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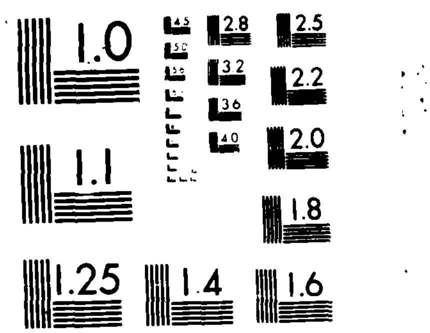

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Development of Lite — A Graphic Module for Lighting Analysis in the Computer-Aided Engineering and Architectural Design System (CAEADS)

by
Cynthia K. Barton

This report documents the development and use of the graphic module LITE, a subsystem of the Computer-Aided Engineering and Architectural Design System (CAEADS). LITE was developed to assist U.S. Army Corps of Engineers (USACE) in-house lighting engineers in performing the required analysis during the concept design phase. The program can do Illuminating Engineering Society (IES) Zonal Cavity calculations internally and, in addition, can build a Conservation of Electric Lighting (CEL-1) input deck for comprehensive daylighting studies.

Also described is the LCHG program which was developed to maintain the luminaire data base file used by LITE for illuminance calculations. The LCHG program relies on textual rather than graphic interaction with the user. The data base is independent of any other project and can store an unlimited number of luminaires.

The program is written in FORTRAN 77 and uses Tektronix 4109, 4014, and 4113 terminals for graphic representations. It is to be field-tested on selected USACE District/Division Harris computers beginning in early FY87.

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This report documents the development and use of the graphic module LITE, a subsystem of the Computer-Aided Engineering and Architectural Design System (CAEADS). LITE was developed to assist U.S. Army Corps of Engineers (USACE) in-house lighting engineers in performing the required analysis during the concept design phase. The program can do Illuminating Engineering Society (IES) Zonal Cavity calculations internally and, in addition, can build a Conservation of Electric Lighting (CEL-1) input deck for comprehensive daylighting studies.

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FOREWORD

This work was performed for the Directorate of Engineering and Construction, Headquarters, U. S. Army Corps of Engineers (HQUSACE), under Project 4A162781AT45, "Energy and Energy Conservation"; Technical Area A, "New Construction Energy Design"; Work Unit 011, "Computer-Aided Mechanical/Electrical Design and Procedures." J. McCarty, DAEN-ECE-E, was the HQUSACE Technical Monitor.

The work was conducted by the Energy Systems (ES) Division, U.S. Army Construction Engineering Research Laboratory (USA-CERL). Dr. G. R. Williamson is Chief, ES.

The initial graphic module for lighting design was created as part of the Computer-Aided Engineering and Architectural Design System (CAEADS) work unit in the USA-CERL Facility Systems Division (FS). This module, called LIGHTING, was created by P. Lynn Borema, University of Michigan, working with Yodyiam Teptaranon of USA-CERL. The LIGHTING subsystem generated lighting design information using the Zonal Cavity Method, which is recognized by the Illuminating Engineering Society (IES).

Another graphic module for lighting design was created at USA-CERL under the "Energy and Conservation" Work Unit of Project 4A162781AT45. This module, initially called LITE, was developed by Steven Dorner. LITE was actually an interface to the Conservation of Electric Lighting (CEL-1) comprehensive lighting design program created by the National Bureau of Standards (NBS) and the Naval Civil Engineering Laboratory (NCEL).

LIGHTING and LITE have been combined and enhanced to produce the current LITE program described herein.

In addition to the program designers just mentioned, appreciation is expressed to Steven Treado and Douglas Holland of NBS for helping interpret the CEL-1 program. The Kansas City District Electrical Branch provided preliminary reviews and helpful input to the LITE program; special recognition is given to two individuals from this District, Gary Harper and James Barnett, who assisted with the field view of lighting design.

COL Norman C. Hintz is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

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DEVELOPMENT OF LITE—A GRAPHIC MODULE FOR LIGHTING ANALYSIS IN THE COMPUTER-AIDED ENGINEERING AND ARCHITECTURAL DESIGN SYSTEM (CAEADS)

1 INTRODUCTION

Background

The U.S. Department of Defense (DOD) requires that all new construction interior, exterior, and sports lighting be designed in accordance with the fundamentals and recommendations of the Illuminating Engineering Society (IES) *Lighting Handbook*,[1] subject to modifications and clarifications in the DOD directive.[2] The IES Zonal Cavity method requires that the engineer calculate maintained illumination using a series of variables. During this process, the engineer must make several decisions about room layout and function. The amount of data to be considered and the complexity of calculations have made it desirable to create an automated program for lighting design.

The Corps of Engineers (USACE) Computer-Aided Engineering and Architectural Design System (CAEADS) could support such a program. CAEADS was developed by the U.S. Army Construction Engineering Research Laboratory (USA-CERL) to help architects and engineers conduct rapid analysis of several design options.[3] The system uses graphic display to show users the possible alternatives, allowing them to select one that optimizes cost and functionality. CAEADS is intended for use during the concept design phase, thereby improving the potential for high-quality construction.

CAEADS allows designers to use separate graphic modules in conjunction with the building data base to run programs that analyze various elements such as energy, structures, and ductwork. These analytical programs are developed by experts in the specific design area to be covered. Examples are the Building Loads Analysis and Systems Thermodynamics (BLAST) program for energy studies in conjunction with the ENERGY data base and the Superduct II program for duct design and analysis. A program for lighting design would fall into this category.

U' A-CERL has been developing a lighting design program for CAEADS. The initial graphic module, called LIGHTING, performed calculations using the IES Zonal Cavity Method.

Recent refinements to the module are based on a concept called "daylighting," in which facility illumination takes advantage of natural light through the use of fenestration, reflective surfaces, and other features. This energy-efficient concept lowers the demand for artificial lighting and affects the Zonal Cavity calculations, which assume no input from outside light.

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[1] *IES Lighting Handbook: Reference Volume* (Illuminating Engineering Society of North America, New York, 1981).

[2] DOD 4270.1-M, *Construction Criteria Manual* (U.S. Department of Defense [DOD], 1983).

[3] J. Spoonamore, *CAEADS—Computer-Aided Engineering and Architectural Design System*, Technical Report P-133/ADA117972 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], August 1982).

It is anticipated that DOD directives will later include a requirement for daylighting studies as part of the facility design process.[4] A national standard for this concept is under development by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE).[5] This or a similar standard may be specified for future military construction.

USA-CERL's first daylighting module was actually an interface to the existing Conservation of Electricity (CEL-1) program as developed by the National Bureau of Standards. Now the features of LIGHTING and the CEL-1 interface have been combined and enhanced to form one comprehensive graphic module called LITE. This program can be used with CAEADS to perform a complete lighting analysis during the concept design phase.

Objective

The objective of this report is to describe the development of the graphic module LITE. The program is intended for use with CAEADS during the first 35 percent of the design phase.

Approach

Existing lighting analysis programs were reviewed to identify one that could provide comprehensive calculations. CEL-1 was selected on this basis as well as for its ability to perform daylighting calculations.

LITE is written in FORTRAN 77 and uses Tektronix 4109, 4014, and 4113 terminals for graphic display. As an interactive graphics computer program, LITE was developed to produce a reflected ceiling plan and an input deck to the CEL-1 daylighting analysis program. A second program, Luminaire Change (LCHG), was developed to help the engineer manage the luminaire data base used in the LITE program.

The programs were reviewed by experts in the field to determine the accuracy and usability before formal field-testing. The USACE Kansas City and Sacramento Districts began field-testing the LITE/LCHG/CEL-1 interface in early 1987.

Scope

Work on computer-aided lighting design to date has focused on interior lighting. No programs are anticipated for exterior and sports lighting.

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[4] Engineer Technical Letter (ETL), *Energy Conservation Design (Including Design Energy Targets)* (Draft) (Office of the Chief of Engineers [OCE], 1986).
[5] ASHRAE Proposed Standard 90.1P, *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings* (1986).

Mode of Technology Transfer

After field-testing and refinement, LITE will be transferred to the field via hands on experience, tutorial, and a user's manual. A USA-CERL draft user's manual provides instructions for the current version of LITE. The program will be available to future users on the Harris computer. In addition, the USACE is in the process of procuring hardware dedicated to computer-aided design; when this hardware is operational, LITE also may be accessible there.

2 BUILDING THE LUMINAIRE DATA BASE: THE LCHG PROGRAM

Overview

LITE uses the IES Zonal Cavity Method to calculate footcandle levels and the number of fixtures required within each cell (Chapter 5). To perform these calculations, the LITE program must gather information about the room and the desired fixture, or luminaire. Physical dimensions of the room are obtained from the model of the building that will have been developed via the CAEADS ARCH program; reflectances and task heights are input directly into the LITE program by the user. Many factors, coefficients, and other values are associated with each luminaire type, with most of them used only in the calculations. Thus, to keep the program at a reasonable size, LITE uses a file called LUMAIR as a data base of luminaire types.

The designer enters luminaire types into the LUMAIR file using the LCHG program. Once entered into the luminaire data base, a luminaire type can be accessed by the LITE program as input for drawing a reflected ceiling plan and performing calculations. The designer chooses the subset of fixture types to be used in each project from the current LUMAIR data file. Besides conserving disk space, this procedure saves the designer time over the course of several projects.

The LCHG program was written to manage the luminaire data base. This chapter presents an overview of the program's capabilities and functions.

Information Exchange

The user interacts with the LCHG program by issuing one-letter commands at a terminal. This activity usually involves typing a command or response on the keyboard and terminating with a carriage return <cr>. Often the program will present an option or a stored value for the user's review. If the user wishes to accept the option, a <cr> may be entered rather than reentering the option or value.

Menus and Commands

The LCHG program uses command menus to help the user execute a session. Each menu lists the one-letter command associated with each function to be performed. When the user begins the LCHG program, the Main Menu appears on the screen (Figure 1). (There is also a submenu, the Change Menu, which will be addressed later in the C command discussion.)

From the Main Menu, the user can list all the luminaire types available in the data file by issuing the L command. The types are numbered sequentially in their order of entry into the program. It should be noted here that the luminaire types associated with each project are alphabetically sequenced to aid the user in distinguishing between luminaires found in the luminaire data file and those in the project data file.

Each time a luminaire type is added to the data base, the user has the option of initializing the new type with the attributes of a type already in the data file. This feature can speed data entry when two types are similar except for a few values. The user can answer each succeeding prompt with a <cr> to accept the old values; manual

L - List Commands
E - Exit

P - Print List of Luminaire Types
K - Print Individual Luminaire Data

A - Add Individual Luminaire Data
C - Change Individual Luminaire Data
D - Delete Individual Luminaire Data

R - Report

Figure 1. Main Menu.

entry is required only for those to be changed. The parameters for each luminaire type include:

1. Descriptive name (19 characters)

2. Drawing 40-06-04 type and suffix[6]

3. Drawing 40-06-04 sheet number

4. Lamp type

5. Lamp description (19 characters)

6. Mounting description (19 characters)

7. Initial lumens

8. Fixture loss factor

9. Width of luminous opening

10. Length of luminous opening

11. Height (see the CEL-1 user's manual for a description of this parameter[7])

12. Spacing-to-mounting height ratio

13. Gain

14. Quadratic coefficient (see the CEL-1 user's manual for a description of the equation relating the gain to the wattage)

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[6]Parameters 2 and 3 are requesting data from Standard Drawing Number 40-06-04, *Lighting Fixtures* (Office of the Chief of Engineers [OCE], November 1980).
[7]*CEL-1 Lighting Computer Program--User's Guide*, CR 81.026 (Naval Civil Engineering Laboratory [NCEL], January 1983).

15. Number of lamps

16. Watts per fixture

17. Watts per lamp

18. Fixture voltage

19. *IES Handbook* number

20. Coefficient of utilization (CU) table (see Chapter 5).

Should a luminaire type in the data file become obsolete at any time, the user may delete it from the data file by issuing the D command and entering the luminaire type number to be deleted. As a preventive measure, the program will list the given luminaire type's parameters on the screen before prompting for confirmation to delete this type. The user then has the option of aborting the command and returning to the Main Menu.

After a luminaire type has been added to the data base, any one or more of its attributes can be changed via the C command. Once issued, the program will list the current luminaire's parameters and place the user in the Change Menu (Figure 2). As before, the L command lists all commands in this menu. The user will remain in the Change Menu mode until typing the R command to return to the Main Menu.

Associated with each command in the Change Menu is one or more parameter values. When a command is issued, the program presents the current value and prompts the user for a new value, which is typed in followed by a <cr>. For the CU table, the program will list the current table by row and ask if changes are to be made before going to the next row. *If a change is needed, the whole row must be retyped.*

```
L - List Commands
N - Name and Description
H - IES Handbook Number
I - Initial Lumens
F - Fixture Loss Factor
D - Dimensions
W - Watts per Fixture
J - # of Lamps/Watts per Lamp
S - Space to Mounting Height (S/MH) Ratio
V - Fixture Voltage
G - Minimum Gain
Q - Quadratic Coefficients
C - CU Table
R - Return to Main Menu
```

Figure 2. Change Menu.

To terminate an LCHG session, the user types the E command. The program leaves the luminaire data file and returns the user to the Harris operating system. It should be noted that, upon initialization of the LITE program, the project data base is checked against the LUMAIR file. If any changes have been made within any of the luminaire types that also exist in the project file, the project file is updated with the new parameter values.

Output Reports

Reports produced by the LCHG program are designed to fit on 8-1/2 by 11 in. paper. A report is stored in a user-defined file for later printing (i.e., after leaving LCHG). The report contains the information stored in the data file for each luminaire type. It is convenient to print the reports for all luminaire types and place them into a three-ring binder for future reference during LITE sessions. Figure A1 in Appendix A shows an example of the LCHG report format.

3 ORGANIZATION OF THE LITE PROGRAM

During the development of the initial CAEADS lighting design module (LIGHTING), it became evident that the electrical engineer needed a better graphic tool for preliminary lighting design and analysis. Although the original program performed IES Zonal Cavity calculations, it could not graphically represent a fixture layout over the floor plan. The report produced by the program was designed to fit on wide computer paper and did not contain all information required in preparing concept design documents.

To bring energy-conscious features into lighting design and analysis and satisfy the increasing demand for more energy-efficient building systems, daylighting programs were reviewed for possible inclusion into the CAEADS program. As mentioned earlier, the CEL-1 program was chosen for its ability to perform comprehensive daylighting calculations. A new CAEADS lighting design module (LITE) was developed as a graphic input preprocessor to CEL-1. Although this first LITE module satisfied the need for a tool to create reflected ceiling plans, the designer was unable to perform initial footcandle calculations and obtain any type of report.

To overcome these drawbacks, the final step in developing the CAEADS lighting design module was to combine the LIGHTING and LITE programs to produce the current version of LITE. Enhancements included two reports produced for 8-1/2 by 11 in. format sheets, ceiling grids for layout reference, a special fixtures mode for placing exit light and floodlight symbols on the ceiling plan, and a more comprehensive luminaire data base file than was available previously. LITE can now perform IES Zonal Cavity calculations internally and, in addition, can build the CEL-1 input deck for comprehensive daylighting studies.

Since LITE is part of CAEADS, it is not a stand-alone program. Before the electrical engineer or lighting designer can initiate a LITE session, there must be an existing ARCH data base for the project made through the ARCH program. A user who is familiar with ARCH should be able to use LITE with minimal difficulty after a brief demonstration. A newcomer to CAEADS should consult the *ARCH User's Manual*[8] before attempting to execute LITE.

Information Exchange

A designer gives the LITE program instructions by issuing commands at an interactive graphics terminal. The terminal must be a Tektronix 4014, 4109, or 4113 or one with identical emulation capabilities. Instructions to LITE are entered by (1) typing a response followed by a <cr> or (2) positioning the "crosshairs" over a specific area of the screen and typing a single key. The crosshairs consist of one vertical and one horizontal line for which the intersection defines a point on a graphics screen. Current technology uses a joystick, "mouse," or keyboard arrows to manipulate the crosshairs. In the crosshairs input mode, the LITE program will interpret the actual position of the crosshairs intersection as well as the key that was typed.

Depending on the type of input, LITE will communicate with the user by an appropriate display or alphanumeric prompt. If LITE does not understand a command or

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[8] *ARCH User's Manual* (Draft) (USA-CERL, 1986).

if a command is not issued correctly, the program will respond with appropriate diagnostics.

The Screen Display

The actual screen seen by the LITE user is divided into two physical areas: the text area and the graphical input area. All written prompts and diagnostics from LITE and all user-typed responses appear in the text area. Whenever the user enters text in response to a prompt, it must be followed by a <cr>. The graphical input area is where all crosshair positioning and single-key commands are used. The graphical input area is subdivided into two areas, the menu area and the layout area, as Figure 3 shows. The Menu Area allows the user to select the type of action to be performed by the program. Each action, called a "mode," has a subset of unique commands. While a user is operating within a mode, only that mode's subset of commands may be issued. The Layout Area is where the lighting design layout is superimposed over the ARCH model of the building.

Project Names and Files

LITE uses much of the information that has been entered through ARCH--for example, room dimensions, room labels, and furniture dimensions--and creates its own data file which is stored on the computer disk. The project name is used to generate the disk file and, therefore, must be unique. During a LITE session, changes to a project are not stored on the the project's data file until the user gives an explicit "save" request.

Modes for Building the LITE Data Base

To perform an action in LITE, that is, to access a mode, the crosshairs are placed within the menu area over the mode desired and any alphanumeric key is pressed. The user may then continue working within that mode or may select another mode.

Although the program is intended to be more than a CEL-1 input preprocessor, the names and expressions contained within LITE use the vernacular of CEL-1. Each menu command name describes, in one or two words, a subset of the design process that may be completed within the mode. For example, the TASK EDIT mode allows the user to describe task locations or task grids within a cell--information that CEL-1 then uses in figuring illuminance levels.

This section briefly describes the functions of each LITE mode. For a more detailed description of the modes and commands, see the *LITE User's Manual.*[9]

Menu Command Mode

The MENU COMMAND mode is an intermediate step between the other modes. LITE is at this neutral position when the user first accesses the program.

[9] *LITE User's Manual* (Draft) (USA-CERL, 1986).

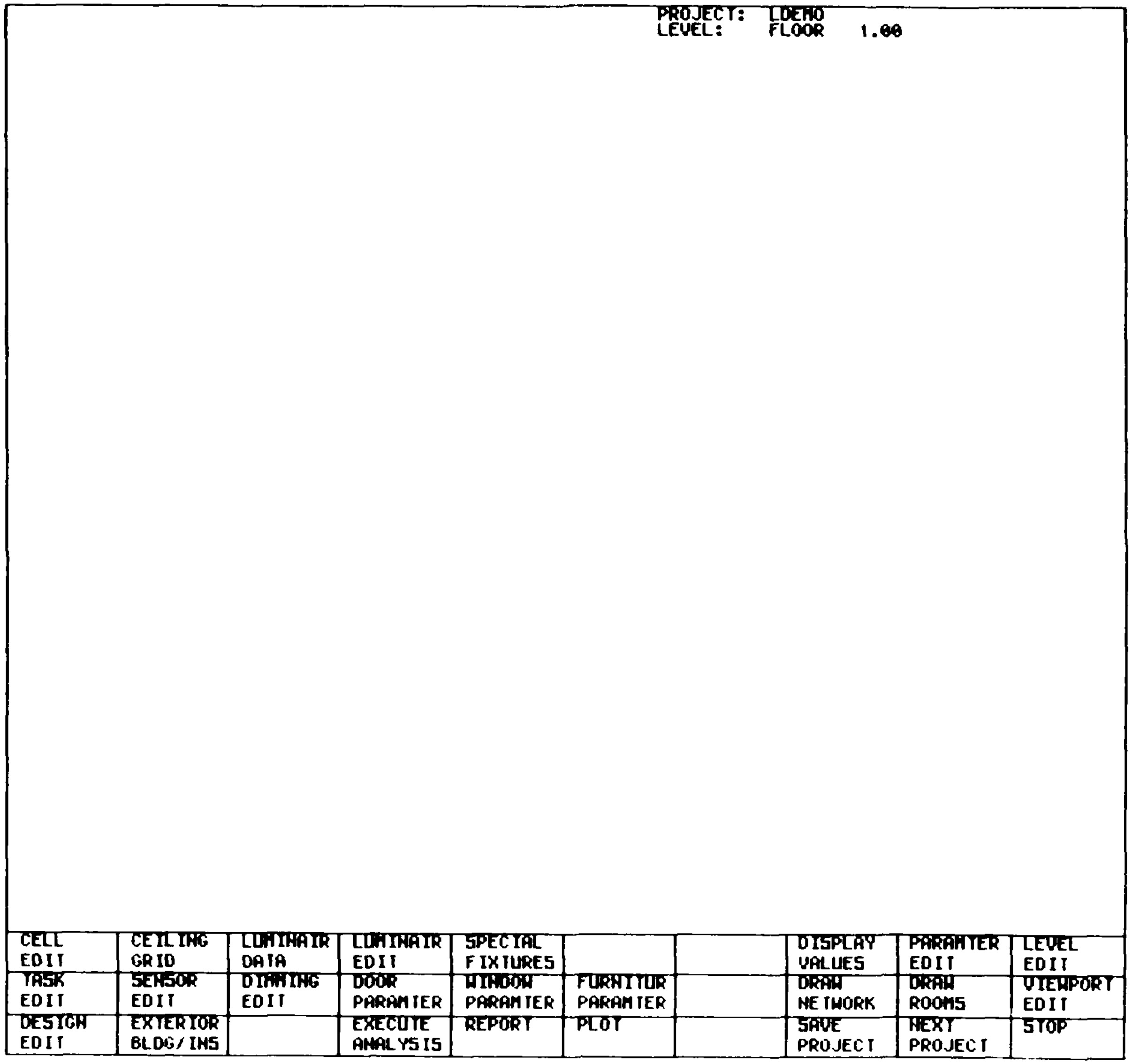

Figure 3. Graphical input area.

Cell Edit Mode

CEL-1 performs its daylighting calculations on an area defined as a cell. For the most part, the user will want the inside surfaces of a room to function as the boundaries of each cell. Within CELL EDIT, the user enters the exact locations of cell boundaries within the building for each room. Associated with each cell, or room, are default values for occupancy schedule (7 a.m. to 4 p.m., 100 percent; 4. p.m. to 7 a.m., 0 percent), room reflectances (walls, 50 percent; floor, 20 percent; ceiling, 80 percent), footcandle level (50), work plane height (2.5 ft), and dirt depreciation factor (0.7). For accurate calculations, CEL-1 divides the cell into smaller pieces. LITE calculates the default discretization for each cell by dividing each surface into 2-ft increments. Each default attribute can be changed to suit the occupancy or intended usage of the room.

