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DOE Standard Compliance Demonstration
Program: An Office Building Example

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June 1993

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Foreword

This report is one in a series of documents describing research activities in support of the U.S. Department of Energy (DOE) Building Energy Standards Program. The Pacific Northwest Laboratory (PNL) leads the program for DOE.

The goal of the program is to develop and encourage the implementation of performance standards to achieve the maximum practicable energy efficiency in the design of new buildings. Such standards are required of DOE by Title III of the Energy Conservation and Production Act (42 USC 6831 et seq.) as amended by the Energy Policy Act of 1992 (Public Law 102-486).

The program approach to meeting the goal is to initiate and manage individual efforts in standards and guidelines research and development--efforts that are planned and conducted in cooperation with representatives from throughout the buildings community. Projects under way involve practicing architects and engineers, professional societies and code organizations, industry representatives, and researchers from the private sector and national laboratories. Research results and the technical justification for standards criteria are provided to standards development and model code organizations and to federal, state, and local jurisdictions as a basis for updating their codes and standards. This approach helps ensure that the standards incorporate the latest research results to achieve maximum energy savings in new buildings, yet remain responsive to the needs of the affected professions, organizations, and jurisdictions. It also assists in the implementation, deployment, and use of the codes and standards.

This report documents an effort to determine whether a building's design can be innovative and aesthetically pleasing, yet still comply with DOE's interim energy conservation standards for new commercial buildings. The researchers set out to demonstrate that the architectural integrity and intent of a building design need not be compromised to achieve the energy-efficiency criteria mandated by the standards.

Other documents produced as part of DOE's energy conservation standards work at PNL are listed in the final main section of this report.

Readers with questions, comments, or suggestions about this document or the work it describes are encouraged to contact the author(s), program managers, or project managers.

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Building Energy Standards Documents

The documents listed here are products of the various building energy conservation standards programs that have been under way at Pacific Northwest Laboratory since 1975. Those marked with an asterisk (*) are available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, Tennessee 37831. Copies are available to the public from the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22168. To obtain documents not marked with an asterisk, readers should contact the specific publisher indicated for the desired document.

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PNL-4870-5.	Appendix B, HVAC and Miscellaneous Envelope Research Implementation.
PNL-4870-6.	Appendix C, Lighting Research Documentation.
PNL-4870-7.	Volume III, Description of the Testing Process.
PNL-4870-8.	Appendix A, Testing Assumptions and Inputs.
PNL-4870-9.	Appendix B, Envelope Compliance Code Documentation.
PNL-4870-10.	Appendix C, Life-Cycle Cost Code Documentation.
Volume IV-A, Documentation of Test Results, Small Office Building (Branch Bank).	
PNL-4870-11	Part 1: Plans, Elevations, Photos, and Compliance-Check and Cost Estimate Data Sheets.
PNL-4870-12.	Part 2: Selected DOE-2.1B Input and Output Files.
PNL-4870-13.	Part 3: Life-Cycle Cost Results.
Volume IV-B, Documentation of Test Results, Medium Office Building.	
PNL-4870-14.	Part 1: Plans, Elevations, Photos, and Compliance-Check and Cost Estimate Data Sheets.
PNL-4870-15.	Part 2: Selected DOE-2.1B Input and Output Files.
PNL-4870-16.	Part 3: Life-Cycle Cost Results.

Volume IV-C, Documentation of Test Results, Large Office Building.

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PNL-4870-19. Part 3: Life-Cycle Cost Results.

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Summary

A study was initiated at the Pacific Northwest Laboratory (PNL) in response to the skepticism regarding the ability to design an aesthetically pleasing building that meets the U.S. Department of Energy (DOE) energy conservation standards for new commercial buildings (10 CFR 435, Subpart A). The study demonstrates that compliance with energy standards does not mean compromising the architectural intent of the building.

This study illustrated the process by which compliance with these standards can be proven for a highly "design-oriented" sample office building. The study also assessed the impact of the whole building simulation compliance alternatives on design.

The sample building, modeled in DOE2.1D (DOE-2), easily complied with the standards using the Building Energy Cost Compliance Alternative. The performance of the design building exceeded that of the prototype building, with approximately \$10,900 in utility bill savings. No changes were made to the original design that had any effect on either the interior floor plan or exterior elevations. Little, if any, impact was on the designer when it came to alterations required to achieve compliance.

An additional, and unanticipated issue addressed during this study was how to properly account for areas of the design building not used as office space. The compliance alternatives use building types to determine set inputs to the simulation models that are globally applied to the whole building. In the design building, the atrium and mechanical rooms are not used as office space; however, as required by these standards, the entire building is modeled as office space in the prototype building model. The lighting, equipment, and occupancy densities for the atrium and mechanical rooms differ considerably from the densities for the office space. Detailed reading of the standards did not yield guidance on what configuration would be acceptable, or expected.

Additional prototype DOE-2 runs were completed under three construction scenarios. The objective was to test the effect of different interpretations of the standards on the ability to comply. The energy consumption levels differed in the three scenarios, but all three allowed compliance of the sample design building.

Although the prototype scenarios complied with the Standard, questions remain about how "soft" the requirements are under the simulation paths. Concern remains that a designer may take a simulation path, and prove compliance, but the simulated comparison of energy cost or consumption may have little meaning because of using unrealistic functional building-use information. DOE could tighten up the performance comparison by requiring that the prototype building include the same distribution of floor area to different uses as found in the design building.

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1.0 Introduction

The U.S. Department of Energy (DOE) issued interim new building energy standards (10 CFR 435 1989) to achieve maximum energy efficiency in the designs of new buildings. DOE then entered into a project to demonstrate and assess the impact of these standards on the design community. One area of focus was a test to see how a less conventional design-focused building would meet the standards' requirements--DOE wanted to demonstrate that compliance with energy standards does not mean compromising the architectural intent of a building.

This study, which was initiated at Pacific Northwest Laboratory^(a) (PNL), illustrated the process by which compliance with the standards can be proven for a highly "design-oriented" office building. The study also assessed the impact of the whole building simulation compliance alternatives on design.

This report documents the compliance requirements, gives a description of the sample building chosen for the study, provides general guidance for the compliance process, documents the method of compliance that was undertaken for the sample building, presents the results of the study, and provides a recommendation on how the compliance requirements could be improved to reflect more realistic use types.

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

2.0 Compliance Requirements

To demonstrate compliance with the standards, a commercial building design must meet the requirements delineated in eight specific, component-based sections of 10 CFR Part 435, Subpart A (1989). The component-based sections include lighting; auxiliary; envelope; electrical power and distribution; heating, ventilation, and air-conditioning (HVAC) systems; HVAC equipment; service hot water; and energy management.

Four of the component-based sections (auxiliary, electrical power and distribution, HVAC equipment, and energy management) spell out simple minimum requirements for compliance. Practical selection of energy-efficient features will easily fulfill these requirements. The other four component-based sections (service hot water, lighting, envelope, and HVAC systems) have additional requirements.

Service hot water, in addition to complying with the minimum requirements, must also meet prescriptive requirements, which are outlined in 10 CFR 435, Subpart A, Section 109.4 (1989). The lighting, envelope, and HVAC systems components will comply if they meet the simple minimum requirements and the additional requirements specified under one of four compliance paths: prescriptive, system performance, building energy cost alternative (cost alternative), or building energy alternative (energy alternative).

The prescriptive requirements are usually the simplest to comply with. However, these requirements are more stringent than those found in the other three compliance paths. The system performance path requires more complex calculations, but, for most climates, its requirements will be less stringent than those of the prescriptive path. Both the cost and energy alternative compliance paths require the development of computer simulation models. Choosing one of these two paths provides a more effective method for obtaining energy credit for innovative or advanced design features such as daylighting, heat recovery, renewable energy, or passive solar applications. However, using either the cost or energy alternative path to demonstrate a design's compliance will take more time and cost more than if either the prescriptive or system performance path were used.

3.0 Building Description

The design chosen for this study is a two-story, 46,000-ft² office building to be sited in Los Angeles, California. What makes the building so unusual and worthy of study is a large, central atrium, 34 ft high, made almost entirely of glass (3518 ft²). It lends an inviting atmosphere to the interior spaces, while also posing a considerable challenge to the HVAC system to keep the building comfortable.

The floor plans (Figures 1 and 2) show six large octagonal areas, four on the first floor and two on the second floor (5822 ft² each) that are open plan office space, suitable for partitioning. The three wings labeled office on the first floor (4140 ft² total) are divided into permanent office spaces and each wing has a central corridor. All office areas have exterior glass doors and 6-ft-high windows in a continuous ribbon on the exterior walls.

The mechanical/storage room (3139 ft²) houses all of the building's HVAC equipment and has a storage area accessible by a large overhead (garage) door. Not shown on the plans is a sky-bridge, connecting the two second-floor spaces, and an elevator tower in the center to access the second floor. The south elevation is shown in Figure 3.

Figure 1. Design Building, First Floor

Figure 2. Design Building, Second Floor

Figure 3. Design Building, South Elevation

4.0 Compliance Demonstration Methodology

Initial attempts at compliance were made by using the two simplest methods available in the standards—the prescriptive path and the system performance path. This entailed using the Envelope Standard (ENVSTD) and Lighting Standard (LTGSTD) software programs (Pacific Northwest Laboratory 1989). The sample building easily passed the prescriptive lighting criteria; however, it failed the envelope requirements because of the high window-to-wall ratio and the percentage of roof area as skylights (the atrium).

At this point, it was obvious that the building would pass the system performance compliance path if the atrium was removed and replaced with a normal roof configuration. Compliance was attempted by using one of the simulation methods rather than altering the design and thus losing the architectural intent of the building.

It was assumed that a designer would choose the path of least resistance when attempting to prove compliance; therefore, the cost alternative was chosen over the energy alternative. The cost alternative requires that the predicted energy costs of the design building, calculated from the predicted energy use and the appropriate utility rate structure(s), be less than the costs predicted for a model of a prototype building. The energy alternative requires that a full life cycle cost analysis be performed on all potential fuel sources for HVAC, service hot water, and process loads in the design building. The results from the Life Cycle Cost Analysis (LCCA) are used to determine the most cost-effective fuel types for each of these loads. After these fuel types have been determined, the design and prototype building models can be compared for predicted energy consumption.

