.) and required evaporative cooling input parameters.

Question #6. List suggested changes or additions to improve the enhancement or related area to the enhancement:

Answer. Include detailed documentation as to relationship between typical design values (peak sensible zone cooling, air volume flow rate, etc.) and required evaporative cooling input parameters.

Response. This type of information will be included in the new BLAST Manual documentation.

Question #7. *Is this enhancement applicable to Corps designs? Should there be other factors* considered for this enhancement in Corps designs?

Answer. This enhancement is definitely applicable to Corps designs. It should be stressed that this evaporative cooling model is not for standalone equipment only applicable to certain weather areas, but has widespread applicability as a supplement to conventional cooling equipment reducing equipment size, loads, and energy consumption.

Question #8. Please provide background on the projects selected for study (e.g., type of building, location), and on the total studies done.

Answer. Direct and indirect-direct evaporative cooling studies for 3.6, 7.5, 15, and 30 air changes per hour versus a conventional three-deck multizone fan system with return air economy cycle in combination with a water cooled chiller, an air cooled chiller, and a direct expansion unit for the Administration Building at Fort Bliss, TX, were accomplished.

Question #9. Are these typical projects for your FOA, are they unique to this fiscal year, or were they improbable samples used to study an enhancement?

Answer. Project was fictitious, but typical of those at Fort Bliss, TX.

Question #10. Were the actual designs done in-house or contracted? Was BLAST used as the principal energy analysis study technique?

Answer. Project was never designed. Study was performed in-house. BLAST was the only energy analysis study technique.

Question #11. Was the information needed to model the new enhancement readily available or was extra effort required on the part of the designer to be able to build BLAST model (e.g., did manufacturer's data have to be collected)?

Answer. Information was readily available and no extra effort was required.

Question #12. If extra effort was required, could this just be part of a learning curve and wouldn't have to be repeated for each study?

Answer. No extra effort was required.

Question #13. Was the time necessary to learn how the enhancement works justified in the information gotten from the BLAST study?

Answer. Information obtained was unique and invaluable.

Question #14. How did perceived or measured accuracy of the results compare with current practice?

Answer. Heretofore, it has not been possible to analyze evaporative cooling as a supplement to conventional cooling equipment.

Question #15. Is the enhancement well explained in the documentation or were "tricks" necessary to get the proper results?

Answer. Are there any constraints on the inputs that should be noted to future users? Only rough draft documentation [is] presently available. Detailed, well written documentation must be made available.

Response. Detailed documentation will be incorporated into the new BLAST manual.

Question #16. How comfortable are you with the output from the enhancement? Does the output provide good information for the designer?

Answer. Output is great. Information is unique and invaluable.

Question #17. What are the best modeling techniques necessary to make full use of this new enhancement?

Answer. Evaporative cooling unit as supplementary to conventional cooling equipment.

Question #18. Please list features liked and disliked. Prioritization of refinements that would improve the enhancement:

Answer. For designing standalone evaporative cooling, include documentation as to the relationship between design values and input requirements.

Question #19. Is special training required to assist the user in learning this enhancement? What form should it take?

Answer. No special training is required. Simple but detailed, well written documentation must be made available.

Question #20. Was the user's manual documentation of the enhancement sufficient to describe how the enhancement should be used? What improvements should be made?

Answer. Only rough draft documentation [is] presently available. Detailed, well written documentation must be made available.

Question #21. Can A/E designers easily pick up on this enhancement?

Answer. There is no reason A/E designers cannot pick up on this enhancement.

Question #22. Quality of the output:

Answer. Very good.

Question #23. What is the best way to represent the results of the study for this new enhancement?

Answer. BLAST Newsletter stressing importance of supplemental role of evaporative cooling.

Response. The results of an extensive study using this enhancement were also presented at the 1991 summer American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) Symposium in Indianapolis, IN, and were in the June and July issues of *BLASTnews*.

Question #24. Is there some item missing from the output that is necessary to provide further information to the designer or reviewer? Is there too much information?

Answer. Information provided is quite satisfactory.

Question #25. Is this enhancement ready for general release or must further work be done?

Answer. Enhancement appears to be ready, however, documentation is not.

Question #26. Do you feel that it was worthwhile for your FOA to study this new enhancement?

Answer. Study was very worthwhile.

J - Expanded Humidity Reporting

Description

During system operating hours, the System Humidity Report provides relative humidity and humidity ratio date for each zone. When the fan system is not operating, the humidities in the zone are undefined. The maximum and minimum humidities, the month, the day and hour are reported. The humidity report can be run for any fan system.

Assuming that the fan system operates during all occupied hours, this report provides a means to observe humidity levels and determine if they are within an acceptable range.

No District selected this option for evaluation.