Ceiling Grid Mode

The CEILING GRID mode allows the user to manipulate ceiling grids. Each grid is created with either the grid or a tile centered within the cell and can be any size specified by the user. Once a grid has been created, it can be shifted within the cell to align with a grid in an adjacent room. The grids are intended for reference only and can be deleted after the placement of luminaires without affecting the luminaire locations.

Luminair Data Mode

Once the cell and ceiling grid are placed, the user can create a reflected ceiling plan. This procedure requires information from the LUMAIR file. Since the LUMAIR file is created using the LCHG program, the user, once in LITE, may not remember which luminaire types were entered into the data file. LUMINAIR DATA mode allows the user to review this data file at any time while executing the LITE program. If the luminaire type desired is not found in the data file, the user must terminate the current LITE session and enter the correct information using the LCHG program.

Luminair Edit Mode

Most of the layout process is completed in LUMINAIR EDIT. In this mode, the user can place lighting fixtures within the building and make simple footcandle and fixture calculations. The user chooses luminaire types from the LUMAIR file and adds them to the project file using the G command. To help users distinguish between the data file and project file, the luminaire types in the project file are referenced by sequential alphabetical letters, whereas the luminaire types in the data file are referenced in numerical sequence. There is no limit to the number of fixture types that the data file can contain, but the project file is limited to 26 luminaire types. A luminaire type can be deleted from the project file provided it is not assigned to any luminaire in the building. At any time, the user can list the luminaire types in the project file onto the text area.

The user can add luminaires individually or as a group. If they are added individually and a ceiling grid is used, the luminaire will be centered in the grid box specified by the location of the crosshairs at the time the command is entered. If a ceiling grid is not being used, the luminaire will be placed at the exact location of the crosshairs. When luminaires are added as a group, the cell must have a ceiling grid. The program prompts the user for the number of luminaires to be added and for which one of five default layout patterns is to be used. The luminaires are then added in the specified pattern within the ceiling grid.

Even though luminaires can be added by group, they are stored in the project file as individual locations and do not retain group attributes. Therefore, the luminaires can be deleted either one at a time or by cell. Once a luminaire has been added to the ceiling plan, the user can change its types or orientation without having to delete it first. There is also a command that gives the user a reference point at the center of each luminaire location on the currently displayed floor plan.

In the layout process, the user first chooses a fixture type and then issues the command that calculates the number of fixtures required for the specified footcandle level. Once the luminaires are positioned, the program will calculate the "installed" footcandle level, picking up each luminaire that was placed within the cell. This process can be repeated as many times and with as many different fixture types and layouts as necessary to obtain the optimal lighting design.

Special Fixtures Mode

The last mode that would be necessary for creating a reflected ceiling plan for 35 percent design review is the one called SPECIAL FIXTURES. This mode allows the user to place symbols for exit lights, task lights, and similar requirements on the drawing. Since the parameters for these fixtures are also in the luminaire data file, a complete fixture schedule can be created for the project. The symbols can be inserted or deleted anywhere on the building (inside or out) since they are not associated with a particular cell.

Door Paramter Mode

Once the reflected ceiling plan has been established, the user can start defining characteristics of the building unique to the execution of CEL-1. Since reflectances have a major part in lighting design, it is important to consider all reflective surfaces including doors. CEL-1 allows the designer to define door attributes using DOOR PARAMTER. On the other hand, the program has the option of ignoring door surfaces in the lighting metrics calculations.

During project initialization, the LITE program gives each door a surface reflectance of 0.12. In DOOR PARAMTER mode, the user can view the reflectance value of any door and change it to suit the actual door material. The user also may mark a door to be ignored or to reactivate one that has been previously ignored.

Task Edit Mode

CEL-1 calculates its illumination metrics at specific points called "task locations." Tasks can be specified individually--for example, to locate the position of a desk--or as a rectangular grid of points when the activity in the room is unknown. Individual task locations and task "grids" are defined or deleted in TASK EDIT mode. While the user is defining the task locations, LITE will ask for the viewing angles as described in the *CEL-1 User's Manual*. The default height of 2.5 ft can be changed to any value between zero and the ceiling height of the room (which is defined in ARCH and known internally to LITE). When equivalent sphere illumination (ESI) ratings are to be calculated for individual task locations, the secondary viewing directions will be determined using either the IES or NAVY option.* The default set by LITE, the IES option, can be changed any time while in TASK EDIT.

Sensor Edit Mode

The user locates interior and exterior sensors in SENSOR EDIT. For CEL-1, a sensor is a location where illuminance is to be calculated. Illuminance computed on interior sensors is the aggregate effect of both daylight and luminaires; illuminance computed on exterior sensors is the result of daylight alone. The illuminance values calculated are for the user's information only and do not influence the dimming of luminaires in any way. The symbols used in LITE show whether an interior sensor is looking up or down and to which compass direction an exterior sensor is looking.

Window Paramter Mode

The fenestration block in CEL-1 is used to define sources of daylight that may enter the room. Exterior objects such as other buildings, parking lots, and lakes can be sources of reflected light; in addition, the amount of light entering a room depends on the glass and window dressings used on the building. LITE gives each window the default attributes of transparent glass and 80 percent transmittance. WINDOW PARAMTER allows the user to define shades, drapes, blinds, light shelves, and exterior barriers such as a wing wall or a light well.

Exterior Bldg/Ins Mode

Exterior sources of reflected light are located in EXTERIOR BLDG/INS, an abbreviation for exterior buildings and ground inserts. For a building, the footprint (rectangular) is located, the height of the building in relation to the room in question is determined, and reflectance values are given to the top and four sides. A ground insert is a rectangular area on the ground that has a reflectance differing from that of the ground as a whole. For an insert, the footprint is located, the height difference between the insert and the floor elevation is determined, and a reflectance value is given to the top surface.

Once a building or insert has been added to the screen, it can be deleted and the reflectances, heights, and dimensions can be changed. During a session, LITE also allows the addition or deletion of a user-defined building or insert label; this information is for the user's clarity only.

Furnitur Paramter Mode

Since furniture will affect the way light enters a room, CEL-1 has an option for locating these "obstructions" within the cell. In CAEADS, furniture will have been located by the architect using ARCH. Thus, since the locations of furniture are already known, the lighting designer needs to assign only reflectance values and heights. This procedure is done in FURNITUR PARAMTER mode.

The LITE program distinguishes between a furniture type and the instance of a piece of that furniture type on the floor plan. Thus, the designer assigns values to a furniture *type* rather than to each instance of that type. LITE assigns a default

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*These options are too detailed for the scope of this report; see the *CEL-1 User's Manual*.

reflectance value of 12 percent to the top and sides and a default height of 2.5 ft to each furniture type. The furniture parameters may be changed any time while in this mode.

Dimming Edit Mode

For energy profile calculations, CEL-1 requires the user to set up a dimming strategy for controlling the luminaires within a cell. For a complete discussion on the method of selecting a dimming strategy, see the *CEL-1 Users Manual.* In DIMMING EDIT, the control method, criterion values, and control indicators are defined.

Also defined in this mode is the control target area, which is a rectangular grid of points defined on a horizontal plane. Horizontal illuminance is computed at each point in the control target area and then the illuminance values computed are used to control the luminaires. In LITE, the "dimming grid" is defined much like the task grid and may be deleted at any time. The luminaires in the cell, by default, are considered to be continuously on; consequently, they would not be controlled by the dimming strategy. For each luminaire to be included in the "dimming group," the user must issue the appropriate command in DIMMING EDIT.

Design Edit Mode

In DESIGN EDIT, the user specifies the set of luminaires as a rectangular grid of locations for use by the CEL-1 design synthesizer.* Associated with each "design grid" is the luminaire type, height from the floor to the luminous opening, bearing, and design criteria. Once a design grid has been defined, the user may change the luminaire type, height of the grid, luminaire orientation, and target values. By default, all grid points are assigned to be valid luminaire locations. The user may deactivate any location which would then be interpreted by CEL-1 as an invalid location for a luminaire.

Execute Analysis Mode

The CEL-1 input deck is created in the EXECUTE ANALYSIS mode. First, the location of the building in world coordinates must be established. These coordinates include latitude, longitude, longitude at the center of the time zone, and station number. The station number identifies the weather station from which cloud conditions are to be determined. LITE can identify 276 cities in the United States, Puerto Rico, and some of the Pacific Islands. Unless the location is intended to be changed later, the values are entered only once. Chapter 4 presents a more detailed description of EXECUTE ANALYSIS mode.

Modes Common to All CAEADS Modules

All modes grouped on the right-hand side of the Menu Area are present in each of the CAEADS modules. In LITE, PARAMTER EDIT allows the user to revise the parameters that control the operation of the LITE program. VIEWPORT EDIT controls which part of the viewport area will appear on the screen. DISPLAY VALUES allows the user to see different dimensions relating to the building geometry. LEVEL EDIT enables the user to move from floor to floor in a building. DRAW ROOMS redraws the screen as

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*For an explanation, see the *CEL-1 User's Manual.*

determined using either the IES or NAVY option.* The default set by LITE, the IES option, can be changed any time while in TASK EDIT.

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Once a building or insert has been added to the screen, it can be deleted and the reflectances, heights, and dimensions can be changed. During a session, LITE also allows the addition or deletion of a user-defined building or insert label; this information is for the user's clarity only.

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Execute Analysis Mode

The CEL-1 input deck is created in the EXECUTE ANALYSIS mode. First, the location of the building in world coordinates must be established. These coordinates include latitude, longitude, longitude at the center of the time zone, and station number. The station number identifies the weather station from which cloud conditions are to be determined. LITE can identify 276 cities in the United States, Puerto Rico, and some of the Pacific Islands. Unless the location is intended to be changed later, the values are entered only once. Chapter 4 presents a more detailed description of EXECUTE ANALYSIS mode.

Modes Common to All CAEADS Modules

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*For an explanation, see the *CEL-1 User's Manual*.

a double-line drawing, whereas DRAW NETWORK redraws the screen as a single-line depiction of the building. The commands SAVE PROJECT, NEXT PROJECT, and SAVE perform the functions indicated by their names.

Within any command mode, there are five commands that can always be issued: REDRAW, ZOOMIN, ZOOMOUT, BACK UP (<), and Stop (!). For a complete description of these commands and the modes introduced in this chapter, consult the *LITE User's Manual.*

Output Reports and Plotting

REPORT mode allows the user to obtain a lighting summary and a fixture schedule for each project. The program creates each report and stores it in a user-defined file for printing later. Once the user has exited the LITE program, this file can be sent to any printer to obtain a hard copy for the project file. Appendix B gives examples of the lighting summary (Figure B22) and fixture schedule formats (Figure B23).

Using PLOT mode, the user can print a hard copy of the screen. Depending on the computer equipment at the user's facility, the LITE program can generate a file readable by a Calcomp plotter or can send a picture of the screen to a Tektronix plotter connected directly to the user's terminal. LITE has a command written specifically for the Tektronix 4692 color plotter which will erase the menu and redraw the screen in the colors best suited to the plotter. Figure B21 in Appendix B is a plot of this type generated using PLOT mode (shown in black and white here).

4 LITE/CEL-1 INTERFACE

Using CEL-1 for Daylighting Analysis

The CEL-1 program, as a lighting analysis tool, provides many different functions for the lighting designer. The program itself consists of approximately 20 separate subprograms, of which only a subset is invoked during a single simulation. The user needs only understand the creation of the input deck and the meaning of the various data variables to execute a CEL-1 run successfully.

The CEL-1 input deck consists of several "blocks" of information. Each block describes some particular aspect of the lighting application being considered and is headed by a keyword, followed by one or more lines of data values as appropriate. Depending on the lighting analysis desired, some blocks are always required and some are optional. No matter which blocks are required for a particular deck, they must always appear in a prescribed order. Figure 4 lists the blocks by keywords in the order they must appear along with a description of the type of information they contain.

CEL-1 groups the different lighting analysis functions into six different "capability sets." For this CEL-1 version, the capability sets are:

A - no furniture, no daylight, unknown task locations

B - furniture, no daylight, any tasks

C - design synthesizer

D - daylight, analysis mode

E - daylight, profile mode.

Future CEL-1 versions will also contain the set F, daylight, BLAST generator. Depending on the capability set chosen and the information contained in the input deck, the CEL-1 program can calculate several lighting metrics, including:

- Illuminance
- Equivalent sphere illuminance (ESI)
- Task illuminance
- Background illuminance
- Contrast rendering factor (CRF)
- Lighting effectiveness factor (LEF)
- Luminance on room surfaces
- Illuminance on room surfaces
- Visual comfort probability (VCP).

1. ROOM - project description, room dimensions, and reflectances

2. TASK - target point definitions, either individual or an unknown grid

3. INSERTS - reflectances of doors, objects on walls, etc.

4. SENSORS - locations of interior and exterior sensors for lighting control

5. FENESTRATION - windows, skylights, etc., object building and exterior building and ground inserts definition

6. FURNITURE - location and reflectances of objects in the room

7. PROFILE - parameters for daylighting computations, including an energy profile

8. ANALYSIS - daylighting simulation information

9. LUMINAIRES - type of fixtures and locations

10. DIMMING - control strategy values

11. DESIGN - sets up criteria and grid for a design synthesis simulation

12. CALCULATE - specifies metrics to be calculated

Figure 4. Input block order and description.

The user states which output reports CEL-1 is to generate through the CALCULATE block that appears at the end of the input deck.

During input deck creation, LITE must translate the CAEADS' coordinate system to the CEL-1 coordinate system. For CEL-1, a rectangular coordinate system is established with its axes parallel to the room surfaces and its origin (0,0,0) located at the southwest corner of the room. Thus, the positive x-direction is room east, positive y-direction is room north, and positive z is up. Angles are listed according to the convention of zero degrees for room north, 90 degrees for east, 180 degrees for south, and -90 or 270 degrees for west.

A complete description of the algorithms used by CEL-1 is in the CEL-1 programmer's guide.[10] For further details and examples of CEL-1 input file generation, see the *CEL-1 Lighting Computer Program User's Guide*. This chapter is limited to a discussion of the process in which LITE builds an input deck using the data bases from the ARCH, LITE, and LCHG programs.

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[10] *CEL-1 Lighting Computer Program - Programmer's Guide*, CR 83.009 (NCEL, January 1983).

Creating a CEL-1 Input Deck

The CEL-1 input deck is created in the EXECUTE ANALYSIS mode using the CREATE CEL-1 INPUT DECK command. The LITE program builds each input block according to the capability set chosen and puts it in its own temporary disk file. When a block is optional for a given set, the user is asked whether or not it should be included in the input deck. In many cases, LITE will prompt the user for more information on how the input deck is supposed to be put together. The program is written to ensure that all the syntax requirements for an input deck are met, such as providing all the information needed for every block. If the program determines that the user has not provided enough information through the LITE menu command modes, it will issue a diagnostic message and exit the CREATE CEL-1 INPUT DECK command. After all blocks are created successfully, they are written into a user-defined disk file in the order required by CEL-1.

This section briefly describes how each block is created and how LITE gathers all the required information. The program first asks the user to locate the desired cell with the crosshairs and then prompts for the capability set desired.

Room Block

Every CEL-1 deck is required to have this block. The first five lines of the deck are for identifying the printed output and have no influence on the computations. Any or all lines may be left completely blank. If the user does not enter five lines of text when prompted, the program inserts blank lines into the block. The LITE program can determine if the input units are English or metric from the project data base and prompts the user for the desired output units. Finally, the room (cell) dimensions, discretization parameters, and reflectances are taken from values input in CELL EDIT.

Inserts Block

This block is optional for every capability set and is included to define areas on room surfaces which have a reflectance value different from that of the underlying surface. LITE first checks to see if there are any doors on the cell's boundaries and, if so, whether the user has marked the doors to be ignored. If there are valid door entries, the program asks the user whether to set up the INSERTS block. If no, the program jumps to the next block. If yes, LITE picks up the location of the door from the ARCH data base and the reflectance value that was assigned in DOOR PARAMTER. The program must ask the user for the height of the door since the z dimension is not stored in the ARCH data base.

Task Block

The TASK block is required at all times and its information on task locations is set up in TASK EDIT. For capability set A, the program automatically picks up the task grid location and viewing angles. Otherwise, LITE asks the user if calculations are to be performed using ESI ratings, an unknown task grid, or simple known task locations.

Calculate Block

This block specifies which lighting metrics are to be computed and is therefore required in every input deck. The program prompts the user for keywords to use and for the task function to take place at each task location. LITE then relates the task function to the proper Bidirectional Reflectance Distribution Function (BRDF)* file name which is inserted into the deck. The BRDF files are stored for use by CEL-1 and are available on the Corps CYBERNET accounts.

Luminaires Block

The luminaires block is forbidden for capability set C and optional for capability set D. Otherwise, this block is a required entry. Using the reflected ceiling plan created in LUMINAIR EDIT, the program searches for all the luminaire types assigned to the cell and reads the appropriate luminaire parameters from the LUMAIR file. Then, all locational information, including x, y, and z dimensions for every fixture, is written into the block.

If the capability set is not D or E (daylighting) the next four blocks in the data deck are forbidden and LITE will skip over them. The following descriptions for these blocks assume that the capability set is for daylighting.

Sensors Block

Since the sensors defined here do not affect the calculations in CEL-1, this block is optional. If sensors were not defined in the specified cell in SENSOR EDIT, the program skips to the next block; otherwise, it asks the user if this block is to be used. If so, the program finds (from the project file) all sensors placed inside the cell and all sensors located outside the building and writes this information into the temporary block file.

Fenestration Block

This block, through several subblocks, defines sources of daylight that may enter the room. It is required when the daylighting capability is being used. Information for the WINDOW subblock is created in WINDOW PARAMTER mode. LITE searches the LITE data base for all window types found in the cell and, together with the locational information from the ARCH data base, writes the WINDOW subblock. As with doors, LITE must ask the user for the height of each window type.

Information for the BUILDING and GROUND subblocks are created in EXTERIOR BLDG/INS mode. The LITE program takes the subject building's attributes from the ARCH project model; any other buildings or ground inserts that were defined are taken from the LITE data base.

Dimming Block

The DIMMING block is optional for ANALYSIS mode, but required for PROFILE mode since it contains the dimming strategy to be used. LITE uses all controls and luminaire information entered through DIMMING EDIT to create this block.

Analysis Block

For daylighting, either the analysis block or the profile block is present in the input deck--never both. This block supplies the daylighting information when an energy profile is not desired. The station identification (ID) and world coordinates are taken from data

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*These auxiliary files are explained in detail in the *CEL-1 User's Manual*.

entered in EXECUTE ANALYSIS mode. Then, LITE prompts the user to specify up to 15 instances during the year that daylighting calculations are to be made.

Profile Block

In this block, the user does not specify particular instances during the year as in the analysis block. Rather, CEL-1 computes the energy consumed for a typical day in each month. LITE retrieves the station ID and world coordinates from data entered in EXECUTE ANALYSIS. It also asks the user if daylight savings time (DST) is to be used. Based on the answer, LITE creates the correct DST map for CEL-1 interpretation. If the answer is "no," the DST map consists of zeroes for all months; if "yes," the zeroes for April through October are replaced with ones. For the last entry, LITE retrieves the occupancy factors from data entered in CELL EDIT and writes them into the temporary block file.

Furniture Block

This block is optional for every input deck except when using capability set A, in which it is forbidden. LITE first searches the ARCH data base to see if the architect has input any furniture into the room. If not, the program skips to the next block. If furniture is found, LITE asks the user if it is to be inserted into the input deck. If so, LITE takes the x and y locations and orientation of each piece from the ARCH data base; the height, or z dimension, of each piece is retrieved from the LITE data base, since all furniture heights and reflectances were assigned in the FURNITUR PARAMTER mode.

For a complete CEL-1 run, there must be a binary OBSTR file on the system. This file is a data base that gives the dimensions and reflections for each piece of sequentially numbered furniture. When LITE builds the FURNITURE block, it first builds the OBSTR data base, which is written in American Standard Code for Information Interchange (ASCII), and then uses the sequential ID numbers when creating the block. Once all the input blocks are gathered to make a complete input deck, LITE inserts the OBSTR data base at the end of the file. Before executing CEL-1, the user must separate the OBSTR data base from the actual input deck and run the data base through a program that puts it into binary form. The CEL-1 user's manual contains a complete discussion of the OBSTR data base and its function during a CEL-1 simulation.

Design Block

The DESIGN block is used instead of the LUMINAIRES block when the design synthesizer is employed. This block is forbidden at all other times. The LITE program retrieves the luminaire type, design criteria, and design grid--all entered in DESIGN EDIT mode--from the LITE data base. Once it knows which luminaire type was used, the program can also retrieve the luminaire parameters from the luminaire data base. LITE interprets the design grid into the luminaire location mask using the syntax required for CEL-1.

Once all appropriate blocks are created, LITE asks the user for the name of the disk file to use when making the input deck. If the user indicates a file that already exists, the program will issue a warning and give the option of specifying a new file name. The program then merges all temporary files into the disk file following the input sequence required by CEL-1. The user need not worry about disk space during the creation of an input deck since the temporary files used will disappear when the user signs off the computer.

Limitations of Using LITE with CEL-1

Since ARCH will model only standard windows, LITE cannot create input data for a clerestory, sawtooth, or skylight. However, the user is encouraged to edit the input file created by LITE and manually enter the information needed for these types of windows. If the formal field tests show a need for LITE to be able to handle these types of windows, another option can be added to the program.

Another limitation is that controlling, or default, values may not always be correct for a given situation. Therefore, while the user is always given the option of using defaults generated by LITE, it is recommended that each input deck be reviewed for correct controlling values. Incorrect values can produce misleading analytical results.

5 ALGORITHMS

IES Zonal Cavity Method

The LITE program offers a general procedure for calculating maintained illumination as recommended by the IES. The IES lumen method is used in calculating the illumination that represents the average of all points on the work plane in an interior. This method assumes that the lighting system will deliver an illumination level uniformly throughout the room and does not include the effects of daylighting. The IES recommends using the lumen method as one of the most practical for interior lighting analysis. It is intended that the engineer use these calculations in LITE for the initial layout of the lighting system. Later, more comprehensive analyses can be performed using CEL-1, which considers the effects of daylighting on the interior environment.

In the LUMINAIR EDIT mode, LITE allows the user to calculate (1) the number of fixtures required within a room based on a given illuminance level or (2) the maintained illuminance level given a specific fixture type. To do these calculations, the CU must be determined. The program uses the Zonal Cavity method to calculate parameters that must be known in order for LITE to look up the CU value from the appropriate table.