5.0 Model Development

The new standards call for an annual energy consumption simulation that accounts for all aspects of building operation. This requires the development of a prototype building model to compare with the design building model on either an energy cost or energy consumption basis. Specifications included in the standards cover almost all aspects of the prototype building model so that it represents a typical building of the type being considered for compliance. The building energy cost method uses the actual energy costs of the design building location to compare the yearly total spent on energy for the design building versus the prototype building. The building energy method directly compares the total amount of energy used by the two buildings in MBtu per year. DOE-2 was used for the models in this report.

The prototype building was modeled according to Section 111 of 10 CFR 435, Subpart A (1989), which contains all of the specifications required for "typical" buildings in a number of categories. Figure 4 shows the floor plan and two elevations of the prototype building.

Figure 4. Prototype Building, First Scenario

The following sections discuss the development of computer simulation models of the design and prototype buildings. The development specifications for both the sample design and prototype simulation models are presented section by section as they appear in 10 CFR 435 (1989). Appendixes A and B contain the DOE-2 input files for the design and prototype buildings, respectively.

5.1 Orientation and Shape

The size and shape of the prototype building are dictated by 10 CFR 435, Subpart A (1989). The prototype building must have the same gross square footage and number of floors as the design building. The shape is specified by a 2.5-to-1 aspect ratio. The standards require that the long dimensions of the building face east and west to provide for any possible unfavorable site constraints. Using this information, the outside dimensions of the prototype were calculated to be 96 ft x 239 ft. The prototype building has two floors, each with 22,944 ft², for a total of 45,888 ft². The design building is 45,729 ft², showing only a 159 ft² difference between the two models.

5.2 Internal Loads

Internal loads are defined as the heating/cooling loads generated by occupants, lighting, and receptacles (equipment). Occupancy and receptacle loads are default values specified by 10 CFR 435 (1989) for both the prototype and design building, and are to be used unless the designer can reasonably assume and support other values that better match the building's intended use. The occupancy requirement in an office building is specified as one person for every 275 ft². Receptacle loads for an office building are specified as 0.75 W/ft². Lighting requirements are prescribed only for the prototype building and the calculated values depend on the square footage. For this prototype, the lighting value (1.65 W/ft²) is taken from the Prescriptive Unit Lighting Power Allowance (ULPA) Table (10 CFR 435 [Table 103.4-1, p. 202] 1989).

The design building is required to have the same occupancy as the prototype, one person for every 275 ft². Receptacle loads were also the same as the prototype and the lighting was designed to be 0.617 W/ft² (T-8s with electronic ballast and reflectors), except for the atrium where it was designed to be 0.7 W/ft² (10 CFR 435 [Table 103.5-1, pp. 206-208] 1989). The office lighting was selected as the most efficient, currently available lighting, while the atrium lighting level was allowed to default to the value specified in 10 CFR 435, Table 103.5-1, pp. 206-208 (1989).

Two schedules exist for internal loads (10 CFR 435, [Table 111-3, pp. 364-368] 1989), occupancy and lighting/receptacles. The schedules are default values required by the standards and are identical for both the design and prototype buildings.

5.3 Insulation and Glazing

One of the benefits of the simulation approach is that insulation and glazing specifications for the design building are entirely up to the building designer. For this building, a number of wall types were specified (Table 1).

The windows are double-pane, aluminum frame with thermal break, with a reflective film offering 9% transmittance and 51% reflectance (DOE-2 default). The reflective film was an extremely influential factor in the envelope calculations for this design. The film had a greater impact on the cooling load than either the glass conductance or the number of panes because it reduced the large solar gain attributed to the huge glass areas (approximately 60% of the building exterior wall area).

The insulation and glazing of the prototype building were specified using the Alternate Component Table (ACP) for Los Angeles (10 CFR 435 [Table 105.4-6, pp. 246-247] 1989). All of the exterior surfaces were entered into DOE-2 as "quick" walls and their U-values were specified in 10 CFR 435, Table 105.4-6, pp. 246-247 (1989). The windows were designed as a continuous ribbon around the building on each floor. The window height was calculated by multiplying the window-to-wall ratio by the floor-to-floor height. Because no insulation is needed for the slab, the thermal transmittance of a 4-in. lightweight concrete floor was used.

Table 1. Wall Types for Sample Building

Component	U-Value
Exterior Wall:	
Concrete aggregate, lightweight concrete block, air space, R-19 fiberglass insulation, and gypsum board	0.041
Roof:	
Gravel, built-up roofing, concrete, R-19 insulation, air space, and concrete deck	0.043
Interior Wall:	
Gypsum board, air space, and gypsum board	0.37
Interior Floor:	
Concrete and carpet with pad	0.62
Ceiling:	
Acoustic tile	0.514
Interior Wall Adjacent to Mechanical Room:	
Medium-weight concrete block, R-19 insulation, and gypsum board	0.033

5.4 Infiltration

The infiltration rate is a default value required by 10 CFR 435, Subpart A (1989), for both the design and prototype buildings. Because the units for infiltration used were different from the DOE-2 units, a conversion was necessary to input the information. While 10 CFR 435 (1989) calls for 0.038 cubic feet per minute (cfm)/ft² of gross exterior wall area, the DOE-2 keyword accepts infiltration as cfm/ft² of *floor area* in the perimeter zones. Thus, it was necessary to convert the infiltration rate by multiplying 0.038 by the exterior wall area, then dividing by the perimeter zone floor area.

No infiltration is in the interior zone, and the schedule for infiltration is the opposite of the HVAC fan schedule (10 CFR 435 [Table 111.3, pp. 364-368] 1989); infiltration is allowed only when the HVAC system is not operating.

5.5 HVAC Systems and Equipment

The design building is served by two variable air volume systems, one for the atrium and one for the rest of the building. In the original design, there was only one system, but the conditions in the atrium were found to be so different (e.g., large solar load, limited internal loads) that a second, separate system was added for that space. The atrium also contains an additional fan that vents the space at 10 air changes per hour if the outside temperature is below 75°F and the inside temperature is above 78°F. Equipment specifications were automatically sized by DOE-2.

The prototype building HVAC systems and equipment were chosen from the appropriate tables for the building type and size. If the equipment size has not been specified by the designer, iterative DOE-2 runs may be required to choose the proper efficiency, as in this case, where DOE-2 sized the equipment.

To model the building in DOE-2, the system description must be matched with a compatible system type. All of the systems listed in 10 CFR 435 (1989) have DOE-2 system types. All of the required system properties specified were input in DOE-2 and the remainder of the DOE-2 input commands for the HVAC system were allowed to default.

The fan schedule and temperature set points (10 CFR 435 [Table 111-3, pp. 364-368] 1989) are specified as default values and are identical for both the design and prototype buildings. Fuel sources are also required to be identical for both the design and prototype buildings. Electricity was chosen for cooling and natural gas for heating.

5.6 HVAC Zones

In the design building, all three of the office areas were included in one zone. One plenum zone was connected to all of the zones on the system serving the office areas. This facilitated optimum use

of the solar gain through the walls surrounding the atrium. Because the atrium had its own HVAC system, it was modeled as direct return, and the mechanical room was considered unconditioned.

The prototype building was divided into five zones per floor, one interior and four perimeter. The perimeter zones were 15-ft wide and trapezoidal in shape. The interior zone was rectangular with dimensions 30-ft less than the building exterior. Because the prototype had a packaged system, each zone had a separate plenum. The conditioned space was 9-ft high, and the plenums were 4-ft high.

5.7 Service Hot Water

The service water heating capacity (Btu/hr) was modeled by multiplying the prescribed value of 175 Btu/person-hr (10 CFR 435 [Table 111-6, p. 371] 1989) by the total number of people in the building. This is then modified by the percent multiplier entered in the water heating schedule (Table 111-3, pp. 364-368). The water heater efficiency was found in Table 109.3-1, pp. 343-344.

5.8 Controls

Space temperature controls were set at 70°F for space heating and 75°F for space cooling. Night setback to 55°F was required during the heating season, as well as night setup to 99°F (DOE-2 maximum) during the cooling season. These temperatures were scheduled according to the HVAC fan schedule (10 CFR 435 [Table 111-3, pp. 364-368] 1989).

6.0 Results of Modeling

The design building complied with 10 CFR 435 (1989) using the cost alternative. This alternative allowed the design to take advantage of the fact that, at this time, natural gas is less expensive than electricity. (The design building had approximately \$10,900 less in utility bills than the prototype.) Figures 5, 6, and 7 show that the performance of the design building easily exceeds that of the prototype building on both an energy and cost basis.

Primarily because of the difference between the variable air volume system and the packaged variable air volume system, the design building required more energy for heating than the prototype (38% more--tied to conduction losses in the atrium). Because natural gas was used for heating, the estimated consumption of natural gas was also 38% higher for the design building. However, using efficient lighting systems in the design building reduced the direct consumption for lighting (66% less than the prototype). This reduced electric consumption allowed the designer to essentially trade-off the added heating consumption caused by the presence of the atrium with reductions in lighting. This trade-off becomes especially favorable because of the cost difference between natural gas and electricity.

During the compliance process, no changes were made to the original design that had any effect on either the interior floor plan or exterior elevations. This clearly shows that it is possible for a building with unique design features to comply with the standards. The standards allow significant room for creativity and/or alternative designs, while demanding energy efficiency.

S9304080.8

Figure 5. Design and Prototype Energy Cost Results

S9304080.9

Figure 6. Design and Prototype Energy Consumption Results

S9304080.4

Figure 7. Design and Prototype Energy Distribution

7.0 Recommendations

A major issue addressed during this study was the interpretation of how to properly account for parts of the design building that were not used as office space in the development of both the design and prototype building models. The atrium in the design building was intended for use as a lobby. The design building also contained a large unconditioned area that served as a mechanical room and storage area. The lighting, equipment, and occupancy densities in these areas are considerably different than the densities for the office space, yet the standards suggest that these be modeled as office space.