Expanded Humidity Reporting Comments - Mobile

Question #1. Was the deck easy to modify for humidity reporting? If not, what problems did you encounter?

Answer. The input deck was very easy to modify for humidity reporting. I encountered no problems.

Question #2. If you were to use BLAST for design, is this an option that you would use?

Answer. This is one option that I would definitely specify for each and every BLAST analysis.

Question #3. What suggestions do you have for improving this report?

Answer. I would like to see the coincident zone dry bulb temperature for the minimum dates in the humidity report.

Response. A PMRF has been initiated to address this request.

The Fort Worth District provided no specific comments regarding this option.

K - Ice Storage Model

The BLAST ice storage model was developed to simulate two types of ice storage configurations; the ice-on-coil storage unit, and the ice shucker (also referred to as the ice harvester). Both use a vapor compression refrigeration cycle but employ different methods to make ice. The evaporator for the ice-on-coils unit is in the shape of tubes submerged in a tank of water. As the refrigerant is cycled through these tubes, ice forms on the coils. The evaporator of the ice shucker is in the form of thin flat plates. Ice forms on these plates and is periodically removed by allowing hot gases to flow through the evaporator plates.

The advent of this model allows the designer to investigate the effect of implementing a ice storage system. Rather than operating a chiller during on-peak electric rate time periods, the facility can now be modeled with an ice storage system that can take advantage of off-peak electric rates.

4 ADDITIONAL RESEARCH EFFORTS

This T^3B demonstration did reveal certain bugs in some of the program routines, and deficiencies in some of the documentation. It is a simple matter to resolve such programming and documentation problems. However, some of the new enhancements were not field tested. Additional research and testing are needed to determine if their implementation meets Corps designers needs and desires. Further testing of BLAST enhancements will be conducted pending the availability of T^3B funding. It is especially beneficial for the Corps districts to evaluate new enhancements to BLAST because it helps BLAST programmers to improve the program to better suit users' needs, because it exposes the districts to new program options, and also because endorsement by T^3B test sites is the best recommendation for this product.

5 CONCLUSIONS AND RECOMMENDATIONS

From an analysis of the users' responses, it is concluded that the new enhancements made to BLAST did satisfy users' needs for building energy analysis. Response indicates that some options will receive widespread use (such as the PC 386 Version), while others will satisfy specialized needs (such as the High Intensity Radiant Heating and Expanded Humidity Reporting options). Most users reported that they were able to install and use the program and its new enhancements quickly relative to other commercial programs, and that BLAST offered a combination of applications, reliability, and accuracy unique among energy analysis programs.

Note that not all of the new enhancements were selected by the participating districts for testing. It is recommended that the remaining options be field tested to test their suitability to the needs and desires of Corps designers.

Participants' response was found to depend to a small degree on general computer experience, and on experience with and attitudes toward BLAST. It is recommended that work continue to resolve minor "bugs" in the program that users reported, and to make BLAST more user-friendly to the novice operator. It is also recommended that BLAST documentation be expanded to include more detailed reference to the new options.

APPENDIX: Sample Surveys

Following are copies of the surveys sent to participating Districts. Responses to survey questions are in Chapter 3 - TEST RESULTS. Most responses to the questionnaires were provided in a text format rather than as a direct response to each question.

Survey Sent to Fort Worth and Louisville

NEW BLAST ENHANCEMENTS
Test Plan

The Building Loads Analysis and System Thermodynamics (BLAST) computer program has been operational for several years. During this time, the BLAST User's Group has been established and has directed several changes to the program's operation. As these enhancements are incorporated, user field tests are necessary to verify that the enhancement meets the user needs.

Several new functions in the BLAST program will be ready for testing in FY1990. Designers are asked to fill out evaluation forms during studies using the new enhancement to BLAST. These evaluation forms can assist the FOA in creating the evaluation report that is the product of this test. Since there may not be sufficient designs during FY 1990 that would actually use the new enhancement, designs are asked to study the enhancement in a proper setting--using previous designs or using a sample building model provided from the BLAST Support Office.

Results of Evaluation

The evaluation should be presented in report form and include all of the evaluation sheets filled out by the designers. Additional information to be covered in the report should include, but is not limited to, the following topics and answers to the questions:

1. Background on the projects selected for study (e.g., type of building, location), total studies done.

1a. Are these typical projects for your FOA or unique to this fiscal year or were they improbable samples used to study the enhancement?

1b. Were the actual designs done-in-house or contracted? Was BLAST used as the principal energy analysis study technique?

1c. If the designs were contracted, did the A/E firm study the enhancement or did the in-house designers?

2. Estimation of cost/benefit in manpower terms should be included.

2a. Was the information needed to model the new enhancement readily available or was extra effort required on the part of the designer to be able to build the BLAST model (e.g., did manufacturer's data have to be collected).