Since rooms may have irregular shapes, Equation 1 is always used to calculate the room cavity ratio (RCR):

$$RCR = \frac{2.5 \times \text{Cavity height} \times \text{Cavity perimeter}}{\text{Area of cavity base}} \qquad \text{[Eq 1]}$$

The ceiling cavity ratio (CCR) and floor cavity ratio (FCR) are then defined as:

$$CCR = RCR \times \frac{\text{Height of ceiling cavity}}{\text{Height of room cavity}} \qquad \text{[Eq 2]}$$

$$FCR = RCR \times \frac{\text{Height of floor cavity}}{\text{Height of room cavity}} \qquad \text{[Eq 3]}$$

Effective reflectances for the ceiling and floor cavities are determined by LITE using a standard table from the *IES Lighting Handbook*. The program then uses the cavity ratios and effective reflectances to look up the correct CU from the specified fixture CU table in the luminaire data base (see Appendix A). These CU tables are based on a 20 percent effective reflectance. If the effective floor cavity reflectance is not 20 percent, LITE uses the multiplier from Figure 9-13 in the *IES Lighting Handbook* to correct the CU value.

The CU table deserves special mention here. During the development of LITE, some reviewers expressed concern that the CU tables offered by different manufacturers use different reflectance values as table headings. To overcome this discrepancy and ensure flexibility, the program was enhanced so that designers can define values for the table headings to match the reflectance values found in respective manufacturer's catalogs. The LCHG program has default values of 80, 70, 50, 30, and 10 percent for reflectance of the ceiling cavity, and 50, 30, and 10 percent for reflectance of the walls.

Another factor in calculating the illuminance levels is the total light loss factor (LLF). Many factors comprising the total LLF are arbitrary and their values vary among users. Selection of the LLF involves multiplying all the individual factors together to obtain one result. LITE offers the user a flexible way to include these factors in the calculations. The program divides the factors into two categories: fixture loss factor and room dirt depreciation factor.

The fixture loss factor is the product of luminaire ambient temperature, luminaire voltage, ballast factor, luminaire surface depreciation, lamp lumen depreciation, lamp burnout factor, and luminaire dirt depreciation. When initializing a fixture's data in the luminaire data base, the program will ask the user for the fixture loss factor. The value entered should include all the factors just mentioned when appropriate.

The room dirt depreciation factor is assigned to the cell in CELL EDIT mode. To do the calculation, LITE multiplies the fixture loss factor (from the LUMAIR file) and the room dirt depreciation factor (from the LITE data base) to obtain the total LLF. The user is advised to take care in making decisions about the LLF since the resulting design can only be as accurate as the assumptions made during that process.

LITE uses Equation 4 to calculate the required number of luminaires:

$$\text{Number of luminaires} = \frac{\text{Footcandles x area in sq ft}}{\text{Lumens per luminaire x CU x LLF}} \qquad \text{[Eq 4]}$$

where LITE retrieves the area in square feet from the ARCH layout, room footcandle level as assigned in CELL EDIT mode, lumens per luminaire, and LLF from the LUMAIR file, and CU as just described. After calculating the number of fixtures required within a room, LITE presents the results to the user as the number of fixtures required and the resultant area per luminaire based on that number.

In calculating the installed footcandle level, LITE uses Equation 5:

$$\text{Footcandles} = \frac{\text{No. luminaires x Lumens per luminaire x CU x LLF}}{\text{Area in sq ft}} \qquad \text{[Eq 5]}$$

where LITE retrieves the area in square feet from the ARCH layout, number of luminaires from the LITE data base, lumens per luminaire and LLF from the LUMAIR file, and CU as described above.

Daylighting Analysis

Many critical decisions about building design must be made early in the design process. Building height, number of floors, floor area, and general site orientation may be among the first building parameters to be chosen. These seemingly basic, simple decisions strongly influence the final building design by setting constraints on potential design options. This is particularly true for features involving the building envelope such as fenestration; the type, design, and size will be dictated in part by the building shape and orientation. For example, toplighting with skylights or other overhead fenestration can be implemented only in building zones with access to the roof surface. Window design also is linked to wall design, and energy concerns must be combined with structural considerations. Moreover, the building's interior design is related to the envelope design since interior partition walls and room layout can influence daylight distribution from fenestration elements.

Daylight, when skillfully employed, provides the designer with one of the most effective modes of esthetic expression. For optimal daylighting, the following design factors should be considered:

1. Variations in the amount and direction of the incident daylight

2. Luminance (photometric brightness) and luminance distribution of clear, partly cloudy, and overcast skies

3. Variations in sunlight intensity and direction

4. Effect of local terrain, landscaping, and nearby buildings on the available light.[11]

The CEL-1 program's energy profile feature allows the lighting designer to perform repeated analyses on various design options to obtain a lighting layout that, when coupled with daylight, will consume the least amount of electrical energy without sacrificing illuminance levels within the building. A complete description of the algorithms used by CEL-1 is in the *CEL-1 Lighting Computer Program - Programmer's Guide.*

---

[11] *IES Lighting Handbook: Reference Volume.*

6 FIELD-TESTING

In November 1985, the USACE Kansas City District reviewed the initial LITE program. Based on the District's suggestions, the LITE program was enhanced with IES Zonal Cavity method calculations and a broader data base. In addition, the LCHG program was developed to support the luminaire data base file, LUMAIR. The District also helped develop the program user interface with standard electrical engineering nomenclature.

USA-CERL conducted initial field training for the revised LITE program at the Kansas City and Omaha Districts in April 1986. A LITE/CEL-1 Test Plan (Appendix C) was presented to the Districts at the same time. Kansas City has agreed to participate in the formal field test using a project for which the concept design phase was completed in January 1987. In addition, Sacramento District began field-testing LITE/CEL-1 in January 1987.

Meanwhile, LITE has been enhanced further to include more accurate data values for the calculations and a feature for adding exit lights and floodlights into the data base. LITE was also upgraded to conform to analysis guidelines specified within Standard Drawing Number 40-06-04. A fixture schedule can now be produced along with the luminaire summary report using REPORT mode.

7 CONCLUSION

A graphic module for lighting design analysis has been developed as a subsystem of CAEADS. The program, called LITE, provides electrical engineers with an automated tool for designing a lighting system in a building during the first 35 percent of the design process.

LITE allows the user to graphically lay out a reflected ceiling plan and perform simple lighting calculations using the IES Zonal Cavity method. It also contains a preprocessor interface to the CEL-1 program for daylighting studies to optimize the building's energy efficiency. LITE builds a CEL-1 input deck from variables that have been entered into the LITE data base. Each project is stored as a separate file on the computer and reports and plots can be generated.

The LCHG program also has been developed to maintain the luminaire data base file LUMAIR, which LITE uses for illuminance calculations. This data base is independent of all other projects and can store an unlimited number of luminaires.

LITE has been subjected to informal reviews and has been enhanced based on the results. Formal field-testing began in early FY87. The LITE/CEL-1 designs are being compared with those using manual calculations and commercially available lighting programs.

A future version of LITE is expected to integrate the LITE data base with the ENERGY data base and BLAST energy calculations.

CITED REFERENCES

ARCH User's Manual (Draft) (U. S. Army Construction Engineering Research Laboratory [USA-CERL], 1986).

ASHRAE Proposed Standard 90.1P, *Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings* (1986).

CEL-1 Lighting Computer Program - Programmer's Guide, CR 83.009 (Naval Civil Engineering Laboratory [NCEL], January 1983).

CEL-1 Lighting Computer Program - User's Guide, CR 81.026 (NCEL, January 1983).

DOD 4270.1-M, *Construction Criteria Manual* (U. S. Department of Defense [DOD], 1983).

Engineer Technical Letter (ETL), *Energy Conservation Design (Including Design Energy Targets)* (Draft) (Office of the Chief of Engineers [OCE], 1986).

IES Lighting Handbook: Reference Volume (Illuminating Engineering Society of North America, New York, 1981).

LITE User's Manual (Draft) (USA-CERL, 30 May 1986).

Spoonamore, J., *CAEADS-Computer-Aided Engineering and Architectural Design System*, Technical Report P-133/ADA117972 (USA-CERL, August 1982).

Standard Drawing Number 40-06-04, *Lighting Fixtures* (OCE, November 1980).

UNCITED REFERENCE

Engineer Regulation (ER) 1110-345-700, *Design Analyses* (OCE, 19 February 1982).

APPENDIX A:

EXAMPLE LCHG SESSION AND OUTPUT

Some features of LCHG can be illustrated through the following example session. Detailed instructions for completing an LCHG session are in the *LITE User's Manual*, Appendix A.

The LCHG program can be accessed through any terminal. It will automatically retrieve the LUMAIR file from the users's current account number. Only one person at a time can edit a specific LUMAIR file.

During the session, the user types responses to prompts from the program. Each entry must be terminated by a carriage return (<cr>). The program retains these responses and may display them again during a selection process. Entering <cr> to a prompt typically indicates that the displayed choice is to be retained as a value. To change an entry, the user simply types the new value in response to the program prompt.

To use LCHG, the user must first complete the signon process for the Harris computer. Then, the LCHG session is initiated by typing LCHG followed by a <cr>.

:LCHG <cr>

```
---------------------------------------------------
WELCOME TO LCHG              VERSION: 1    LEVEL: 0
---------------------------------------------------

Type "L" to list MAIN MENU commands

MAIN MENU COMMAND?:  L <cr>

     L  LIST COMMANDS
     E  EXIT

     P  PRINT LIST OF LUMINAIRE TYPES
     K  PRINT INDIVIDUAL LUMINAIRE DATA

     A  ADD LUMINAIRE TO DATA FILE
     C  CHANGE INDIVIDUAL LUMINAIRE DATA
     D  DELETE INDIVIDUAL LUMINAIRE DATA

     R  REPORT

MAIN MENU COMMAND?:P <cr>
    1. 2X4-2 LAMP GRID TRO
    2. HIGH INT. DIS. T503
    3. HID FLOODLIGHT/RECT
    4. EM. UNIT W/6 VOLT F

MAIN MENU COMMAND?:K <cr>

     ENTER LUMINAIRE DATA TYPE (0):1 <cr>
    1. 2X4-2 LAMP GRID TRO    IES#:        41   LENGTH:  48.00   GAIN:     0.00
       TYPE: 206A             LUMENS:    5600   WIDTH:   12.00   COEFA:    0.00
```

```
SHEET NO: 19          WATTS/F:  100   HEIGHT:    0.00   COEFB:   0.00
LAMP: F40CW/RS        WATTS/L:   40   S/HM:      1.20   COEFC:   0.00
RECESSED              #LAMPS:     2   FLF:      95.00   VLT/F:    277

MAIN MENU COMMAND?:A
     IS THIS A SPECIAL FIXTURE?
     (EXIT LIGHT, SPOTLIGHT, ETC):N <cr>
     ENTER TYPE TO START WITH,
     OR HIT RETURN FOR NONE: <cr>
     DESCRIPTION  ( ):2X4-4 LAMP GRID TROF <cr>
     TYPE         ( ):206C <cr>
     SHEET NO.    ( ):19 <cr>
     LAMP TYPE    ( ):FLUORESCENT <cr>
     LAMP DESC.   ( ):F40CW/RS <cr>
     MOUNTING DESC( ):RECESSED <cr>
     # OF LAMPS (0.00):4 <cr>
     WATTS PER LAMP (0.00):40 <cr>
     WATTS PER FIXTURE (0.00):200 <cr>
     FIXTURE VOLTAGE (0.00):277 <cr>
     WIDTH OF LUM. OPENING (0.00): <cr>
     LENGTH OF LUM. OPENING (0.00): <cr>
     HEIGHT (0.00):0 <cr>
     S/MH RATIO (0.00):1.2 <cr>
     ENTER IES LUMINAIRE NUMBER (0):41 <cr>
     INITIAL LUMENS (0.00):11400 <cr>
     FIXTURE LOSS FACTOR (0.00):95 <cr>
     WILL THIS LUMINAIRE BE DIMMED?:N <cr>  (because the user said no,
                                             the gain and quadratic
                                             coefficients are initialized
     TABLE HEADINGS FOR WALL                 to zero.)
    REFLECTANCE(50.,30.,10.):
     OK?:<cr>                               (<cr> means yes)
     TABLE HEADINGS FOR EFF. CLG.
    REFLECTANCE(80.,70.,50.,30.,10.):
     OK?: <cr>                              (<cr> means yes)
```

PCC	80.			70.			50.			30.			10.			
PW	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	
RCR 1	.61	.59	.57	.59	.58	.56	.57	.56	.54	.55	.54	.53	.53	.52	.51	<cr>
RCR 2	.55	.52	.50	.54	.52	.49	.52	.50	.48	.50	.48	.47	.49	.47	.46	<cr>
RCR 3	.50	.46	.43	.49	.46	.43	.47	.45	.42	.46	.44	.42	.45	.43	.41	<cr>
RCR 4	.45	.41	.38	.45	.41	.38	.43	.40	.38	.42	.39	.37	.41	.39	.37	<cr>
RCR 5	.41	.37	.34	.40	.36	.34	.39	.36	.33	.38	.35	.33	.37	.35	.33	<cr>
RCR 6	.37	.33	.30	.37	.33	.30	.36	.32	.30	.35	.32	.29	.34	.31	.29	<cr>
RCR 7	.37	.30	.27	.34	.29	.27	.33	.29	.26	.32	.29	.26	.31	.28	.26	<cr>
RCR 8	.31	.26	.24	.30	.26	.23	.30	.26	.23	.29	.26	.23	.28	.25	.23	<cr>
RCR 9	.28	.23	.21	.27	.23	.21	.27	.23	.20	.26	.23	.20	.26	.23	.20	<cr>
RCR 10	.25	.21	.18	.25	.21	.18	.24	.21	.18	.24	.21	.18	.23	.20	.18	<cr>

```
MAIN MENU COMMAND?:A <cr>
     IS THIS A SPECIAL FIXTURE?
     (EXIT LIGHT, SPOTLIGHT, ETC):Y <cr>
     ENTER TYPE TO START WITH,
     OR HIT RETURN FOR NONE: <cr>
     DESCRIPTION   ( ):EXIT LIGHT 605A3 <cr>
     TYPE          ( ):605A3 <cr>
     SHEET NO.     ( ):56 <cr>
     LAMP TYPE     ( ):INCANDESCENT <cr>
     LAMP DESC.    ( ): <cr>
     MOUNTING DESC( ):1' ABOVE DOOR <cr>
     # OF LAMPS (0.00):2 <cr>
     WATTS PER LAMP (0.00):20 <cr>
     WATTS PER FIXTURE (0.00):40 <cr>
     FIXTURE VOLTAGE (0.00):277 <cr>
```

```
MAIN MENU COMMAND?:P <cr>
    1. 2X4-2 LAMP GRID TRO
    2. HIGH INT. DIS. T503
    3. HID FLOODLIGHT/RECT
    4. EM. UNIT W/6 VOLT F
    5. 2X4-4 LAMP GRID TRO
    6. EXIT LIGHT 605A3
```

```
MAIN MENU COMMAND?:C <cr>
     ENTER LUMINAIRE DATA TYPE (   6):5 <cr>

     CHANGING THE FOLLOWING LUMINAIRE TYPE:
    5. 2X4-4 LAMP GRID TRO    IES#:         41   LENGTH:  48.00   GAIN:     0.00
       TYPE: 206C             LUMENS: 11400      WIDTH:   12.00   COEFA:    0.00
       SHEET NO: 19           WATTS/F:   200     HEIGHT:   0.00   COEFB:    0.00
       LAMP: F40CW/RS         WATTS/L:    40     S/HM:     1.20   COEFC:    0.00
       RECESSED               #LAMPS:      4     FLF:     95.00   VLT/F:     277
```

```
Type "L" to list CHANGE MODE commands

CHANGE MODE COMMAND?:L <cr>

     N  NAME AND DESCRIPTION
     H  IES HANDBOOK NUMBER
     I  INITIAL LUMENS
     F  FIXTURE LOSS FACTOR
     D  DIMENSIONS
     W  WATTS PER FIXTURE
     J  # OF LAMPS/WATTS PER LAMP
     S  S/MH RATIO
     V  FIXTURE VOLTAGE
     G  MINIMUM GAIN
     Q  QUADRATIC COEFFICIENTS
     C  CU TABLE

     R  RETURN TO MAIN MENU


CHANGE MODE COMMAND?:G <cr>                 (to change gain)
     MINIMUM GAIN (0.00):0.2 <cr>


CHANGE MODE COMMAND?:Q <cr>                 (to change quadratic coefficient)
     FIRST ORDER COEF. (0.00):-49 <cr>
     SECOND ORDER COEF. (0.00):150 <cr>
     CONSTANT (0.00):1 <cr>


CHANGE MODE COMMAND?:R <cr>                 (to return to Main Menu)


MAIN MENU COMMAND?:K <cr>
     ENTER LUMINAIRE DATA TYPE (  5): <cr>  (current type already 5)
   5. 2X4-4 LAMP GRID TRO   IES#:       41   LENGTH:  48.00   GAIN:     0.20
      TYPE: 206C            LUMENS: 11400   WIDTH:   12.00   COEFA:  -49.00
      SHEET NO: 19          WATTS/F:   200   HEIGHT:   0.00   COEFB:  150.00
      LAMP: F40CW/RS        WATTS/L:    40   S/HM:     1.20   COEFC:    1.00
      RECESSED              #LAMPS:      4   FLF:     95.00   VLT/F:     277


MAIN MENU COMMAND?:D <cr>
     ENTER LUMINAIRE DATA TYPE (  5):LIST <cr>
   1. 2X4-2 LAMP GRID TRO
   2. HIGH INT. DIS. T503
   3. HID FLOODLIGHT/RECT
   4. EM. UNIT W/6 VOLT F
   5. 2X4-4 LAMP GRID TRO
   6. EXIT LIGHT 605A3
```

```
 ENTER LUMINAIRE DATA TYPE (  5):2 <cr>
 DELETING THE FOLLOWING LUMINAIRE TYPE:
2. HIGH INT. DIS. T503   IES#:        0   LENGTH:   0.00   GAIN:     0.00
   TYPE: 503C            LUMENS:      0   WIDTH:    0.00   COEFA:    0.00
   SHEET NO: 46          WATTS/F:   300   HEIGHT:   0.00   COEFB:    0.00
   LAMP: C250S50         WATTS/L:   250   S/HM:     0.00   COEFC:    0.00
   1' ABOVE DOOR         #LAMPS:      1   FLF:      0.00   VLT/F:     277


 DO YOU STILL WANT TO DELETE IT?Y <cr>


MAIN MENU COMMAND?:R <cr>
     ENTER SUMMARY FILE NAME: DATARPT <cr>


MAIN MENU COMMAND?:E <cr>

:LCHG COMPLETE
```

In the example, the user created a report and named it DATARPT. The printed report is shown in Figure A1. Note that during initialization of all the special fixtures, the CU table was skipped along with a few other unnecessary variables. These variables will still be shown in the data file summary, but will have a zero value.

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1. 2X4-2 LAMP GRID TRO	IES#:	41	LENGTH:	48.00	GAIN:	0.00
TYPE: 206A	LUMENS:	5600	WIDTH:	12.00	COEFA:	0.00
SHEET NO: 19	WATTS/F:	100	HEIGHT:	0.00	COEFB:	0.00
LAMP: F40CW/RS	WATTS/L:	40	S/HM:	1.20	COEFC:	0.00
RECESSED	#LAMPS:	2	FLF:	95.00	VLT/F:	277

PCC	80.			70.			50.			30.			10.		
PW	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.
RCR 1	.65	.63	.61	.63	.62	.60	.61	.59	.58	.59	.57	.56	.57	.56	.55
RCR 2	.59	.55	.53	.57	.55	.52	.55	.53	.51	.54	.52	.50	.52	.50	.49
RCR 3	.53	.49	.46	.52	.49	.46	.50	.47	.45	.49	.46	.44	.47	.45	.43
RCR 4	.48	.44	.40	.47	.43	.40	.46	.42	.40	.45	.42	.39	.43	.42	.39
RCR 5	.43	.39	.35	.43	.38	.35	.42	.38	.35	.40	.37	.34	.39	.36	.34
RCR 6	.39	.35	.31	.39	.34	.31	.38	.34	.31	.37	.33	.31	.36	.33	.31
RCR 7	.36	.31	.28	.35	.31	.28	.34	.30	.27	.33	.30	.27	.33	.30	.27
RCR 8	.32	.27	.24	.32	.27	.24	.31	.27	.24	.30	.27	.24	.30	.26	.24
RCR 9	.29	.24	.21	.29	.24	.21	.28	.24	.21	.27	.24	.21	.27	.23	.21
RCR 10	.26	.22	.19	.26	.22	.19	.25	.21	.19	.25	.21	.29	.24	.21	.18

2. HID FLOODLIGHT/RECT	IES#:	0	LENGTH:	0.00	GAIN:	0.00
TYPE: 506C	LUMENS:	0	WIDTH:	0.00	COEFA:	0.00
SHEET NO: 49	WATTS/F:	200	HEIGHT:	0.00	COEFB:	0.00
LAMP:	WATTS/L:	150	S/HM:	0.00	COEFC:	0.00
WALL BRACKET MTG.	#LAMPS:	1	FLF:	0.00	VLT/F:	277

PCC	80.			70.			50.			30.			10.		
PW	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.
RCR 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 4	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Figure A1. Sample LCHG output report.