To assess the effect on compliance of different interpretations of the standards, three alternative prototype scenarios were modeled. These construction scenarios included an office building with a lobby (atrium) specified, an office building with a mechanical room specified, and an office building with both a lobby and mechanical room specified.

All three alternative prototype scenarios complied on both an energy consumption and cost basis. Figures 8 and 9 demonstrate that the predicted consumption of the prototype and, therefore, the energy cost budget, decrease with the addition of lobby area, mechanical room area, and the addition of both areas.

Figure 8. Total Site Energy Consumption in the Design and Prototype Buildings

Figure 9. Total Site Energy Cost in the Design and Prototype Buildings

Figures 10, 11, 12, and 13 show the energy cost, energy use, and energy use distribution of the three alternatives. The three differ little, with the exception of approximately 20% more space heat, and slightly more overall energy use in the office with the lobby alternative.

The third construction scenario, the model with both a lobby and mechanical room, is a more realistic comparison to the actual building, however, this level of comparison is not required. It appears that it is not difficult to comply with 10 CFR 435 (1989), but the performance comparison could be unrealistic because of the different use areas in the building. DOE could tighten up the performance comparison by requiring that the prototype building include the same distribution of floor area to different uses as found in the design building. As shown by the additional simulation runs in this study, it does not appear that compliance would be adversely affected.

Office with Lobby Prototype
\$29,001 Total

Office with Mech. Rm. Prototype
\$26,904 Total

Office with Lobby & Mech. Rm. Prototype
\$27,570 Total

Figure 10. Alternative Prototype Energy Cost

Office with Lobby Prototype
1,491 MBtu Total

Office with Mech. Rm. Prototype
1,405 MBtu Total

Office with Lobby & Mech. Rm. Prototype
1,378 MBtu Total

S9304080.7

Figure 11. Alternative Prototype Energy Consumption

Office with Lobby Prototype

Office with Mech. Room Prototype

S9304080.3

Figure 12. Alternative Prototype Energy Distribution

Office with Lobby & Mech. Rm. Prototype

S9304080.5

Figure 13. Alternative Prototype Energy Distribution

8.0 References

Landsberg, D. R., H. P. Misuriello, and S. Moreno. 1986. *Design Strategies for Energy-Efficient Atrium Spaces*. ASHRAE Transactions Vol. 92, Part 2A, No. 2996 (RP-315).

Lawrence Berkeley Laboratory. 1989. DOE-2 Supplement. Version 2. ID. LBL- 8706 Suppl., Rev. 5, Lawrence Berkeley Laboratory, Berkeley, California.

Pacific Northwest Laboratory. 1989. Users Guide for ENVSTD Program Version 2.1 and LTGSTD Program Version 2.1. PNL-6839, Rev. 1, Pacific Northwest Laboratory, Richland, Washington.

10 CFR 435. 1989. "Subpart A - Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings; Mandatory for Federal Buildings." U.S. Code of Federal Regulations.

Appendix A

DOE-2 Input File for the Sample Design Building

TITLE LINE-1 *Simulation of 2 story office with *
 LINE-2 *central atrium.*
 LINE-3 * Adapted from MED-44-STD93 * ..

INPUT LOADS ..

ABORT ERRORS ..

DIAGNOSTIC CAUTIONS NARROW ..

BUILDING-LOCATION

AZIMUTH = 0

..

RUN-PERIOD JAN 1 1981 THRU DEC 31 1981 ..

PARAMETER

LTWTS1 = 0.617 \$ Lighting W/sf: 2x4 4 tube T-8 w/ Elec. Bal. & Reflector \$

WH1 = 19.8

WW1 = 29.8

WH2 = 19.8

WW2 = 23.8

..

\$ *** SCHEDULES *** \$

OCCUPANCY =	SCHEDULE THRU DEC 31	(WD)	(1,7)	(0)	
			(8)	(.1)	
			(9)	(.2)	
			(10,11)	(.95)	
			(12,13)	(.45)	
			(14,18)	(.95)	
			(19)	(.3)	
			(20,22)	(.1)	
			(23,24)	(0)	
		(SAT)	(1,7)	(0)	
			(8,9)	(.1)	
			(10,13)	(.3)	
			(14,18)	(.1)	
			(19,24)	(0)	
		(SUN,HOL)	(1,24)	(0)	..

LIGHTS =	SCHEDULE THRU DEC 31	(WD)	(1,6)	(0)	
			(7)	(.1)	
			(8)	(.3)	
			(9,12)	(.9)	
			(13)	(.8)	
			(14,17)	(.9)	
			(18)	(.5)	
			(19,20)	(.3)	
			(21,22)	(.2)	
			(23,24)	(0)	
		(SAT)	(1,6)	(0)	
			(7,8)	(.1)	
			(9,12)	(.3)	
			(13,17)	(.15)	
			(18,24)	(0)	
		(SUN,HOL)	(1,24)	(0)	..

INFIL =	SCHEDULE THRU DEC 31	(WD)	(1,6)	(1)	
			(7,18)	(0)	
			(19,24)	(1)	
		(SAT)	(1,7)	(1)	
			(8,14)	(0)	
			(15,24)	(1)	
		(SUN,HOL)	(1,24)	(1)	..

A.1

SERVICE-HW=	SCHEDULE	THRU DEC 31	(WD)	(1,7)	(0)	
				(8)	(.15)	
				(9)	(.3)	
				(10,11)	(.35)	
				(12)	(.45)	
				(13)	(.55)	
				(14)	(.5)	
				(15,16)	(.3)	
				(17)	(.4)	
				(18,19)	(.2)	
				(20)	(.1)	
				(21)	(.15)	
				(22)	(.05)	
				(23,24)	(0)	
	(SAT)			(1,7)	(0)	
				(8,9)	(.1)	
				(10)	(.2)	
				(11)	(.15)	
				(12)	(.2)	
				(13,14)	(.15)	
				(15,17)	(.1)	
				(18,24)	(0)	
	(SUN,HOL)			(1,24)	(0)	..

ELEVATOR =	SCHEDULE	THRU DEC 31	(WD)	(1,6)	(0)	
				(7)	(.05)	
				(8)	(.35)	
				(9)	(.7)	
				(10)	(.45)	
				(11)	(.35)	
				(12)	(.45)	
				(13,14)	(.5)	
				(15)	(.35)	
				(16)	(.45)	
				(17)	(.6)	
				(18)	(.2)	
				(19)	(.1)	
				(20,24)	(0)	
	(SAT)			(1,6)	(0)	
				(7)	(.05)	
				(8,9)	(.15)	
				(10,11)	(.2)	
				(12)	(.25)	
				(13)	(.2)	
				(14)	(.15)	
				(15)	(.1)	
				(16,17)	(.05)	
				(18,24)	(0)	
	(SUN,HOL)			(1,24)	(0)	..

\$ ***CONSTRUCTION*** \$

W1=LAYERS MATERIAL = (CC01,CB46,BP01,AL11,IN03,GP01) ..

\$ 1.25" CONCRETE AGGREGATE, 6" LW HOLLOW CONC. BLK, FELT, 0.75"

\$ AIRSPACE, R-19 BATT, 0.5" GYP BOARD \$

\$ ROOF LAYERS \$

RF1=LAYERS MATERIAL = (RG01,BP01,CC31,IN03,AL33,CC14) ..

\$ ROOF GRAVEL, BUILT-UP ROOFING, 0.75" CONCRETE, R-19 BATT, 4" AIRSPACE,

\$ 4" CONCRETE \$

\$ STANDARD INTERIOR WALL LAYERS \$

P1=LAYERS MATERIAL = (GP02,AL11,GP02) ..

\$ 5/8" GYP BOARD, 0.75" AIR SPACE, 5/8" GYP BOARD \$

\$ INTERIOR FLOOR LAYERS \$

FL1=LAYERS MATERIAL = (CC03,CP01) ..

\$ 4" HWY WGT CONC., CARPET W/ PAD \$

\$ CEILING LAYER \$

C1 =LAYERS MATERIAL = (AC02) ..

\$ 0.5" ACOUSTIC TILE \$

\$ INTERIOR WALL IN MECH ROOM \$

P2 = LAYERS MATERIAL = (GP02,IN03,CC36) ..

\$ 5/8" GYP BOARD, R-19 BATT, 12" MED. WGHT HOLLOW CONC. BLK. \$

STD-WALL =CONSTRUCTION LAYERS = WA1 ABSORPTANCE = 0.55 ..

STD-ROOF =CONSTRUCTION LAYERS = RF1 ABSORPTANCE = 0.50 ..

PARTITION =CONSTRUCTION LAYERS = P1 ..

FLOOR =CONSTRUCTION U = 0.62 ..

INTFLOOR =CONSTRUCTION LAYERS = FL1 ..

CEILING =CONSTRUCTION LAYERS = C1 ..

NTM =CONSTRUCTION LAYERS = P2 .. \$MECH RM WALLS\$

AIR-WALL =CONSTRUCTION U = 2.6 .. \$ ARBITRARY LARGE NUMBER \$

\$ GLASS TYPE CODE 11: 9% TRANSMITTANCE, 51% REFLECTANCE \$

\$ VERTICAL GLASS: \$

GLASS1 =GLASS-TYPE

PANES = 2

GLASS-TYPE-CODE = 11

GLASS-CONDUCTANCE = 0.4 ..

\$ HORIZONTAL GLASS: \$

GLASS2 = GLASS-TYPE

PANES = 2

GLASS-TYPE-CODE = 11

GLASS-CONDUCTANCE = 0.51 ..

\$ *** DEFAULTS *** \$

SET-DEFAULT FOR EXTERIOR-WALL CONSTRUCTION = STD-WALL

HEIGHT = 10 ..

SET-DEFAULT FOR WINDOW GLASS-TYPE = GLASS1

HEIGHT = 6

Y = 2 ..

SET-DEFAULT FOR INTERIOR-WALL HEIGHT = 10 INT-WALL-TYPE=ADIABATIC ..