2b. If extra effort was required, could this just be part of a learning curve and wouldn't have to be repeated for each study?

2c. Was the time necessary to learn how the enhancement work justified in the information gotten from the BLAST study?

3. Preceived or measured accuracy of the results compared with current practice.

3a. Is the enhancement well explained in the documentation or were "tricks" necessary to get the proper results? Are there any constraints on the inputs that should be noted to future users?

3b. How comfortable are you with the output from the enhancement? Does the output provide good information for the designer?

3c. What are the best modelling techniques necessary to make full use of this new enhancement?

4. Features liked and disliked. Prioritization of refinements that would improve the enhancement.

4a. Is special training required to assist the user in learning this enhancement? What form should it take?

4b. Was the user's manual documentation of the enhancement sufficient to describe how the enhancement should be used? What improvements should be made?

4c. Can A/E designers easily pick up on this enhancement?

5. Quality of the output.

5a. What is the best way to represent the results of the study for this new enhancement?

5b. Is there some item missing from the output that is necessary to provide further information to the designer or reviewer? Is there too much information?

6. Recommendations for future testing or broader application.

6a. Is this enhancement ready for general release or must further work be done?

6b. Do you feel that it was worthwhile for your FOA to study this new enhancement?

6c. Would you participate in future field tests of BLAST enhancements?

7. If another energy analysis program already has this feature, compare, if possible, the use of it versus the use of BLAST for this feature.

BLAST Enhancement Evaluation

(Attach separate sheets as necessary)

1. User:____________________ DATE:_______________

2. Enhancement title: ____

3. Version of BLAST being used (computer and level #): _____________

4. What is your experience level with using BLAST? Was this your first time to try the enhancement? If no, how many times had you used the enhancement before (approximately)?

5. Project: ____

6. Did you need to call the BLAST Support Office (800-UI-BLAST) for further clarification before or during using this enhancement? Was the call beneficial?

7. Explain any problems you encountered.

8. List suggested changes or additions to improve the enhancement or related area the enhancement:

9. Is this enhancement applicable to Corps designs? Should there be other factors considered for this enhancement in Corps designs?

Survey Sent to Mobile

BLAST Enhancement Review Report Form

I. Preevaluation Questionnaire

The software to be used for this evaluation is to be installed by the reviewer themselves. Following installation, please complete this questionnaire.

1. What type of BLAST user do you consider yourself to be?

Novice	Trained	Expert
For what reason do you currently use:	**BLAST**	**Other Program**
1. Determine peak heating and cooling loads		
2. Determine energy budgets		
3. Study building sitting/orientation		
4. Study envelope alternatives		
5. Study equipment alternatives		
6. Study boiler/chiller alternatives		
7. Other - describe. Model building we have had problems with.		

2. What features do you currently use in other energy analysis programs that are not available in BLAST?

3. Did you personally load BLAST onto the computer which will be used for the evaluation test?

4. What type of computer did you load it onto? (briefly describe hardware)

5. Were the instructions clear regarding installation of the software?

6. Did you encounter any problems installing of the software?

7. How long did it take you to install the software?

8. Do you have any suggestions regarding software installation improvements?

After software installation, run the Dental building input deck (design day and annual run).

9. Did the deck run successfully? If not, what problems did you encounter and how did you resolve them?

II. Input Process

Select a building that will be modelled with BLAST and another energy analysis program. This should not be a building that you have already analyzed with either BLAST or another program in the past. Collect all data that will be required for input, e.g., building plan/size/orientation, floor/wall/roof composition, glazing type/area/orientation, internal loads, occupacny, mechanical system characteristics, etc. For an objective comparison, the models created for both programs should be of equal complexity, i.e., both models should have the same number of zones, systems, construction specifications, etc. Specify similar types of reports.

I. Develop a BLAST input deck using the above gathered information with BTEXT.

1. How long did it take to input the data?

2. Did you encounter any problems? If so, how did you resolve them?

3. Were most of the construction assemblies that you required in the BLAST library, or did you have to develop your own?

4. If you had to develop your own construction assemblies, did you find this to be simple or did you encounter difficulties?

5. What suggestions do you have for improving the BTEXT input process?

II. Develop a Carrier and/or Trace input deck using the same gathered information.

6. How long did it take to input the data?

7. Did you encounter any problems? If so, how did you resolve them?

8. Which program do you prefer to use and why?

9. Was more or less information required for input for the selected program? Describe.

10. Assuming the same type of analysis, rate the BLAST and other program's input process:

Selection	Program	Easy				Hard
User/Program interface	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Time Requirements	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Level of detail required	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to correct mistakes	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to input building geometry	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Ease to input mechanical systems	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Support	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
User Manual/Documentation	BTEXT	1	2	3	4	5
	Other Prgm	1	2	3	4	5
Other - Describe*	BTEXT	1	2	3	4	5
____________________	Other Prgm	1	2	3	4	5

*Desire to use

11. Other comments regarding the input process:

III. Program Execution

Following creation of the input decks, design day and annual runs will be conducted. For an objective comparison, both models should be of equal complexity. Similar reports should be specified for subsequent output comparisons.