3\. EM. UNIT W/6 VOLT F

TYPE: 603	IES#:	0	LENGTH:	0.00	GAIN:	0.00
SHEET NO: 54	LUMENS:	0	WIDTH:	0.00	COEFA:	0.00
LAMP:	WATTS/F:	0	HEIGHT:	0.00	COEFB:	0.00
WALL MTG.	WATTS/L:	0	S/HM:	0.00	COEFC:	0.00
	#LAMPS:	2	FLF:	0.00	VLT/F:	120

PCC	80.			70.			50.			30.			10.		
PW	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.
RCR 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 4	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

4\. 2X4-4 LAMP GRID TRO

TYPE: 206C	IES#:	41	LENGTH:	48.00	GAIN:	0.20
SHEET NO: 19	LUMENS:	11400	WIDTH:	12.00	COEFA:	-49.00
LAMP: F40CW/RS	WATTS/F:	200	HEIGHT:	0.00	COEFB:	150.00
RECESSED	WATTS/L:	40	S/HM:	1.20	COEFC:	1.00
	#LAMPS:	4	FLF:	95.00	VLT/F:	277

PCC	80.			70.			50.			30.			10.		
PW	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.
RCR 1	.61	.59	.57	.59	.58	.56	.57	.56	.54	.55	.54	.53	.53	.52	.51
RCR 2	.55	.52	.50	.54	.52	.49	.52	.50	.48	.50	.48	.47	.49	.47	.46
RCR 3	.50	.46	.43	.49	.46	.43	.47	.45	.42	.46	.44	.42	.45	.43	.41
RCR 4	.45	.41	.38	.45	.41	.38	.43	.40	.38	.42	.39	.37	.41	.39	.37
RCR 5	.41	.37	.34	.40	.36	.34	.39	.36	.33	.38	.35	.33	.37	.35	.33
RCR 6	.37	.33	.30	.37	.33	.30	.36	.32	.30	.35	.32	.29	.34	.31	.29
RCR 7	.34	.30	.27	.34	.29	.27	.33	.29	.26	.32	.29	.26	.31	.28	.26
RCR 8	.31	.26	.24	.30	.26	.23	.30	.26	.23	.29	.26	.23	.28	.25	.23
RCR 9	.28	.23	.21	.27	.23	.21	.27	.23	.20	.26	.23	.20	.26	.23	.20
RCR 10	.25	.21	.18	.25	.21	.18	.24	.21	.18	.24	.21	.18	.23	.20	.18

Figure A1 (Cont'd)

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5. EXIT LIGHT 605A3	IES#:	0	LENGTH:	0.00	GAIN:	0.00
TYPE: 605A3	LUMENS:	0	WIDTH:	0.00	COEFA:	0.00
SHEET NO: 56	WATTS/F:	40	HEIGHT:	0.00	COEFB:	0.00
LAMP:	WATTS/L:	20	S/HM:	0.00	COEFC:	0.00
1' ABOVE DOOR	#LAMPS:	2	FLF:	0.00	VLT/F:	277

PCC	80.			70.			50.			30.			10.		
PW	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.	50.	30.	10.
RCR 1	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 2	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 3	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 4	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 5	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 6	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 8	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 9	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
RCR 10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00

Figure A1 (Cont'd).

APPENDIX B:

EXAMPLE LITE SESSION AND OUTPUT

Some of LITE's features can be illustrated through the following example session. Detailed instructions for completing a LITE session are in the *LITE User's Manual*.

During a session, the user types responses to prompts from the program. The program retains these responses and may display them again during a selection process. Entering <cr> to a prompt typically indicates that a displayed choice is to be retained as a value. To change an entry, the user simply types the new value in response to the program prompt.

The following abbreviations are used here to describe the computer/user interaction:

<cr> - carriage return

C: - computer response or prompt

U: - a user response or action

! - stop current action.

Computer prompts are designated by capital letters whereas user responses and any explanations of expected actions are lower-cased.

The following example assumes that an architect has already entered the building floor plan into the ARCH program. To execute LITE, the following steps are required:

1. Access the Harris computer with a Tektronix 4109, 4014, or 4113 terminal or its equal. Enter appropriate responses to the prompts for signing on to the computer.

2. To execute LITE:

U: type LITE <cr>

C: --
WELCOME TO LITE VERSION: 1 LEVEL: 0

ENTER TERMINAL TYPE( ):

U: 1. enter <cr> if the type in parentheses is correct, or
2. enter the appropriate terminal type <cr>
(e.g., T4109)

C: when LITE has been loaded, the screen is erased and the program prompts:
ENTER PROJECT NAME:

U: enter the project name desired <cr>

C: 1. if the LITE file cannot be found, the program prompts with:

NEW LITE PROJECT:
U: 1. Y <cr>, or
2. N <cr> causes program to ask for another project name

C: ENTER EXISTING PROJECT TO START WITH OR HIT RETURN FOR NONE:

U: 1. <cr> if there is no existing project, or
2. enter the name of an existing project to start with followed by <cr>

2. if the project is found, LITE will begin drawing. For multi-story buildings, the last floor accessed during the last LITE session will be drawn on the screen.

3. The LITE session can now proceed. The program erases the screen and draws the menu and the ARCH building layout (Figure B1). If a LITE project file was found, the program will also draw the current reflected ceiling plan. The program begins in MENU COMMAND mode.

Cell Edit Mode

The user starts by setting up the cell definitions in CELL EDIT mode (Figure B2). The crosshairs are placed over the correct menu box, and any alphanumeric key is pressed. Once inside the CELL EDIT mode, the user types A and responds to the computer using the crosshairs if a location is desired or using the keyboard if the computer issues a written prompt. To redraw at any time, the user types R.

In Figure B2, the user initializes the cell for room 101A and checks the footcandle level, dirt depreciation factor, and occupancy schedule. Note the use of the "!" symbol to indicate that no more occupancy factors are to be changed. Room 100 is also shown initialized. The user then initializes all the other rooms in the same way and redraws the screen to clear the construction lines and marks.

Ceiling Grid Mode

After the cells have been initialized, the user enters the CEILING GRID mode by placing the crosshairs over the correct menu box and striking an alphanumeric key. The ceiling grids may now be placed and shifted to suit the user's intended layout.

As explained in Chapter 4, there is a ZOOMIN function in every mode. The screen in Figure B3 shows only a portion of the building as defined by the user through the zoomin command.

In Figure B3, the user places a grid in rooms 100, 101, 107, 108, and 109. Since the ceiling grids in rooms 100 and 101 should align, the grid in room 101 is shifted to create a continuous grid system between the two rooms. A grid is added to room 101A and then deleted. For the rest of this example, work will be concentrated within the seven rooms

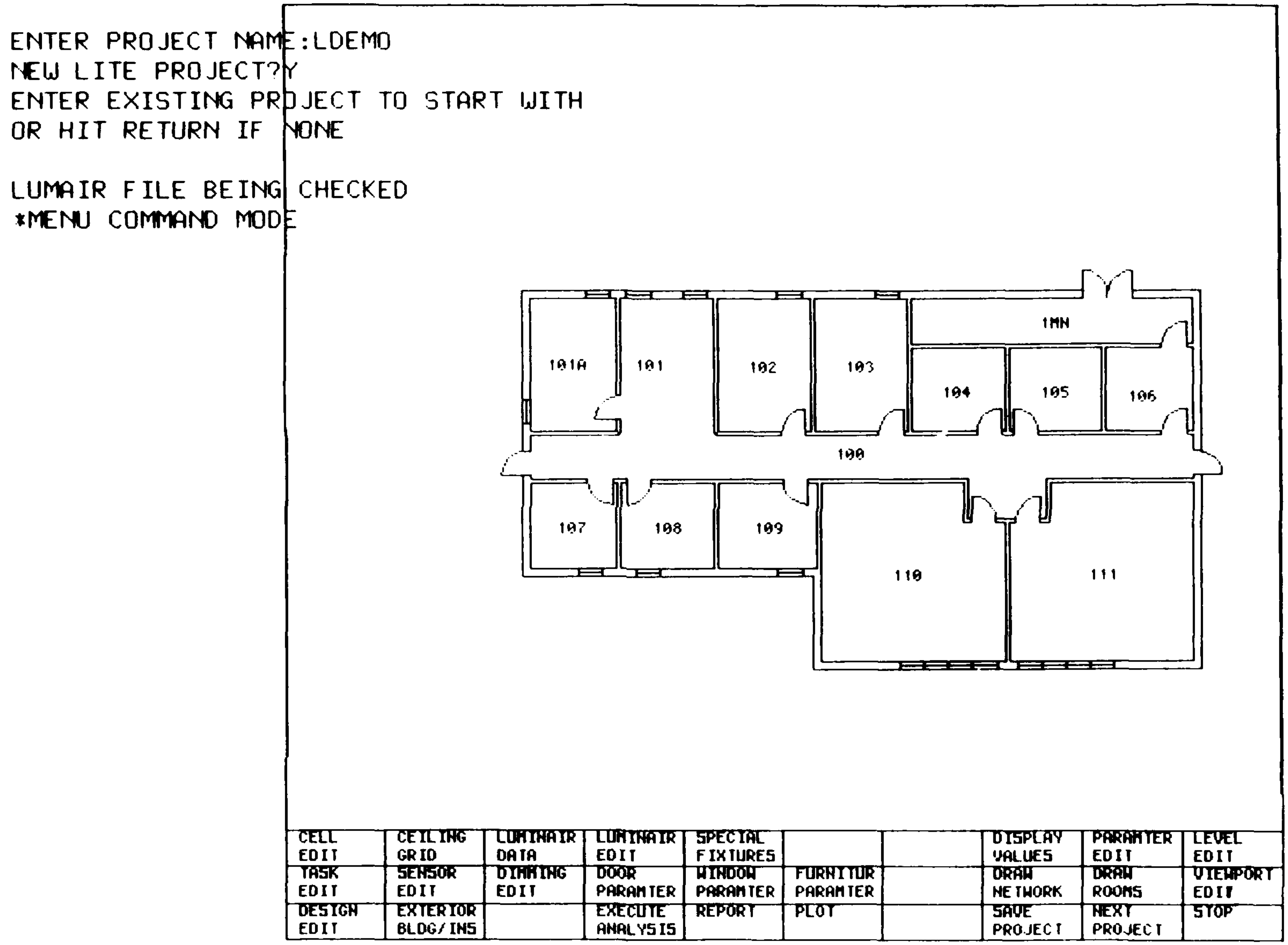
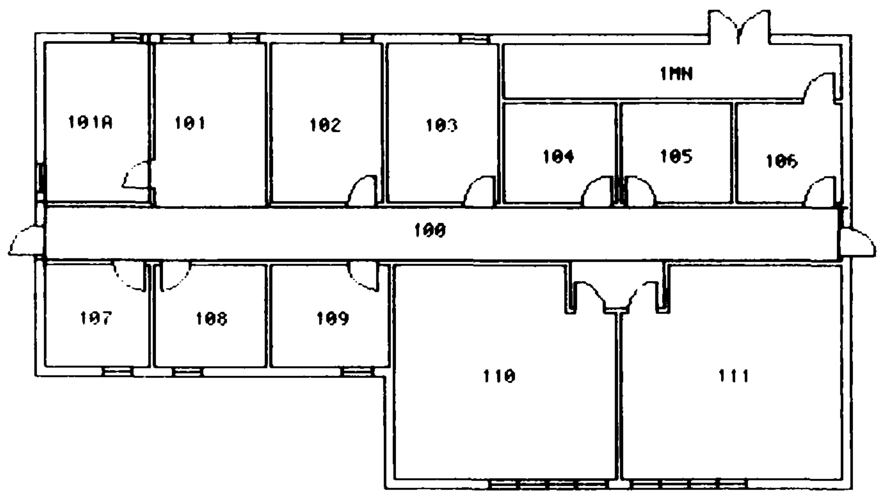


Figure B1. Initial screen in LITE—MENU COMMAND mode.

```
*CELL EDIT MODE
LOCATE LOWER LEFT.
LOCATE UPPER RIGHT.
OK?Y
*CELL EDIT MODE
FOOTCANDLE LEVEL (50):
*CELL EDIT MODE
DIRT DEPRECIATION FACTOR (0.70):
*CELL EDIT MODE
HOURS AND FRACTIONS
PRESENTLY OCCUPIED:
 8. (0700-0800)   1.00
 9. (0800-0900)   1.00
10. (0500-1000)   1.00
11. (1000-1100)   1.00
12. (1100-1200)   1.00
13. (1200-1300)   1.00
14. (1300-1400)   1.00
15. (1400-1500)   1.00
16. (1500-1600)   1.00
ANY CHANGES?:Y
TYPE "L" TO SEE SCHEDULE AGAIN
ENTER HOUR NUMBER AND FRACTION
OCCUPIED ("D" FOR DEFAULT FRACTION):13 .5
ENTER HOUR NUMBER AND FRACTION
OCCUPIED ("D" FOR DEFAULT FRACTION):!
*CELL EDIT MODE
```



CELL EDIT	CEILING GRID	LUMINAIR DATA	LUMINAIR EDIT	SPECIAL FIXTURES			DISPLAY VALUES	PARAMTER EDIT	LEVEL EDIT
TASK EDIT	SENSOR EDIT	DIMMING EDIT	DOOR PARAMTER	WINDOW PARAMTER	FURNITUR PARAMTER		DRAW NETWOK	DRAW ROOMS	VIEWPORT EDIT
DESIGN EDIT	EXTERIOR BLDG/INS		EXECUTE ANALYSIS	REPORT	PLOT		SAVE PROJECT	NEXT PROJECT	STOP

Figure B2. CELL EDIT mode.

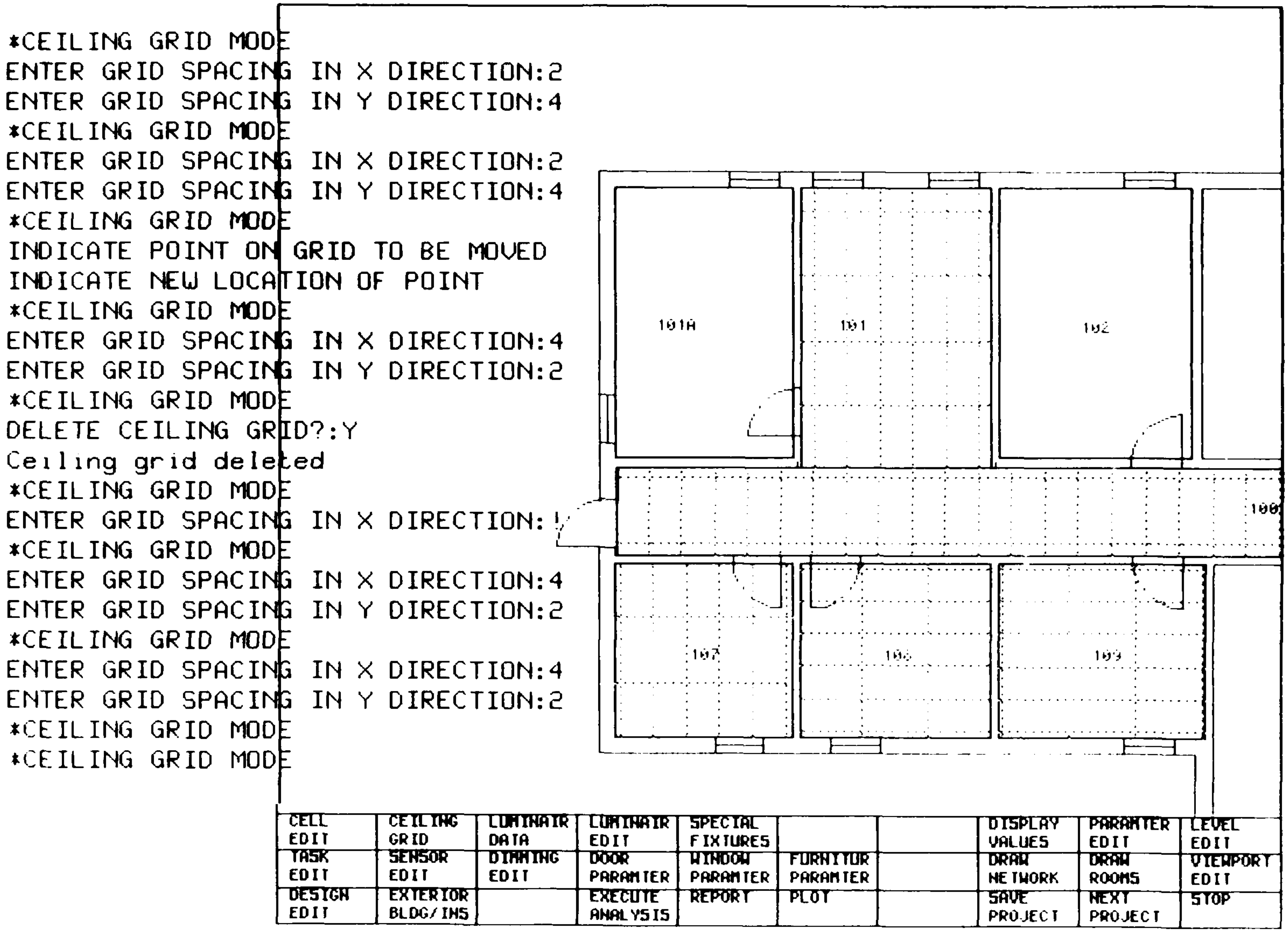


Figure B3. CEILING GRID mode.

shown on the screen. After shifting the grid, the user must redraw the screen to remove the old grid.

Luminair Data and Luminair Edit Modes

At this point or at any other time during a LITE session, the LUMINAIR DATA mode can be accessed to review the luminaires in the data file. This mode has no other purpose except to display this information (Figure B4).

The user enters the LUMINAIR EDIT mode where most of the lighting analysis is performed. If not done already, the desired luminaire types are read from the LUMAIR file into the project data base. In this example, the user chooses to use data types 1, 2, 4, and 5. Figure B4 also illustrates that the data file is numbered sequentially, whereas the project data file is referenced alphabetically.

Once the luminaire types have been read into the data file, fixtures are added to the reflected ceiling plan (Figure B5). For room 101A, the number of fixtures required is calculated and luminaires are added to the plan via the group command using layout pattern 1. Then the footcandle level is checked. Eight luminaires are added to room 100, again using the group command; however, pattern 5 is used where the user specifies the spacing in each direction.

The procedure used for room 107 is exactly the same as that for room 101A (Figure B6). Since room 108 is the same size as room 107, the user decides to add two luminaires individually instead of using the group command. Note that the program still centers the luminaires within the ceiling grid tiles, but must now ask for the rotation of the luminaire within the plan (bearing). Then the footcandles are checked for room 108.

Since rooms 101 and 102 are similar, the fixture calculation will be the same. In Figure B7, the user decides to use fixture type A, which requires six luminaires. The luminaires are placed using the group command and pattern 3. The command to calculate footcandle levels shows the installed level to be 51.2 fc in room 102. Two luminaires are placed in room 109.

Special Fixtures Mode

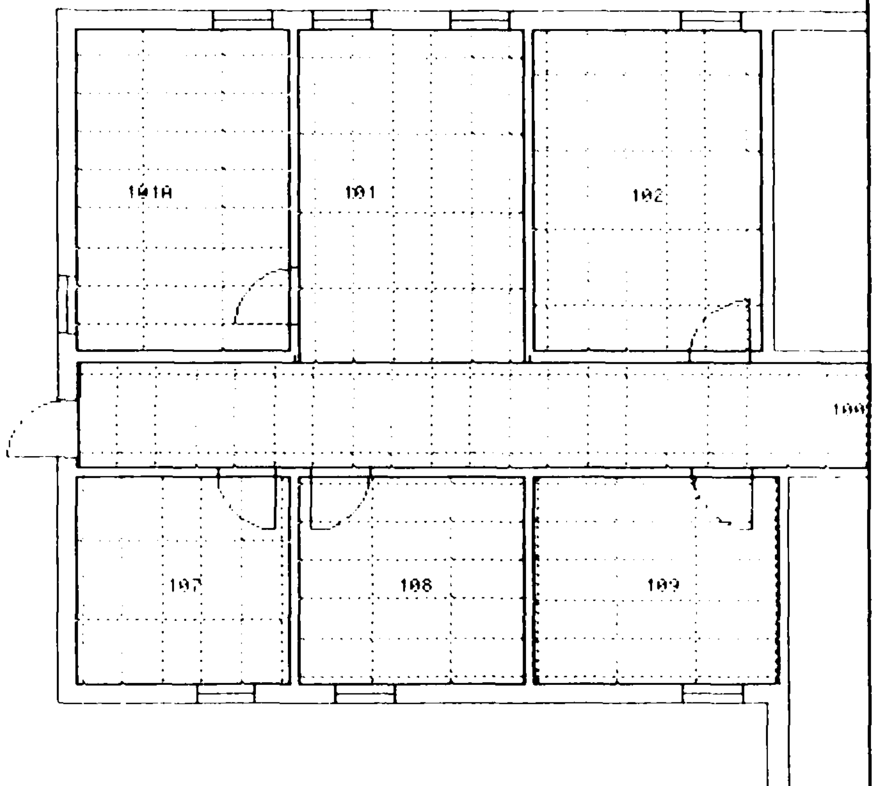
The user now enters the SPECIAL FIXTURES mode to add an exit light and outdoor floodlight to the plan (Figure B8). Even though these fixtures are not used for illuminance calculations, they will still appear in the lighting summary and fixture schedule reports. Note that the user first executes the L command to list the commands available in this mode.

Task Edit Mode

Depending on a room's intended function, the user can specify individual task locations based on the furniture layout or a grid of unknown locations for rooms with no furniture specified.

The architect has already defined the furniture layout using the ARCH program. To keep the screen less cluttered, the LITE program makes the furniture invisible. The lighting engineer can use PARAMTER EDIT to make the furniture visible if desired and

```
*LUMINAIR DATA MODE
  1. 2X4-2 LAMP GRID TRO
  2. HID FLOODLIGHT/RECT
  3. EM. UNIT W/6 VOLT F
  4. 2X4-4 LAMP GRID TRO
  5. EXIT LIGHT 605A3
*LUMINAIR DATA MODE
*LUMINAIR EDIT MODE
ENTER LUMINAIRE DATA TYPE (0):1
*LUMINAIR EDIT MODE
ENTER LUMINAIRE DATA TYPE (   1):4
*LUMINAIR EDIT MODE
ENTER LUMINAIRE DATA TYPE (   4):5
*LUMINAIR EDIT MODE
ENTER LUMINAIRE DATA TYPE (   5):2
*LUMINAIR EDIT MODE
A. 2X4-2 LAMP GRID TRO
B. 2X4-4 LAMP GRID TRO
C. EXIT LIGHT 605A3
D. HID FLOODLIGHT/RECT
*LUMINAIR EDIT MODE
```



CELL EDIT	CEILING GRID	LUMINAIR DATA	LUMINAIR EDIT	SPECIAL FIXTURES			DISPLAY VALUES	PARAMTER EDIT	LEVEL EDIT
TASK EDIT	SENSOR EDIT	DIMMING EDIT	DOOR PARAMTER	WINDOW PARAMTER	FURNITUR PARAMTER		DRAW NETWORK	DRAW ROOMS	VIEWPORT EDIT
DESIGN EDIT	EXTERIOR BLDG/INS		EXECUTE ANALYSIS	REPORT	PLOT		SAVE PROJECT	NEXT PROJECT	STOP

Figure B4. LUMINAIR DATA and LUMINAIR EDIT modes.