\$ *** SPACE CONDITIONS *** \$

\$ Zones are named according to their principal location or use. Walls \$

\$ are named as a series of: the zone name, old wall number, and direction

\$ (outward normal). Windows and doors are named after the wall they are

\$ located in, as F1 and D1, respectively. \$

SW1 = SPACE AREA = 5822
VOLUME = 58220

TEMPERATURE = (72)

PEOPLE-SCHEDULE = OCCUPANCY

NUMBER-OF-PEOPLE = 21.17

PEOPLE-HG-LAT = 230

PEOPLE-HG-SENS = 190

EQUIPMENT-W/SQFT = .75

EQUIP-SCHEDULE = LIGHTS

LIGHTING-W/SQFT = LTWTS1

LIGHTING-SCHEDULE = LIGHTS

LIGHTING-TYPE = REC-FLUOR-RV

INF-METHOD = AIR-CHANGE

INF-CFM/SQFT = 0.0107

INF-SCHEDULE = INFIL

A.3

SW1EW1-NW=	EXTERIOR-WALL	X = 17 Y = 63 AZIMUTH = -45 WIDTH = 24 ..
SW1EW1F1 =	WINDOW	WIDTH = 15 ..
SW1EW2-W =	EXTERIOR-WALL	X = 0 Y = 46 AZIMUTH = 270 WIDTH = 46 ..
SW1EW2F1 =	WINDOW	WIDTH = 30 ..
SW1EW3-SW =	EXTERIOR-WALL	WIDTH = 24 AZIMUTH = 225 ..
SW1EW3F1 =	WINDOW	WIDTH = 15 ..
SW1EW4-S =	EXTERIOR-WALL	X = 17 Y = -17 AZIMUTH = 180 WIDTH = 46 ..
SW1EW4F1 =	WINDOW	WIDTH = 30 ..
SW1EW5-SE =	EXTERIOR-WALL	X = 63 Y = -17 AZIMUTH = 135 WIDTH = 24 ..
SW1EW5F1 =	WINDOW	WIDTH = 15 ..
INT-FLOOR =	UNDERGROUND-FLOOR	AREA = 164 CONSTRUCTION = FLOOR TILT = 180 ..
INT-CEILING =	INTERIOR-WALL	AREA = 5822 CONSTRUCTION = CEILING TILT = 180 NEXT-TO = PLENM
INT-PART1 =	INTERIOR-WALL	INT-WALL-TYPE = STANDARD .. HEIGHT = 10 WIDTH = 92 INT-WALL-TYPE = ADIABATIC CONSTRUCTION = PARTITION ..
SE1 =	SPACE	AREA = 5822 VOLUME = 58220 X = 110 Y = 0 TEMPERATURE = (72) PEOPLE-SCHEDULE = OCCUPANCY NUMBER-OF-PEOPLE = 21.17 PEOPLE-HG-LAT = 230 PEOPLE-HG-SENS = 190 EQUIPMENT-W/SQFT = 0.75 EQUIP-SCHEDULE = LIGHTS LIGHTING-W/SQFT = LTWTS1 LIGHTING-SCHEDULE = LIGHTS LIGHTING-TYPE = REC-FLUOR-RV INF-METHOD = AIR-CHANGE INF-CFM/SQFT = 0.0107 INF-SCHEDULE = INFIL ..
SE1EW3-SW =	EXTERIOR-WALL	LIKE SW1EW3-SW ..
SE1EW3F1 =	WINDOW	WIDTH=15 ..
SE1EW4-S =	EXTERIOR-WALL	LIKE SW1EW4-S ..
SE1EW4F1 =	WINDOW	WIDTH=30 ..
SE1EW5-SE =	EXTERIOR-WALL	LIKE SW1EW5-SE ..
SE1EW5F1 =	WINDOW	WIDTH = 15 ..
SE1EW6-E =	EXTERIOR-WALL	X = 80 Y = 0 WIDTH = 46 AZIMUTH = 90 ..
SE1EW6F1 =	WINDOW	WIDTH = 30 ..
SE1EW7-NE =	EXTERIOR-WALL	X = 80 Y = 46 WIDTH = 24 AZIMUTH = 45 ..
SE1EW7F1 =	WINDOW	WIDTH = 15 ..

INT-PART2 = INTERIOR-WALL WIDTH = 46 HEIGHT = 10
 INT-WALL-TYPE=ADIABATIC
 CONSTRUCTION = PARTITION ..

SE1-FLOOR = UNDERGROUND-FLOOR LIKE INT-FLOOR ..
 SE1CEILING = INTERIOR-WALL LIKE INT-CEILING ..
 SE1-PART1 = INTERIOR-WALL LIKE INT-PART1 ..

NE1 = SPACE AREA = 5822
 VOLUME = 58220
 X = 110
 Y = 110
 TEMPERATURE = (72)
 PEOPLE-SCHEDULE = OCCUPANCY
 NUMBER-OF-PEOPLE = 21.17
 PEOPLE-HG-LAT = 230
 PEOPLE-HG-SENS = 190
 EQUIPMENT-W/SQFT = 0.75
 EQUIP-SCHEDULE = LIGHTS
 LIGHTING-W/SQFT = LTWTS1
 LIGHTING-SCHEDULE = LIGHTS
 LIGHTING-TYPE = REC-FLUOR-RV
 INF-METHOD = AIR-CHANGE
 INF-CFM/SQFT = 0.00914
 INF-SCHEDULE = INFIL ..

NE1EW5-SE = EXTERIOR-WALL LIKE SW1EW5-SE ..
 NE1EW5F1 = WINDOW WIDTH = 15 ..
 NE1EW6-E = EXTERIOR-WALL LIKE SE1EW6-E ..
 NE1EW6F1 = WINDOW WIDTH = 30 ..
 NE1EW7-NE = EXTERIOR-WALL LIKE SE1EW7-NE ..
 NE1EW7F1 = WINDOW WIDTH = 15 ..
 NE1EW8-N = EXTERIOR-WALL X = 63 Y = 63
 WIDTH = 46 AZIMUTH = 0 ..
 NE1EW8F1 = WINDOW WIDTH = 30 ..
 NE1-FLOOR = UNDERGROUND-FLOOR LIKE INT-FLOOR ..
 NE1CEILING = INTERIOR-WALL LIKE INT-CEILING ..

INT2MECH = INTERIOR-WALL WIDTH = 60 HEIGHT = 10
 INT-WALL-TYPE = STANDARD
 NEXT-TO = MECH
 CONSTRUCTION = NTM ..

PART2 = INTERIOR-WALL WIDTH = 45 HEIGHT = 10
 INT-WALL-TYPE = ADIABATIC
 CONSTRUCTION = PARTITION ..

NW1 = SPACE AREA = 5822
 VOLUME = 58220
 X = 0
 Y = 110
 TEMPERATURE = (72)
 PEOPLE-SCHEDULE = OCCUPANCY
 NUMBER-OF-PEOPLE = 21.17
 PEOPLE-HG-LAT = 230
 PEOPLE-HG-SENS = 190
 EQUIPMENT-W/SQFT = 0.75
 EQUIP-SCHEDULE = LIGHTS
 LIGHTING-W/SQFT = LTWTS1
 LIGHTING-SCHEDULE = LIGHTS

		LIGHTING-TYPE	=	REC-FLUOR-RV	
		INF-METHOD	=	AIR-CHANGE	
		INF-CFM/SQFT	=	0.00914	
		INF-SCHEDULE	=	INFIL	
NW1EW8-N	=	EXTERIOR-WALL	LIKE	NE1EW8-N	..
NW1EW8F1	=	WINDOW WIDTH	=	30	..
NW1EW1-NW	=	EXTERIOR-WALL	LIKE	SW1EW1-NW	..
NW1EW1F1	=	WINDOW WIDTH	=	15	..
NW1EW2-W	=	EXTERIOR-WALL	LIKE	SW1EW2-W	..
NW1EW2F1	=	WINDOW WIDTH	=	30	..
NW1EW3-SW	=	EXTERIOR-WALL	LIKE	SW1EW3-SW	..
NW1EW3F1	=	WINDOW WIDTH	=	15	..
NW1-FLOOR	=	UNDERGROUND-FLOOR	LIKE	INT-FLOOR	..
NW1CEILING	=	INTERIOR-WALL	LIKE	INT-CEILING	..
NW1-PART2	=	INTERIOR-WALL	LIKE	PART2	..
NW1-2MECH	=	INTERIOR-WALL	LIKE	INT2MECH	..
MECH =	SPACE	AREA	=	3139	
		VOLUME	=	31390	
		X	=	80	
		Y	=	110	
		TEMPERATURE	=	(72)	
		ZONE-TYPE	=	UNCONDITIONED	
		INF-METHOD	=	AIR-CHANGE	
		INF-CFM/SQFT	=	0.01379	
		INF-SCHEDULE	=	INFIL	
		EQUIPMENT-W/SQFT	=	0.75	
		EQUIP-SCHEDULE	=	LIGHTS	
		PEOPLE-SCHEDULE	=	OCCUPANCY	
		NUMBER-OF-PEOPLE	=	11.4	
		PEOPLE-HG-LAT	=	230	
		PEOPLE-HG-SENS	=	190	..
MECHEW6-E	=	EXTERIOR-WALL	LIKE	SE1EW6-E	
		WIDTH	=	15	HEIGHT = 14 ..
MECHEW8-N	=	EXTERIOR-WALL	LIKE	NE1EW8-N	
		WIDTH	=	66	HEIGHT = 14 ..
MECHEW2-W	=	EXTERIOR-WALL	LIKE	SW1EW2-W	
		WIDTH	=	15	HEIGHT = 14 ..
MECH-UF	=	UNDERGROUND-FLOOR	LIKE	INT-FLOOR	
		AREA	=	96	..
MECH-CEILING=		INTERIOR-WALL	LIKE	INT-CEILING	
		AREA	=	3139	..
OFFICE	SPACE	AREA	=	4140	
		VOLUME	=	41400	
		X = 80 Y = 0			
		TEMPERATURE	=	(72)	
		PEOPLE-SCHEDULE	=	OCCUPANCY	
		NUMBER-OF-PEOPLE	=	15.06	
		PEOPLE-HG-LAT	=	230	
		PEOPLE-HG-SENS	=	190	
		EQUIPMENT-W/SQFT	=	.75	
		EQUIP-SCHEDULE	=	LIGHTS	
		LIGHTING-W/SQFT	=	LTWTS1	
		LIGHTING-SCHEDULE	=	LIGHTS	
		LIGHTING-TYPE	=	REC-FLUOR-RV	

INF-METHOD = AIR-CHANGE
 INF-CFM/SQFT = 0.0083
 INF-SCHEDULE = INFIL

 DAYLIGHTING = NO

 OFF-CEILING = INTERIOR-WALL LIKE INT-CEILING
 AREA = 4140 ..
 OFF-UF = UNDERGROUND-FLOOR LIKE INT-FLOOR
 AREA = 90 ..
 OFFEW2-W = EXTERIOR-WALL LIKE SW1EW2-W
 WIDTH = 30 X = -63 Y = 0 ..
 OFFEW2F1 = WINDOW WIDTH = 20 ..
 OFFEW4-S = EXTERIOR-WALL LIKE SW1EW4-S
 WIDTH = 30 ..
 OFFEW4F1 = WINDOW WIDTH = 20 ..
 OFFEW6-E = EXTERIOR-WALL LIKE SE1EW6-E
 X = 93 Y = 63 WIDTH = 30 ..
 OFFEW6F1 = WINDOW WIDTH = 20 ..