I. Perform a design day run using BLAST:

1. How long did the run take?

2. Were any problems encountered (e.g., did the program run the first time through)? If so, describe, how were they resolved?

II. Perform a design day run using the other energy analysis program:

3. How long did the run take?

4. Were any problems encountered? If so, describe, how were they resolved?

III. Perform an annual run using BLAST:

5. How long did the run take?

6. Were any problems encountered? If so, describe, how were they resolved?

IV. Perform an annual run using the other energy analysis program:

7. How long did the run take?

8. Were problems encountered? If so, describe, how were they resolved?

IV. Results Evaluation

Following execution of the design day and annual runs, analyze the output from each run.

Re: BLAST output:

1. Is the Design Day output what you would need for design purposes? What would be of greater value, or would you see as an improvement? Describe.

2. Is the annual output what you would need for design purposes? What would be of greater value, or would you see as an improvement? Describe.

Re: Other program output (Type of program____________)

3. Is the Design Day output what you would need for design purposes? What would be of greater value, or would you see as an improvem^nt? Describe.

4. Is the annual output what you would need for design purposes? What would be of greater value, or would you see as an improvement? Describe.

Program output comparison

5. Which programs output is easier to interpret? Why?

6. Which program would you select if given the choice? Why?

7. In your opinion, does ease of use possibly compromise quality of output, or do you consider the easier program to be "close enough" for design purposes?

8. Is the interface to BLAST (DoBLAST) convenient and user friendly? Describe any improvements that you would like to see.

V. Humidity Report Option

This portion of the evaluation does not have to be conducted as rigorously as the previous section. Please take some of your previously developed input, modify the deck for humidity reporting, and rerun it.

1. Was the deck easy to modify for humidity reporting? If not, what problems did you encounter?

2. If you were to use BLAST for design, is this an option that you would use?

3. What suggestions do you have for improving this report?

Survey Sent to Sacramento

Amin. Building Study - Tentative Analysis Methodology

1. Prepare BLAST deck

2. Preform comfort analysis using forced ventilation. Determine if ventilation is a viable option for maintaining comfortable interior conditions. (See test plan suggestions for using the comfort capabilities of BLAST).

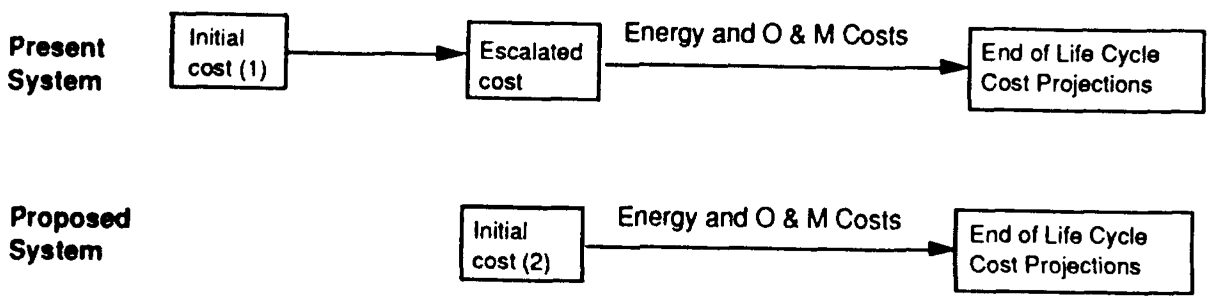
3. Perform two annual runs

   a. Using forced ventilation
   b. Using mechanical cooling

4. Compare energy usage for schemes

5. Perform Life Cycle Cost Analysis

Life Cycle Cost Analysis for this particular project



For this particular analysis, proposed new system cost (initial cost 2) should include:

1. New (mechanical cooling) system cost

2. Old (forced ventilation) system cost

3. Removal and replacement cost for swappiing forced ventilation with mechanical cooling system

4. Cost of worker displacement and inconvenience (i.e., loss of productivity) during changeover to new system

LCCA of forced ventilation versus mechanical cooling for this project will penalize the mechanical cooling system since funds previously expended for the existing system (and its replacement) should be included in the initial cost estimate for the mechanical cooling scheme. This however would not be the case in future projects if both schemes were evaluated during schematic design rather than as an afterthought once construction has already been completed.

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