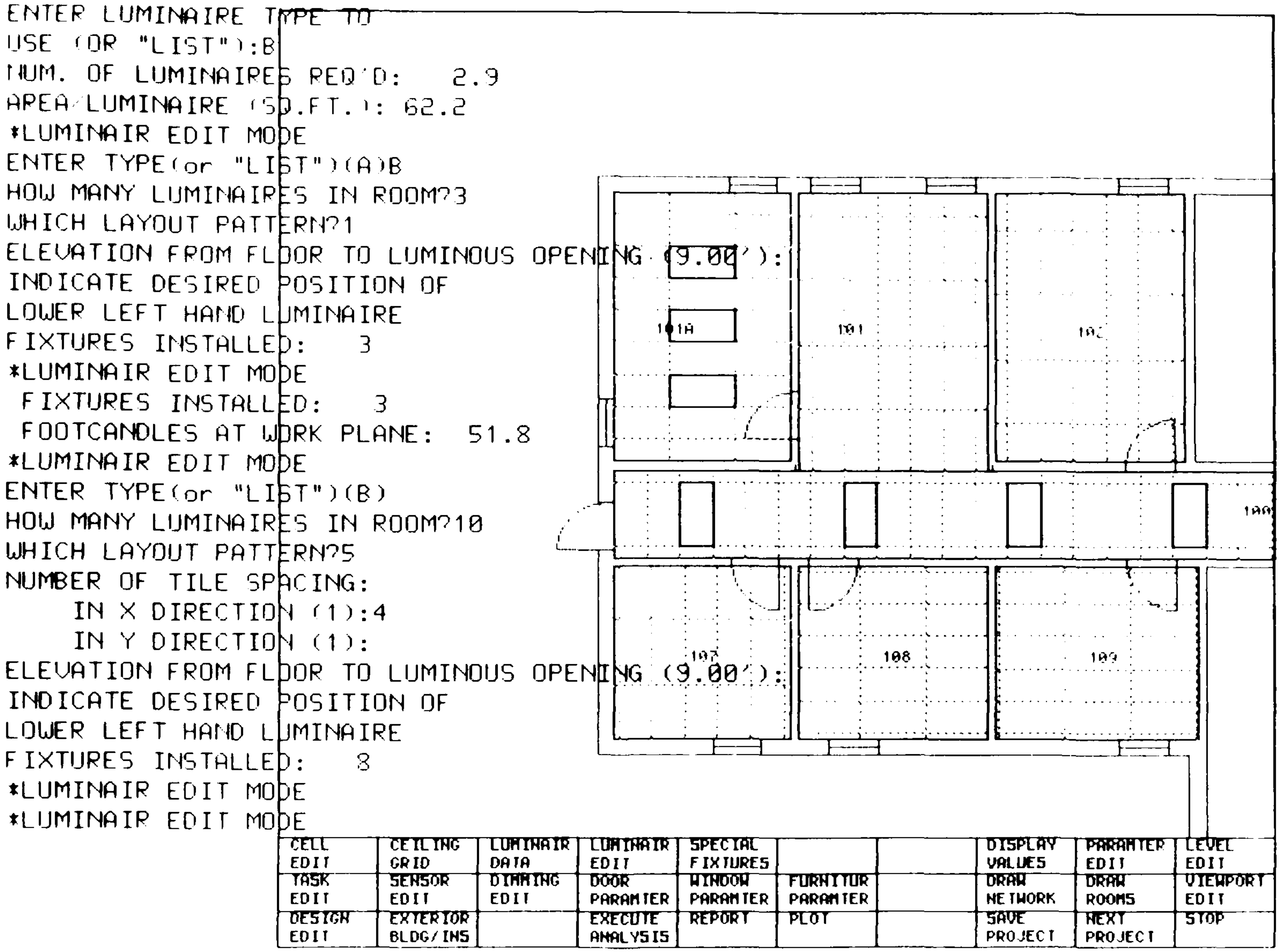


Figure B5. Luminaires for rooms 101A and 100.

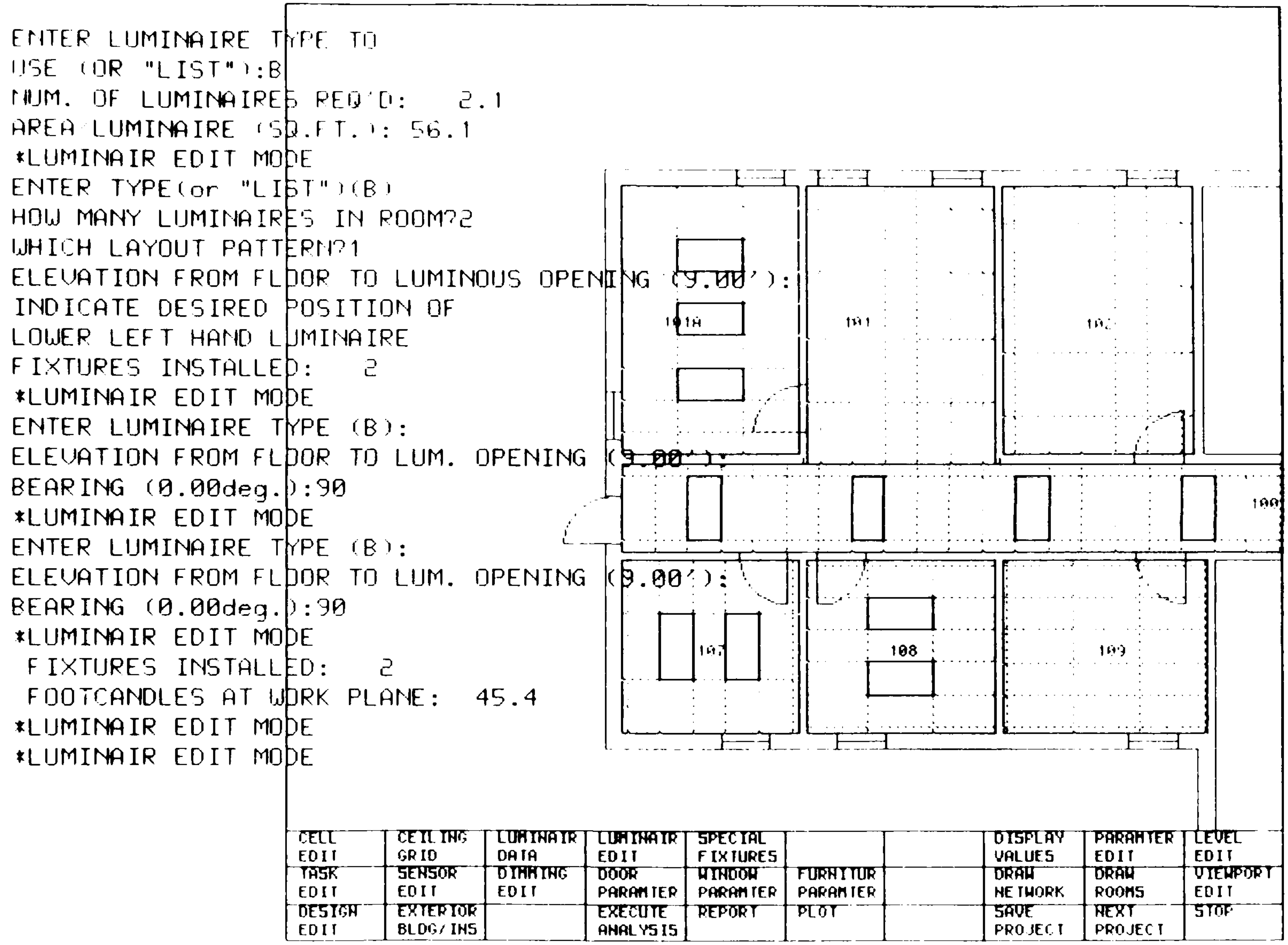


Figure B6. Luminaires for rooms 107 and 108.

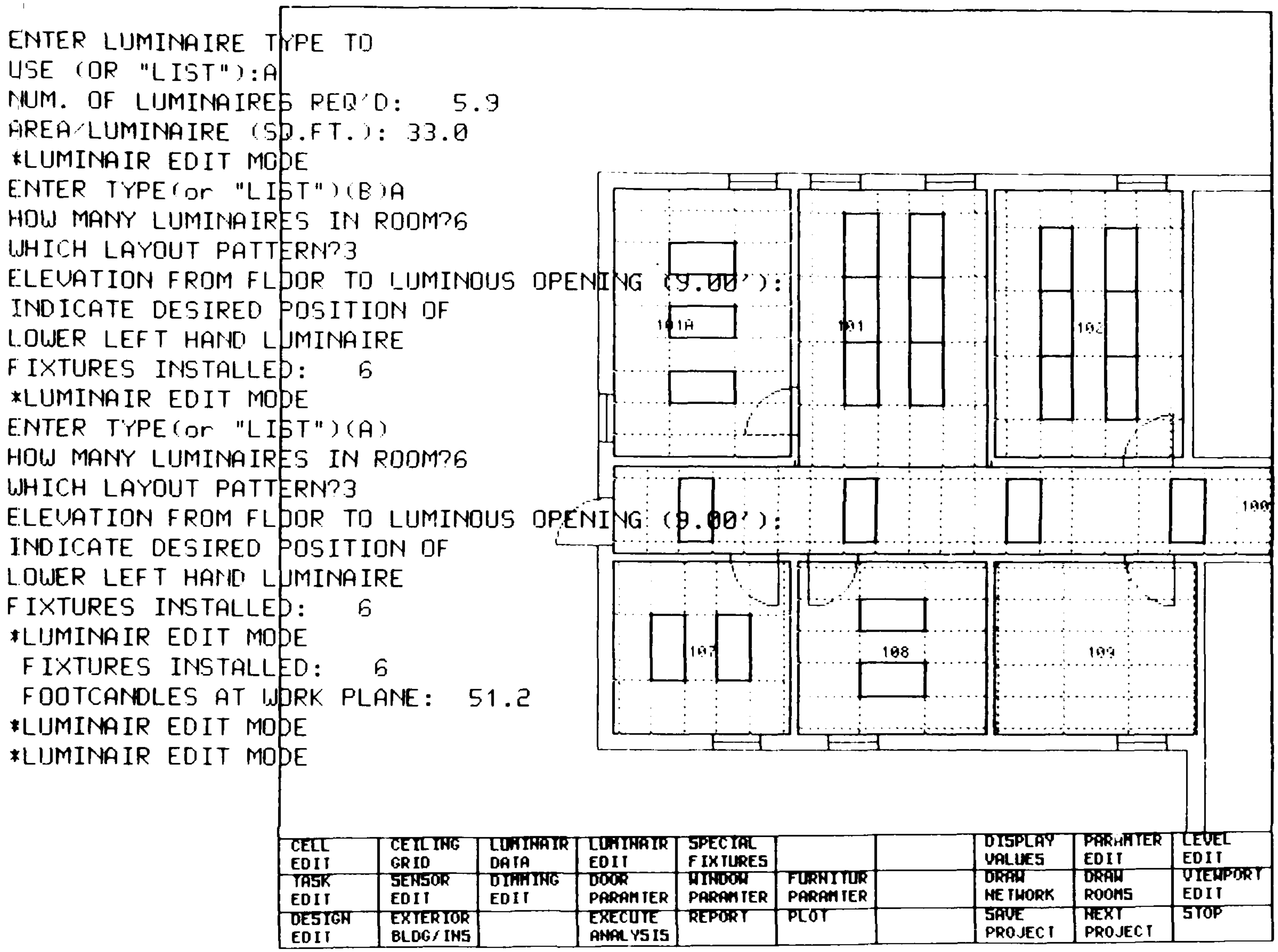


Figure B7. Luminaires for rooms 101, 102, and 109.

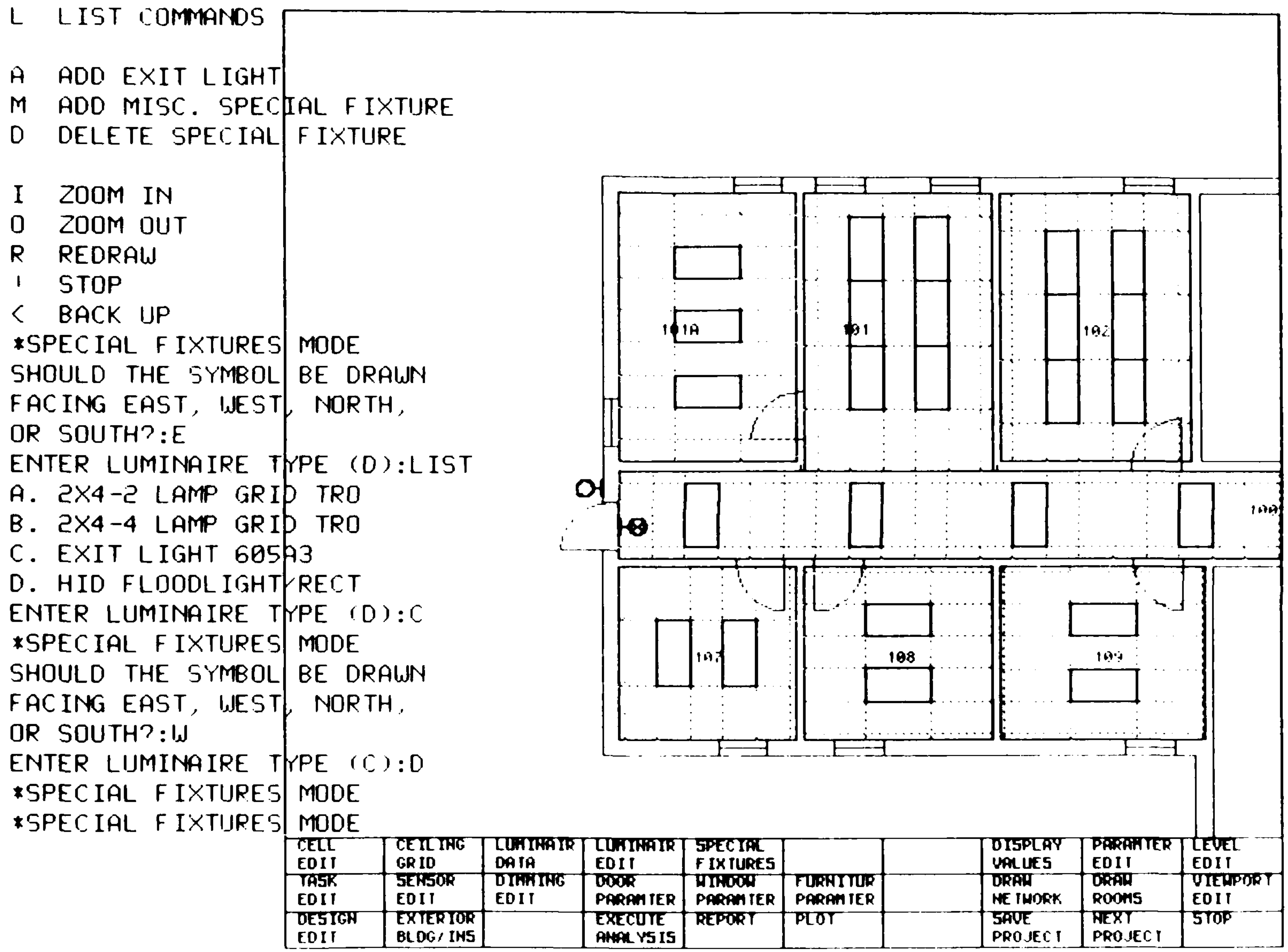


Figure B8. SPECIAL FIXTURES mode.

can then make it invisible again after defining task locations or determining reflectances. Before entering TASK EDIT to make these changes, the user turns on the correct PARAMTER EDIT values so that the furniture appears on the screen.

In Figure B9, the user has entered TASK EDIT mode to place individual tasks in rooms 101, 101A, 107, 108, and 109 at each desk location shown by the small block figures. The figures are pointing in the viewing direction specified by the user. An unknown task grid is placed in room 102 since no furniture was specified for that room. After the tasks have been placed, the user makes the furniture invisible again before proceeding.

Sensor Edit Mode

The locations of sensors are established in SENSOR EDIT mode (Figure B10). The symbols for interior sensors are squares with a plus symbol (+) to indicate the sensor is looking up (rooms 101 and 101A) and an X to indicate it is looking down (rooms 107, 108, and 109). Exterior sensors are denoted by arrows indicating a north, south, east, or west viewing direction (outside rooms 101, 101A, 102, and 108). The user places the crosshairs at the desired location of a sensor and types either A or E. To delete a sensor, the user places the crosshairs over an existing sensor and then types D.

Dimming Edit Mode

If an energy profile is to be calculated by CEL-1, the dimming controls must be defined in DIMMING EDIT. In Figure B11, the user sets up room 101 with a dimming strategy. The crosshairs are placed in the desired room and the appropriate commands entered. Each room can have a different strategy to accommodate differing occupancies.

Once the dimming target area is defined, the luminaires in the room must be identified for dimming (or no dimming). In Figure B12, the user uses the A command to add two luminaires to the dimming group. Using the same procedure, the rest of the luminaires are added into the room. Note again that commands for this mode have been listed.

Door Paramter Mode

In assigning the door attributes, the user puts the crosshairs over a door and strikes the appropriate command key. The program will display the current status of the door and ask if it is really to be changed. If the user responds yes, the program, using the command key selected initially, updates the door's status.

In Figure B13, the user first shows the door type and reflectance of the door between rooms 100 and 102 using the S command. Then the door between rooms 101A and 101 is marked to be ignored. After the parameters of the outside door in room 100 are shown, the user changes them using the C command. The default value, specified by entering D, is 0.12. Note that, by giving the door a reflectance value, the user is implying that the CEL-1 program will not ignore the door.

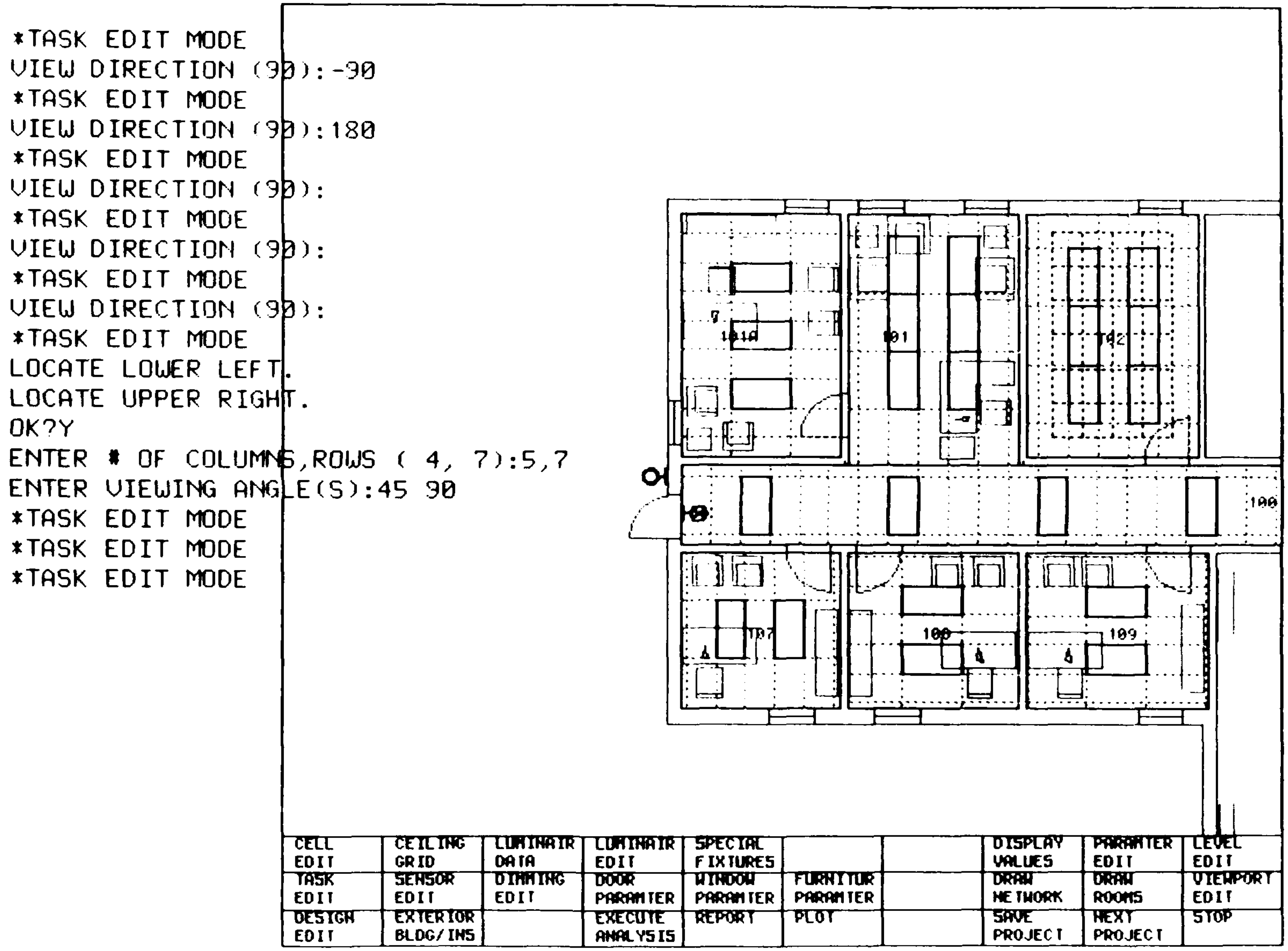


Figure B9. TASK EDIT mode.