 ATRIUM SPACE AREA = 3518
 VOLUME = 119612

 X = 63
 Y = 63

 TEMPERATURE = (72)

 PEOPLE-SCHEDULE = OCCUPANCY
 NUMBER-OF-PEOPLE = 12.79
 PEOPLE-HG-LAT = 230
 PEOPLE-HG-SENS = 190

 EQUIPMENT-W/SQFT = .75
 EQUIP-SCHEDULE = LIGHTS

 LIGHTING-W/SQFT = 0.7 \$ TABLE 3.5-1 \$
 LIGHTING-SCHEDULE = LIGHTS

 DAYLIGHTING = NO
 LIGHT-REF-POINT1 = (14,13,2.5)
 LIGHT-SET-POINT1 = 20
 LIGHT-CTRL-TYPE1 = STEPPED
 LIGHT-CTRL-STEPS = 4

 INF-METHOD = AIR-CHANGE
 INF-CFM/SQFT = 0.04139
 INF-SCHEDULE = INFIL

 SUNSPACE = YES
 FLOOR-WEIGHT = 130 ..

 AT-FLOOR = UNDERGROUND-FLOOR CONSTRUCTION = FLOOR
 AREA = 3518 TILT = 180 ..

 ATEW9-W = EXTERIOR-WALL HEIGHT = 20
 WIDTH = 30
 AZIMUTH = 270
 X = 0 Y = 30 Z = 14 ..
 ATEW9F1 = WINDOW HEIGHT = WH1 WIDTH = WW1 Y = 0
 GLASS-TYPE=GLASS1 ..
 ATEW10-SW = EXTERIOR-WALL HEIGHT = 20
 WIDTH = 24
 AZIMUTH = 225
 X = 0 Y = 0 Z = 14 ..
 ATEW10F1 = WINDOW HEIGHT = WH2 WIDTH = WW2 Y = 0
 GLASS-TYPE = GLASS1 ..
 ATEW11-S = EXTERIOR-WALL HEIGHT = 20 WIDTH = 30

```

                                AZIMUTH = 180
                                X = -17 Y = 17 Z = 14 ..
ATEW11F1 = WINDOW LIKE ATEW9F1 ..
ATEW12-E = EXTERIOR-WALL LIKE ATEW9-W X = 64 Y = 0
                                AZIMUTH=90 ..
ATEW12F1 = WINDOW LIKE ATEW9F1 ..
ATEW13-NE = EXTERIOR-WALL LIKE ATEW10-SW X = 64 Y = 30
                                AZIMUTH=45 ..
ATEW13F1 = WINDOW LIKE ATEW10F1 ..
ATEW14-N = EXTERIOR-WALL LIKE ATEW11-S X = 47 Y = 47
                                AZIMUTH=0 ..
ATEW14F1 = WINDOW LIKE ATEW9F1 ..
ATEW15-NW = EXTERIOR-WALL HEIGHT=6 WIDTH=24
                                X = 17 Y = 47 AZIMUTH = 315 ..
ATEW15F1 = WINDOW HEIGHT=5.5 WIDTH=24 Y = 0
                                GLASS-TYPE = GLASS1 ..
ATEW16-SE = EXTERIOR-WALL LIKE ATEW15-NW X = 47 Y = -17
                                AZIMUTH=135 ..
ATEW16F1 = WINDOW LIKE ATEW15F1 ..

```

\$ ATRIUM ROOF IS MADE UP OF 8 TRIANGLES, RISING 5.76 FT. TO MAKE A CONE
 \$ SHAPED ROOF. THIS IS MODELED BY 8 RECTANGLES OF EQUIV. AREA, TILT,
 \$ AND DIRECTION. \$

```

ATROOF-A = ROOF X = 47 Y = 47 Z = 34 AZIMUTH = 0
                                TILT = 10.2 WIDTH = 30 HEIGHT = 16.25 ..
ATR-A-F1 = WINDOW WIDTH = 30 HEIGHT = 16 Y = 0
                                GLASS-TYPE = GLASS2 ..
ATROOF-B = ROOF LIKE ATROOF-A
                                X = 64 Y = 0 AZIMUTH = 90 ..
ATR-B-F1 = WINDOW LIKE ATR-A-F1 ..
ATROOF-C = ROOF LIKE ATROOF-A
                                X = 17 Y = -17 AZIMUTH = 180 ..
ATR-C-F1 = WINDOW LIKE ATR-A-F1 ..
ATROOF-D = ROOF LIKE ATROOF-A
                                X = 0 Y = 30 AZIMUTH = 270 ..
ATR-D-F1 = WINDOW LIKE ATR-A-F1 ..
ATROOF-E = ROOF X = 64 Y = 30 Z = 34 AZIMUTH = 45
                                TILT = 9.8 WIDTH = 24 HEIGHT = 16.87 ..
ATR-E-F1 = WINDOW WIDTH = 24 HEIGHT = 16.5 Y = 0
                                GLASS-TYPE = GLASS2 ..
ATROOF-F = ROOF LIKE ATROOF-E
                                X = 47 Y = -17 AZIMUTH = 135 ..
ATR-F-F1 = WINDOW LIKE ATR-E-F1 ..
ATROOF-G = ROOF LIKE ATROOF-E
                                X = 0 Y = 0 AZIMUTH = 225 ..
ATR-G-F1 = WINDOW LIKE ATR-E-F1 ..
ATROOF-H = ROOF LIKE ATROOF-E
                                X = 17 Y = 47 AZIMUTH = 315 ..
ATR-H-F1 = WINDOW LIKE ATR-E-F1 ..

```

\$ ATRIUM INTERIOR WALLS. ALL WALLS FOR A DIRECTION ARE GROUPED TOGETHER
 \$ AND NAMED FOR THAT DIRECTION, INCLUDING PLENUM WALLS. THE ONLY
 \$ EXCEPTION ARE THE OFFICE AND MECH, WHERE THE WALLS ARE NAMED AFTER
 \$ THE ZONE NAMES. \$

```

AT-IW1-SW = INTERIOR-WALL WIDTH = 24 HEIGHT = 10
                                X = 0 Y = 0 Z = 0 AZIMUTH = 225
                                INT-WALL-TYPE = STANDARD
                                CONSTRUCTION = PARTITION
                                NEXT-TO = SW1 ..
AT-IW2-SW = INTERIOR-WALL LIKE AT-IW1-SW
                                HEIGHT = 4 Z = 10 NEXT-TO = PLENM ..

```

\$ OFFICE WALLS, CLOCKWISE FROM WEST SIDE. WALLS ARE MADE UP OF 18 FT
 \$ WIDE PARTITION, 6 FT AIR-WALL(OPEN TO OFFICE HALL), AND ANOTHER 18 FT
 \$ WIDE PARTITION. EVERY 4TH WALL IS THE PLENUM WALL ABOVE THE OTHER THREE
 \$ WALLS. \$

AT-IW1-OFF = INTERIOR-WALL WIDTH = 12 HEIGHT = 10
                   X = 0 Y = 12 Z = 0 AZIMUTH = 270
                   INT-WALL-TYPE = STANDARD
                   CONSTRUCTION = PARTITION
                   NEXT-TO = OFFICE ..
 AT-IW2-OFF = INTERIOR-WALL WIDTH = 6 HEIGHT = 10
                   X = 0 Y = 18 Z = 0 AZIMUTH = 270
                   INT-WALL-TYPE = AIR
                   CONSTRUCTION = AIR-WALL
                   NEXT-TO = OFFICE ..
 AT-IW3-OFF = INTERIOR-WALL LIKE AT-IW1-OFF
                   Y = 30 ..
 AT-IW4-OFF = INTERIOR-WALL WIDTH = 30 HEIGHT = 4
                   X = 0 Y = 30 Z = 10 AZIMUTH = 270
                   INT-WALL-TYPE = STANDARD
                   CONSTRUCTION = PARTITION
                   NEXT-TO = PLENM ..

 AT-IW5-OFF = INTERIOR-WALL LIKE AT-IW1-OFF
                   X = 64 Y = 18 AZIMUTH = 90 ..
 AT-IW6-OFF = INTERIOR-WALL LIKE AT-IW2-OFF
                   X = 64 Y = 12 AZIMUTH = 90 ..
 AT-IW7-OFF = INTERIOR-WALL LIKE AT-IW1-OFF
                   X = 64 Y = 0 AZIMUTH = 90 ..
 AT-IW8-OFF = INTERIOR-WALL LIKE AT-IW4-OFF
                   X = 64 Y = 0 AZIMUTH = 90 ..

 AT-IW9-OFF = INTERIOR-WALL LIKE AT-IW1-OFF
                   X = 35 Y = -17 AZIMUTH = 180 ..
 AT-IW10-OFF= INTERIOR-WALL LIKE AT-IW2-OFF
                   X = 29 Y = -17 AZIMUTH = 180 ..
 AT-IW11-OFF= INTERIOR-WALL LIKE AT-IW1-OFF
                   X = 17 Y = -17 AZIMUTH = 180 ..
 AT-IW12-OFF= INTERIOR-WALL LIKE AT-IW4-OFF
                   X = 17 Y = -17 AZIMUTH = 180 ..

 AT-IW1-NW = INTERIOR-WALL LIKE AT-IW1-SW
                   X = 17 Y = 47 AZIMUTH = 315
                   NEXT-TO = NW1 ..
 AT-IW2-NW = INTERIOR-WALL LIKE AT-IW2-SW
                   X = 17 Y = 47 AZIMUTH = 315 ..
 AT-IW3-NW = INTERIOR-WALL LIKE AT-IW1-NW
                   Z = 14 NEXT-TO = NW2 ..
 AT-IW4-NW = INTERIOR-WALL LIKE AT-IW2-NW
                   Z = 24 ..

 AT-IW1-MECH= INTERIOR-WALL X = 47 Y = 47 Z = 0
                   HEIGHT = 14 WIDTH = 30 AZIMUTH = 0
                   INT-WALL-TYPE = STANDARD
                   CONSTRUCTION = NTM
                   NEXT-TO = MECH ..

 AT-IW1-NE = INTERIOR-WALL LIKE AT-IW1-SW
                   X = 64 Y = 30 AZIMUTH = 45
                   NEXT-TO = NE1 ..
 AT-IW2-NE = INTERIOR-WALL LIKE AT-IW2-SW
                   X = 64 Y = 30 AZIMUTH = 45 ..

 AT-IW1-SE = INTERIOR-WALL LIKE AT-IW1-SW
                   X = 47 Y = -17 AZIMUTH = 135
                   NEXT-TO = SE1 ..
 AT-IW2-SE = INTERIOR-WALL LIKE AT-IW2-SW
                   X = 47 Y = -17 AZIMUTH = 135 ..
 AT-IW3-SE = INTERIOR-WALL LIKE AT-IW1-SE
                   Z = 14 NEXT-TO = SE2 ..
 AT-IW4-SE = INTERIOR-WALL LIKE AT-IW2-SE Z= 24 ..

```

SE2      SPACE  AREA          = 5822
          VOLUME       = 58220
          X             = 110
          Y             = 0
          Z             = 14

          TEMPERATURE   = (72)

          PEOPLE-SCHEDULE = OCCUPANCY
          NUMBER-OF-PEOPLE = 21.17
          PEOPLE-HG-LAT   = 230
          PEOPLE-HG-SENS  = 190

          EQUIPMENT-W/SQFT = .75
          EQUIP-SCHEDULE  = LIGHTS

          LIGHTING-W/SQFT = LTWTS1
          LIGHTING-SCHEDULE = LIGHTS
          LIGHTING-TYPE   = REC-FLUOR-RV

          INF-METHOD     = AIR-CHANGE
          INF-CFM/SQFT    = 0.01671
          INF-SCHEDULE    = INFIL

SE2EW2-W = EXTERIOR-WALL LIKE SW1EW2-W ..
SE2EW2F1 = WINDOW WIDTH=30 ..
SE2EW3-SW = EXTERIOR-WALL LIKE SW1EW3-SW ..
SE2EW3F1 = WINDOW WIDTH =15 ..
SE2EW4-S = EXTERIOR-WALL LIKE SW1EW4-S ..
SE2EW4F1 = WINDOW WIDTH = 30 ..
SE2EW5-SE = EXTERIOR-WALL LIKE SW1EW5-SE ..
SE2EW5F1 = WINDOW WIDTH = 15 ..
SE2EW6-E = EXTERIOR-WALL LIKE SE1EW6-E ..
SE2EW6F1 = WINDOW WIDTH = 30 ..
SE2EW7-NE = EXTERIOR-WALL LIKE SE1EW7-NE ..
SE2EW7F1 = WINDOW WIDTH = 15 ..
SE2CEILING = INTERIOR-WALL LIKE INT-CEILING ..
SE2-FLOOR = INTERIOR-WALL CONSTRUCTION = INTFLOOR
          INT-WALL-TYPE=STANDARD
          NEXT-TO=PLENM
          AREA = 5822 TILT = 180 ..

```

```

NW2      SPACE  AREA          = 5822
          VOLUME       = 58220
          X             = 0
          Y             = 110
          Z             = 14

          TEMPERATURE   = (72)

          PEOPLE-SCHEDULE = OCCUPANCY
          NUMBER-OF-PEOPLE = 21.17
          PEOPLE-HG-LAT   = 230
          PEOPLE-HG-SENS  = 190

          EQUIPMENT-W/SQFT = .75
          EQUIP-SCHEDULE  = LIGHTS

          LIGHTING-W/SQFT = LTWTS1
          LIGHTING-SCHEDULE = LIGHTS
          LIGHTING-TYPE   = REC-FLUOR-RV

          INF-METHOD     = AIR-CHANGE
          INF-CFM/SQFT    = 0.01671
          INF-SCHEDULE    = INFIL

NW2EW4-S = EXTERIOR-WALL LIKE SW1EW4-S ..
NW2EW4F1 = WINDOW WIDTH = 30 ..

```

```

NW2EW6-E = EXTERIOR-WALL LIKE SE1EW6-E ..
NW2EW6F1 = WINDOW WIDTH = 30 ..
NW2EW7-NE = EXTERIOR-WALL LIKE SE1EW7-NE ..
NW2EW7F1 = WINDOW WIDTH = 15 ..
NW2EW8-N = EXTERIOR-WALL LIKE NE1EW8-N ..
NW2EW8F1 = WINDOW WIDTH = 30 ..
NW2EW1-NW = EXTERIOR-WALL LIKE SW1EW1-NW ..
NW2EW1F1 = WINDOW WIDTH = 15 ..
NW2EW2-W = EXTERIOR-WALL LIKE SW1EW2-W ..
NW2EW2F1 = WINDOW WIDTH = 30 ..
NW2EW3-SW = EXTERIOR-WALL LIKE SW1EW3-SW ..
NW2EW3F1 = WINDOW WIDTH = 15 ..
NW2-CEILING= INTERIOR-WALL LIKE INT-CEILING ..
NW2-FLOOR = INTERIOR-WALL LIKE SE2-FLOOR ..

PLENM SPACE ZONE-TYPE = PLENUM
AREA = 39072
VOLUME = 156288

TEMPERATURE = (72) ..

ROOF HEIGHT = 166
WIDTH = 166
CONSTRUCTION = STD-ROOF
TILT = 0
GND-REFLECTANCE= 0
Z = 4 ..

$ EXTERIOR PLENUM WALLS ARE DEFINED AS THE SUM OF ALL OF THE WALLS $
$ FACING IN THE SAME DIRECTION $

WALLP-N = EXTERIOR-WALL HEIGHT = 4
WIDTH = 138 ..
WALLP-E = EXTERIOR-WALL LIKE WALLP-N
WIDTH = 184
AZIMUTH = 90 ..
WALLP-S = EXTERIOR-WALL LIKE WALLP-N
AZIMUTH = 180 ..
WALLP-W = EXTERIOR-WALL LIKE WALLP-N
WIDTH = 184
AZIMUTH = 270 ..
WALLP-NE = EXTERIOR-WALL LIKE WALLP-N
WIDTH = 96 AZIMUTH = 45 ..
WALLP-SE = EXTERIOR-WALL LIKE WALLP-N
WIDTH = 96 AZIMUTH = 135 ..
WALLP-SW = EXTERIOR-WALL LIKE WALLP-N
WIDTH = 120 AZIMUTH=225 ..
WALLP-NW = EXTERIOR-WALL LIKE WALLP-N
WIDTH = 72 AZIMUTH=315 ..

$ THE ELEVATORS ARE COMMENTED OUT DUE TO A LACK OF INFO IN THE STANDARDS
$ CONCERNING ELEVATORS IN THE PROTOTYPE BLDG. $

BUILDING-RESOURCE $ VERT-TRANS-SCH = ELEVATOR
$ VERT-TRANS-KW = 100
HW-SCHEDULE = SERVICE-HW
HOT-WATER = 29096 ..

$ HOT WATER SIZED FOR 166 PEOPLE AT 175 BTU/PERSON-HOUR $

LOADS-REPORT VERIFICATION=(LV-A,LV-B,LV-C)
SUMMARY=(1s-a,1s-b,LS-C,LS-D) ..

END
COMPUTE LOADS

$ ***** SYSTEMS INPUT ***** $

INPUT SYSTEMS