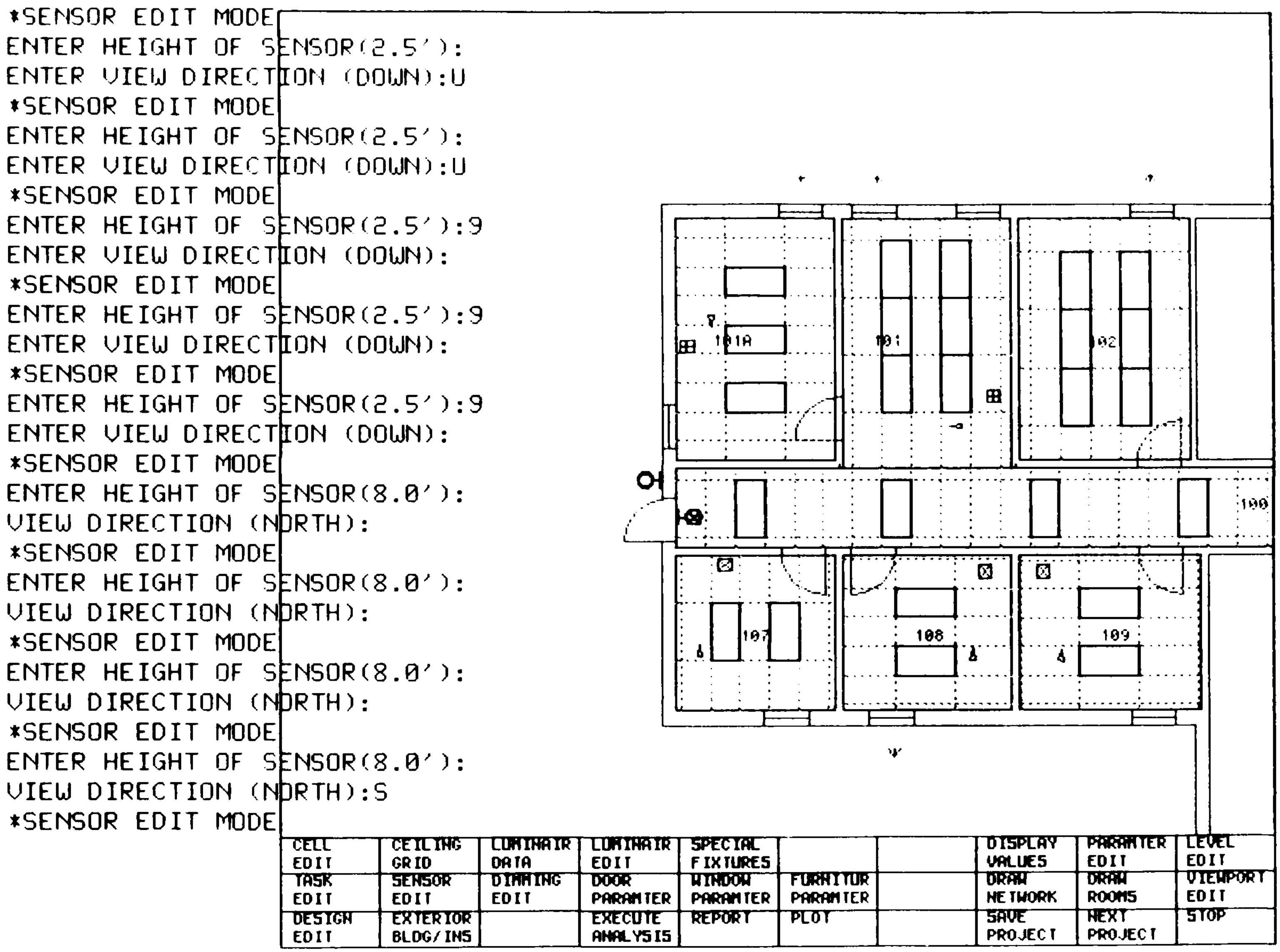


Figure B10. SENSOR EDIT mode.

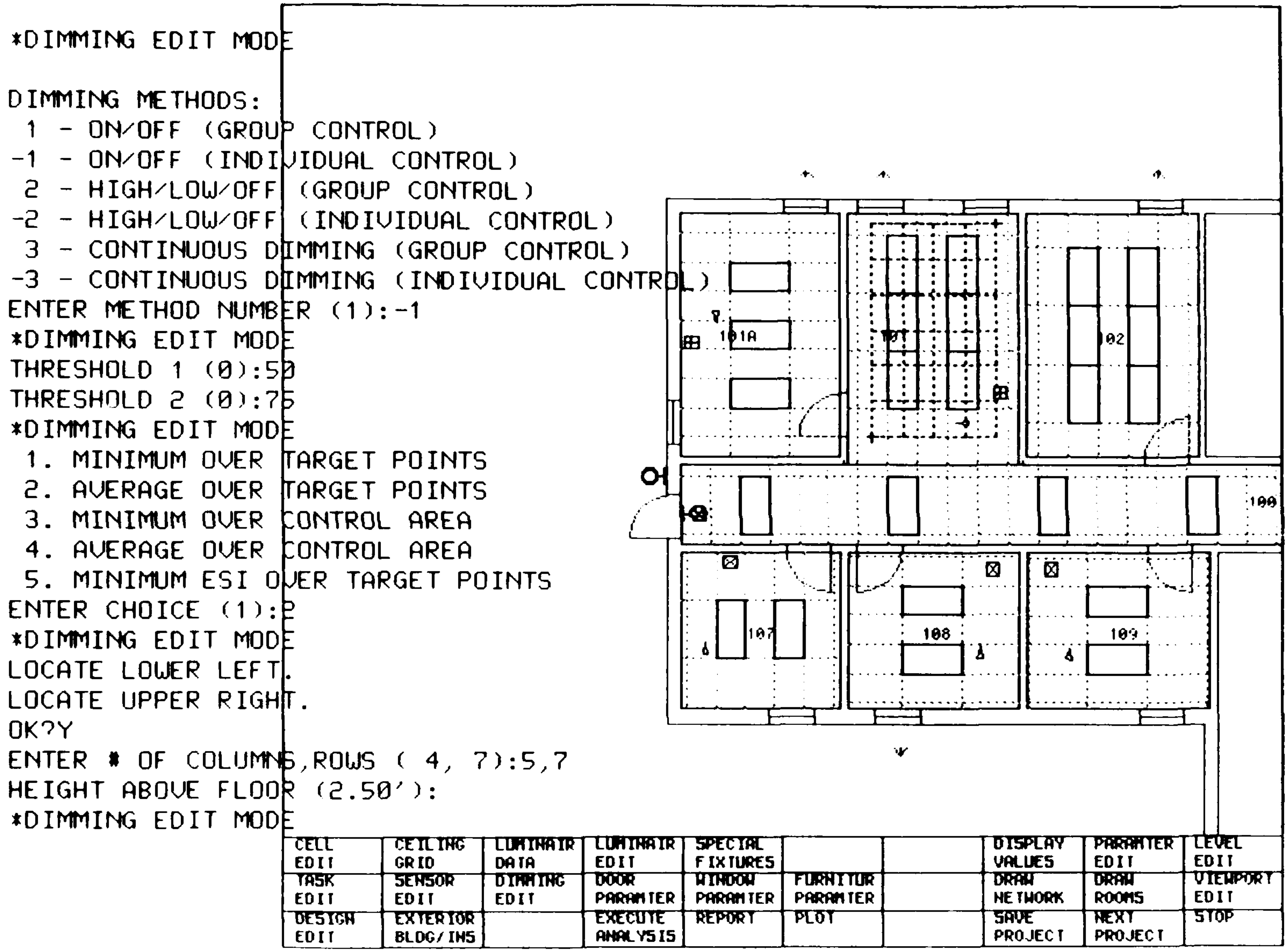


Figure B11. DIMMING EDIT mode.

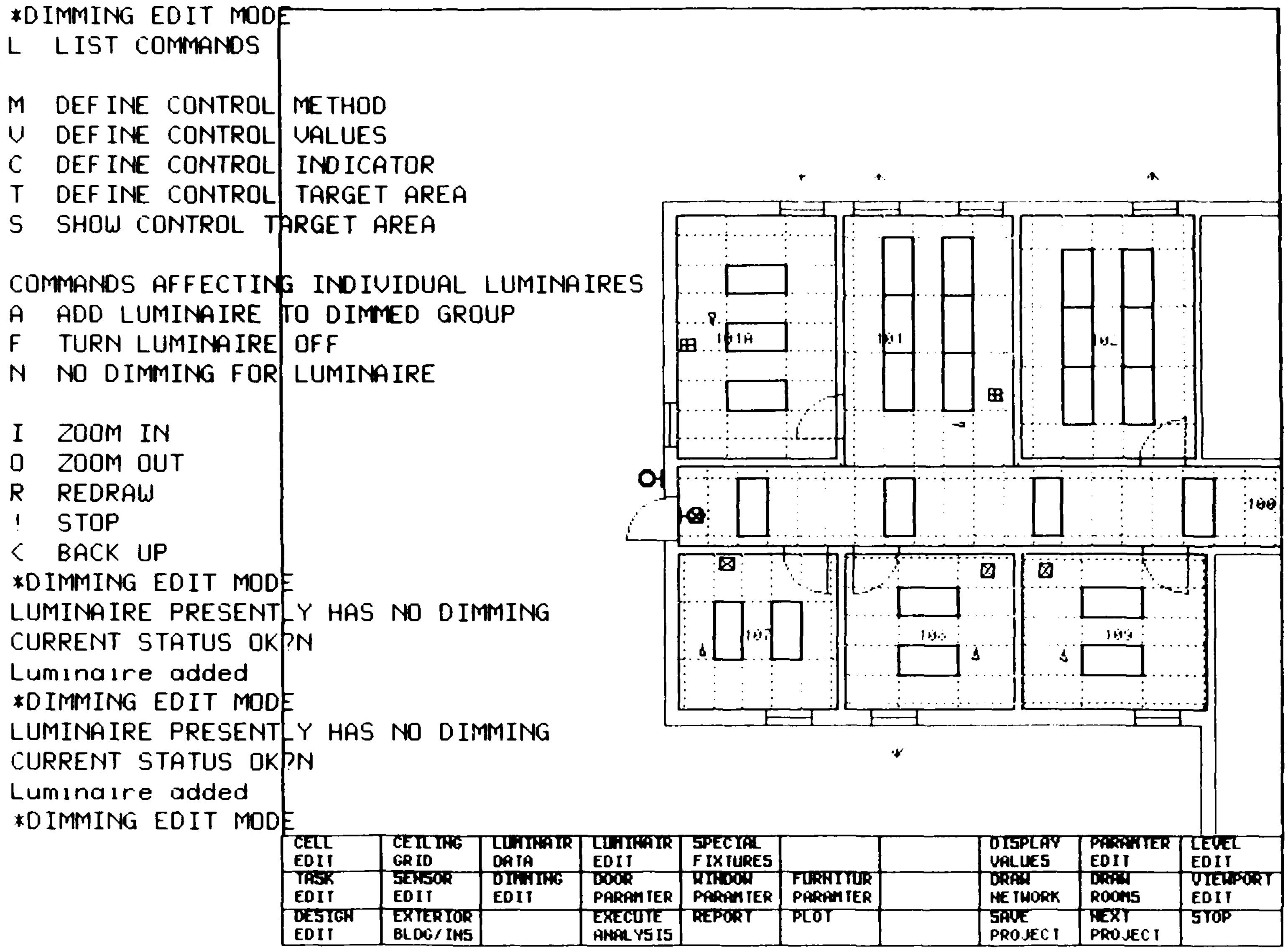
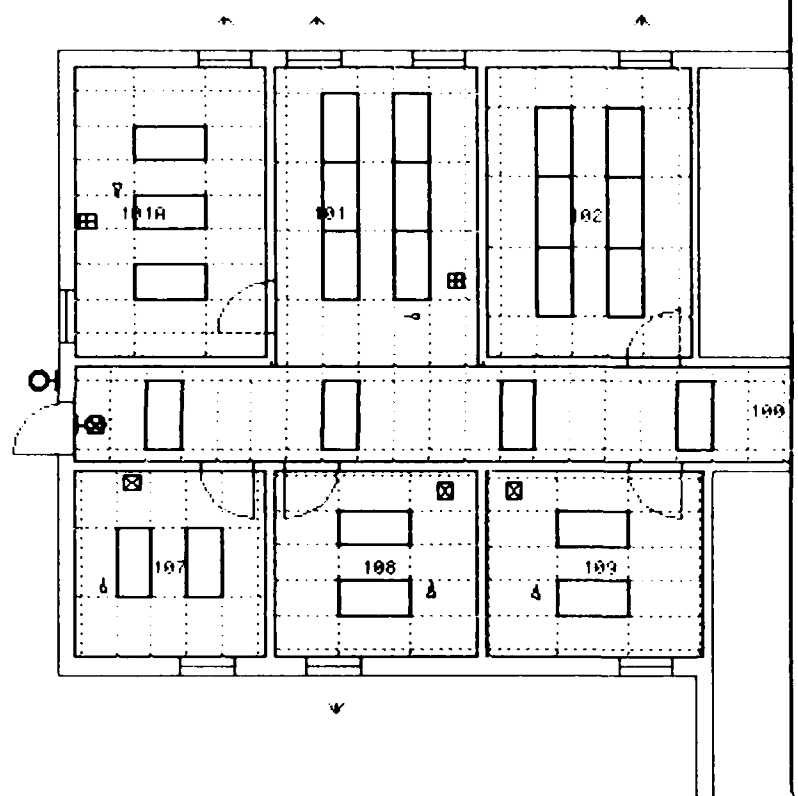


Figure B12. Addition of two luminaires to the dimming group.

```
*DOOR PARAMTER MODE
L  LIST COMMANDS

S  SHOW DOOR TYPE AND REFLECTANCE
C  CHANGE DOOR REFLECTANCE
D  DEFAULT DOOR REFLECTANCE
F  IGNORE/REACTIVATE DOOR

I  ZOOM IN
O  ZOOM OUT
R  REDRAW
!  STOP
<  BACK UP
*DOOR PARAMTER MODE
 18. SOLID WOOD DOOR
REFLECTANCE IS 0.12
*DOOR PARAMTER MODE
DOOR PRESENTLY NOT IGNORED
CURRENT STATUS OK?N
Door ignored!
*DOOR PARAMTER MODE
 17. METAL INSULATED DOOR
REFLECTANCE IS 0.12
*DOOR PARAMTER MODE
REFLECTANCE(0.12)(D FOR DEFAULT):0.4
*DOOR PARAMTER MODE
```



CELL EDIT	CEILING GRID	LUMINAIR DATA	LUMINAIR EDIT	SPECIAL FIXTURES			DISPLAY VALUES	PARAMTER EDIT	LEVEL EDIT
TASK EDIT	SENSOR EDIT	DIMMING EDIT	DOOR PARAMTER	WINDOW PARAMTER	FURNITUR PARAMTER		DRAW NETWORK	DRAW ROOMS	VIEWPORT EDIT
DESIGN EDIT	EXTERIOR BLDG/INS		EXECUTE ANALYSIS	REPORT	PLOT		SAVE PROJECT	NEXT PROJECT	STOP

Figure B13. DOOR PARAMTER mode.

Window Paramter Mode

The window material type has already been assigned to each window by the architect using the ARCH program. In Figure B14, the architect has selected a window with blinds. The electrical engineer can now define the blind attributes using WINDOW PARAMTER mode. To do this, the crosshairs are placed over a window of the type to be changed, and the appropriate command (B in this example) is entered on the keyboard. The user then types responses to prompts issued by the computer in the dialog area. Note that the user in Figure B14 has typed HELP for more information when the required response to a prompt is not readily apparent. To review the window parameters, the user issues the S command. The other window attributes are defined using exactly the same procedure.

Furnitur Paramter Mode

In FURNITUR PARAMTER, the user decides to change only a few of the values (Figure B15). First, the height of furniture type 10 (FILE18) is changed. Then the reflectances of types 10 and 15 (DESK60X30) are changed. Note that when the user does not satisfy the requirements of a prompt, the computer issues a diagnostic message and prompts again for the information. Typing an exclamation point (!) indicates the user has completed the action.

Design Synthesis

There may be the one or more rooms in which the designer is unsure about the final lighting design. In these cases, the design synthesis option in CEL-1 should be used. The user places the crosshairs in the desired room (room 102 in Figure B16) and enters A. The program will then prompt the user for all the necessary information. After the design grid has been defined, the user deactivates some of the locations and redraws the screen. The active locations are represented by squares, whereas the deactivated ones are indicated by plus signs.

Exterior Bldg/Ins Mode

In this example, a parking lot is to be added to the north of the building. Therefore, the user enters the EXTERIOR BLDG/INS mode and defines a ground insert (Figure B17). A shed also is located southwest of the building. In each case, the user, after entering the location and reflectance information, places the crosshairs over the object and gives it a descriptive label. Entering <cr> to prompts that give the reflectance values indicates that the user wishes to retain those values.

Creating the Input Deck

The user is now ready to create a CEL-1 input deck. First, the locational information is input into the data base. This step is done only once unless the building location will be changed later. The work coordinates for the site are entered in terms of latitude and longitude. Then the program asks for a station ID. A small subprogram has been written which lists all the station locations and their corresponding sequence numbers in the CEL-1 CLOUDS data base. By typing LIST in response to the station ID prompt, the user can obtain a listing of the cities by state. In Figure B18, the user

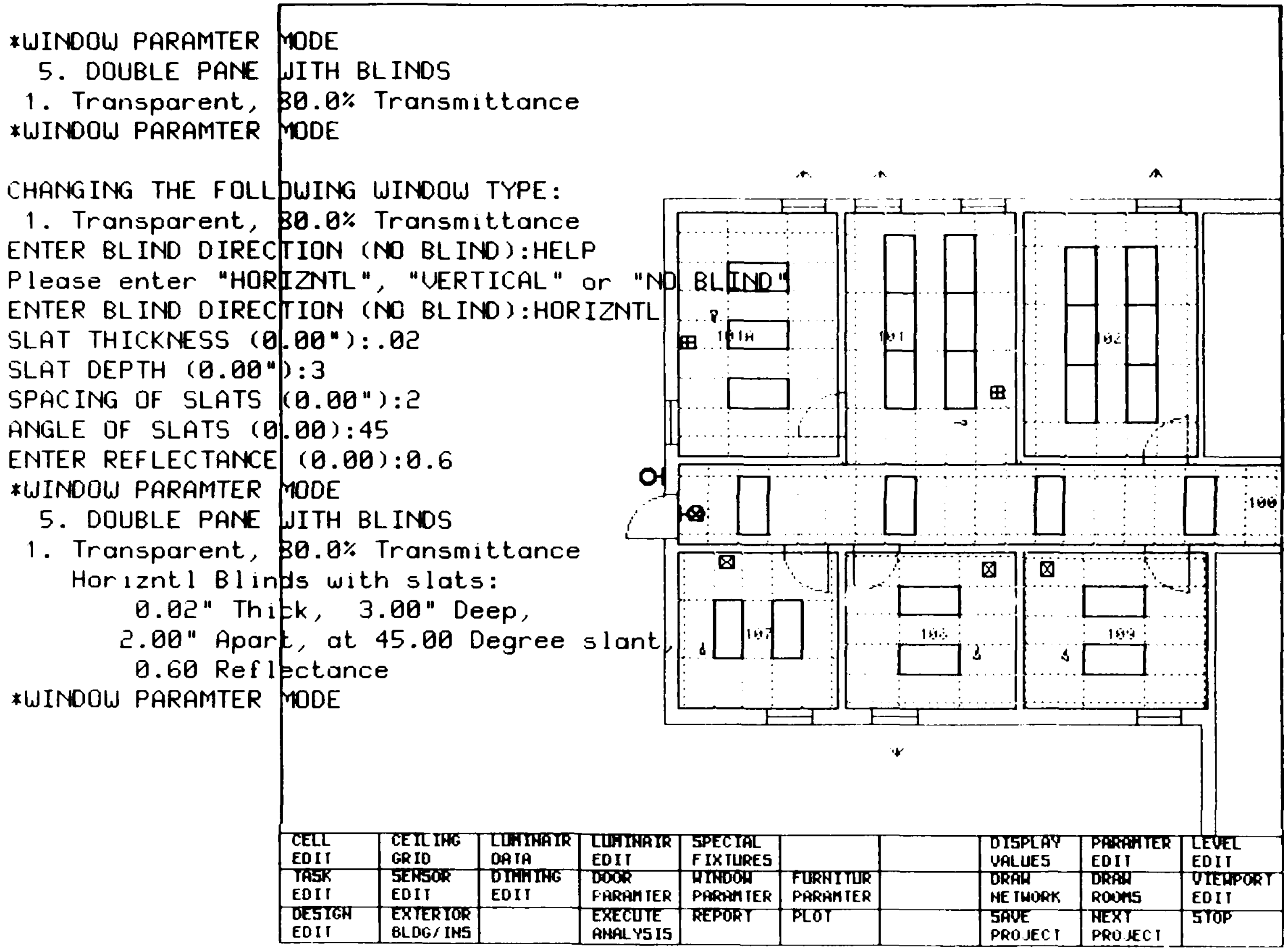


Figure B14. WINDOW PARAMTER mode.

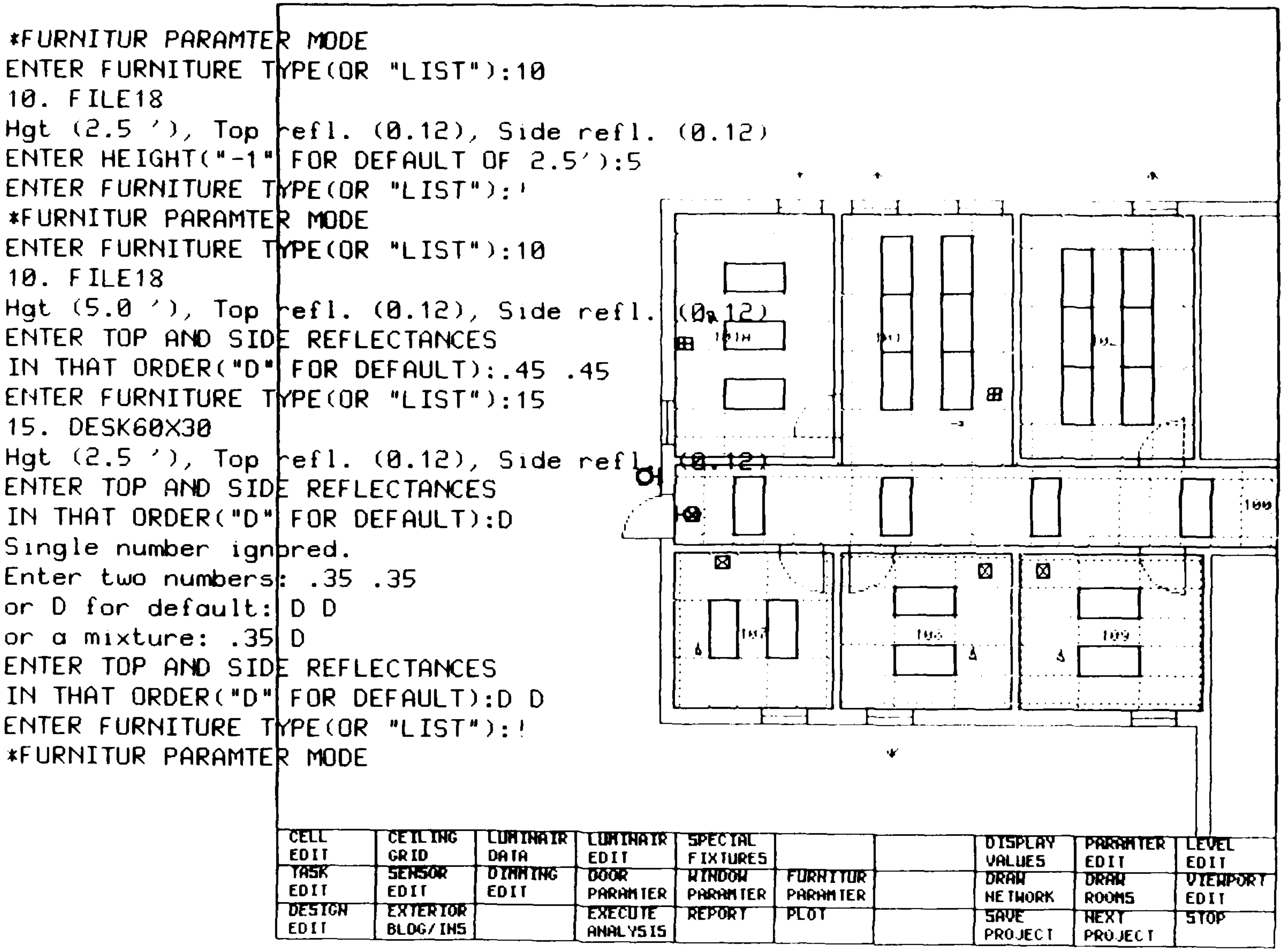


Figure B15. FURNITUR PARAMTER mode.