```



```

SYSTEMS-REPORT      VERIFICATION = (SV-A)
                     SUMMARY      = (SS-A,SS-B,SS-F) ..

FANS      =    SCHEDULE THRU DEC 31  (WD)      (1,6)      (0)
                                           (7,18)      (1)
                                           (19,24)     (0)
                                           (SAT)      (1,7)      (0)
                                           (8,14)      (1)
                                           (15,24)     (0)
                                           (SUN,HOL) (1,24)    (0) ..

HEAT-SET =    SCHEDULE THRU DEC 31  (WD)      (1,6)      (55)
                                           (7,18)      (70)
                                           (19,24)     (55)
                                           (SAT)      (1,7)      (55)
                                           (8,14)      (70)
                                           (15,24)     (55)
                                           (SUN,HOL) (1,24)    (55) ..

COOL-SET =    SCHEDULE THRU DEC 31  (WD)      (1,6)      (99)
                                           (7,18)      (75)
                                           (19,24)     (99)
                                           (SAT)      (1,7)      (99)
                                           (8,14)      (75)
                                           (15,24)     (99)
                                           (SUN,HOL) (1,24)    (99) ..

$ SCHEDULE OF SETPOINT FOR MAXIMUM INTERIOR TEMPERATURE BEFORE VENTING
TV-SCH-1 =    SCHEDULE THRU DEC 31 (ALL)      (1,24)    (80) ..

SET-DEFAULT FOR ZONE      ZONE-TYPE      =    CONDITIONED
                           OA-CFM/PER     =    15
                           DESIGN-HEAT-T   =    70
                           HEAT-TEMP-SCH   =    HEAT-SET
                           DESIGN-COOL-T   =    75
                           COOL-TEMP-SCH   =    COOL-SET
                           THERMOSTAT-TYPE =    REVERSE-ACTION
                           THROTTLING-RANGE =    5
                           ..

MECH      =    ZONE      ZONE-TYPE=UNCONDITIONED ..

PLENM     =    ZONE      ZONE-TYPE      =    PLENUM ..

SE1 = ZONE ..
SE2 = ZONE ..
NE1 = ZONE ..
NW1 = ZONE ..
NW2 = ZONE ..
SW1 = ZONE ..
OFFICE =    ZONE      EXHAUST-CFM = 250
                     EXHAUST-STATIC = 0.5
                     EXHAUST-EFF = 0.80
                     EXHAUST-KW = 0.00072 ..

$ ATRIUM IS MECHANICALLY VENTED AT 10 ACH IF THE INSIDE TEMPERATURE
$ EXCEEDS 78 F AND THE OUTSIDE TEMPERATURE IS BELOW 75 F. THE VENTING FAN
$ USES 0.05 WATTS/CFM. VENTING IS ALLOWED ANYTIME THE HVAC SYSTEM IS ON.
ATRIUM =    ZONE      SS-VENT-SCH = FANS
                     SS-VENT-T-SCH = TV-SCH-1
                     SS-VENT-CST = 10
                     SS-VENT-LIMIT-T = 75
                     SS-VENT-KW = 0.00005
                     ..

```

```

SYS-VAV  =  SYSTEM  SYSTEM-TYPE      =  VAVS
                  MAX-SUPPLY-T      =  90
                  MIN-SUPPLY-T      =  55
                  COOL-CONTROL       =  WARMEST
                  HEAT-SET-T         =  90
                  REHEAT-DELTA-T     =  30
                  OA-CONTROL         =  TEMP
                  FAN-SCHEDULE        =  FANS
                  FAN-CONTROL        =  INLET
                  SUPPLY-STATIC       =  4.0
                  SUPPLY-EFF         =  .55
                  MOTOR-PLACEMENT     =  IN-AIRFLOW
                  RETURN-STATIC       =  1.0
                  RETURN-EFF         =  .30
                  HEAT-SOURCE        =  HOT-WATER
                  PLENUM-NAMES       =  (PLENM)
                  RETURN-AIR-PATH     =  PLENUM-ZONES
                  ZONE-NAMES         =  (SE1,SE2,NE1,NW1,NW2
                                      SW1,OFFICE,MECH,PLENM)

```

..

```

SYS-ATRIUM =  SYSTEM  SYSTEM-TYPE      =  VAVS
                  MAX-SUPPLY-T      =  90
                  MIN-SUPPLY-T      =  55
                  COOL-CONTROL       =  WARMEST
                  HEAT-SET-T         =  90
                  REHEAT-DELTA-T     =  30
                  OA-CONTROL         =  TEMP
                  FAN-SCHEDULE        =  FANS
                  FAN-CONTROL        =  INLET
                  SUPPLY-STATIC       =  4.0
                  SUPPLY-EFF         =  .55
                  MOTOR-PLACEMENT     =  IN-AIRFLOW
                  RETURN-STATIC       =  1.0
                  RETURN-EFF         =  .30
                  HEAT-SOURCE        =  HOT-WATER
                  RETURN-AIR-PATH     =  DIRECT
                  ZONE-NAMES         =  (ATRIUM)

```

..

END ..

COMPUTE SYSTEMS ..

INPUT PLANT ..

PLANT-REPORT SUMMARY=(PS-A,PS-B,PS-D,BEPS) ..

PARAMETER
 SHW-HIR= 1.3
 BOIL-HIR= 1.25
 HR-CHIL-EIR= 0.37
 ..

```

SERVICE-HW-HEATER =  PLANT-EQUIPMENT
                      TYPE      =  DHW-HEATER
                      SIZE      =  -999

```

```

BOILER      =  PLANT-EQUIPMENT
               TYPE      =  HW-BOILER
               SIZE      =  -999

```

```

CHILLER     =  PLANT-EQUIPMENT
               TYPE      =  HERM-REC-CHLR
               INSTALLED-NUMBER =  1
               SIZE      =  -999

```

```

COOLTWR      =  PLANT-EQUIPMENT
                TYPE              =  COOLING-TWR
                SIZE              =  -999  ..

PLANT-PARAMETERS  DHW-HIR          =  SHW-HIR
                   DHW-HEATER-FUEL =  NATURAL-GAS
                   BOILER-FUEL     =  NATURAL-GAS
                   HW-BOILER-HIR   =  BOIL-HIR
                   HCIRC-DESIGN-T-DROP =  30
                   HCIRC-HEAD      =  60
                   HCIRC-IMPELLER-EFF =  .67
                   HCIRC-MOTOR-EFF =  .9
                   HERM-REC-COND-TYPE =  TOWER
                   CHILL-WTR-T     =  44
                   CHILL-WTR-THROTTLE =  1.0
                   CCIRC-DESIGN-T-DROP =  12
                   CCIRC-HEAD      =  75
                   CCIRC-IMPELLER-EFF =  .72
                   CCIRC-MOTOR-EFF =  .9  ..

END
COMPUTE PLANT  ..

##fileprefix /user0/d3f057/office/
##include econ.inp
##include econ2.inp

STOP          ..

```

Appendix B

DOE-2 Input File for the Prototype Building

TITLE LINE-1 = *FIVE-ZONE OFFICE, BASELINE MODEL *
 LINE-2 = * LOS ANGELES CA PROTOTYPE *
 LINE-4 = * PACIFIC NORTHWEST LABORATORY * ..

\$ THIS INPUT DECK IS SET UP TO MODEL A RECTANGULAR OFFICE BUILDING WITH
 \$ A 2.5-TO-1 ASPECT RATIO, AND THE LONG DIMENSION FACING EAST-WEST. IT
 \$ IS CURRENTLY SET FOR 10 CFR 435, SECTION 11 COMPLIANCE IN LOS ANGELES, CA.

INPUT LOADS ..
 ABORT ERRORS ..
 LIST WARNINGS ..

PARAMETER

\$ WINDOWS
 WINDOW-HT = 2.34 \$ WWR = 0.18 FROM ACP TABLE 5.4-6

\$ BUILDING CONFIGURATION AND INSULATION
 ROTATION = 0 \$ BUILDING ROTATION
 PCTROOFEXP = 0.50 \$ PERCENT OF ROOF NEXT TO OUTSIDE AIR
 PCTSLAB = 0.50 \$ PERCENT OF FLOOR THAT IS SLAB
 PCTFLRPLN = 0.50 \$ PERCENT OF FLOOR NEXT TO PLENUM
 PCTPLN-EXP = 0.50 & PCTFLREXP PLUS PCTFLRPLN
 PCTPART = 0.70 \$ PERCENT OF WALL PARTITION
 PCTAIR = 0.30 \$ PERCENT OF WALL AIR

\$ ----- BUILDING DIMENSIONS ----- \$
 \$ WITH THESE COMMANDS IT IS POSSIBLE TO VARY THE SIZE OF THE BUILDING
 \$ WITHOUT CHANGING VALUES THROUGHOUT THE INPUT DECK. THE ONLY \$
 \$ EXCEPTION IS THE AMOUNT OF HOT WATER, WHICH MUST BE DETERMINED
 \$ ON A PER-PERSON BASIS, FOR THE WHOLE BUILDING. \$

NO-OF-FLOORS = 2
 EW-DIM = 239 \$ LENGTH OF EAST & WEST WALLS \$
 NS-DIM = 96 \$ LENGTH OF NORTH & SOUTH WALLS \$
 INT-NS-DIM = 66 \$ NS-DIM - 30 FT, N-S DIMENSION OF CORE \$
 INT-EW-DIM = 209 \$ EW-DIM - 30 FT, E-W DIMENSION OF CORE \$
 NS-AREA = #eval[7.5 * #eval[96 + 66]]
 NS-ROOF = #eval[SQRT OF #eval[7.5 * #eval[96 + 66]]]
 EW-ROOF = #eval[SQRT OF #eval[7.5 * #eval[239 + 209]]]
 EW-AREA = #eval[7.5 * #eval[239 + 209]]
 \$ NS-AREA = THE FLOOR AREA OF THE NO. & SO. PERIMETER ZONES. \$
 \$ NS-ROOF = THE DIMENSIONS OF THE ROOF FOR THE NO. & SO. ZONES. \$
 \$ LIKEWISE FOR EW-AREA AND EW-ROOF. \$
 INT-AREA = #eval[66 * 209] \$ AREA OF CORE ZONE \$
 PCTAIR-NS = #eval[66 * 0.30] \$ INT-NS-DIM TIMES PCTAIR
 PCTAIR-EW = #eval[209 * 0.30] \$ INT-EW-DIM TIMES PCTAIR
 PCTPART-NS = #eval[66 * 0.70] \$ INT-NS-DIM TIMES PCTPART
 PCTPART-EW = #eval[209 * 0.70] \$ INT-EW-DIM TIMES PCTPART
 PCTFLRPLN-INT = #eval[66 * 0.50] \$ INT-NS-DIM TIMES PCTFLRPLN

\$ OPERATING CONDITIONS
 LIGHT-W/SF = 1.65 \$ TABLE 3.4-1, 25-50K OFFICE
 EQUIP-W/SF = 0.75 \$ TABLE 11-4, OFFICE
 PEOPLE = OFFICE-PEOPLE
 LIGHTS = OFFICE-LIGHTS
 INFIL = OFFICE-INFIL
 SHADE-CO = 0.5
 GLASS-COND = 1.15
 \$ INFIL EQUATIONS NECESSARY TO CONVERT CFM-WALL TO CFM-FLOOR \$
 INFIL-NS = 1.0272 \$ (13*NS-DIM)/7.5(NSDIM+INT-NS-DIM) \$
 INFIL-EW = 0.9247 \$ (13*EW-DIM)/7.5(EWDIM+INT-EW-DIM) \$
 ..