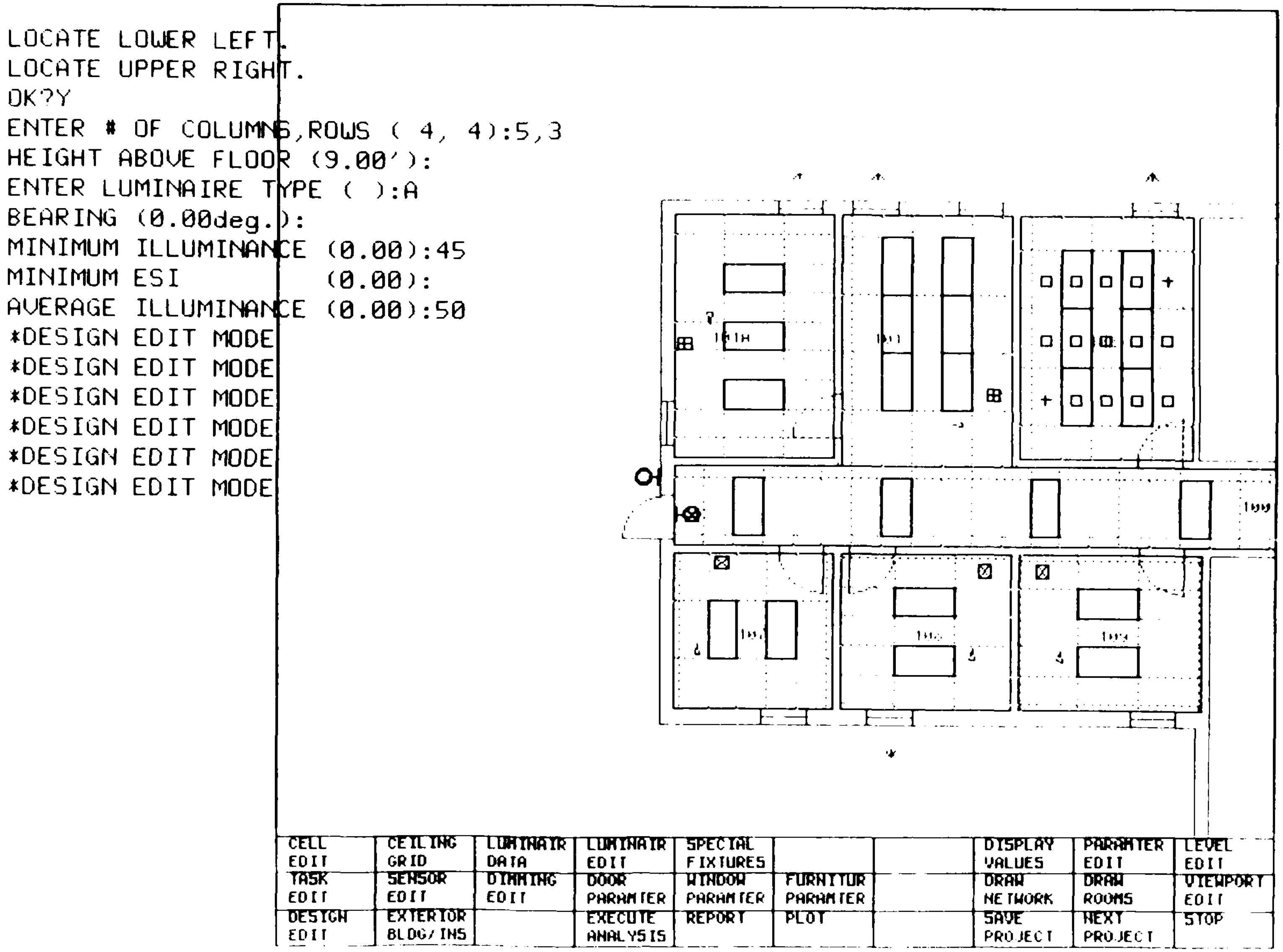


Figure B16. DESIGN EDIT mode.

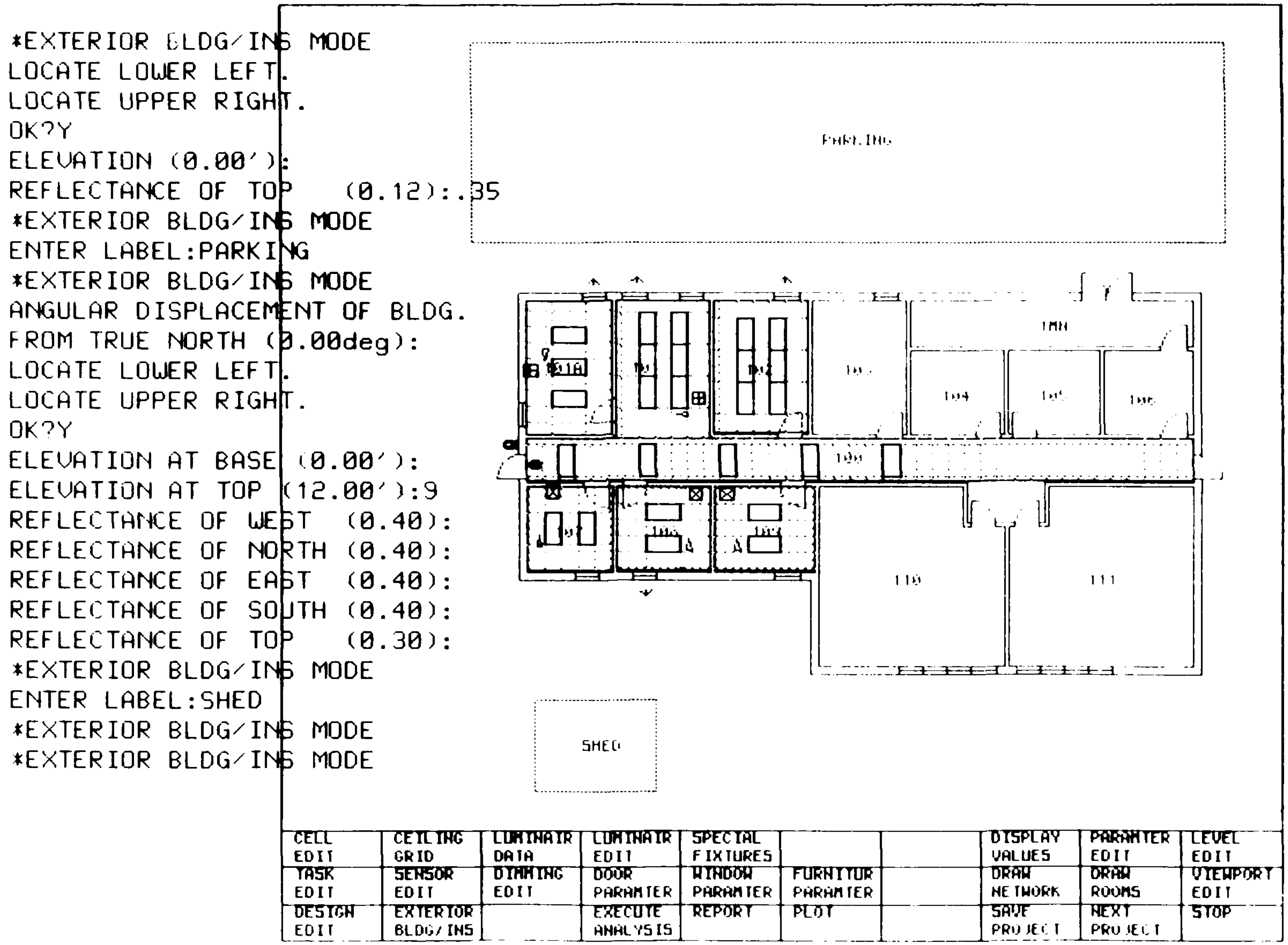


Figure B17. EXTERIOR BLDG/INS mode.

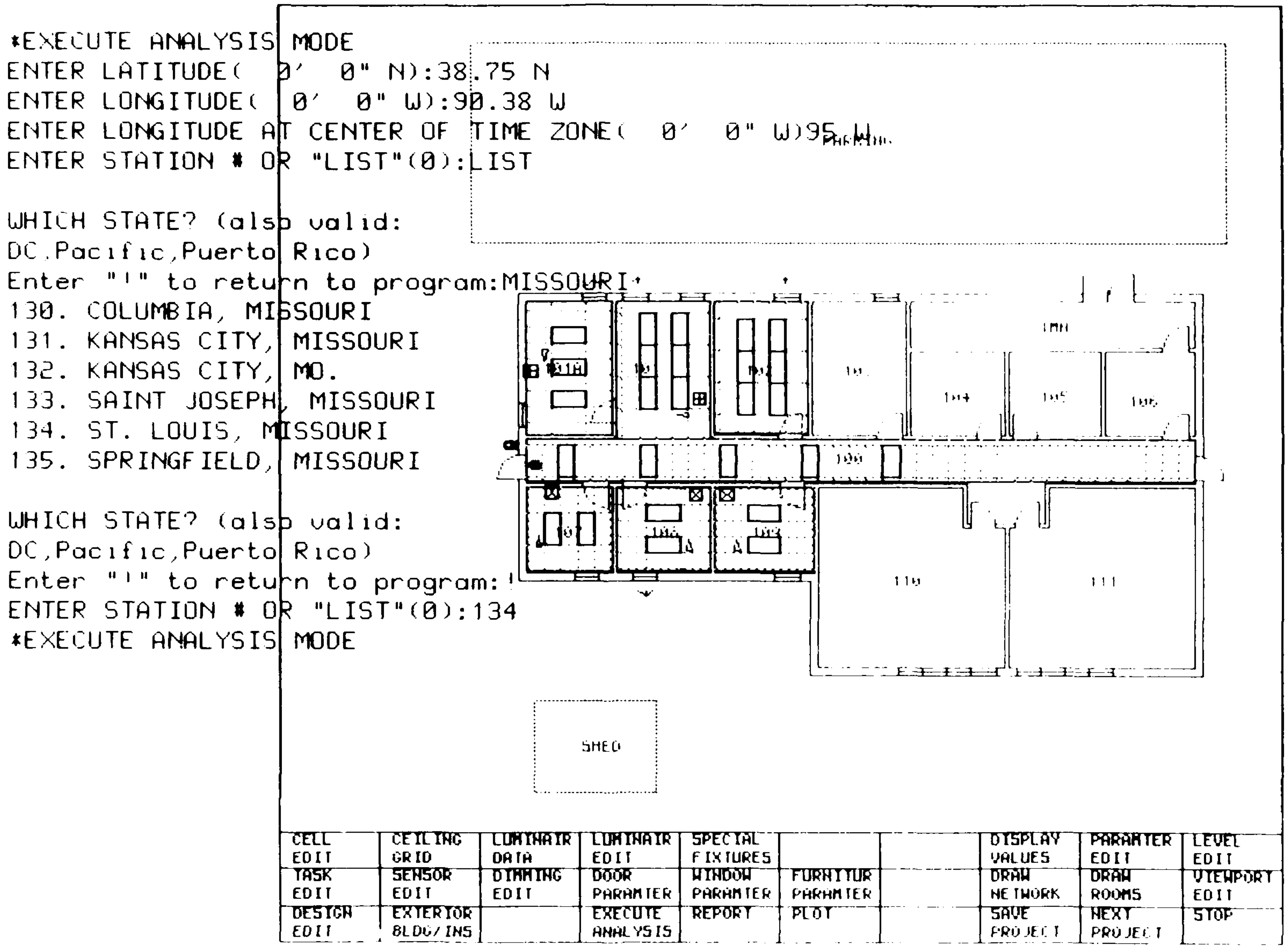


Figure B18. World coordinates.

chooses Missouri. To end the subprogram, the user types an exclamation point (!) and then types the correct station ID after the new prompt.

The deck-building process is initiated by issuing the C command while in the EXECUTE ANALYSIS mode. The user decides to compile an input deck for the E capability set (Figure B19). The program prompts for all information necessary to construct the deck in the required sequence. The capability set is chosen and the information block is written. The output will be in English units.

Continuing, the user elects to use doors (Figure B19). Task metrics are to be calculated using ESI ratings, and the CEL-1 output reports will be horizontal footcandle levels, and equivalent sphere illumination (Chapter 4 lists the available CEL-1 output reports). The target point indicates which BRDF files to use. The user also indicates that sensors are to be inserted in the deck.

Finally, the user enters the height of the window type found in the room and indicates that LITE is to set up a DST map (Figure B19). The program creates the furniture data base and inserts it at the end of the completed input deck. The user then names the input deck DECKE1 and the program copies all temporary block files into the proper disk file. Figure B20 shows the input file created in this example.

Plot Mode

To obtain a plot of the building, the user enters the PLOT mode and is prompted for the output device as shown in Figure B21. The user picks option 3 which redraws the screen without the menu. Then a copy of the screen is sent to a Tektronix 4692 color plotter which is connected to the terminal.

Report Mode

A lighting summary or fixture schedule report can be generated any time after the luminaires have been added to the ceiling plan. In REPORT mode, the program places the desired report in a disk file specified by the user. After the user exits LITE, the report can be sent to a local printer or to a line printer connected to the Harris. Figure B22 is a summary file and Figure B23 is a fixture schedule generated in the example lighting layout.

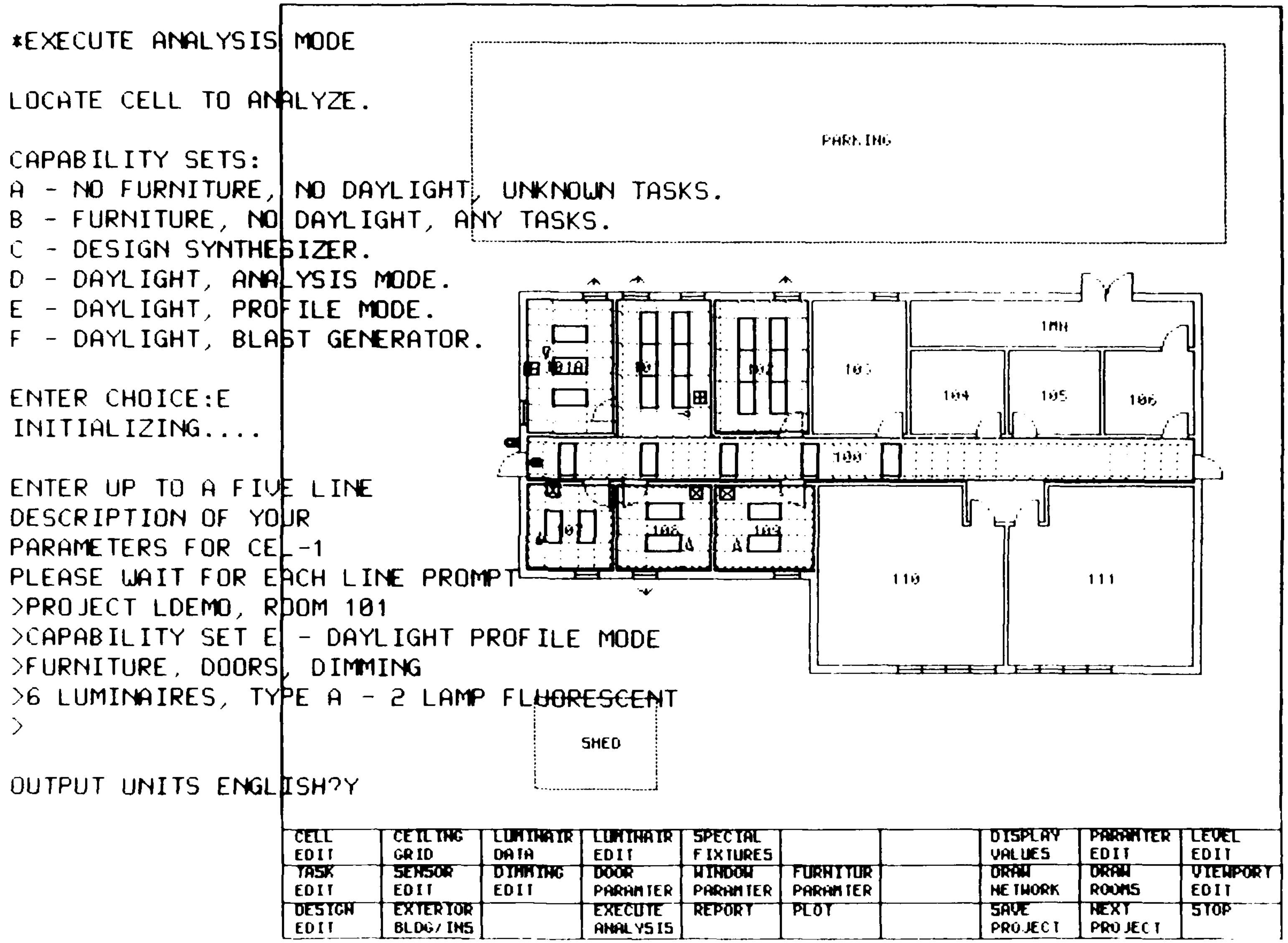


Figure B19. Creating the CEL-1 input deck.

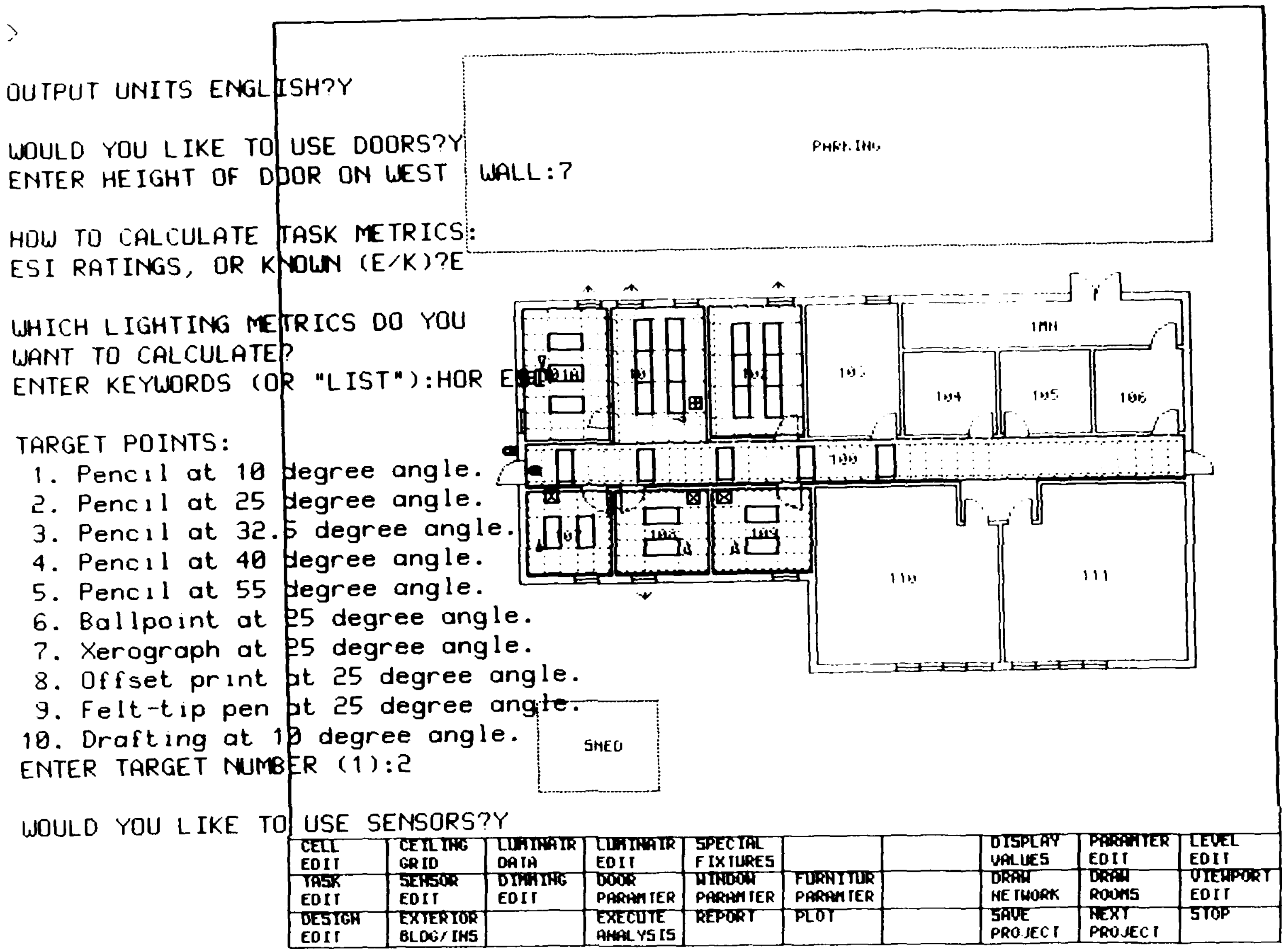


Figure B19 (Cont'd).

```
 5. Pencil at 55 degree angle.
 6. Ballpoint at 25 degree angle.
 7. Xerograph at 25 degree angle.
 8. Offset print at 25 degree angle.
 9. Felt-tip pen at 25 degree angle.
10. Drafting at 10 degree angle.
ENTER TARGET NUMBER (1):2

WOULD YOU LIKE TO USE SENSORS?Y
 1. Transparent, 80.0% Transmittance
    Horizntl Blinds with slats:
        0.02" Thick,  3.00" Deep,
       2.00" Apart, at 45.00 Degree slant,
        0.60 Reflectance
ENTER HEIGHT OF WINDOW:5

USE DAYLIGHT SAVINGS TIME?Y

WOULD YOU LIKE TO USE FURNITURE?Y

Your OBSTR database will be at the
end of your CEL-1 deck.

ENTER FILENAME FOR DECK:DECKE1

Input deck completed!

*EXECUTE ANALYSIS MODE
```

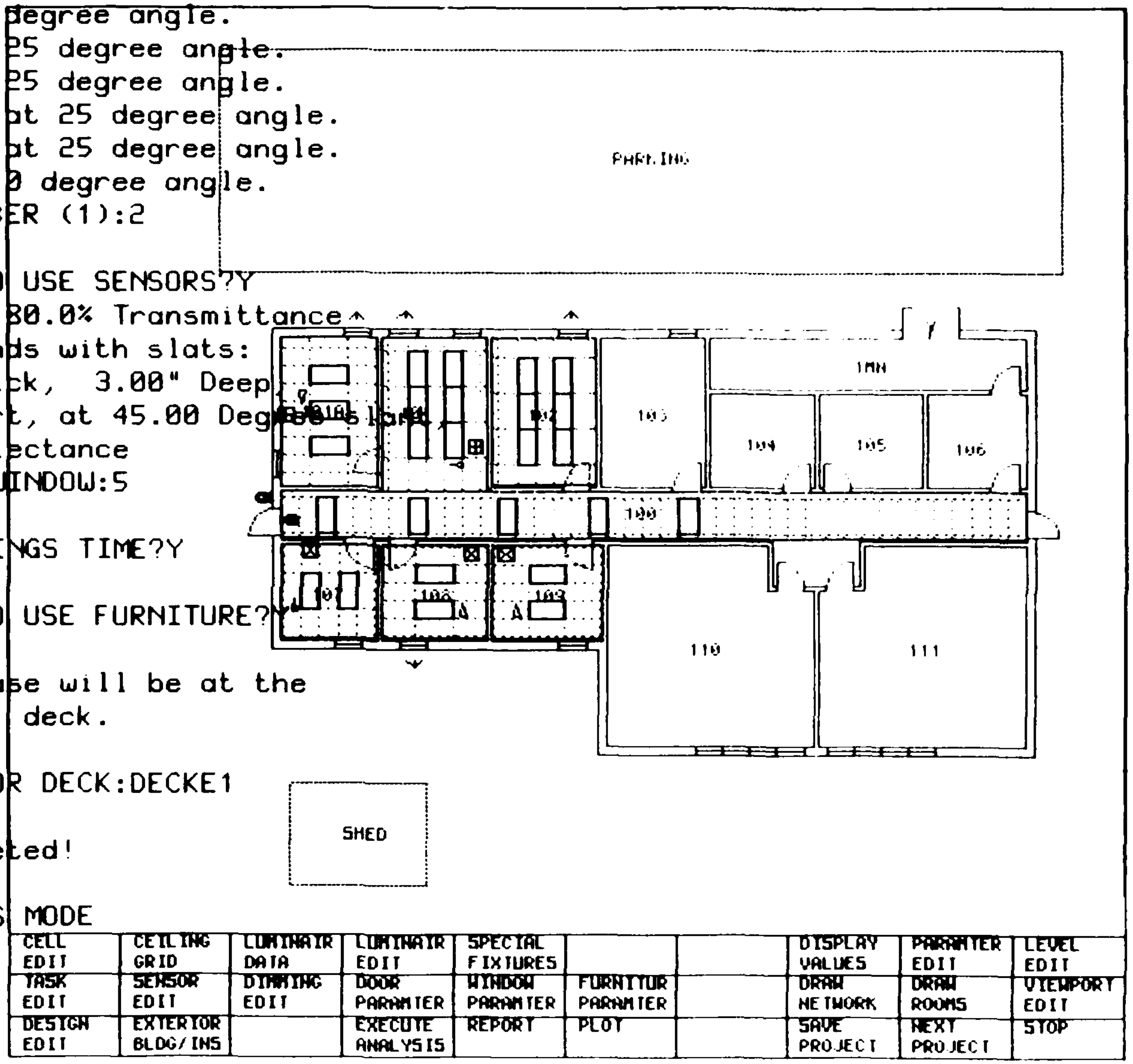


Figure B19 (Cont'd).

```
ROOM
PROJECT LDEMO, ROOM 101
CAPABILITY SET E - DAYLIGHT PROFILE MODE
FURNITURE, DOORS, DIMMING
6 LUMINAIRES, TYPE A - 2 LAMP FLUORESCENT

    1    1
     11.470     5      17.257     8       9.000     4
  0.5000  0.5000  0.5000  0.5000  0.2000  0.8000
INSERTS
    1
    1   0.1200  0.0000  0.0000  1.9033  4.9033  0.0000  7.0000
TASK
RATING
    1      2.500     2
      7.255       2.894     -90.000
SENSORS
    1
     31.821      50.290       2.500     6
    4
     18.799      65.450       8.000     2
     24.041      65.492       8.000     2
     42.410      65.576       8.000     2
     25.027      25.422       8.000     4
FENESTRATION
WINDOW
    1  0.800
      3.000       5.000
    2
    2       7.766      17.257       2.500
    2       0.747      17.257       2.500
BLIND
    1       0.020       3.000       2.000      45.000       0.600
BUILDING
    2
    -12.246    -29.767     -2.000     84.000     48.000     18.000
  0.400  0.400  0.400  0.400  0.300
 0.00
    -10.138    -44.531     -2.000     14.943     11.512      9.000
  0.400  0.400  0.400  0.400  0.300
 0.00
GROUND
  .12
    1
      0.350    -17.797     74.720     24.579     49.521      0.000
FURNITURE
    8
    9       1.264      15.782       2.500       0.000
    8      13.803      13.814       2.500      90.000
    9       9.961      15.782       2.500       0.000
   13       9.135       5.294       2.500      90.000
```

Figure B20. CEL-1 input file.

```
   10      8.519      3.199      5.000     90.000
   12     12.334      4.423      2.500     90.000
    8      8.195     19.504      2.500    180.000
    8      2.784     16.644      2.500    -90.000
PROFILE
     38.750     90.380     95.000  134     1   1      1
0 0 0 0 1 1 1 1 1 1 0 0
 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 0 0 0 0 0 0 0 0
LUMINAIRES
HB41
 5600.0000   66.5000
    2.0000    4.0000    0.0000  100.0000
    0.0000    0.0000    0.0000    0.0000
    6
    1     3.735     5.782     9.000     0.000     0.000      0.000
    2     7.735     5.782     9.000     0.000     0.000      0.000
    3     3.735     9.782     9.000     0.000     0.000      0.000
    4     7.735     9.782     9.000     0.000     0.000      0.000
    5     3.735    13.782     9.000     0.000     0.000      0.000
    6     7.735    13.782     9.000     0.000     0.000      0.000
DIMMING
   -1
        50        75
0 1 0 0 0
0 0 0 0 0 0 0
    0
    2
    1    2
CALCULATE
HOR ESI
P25B
P25T
```

What follows is the OBSTR data base that was appended to the CEL-1 input deck by the LITE program.

```
CREATE
ADD
    1  0.26  0.34  2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  0.08  2.00  2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  0.36  8.50  2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  0.32  5.66  2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  0.78  1.34  2.50 0.12 0.12 0.12 0.12 0.12 0.12
```

Figure B20 (Cont'd).

```
ADD
    1  1.83   0.77   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  1.33   1.50   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  2.60   2.83   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  1.50   1.50   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  2.33   1.50   5.00 0.45 0.45 0.45 0.45 0.45 0.45
ADD
    1  2.00   2.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  2.00   1.67   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  3.33   5.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  2.50   4.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  2.50   5.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  1.50   6.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  0.99   5.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
ADD
    1  4.00  12.00   2.50 0.12 0.12 0.12 0.12 0.12 0.12
STOP
```

Figure B20 (Cont'd).

```
*PLOT MODE
ENTER OUTPUT DEVICE OR "LIST":LIST
   1. HARRIS CALCOMP PLOTTER
   2. TEKTRONIX 4663 PLOTTER
   3. COLOR PLOTTER (TEKTRONIX 4692)
   4. DRAFT PROGRAM
   5. INITIAL GRAPHICS EXCHANGE
      SPECIFICATION (IGES)
ENTER OUTPUT DEVICE OR "LIST":3
DO YOU WANT TASK GRIDS DRAWN?N
DO YOU WANT DESIGN GRIDS DRAWN?Y
```

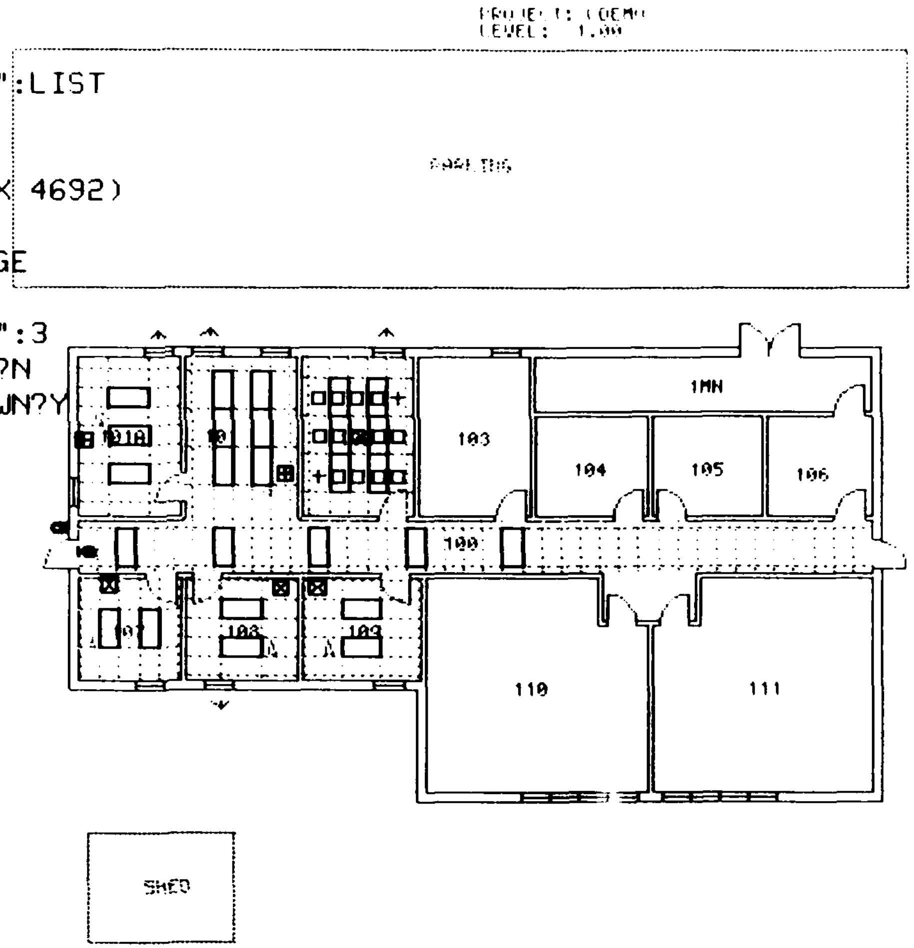


Figure B21. PLOT mode.

```
----------------------------------------------------------------

     LIGHTING SUMMARY

     PROJECT: LDEMO

----------------------------------------------------------------


 NOMENCLATURE:


 AREA     AREA OF ROOM (SF/SM)
 CCR      CEILING CAVITY RATIO
 CU       COEFFICIENT OF UTILIZATION
 DFC      DESIGN FOOTCANDLES
 DFIX     DESIGN FIXTURES REQUIRED
 FCR      FLOOR CAVITY RATIO
 HEIGHT   FLOOR TO CEILING HEIGHT (FT/M)
 HCC      HEIGHT OF CEILING CAVITY (FT/M)
 HFC      HEIGHT OF FLOOR CAVITY(WORK PLANE) (FT/M)
 HRC      HEIGHT OF ROOM CAVITY(MOUNTING HT.) (FT/M)
 IFC      INSTALLED FOOTCANDLES
 IFIX     NUMBER OF FIXTURES INSTALLED
 LENGTH   LONGEST DIMENSION OF ROOM (FT/M) (SEE NOTE BELOW)
 LUMEN    LUMENS PER FIXTURE
 #LAMPS   NUMBER OF LAMPS PER FIXTURE
 MF       MAINTENANCE FACTOR
 PC       CEILING REFLECTANCE (%)
 PCC      CEILING CAVITY REFLECTANCE (%)
 PERIM    PERIMETER OF ROOM (FT/M)
 PF       FLOOR REFLECTANCE (%)
 PFC      FLOOR CAVITY REFLECTANCE (%)
 PW       WALL REFLECTANCE (%)
 RCR      ROOM CAVITY RATIO
 S/MH     SPACING TO MOUNTING HEIGHT RATIO
 WATTS    TOTAL WATTS PER LUMINAIRE
 W/SF     WATTS PER SQUARE FOOT/METER
 WIDTH    WIDTH OF ROOM (FT/M) (SEE NOTE BELOW)

 NOTE: '!' NEXT TO THE LENGTH AND WIDTH VALUES IN THE TABLE
       INDICATES THAT THE PERIMETER OF THE ROOM IS DEFINED BY
       MORE THAN 4 POINTS.  WHEN THIS OCCURS, THE LENGTH AND
       WIDTH ARE CALCULATED AS THE LONGEST OVERALL LENGTH AND
       WIDTH OF THE ROOM.


----------------------------------------------------------------

     FOR THIS PROJECT UNITS ARE ENGLISH

----------------------------------------------------------------
```

Figure B22. Sample summary file.

PROJECT: LDEMO LIGHTING SUMMARY DATE: 2 JUN 86 PAGE 1

ROOM NO.	AREA	LENGTH	WIDTH	PERIM	HEIGHT	DFC	DFIX
FIX. DESCRIPTION	LUMEN	#LAMPS	WATTS	CU	MF	IFC	IFIX
FIX. TYPE	HRC	HFC	HCC	RCR	FCR	CCR	S/MH
LAMP DESCRIPTION	PW	PF	PC	PCC	PFC		W/SF
111	** NO LUMINAIRES ASSIGNED YET **						
101	195.50	17.00	11.50	57.00	9.00	50.00	5.92
2X4-2 LAMP GRID TRO	5600.00	2.00	100.00	0.44	0.66	50.64	6.00
206A	6.50	2.50	0.00	4.74	1.82	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		1.95
107	115.56	10.75	10.75	43.00	9.00	50.00	2.06
2X4-4 LAMP GRID TRO	11400.00	4.00	200.00	0.37	0.66	48.54	2.00
206C	6.50	2.50	0.00	6.05	2.33	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		0.58
110	** NO LUMINAIRES ASSIGNED YET **						
105	** NO LUMINAIRES ASSIGNED YET **						
104	** NO LUMINAIRES ASSIGNED YET **						
1MN	** NO LUMINAIRES ASSIGNED YET **						
109	131.69	12.25	10.75	46.00	9.00	50.00	2.27
2X4-4 LAMP GRID TRO	11400.00	4.00	200.00	0.38	0.66	44.09	2.00
206C	6.50	2.50	0.00	5.68	2.18	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		0.66
108	123.63	11.50	10.75	44.50	9.00	50.00	2.20
2X4-4 LAMP GRID TRO	11400.00	4.00	200.00	0.37	0.66	45.38	2.00
206C	6.50	2.50	0.00	5.85	2.25	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		0.62
102	192.63	16.75	11.50	56.50	9.00	50.00	5.86
2X4-2 LAMP GRID TRO	5600.00	2.00	100.00	0.44	0.66	51.23	6.00
206A	6.50	2.50	0.00	4.77	1.83	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		1.93

Figure B22 (Cont'd).

PROJECT: LDEMO LIGHTING SUMMARY DATE: 2 JUN 86 PAGE 2

ROOM NO.	AREA	LENGTH	WIDTH	PERIM	HEIGHT	DFC	DFIX
FIX. DESCRIPTION	LUMEN	#LAMPS	WATTS	CU	MF	IFC	IFIX
FIX. TYPE	HRC	HFC	HCC	RCR	FCR	CCR	S/MH
LAMP DESCRIPTION	PW	PF	PC	PCC	PFC		W/SF
103	** NO LUMINAIRES ASSIGNED YET **						
106	** NO LUMINAIRES ASSIGNED YET **						
100	501.50	82.00!	10.75!	185.50	9.00	50.00	8.94
2X4-4 LAMP GRID TRO	11400.00	4.00	200.00	0.37	0.66	44.75	8.00
206C	6.50	2.50	0.00	6.01	2.31	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		2.51
101A	180.06	16.75	10.75	55.00	9.00	50.00	2.90
2X4-4 LAMP GRID TRO	11400.00	4.00	200.00	0.41	0.66	51.79	3.00
206C	6.50	2.50	0.00	4.96	1.91	0.00	1.20
F40CW/RS	50.00	20.00	80.00	80.00	18.00		0.90

BUILDING LUMINAIRE SUMMARY

LUMINAIRES

12	2X4-2 LAMP GRID TRO
17	2X4-4 LAMP GRID TRO
0	EXIT LIGHT 605A3
0	HID FLOODLIGHT/RECT
29	TOTAL LUMINAIRES

SPECIAL FIXTURES

0	2X4-2 LAMP GRID TRO
0	2X4-4 LAMP GRID TRO
1	EXIT LIGHT 605A3
1	HID FLOODLIGHT/RECT
2	TOTAL SPECIAL FIXTURES

Figure B22 (Cont'd).

PROJECT: LDEMO FIXTURE SCHEDULE DATE: 2 JUN 86 PAGE 1

CNTR. DWG. FIXT. MARK	DWG. NO. 40-06-04		LAMP			WATTS PER FIXT.	FIXT. VOLT.	MOUNTING & HEIGHT A.F.F.
	TYPE/ SUFFIX	SHEET NO.	TYPE	NO.	WATTS			
A	206A	19	F40CW/RS	2	40	100	277	RECESSED
B	206C	19	F40CW/RS	4	40	200	277	RECESSED
C	605A3	56		2	20	40	277	1' ABOVE DOOR
D	506C	49		1	150	200	277	WALL BRACKET MTG.

Figure B23. Sample fixture schedule.

APPENDIX C:

LITE/CEL-1 TEST PLAN

One of the basic usages of the Computer Aided Engineering and Architectural Design System (CAEADS) is envisioned to have designers use graphic modules with the integrated building data base to run various design analysis programs. Each discipline of the multi-disciplinary design team can then concentrate on the aspects of design analysis particular to that discipline. By having an integrated approach to the design, it is felt that design costs will be reduced overall. Design analyses during early or concept design can make an impact on the quality of the overall design. Thus, providing easy to use tools for the designer (CAEADS) will allow the designer to evaluate more of these design alternatives.

The LITE program has been designed by the US Army Construction Engineering Research Laboratory (USA-CERL) to provide both simple lighting calculations and an interface to a complex lighting design program (CEL1). Since initial implementation is now complete, USA-CERL needs field evaluation of the applicability of LITE and LITE/CEL1 to the designer. As a result of this evaluation, LITE and / or CEL1 may be modified to be more usable, may be released for general field use, or may be reevaluated as to the place of such programs in the concept design phase.

To assist the designer in the required evaluations, the outline of the proposed test plan for LITE, LCHG and LITE/CEL1 has been prepared. LITE has already undergone a field review and the function of the program has been changed because of the review. During the life of computer software, indeed, continual user review is / will be necessary to assure the continual change in user requirements. Though it is not the intent of this test to evaluate CEL1 capabilities, some comments on the program will come naturally and are welcomed. Should the CEL1 portions show enough promise, support for CEL1 may come under the purview of the Corps though currently CEL1 is a public domain program under research type support from National Bureau of Standards. Another concept of the CAEADS system is to use "off the shelf" analysis programs, not necessarily under direct support of the Corps, to accomplish the design studies. The desirability of this concept can also be evaluated / commented on during this test.

Specifically, the basis for this test is to evaluate the usage of LITE and LITE CEL1 during concept design phases of the facility. Comments are equally welcomed for above concept design levels. The evaluation is broken into two parts: LITE and LITE/CEL1.

LITE/LCHG Evaluation

The LITE program is the graphic layout module for CAEADS lighting design. In addition to reflected ceiling plans, simple zonal cavity calculations are available and the interface to major features of CEL1. LITE accesses a file of luminaire data which can be site modified using the LCHG program.

During the test, LITE should be used extensively even for projects that might not ordinarily require the features of LITE/CEL1. For proper evaluation of software, the user must be more than a beginning user though first impressions are also important. The luminaire data base should be reviewed for site applicability initially and continually throughout the test duration.

The following can serve as the outline for evaluation:

I. LCHG Program

a. Initial Impressions
   (1) Data base completeness
   (2) Data base accuracy
   (3) Data base applicability to site / Corps designs

b. Test Evaluation
   (1) Ease of using LCHG
   (2) Problems encountered
   (3) Suggested changes
   (4) Applicability to site / Corps designs
   (5) Number of times used

II. LITE Program

a. Initial Impressions
   (1) Ease of using LITE
   (2) Problems encountered
   (3) Applicability to site / Corps designs

b. Test Evaluation
   (1) Ease of using LITE
   (2) Problems encountered
   (3) Suggested changes
   (4) Applicability to site / Corps designs
   (5) Number of times / projects used

LITE/CEL1 Evaluation

LITE can be used to access the major features of CEL1. The CEL1 program is a comprehensive lighting design program which includes studying the effects of daylighting on both lighting design and energy aspects of the facility. However, no direct training on CEL1 is provided either by the Corps or the CEL1 developers. The evaluation of the LITE/CEL1 interface must take this into account and evaluate whether training is necessary to learn CEL1 or if the user's manual is sufficient.

III. LITE/CEL1

a. Initial Impressions
   (1) CEL1 usability
   (2) CEL1 completeness
   (3) CEL1 applicability to site / Corps designs

b. Test Evaluation
   (1) Completeness of LITE/CEL1 interface
   (2) Problems encountered
   (3) Suggested changes
   (4) Applicability to site / Corps designs

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 should include:

1. Background on the projects (e.g. type of building, location), total number of LITE, LCHG, and LITE/CEL1 uses

2. Estimation of cost/benefit in manpower terms should be included; some of the studies may not usually be done so this estimation should be based on the manpower cost/benefit if the study were done

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

4. Features liked and disliked. Prioritization of enhancements that would improve the tool.

5. Quality of graphics.

6. Recommendations for further testing or broader application.

Time frame for reporting results will be agreed upon between USA-CERL and the USACE FOA.

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