BUILDING-LOCATION
 AZIMUTH = ROTATION ..

RUN-PERIOD JAN 1, 1981 THRU DEC 31 1981 .. \$ ANNUAL RUN

\$----- OPERATING SCHEDULES: TABLE 11-3 -----\$

OFFICE-PEOPLE = SCH THRU DEC 31

(MON,FRI)	(1,7)	(0.0)
	(8)	(0.1)
	(9)	(0.2)
	(10,11)	(0.95)
	(12,13)	(0.45)
	(14,18)	(0.95)
	(19)	(0.3)
	(20,22)	(0.1)
	(23,24)	(0.0)
(SAT)	(1,7)	(0.0)
	(8,9)	(0.1)
	(10,13)	(0.3)
	(14,18)	(0.1)
	(19,24)	(0.0)
(SUN,HOL)	(1,6)	(0.0)
	(7,18)	(0.0)
	(19,24)	(0.0)

..

OFFICE-LIGHTS = SCH THRU DEC 31

(MON,FRI)	(1,6)	(0.0)
	(7)	(0.1)
	(8)	(0.3)
	(9,12)	(0.9)
	(13)	(0.8)
	(14,18)	(0.9)
	(19,20)	(0.3)
	(21,22)	(0.2)
	(23)	(0.0)
	(24)	(0.0)
(SAT)	(1,6)	(0.0)
	(7,8)	(0.1)
	(9,12)	(0.30)
	(13,18)	(0.15)
	(19,24)	(0.0)
(SUN,HOL)	(1,24)	(0.0)

..

OFFICE-INFIL = SCH THRU DEC 31

(MON,FRI)	(1,6)	(1.0)
	(7,18)	(0.0)
	(19,24)	(1.0)
(SAT)	(1,6)	(1.0)
	(7,14)	(0.0)
	(15,24)	(1.0)
(SUN)	(1,24)	(1.0)
(HOL)	(1,24)	(1.0)

..

SERVICE-HW = SCH THRU DEC 31

(MON,FRI)	(1,7)	(0.0)
	(8)	(0.15)
	(9)	(0.3)
	(10,11)	(0.35)
	(12)	(0.45)
	(13)	(0.55)
	(14)	(0.5)
	(15,16)	(0.3)
	(17)	(0.4)
	(18,19)	(0.2)
	(20)	(0.1)
	(21)	(0.15)
	(22)	(0.05)
	(23,24)	(0.0)
(SAT)	(1,7)	(0.0)
	(8,9)	(0.1)

	(10)	(0.2)
	(11)	(0.15)
	(12)	(0.2)
	(13,14)	(0.15)
	(15,17)	(0.1)
	(18,24)	(0.0)
(SUN,HOL)	(1,24)	(0.0) ..

\$----- LAYERS AND CONSTRUCTIONS ----- \$

EXTWALL = CONS U = 0.23 .. \$ACP TABLE 5.4-6

EXTROOF = CONS U = 0.10 .. \$ACP TABLE 5.4-6

AIRWALL = CONS U-VALUE=2.60 .. \$ ARBITRARY LARGE NUMBER \$

PLNFLOOR = CONS U = 0.18 .. \$ACP TABLE 5.4-6, FLOOR ADJ. TO UNCOND.

SLAB = CONS U = 0.8 .. \$ACP TABLE 5.4-6, UNHEATED S-O-G, R=0
 \$ U VALUE OF SLAB IS HEAT LOSS COEFFICIENT FROM TABLE 5, CHAP 25
 \$ ASHRAE FUNDAMENTALS FOR 4" BLOCK WALL, NO INSULATION, 2950 DD
 \$ AREA OF SLAB BELOW IS EXPOSED LENGTH, OR PERIMETER, OF FLOOR IN FT.

\$ 5/8" GYPSUM BOARD, AIR SPACE, 5/8" GYPSUM BOARD
 PARTITIONL=LAYERS MAT=(GP02,AL21,GP02) ..

PARTITION = CONS LAYERS=PARTITIONL ..

\$ 1/2 IN ACOUSTIC TILE CEILING
 CEILINGL=LAYERS I-F-R=0.68 MAT=(AC02) ..

CEILING = CONS LAYERS=CEILINGL ABS=0.50 RO=5 ..

\$----- GLASS ----- \$

MINCOMPGL = GLASS-TYPE SHADING-COEF = SHADE-CO
 PANES = 1
 GLASS-CONDUCTANCE = GLASS-COND ..

LIST WARNINGS ..

\$----- DEFAULTS ----- \$

SET-DEFAULT FOR WINDOW
 HEIGHT = WINDOW-HT \$ WWR= 0.18 \$
 GLASS-TYPE = MINCOMPGL
 Y = 2.5 ..

\$----- INSIDE CONDITIONS ----- \$

ZONE-CONDITIONS = SPACE-CONDITIONS
 PEOPLE-SCHEDULE = PEOPLE
 TEMPERATURE = (72)
 PEOPLE-HG-SENS = 230 \$ TABLE 11-2 \$
 PEOPLE-HG-LAT = 190 \$ TABLE 11-2 \$
 LIGHTING-SCHEDULE = LIGHTS
 LIGHTING-TYPE = REC-FLUOR-RV \$ SAME AS DESIGN \$
 LIGHTING-W/SQFT = LIGHT-W/SF
 EQUIP-SCHEDULE = LIGHTS
 EQUIPMENT-W/SQFT = EQUIP-W/SF
 INF-SCHEDULE = OFFICE-INFIL
 INF-METHOD = AIR-CHANGE
 ..

\$*****\$

NORTH-ZONE1 = SPACE
 AREA = NS-AREA
 VOLUME = NS-AREA TIMES 9
 AZIMUTH = 0
 INF-CFM/SQFT = INFIL-NS TIMES 0.038
 SPACE-CONDITIONS = ZONE-CONDITIONS
 NUMBER-OF-PEOPLE = NS-AREA TIMES 0.00363636 \$ 1 person/275 sq.ft.

FLOOR-MULTIPLIER = NO-OF-FLOORS ..

\$CEILING

I-W CONS=CEILING AREA = NS-AREA TILT = 0
NEXT-TO NORTH-PLN1 ..

\$FLOOR

I-W CONS = PLNFLOOR
Y = PCTFLRPLN TIMES 15 H = PCTFLRPLN TIMES 15
W = NS-DIM NEXT-TO NORTH-PLN1 TILT = 180 ..
U-F CONS = SLAB
Y = 15 TILT = 180 AREA = NS-DIM TIMES 0.50 ..

\$PARTITIONS

I-W CONS=PARTITION NEXT-TO INTERIOR1 W=PCTPART-NS H=9 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR1 INT-WALL-TYPE = AIR
W=PCTAIR-NS H=9 ..
I-W CONS=PARTITION NEXT-TO EAST-ZONE1 W=PCTPART TIMES 21.21 H = 9 ..
I-W CONS=AIRWALL NEXT-TO EAST-ZONE1 INT-WALL-TYPE = AIR
W=PCTAIR TIMES 21.21 H = 9 ..
I-W CONS=PARTITION NEXT-TO WEST-ZONE1 W=PCTPART TIMES 21.21 H = 9 ..
I-W CONS=AIRWALL NEXT-TO WEST-ZONE1 INT-WALL-TYPE = AIR
W=PCTAIR TIMES 21.21 H = 9 ..

\$OUTSIDE WALL

NZEW = E-W CONS=EXTWALL WIDTH = NS DIM HEIGHT = 9 ..
WINDOW WIDTH = NS-DIM ..

*****\$

EAST-ZONE1 = SPACE LIKE NORTH-ZONE1
AZIMUTH = 90
AREA = EW-AREA
VOLUME = EW-AREA TIMES 9
INF-CFM/SQFT = IN/IL-EW TIMES 0.038
NUMBER-OF-PEOPLE = EW-AREA TIMES 0.00363636 \$ 1 person/275 sq.ft.
..

\$CEILING

I-W CONS=CEILING NEXT-TO EAST-PLN1 AREA = EW-AREA
..

\$FLOOR

I-W CONS = PLNFLOOR
Y = PCTFLRPLN TIMES 15 H = PCTFLRPLN TIMES 15
W = EW-DIM NEXT-TO EAST-PLN1 TILT = 180 ..
U-F CONS = SLAB
Y = 15 TILT = 180 AREA = EW-DIM TIMES 0.5 ..

\$PARTITIONS

I-W CONS=PARTITION NEXT-TO INTERIOR1 W=PCTPART-EW H=9 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR1 INT-WALL-TYPE = AIR
W=PCTAIR-EW H=9 ..

\$OUTSIDE WALL

EZEW = E-W CONS=EXTWALL WIDTH = EW-DIM HEIGHT = 9 ..
WINDOW WIDTH = EW-DIM ..

*****\$

SOUTH-ZONE1 = SPACE LIKE NORTH-ZONE1
AZIMUTH = 180 ..

\$CEILING

I-W CONS=CEILING NEXT-TO SOUTH-PLN1 AREA = NS-AREA
TILT = 0 ..

\$FLOOR

I-W CONS = PLNFLOOR
Y = PCTFLRPLN TIMES 15 H = PCTFLRPLN TIMES 15
W = NS-DIM NEXT-TO SOUTH-PLN1 TILT = 180 ..
U-F CONS = SLAB
Y = 15 TILT = 180 AREA = NS-DIM TIMES 0.5 ..


```

$PARTITIONS
I-W CONS=PARTITION NEXT-TO INTERIOR1 W=PCTPART-NS H=9 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR1 INT-WALL-TYPE = AIR
      W=PCTAIR-NS H=9 ..
I-W CONS=PARTITION NEXT-TO EAST-ZONE1 W=PCTPART TIMES 21.21 H = 9 ..
I-W CONS=AIRWALL NEXT-TO EAST-ZONE1 INT-WALL-TYPE = AIR
      W=PCTAIR TIMES 21.21 H = 9 ..
I-W CONS=PARTITION NEXT-TO WEST-ZONE1 W=PCTPART TIMES 21.21 H = 9 ..
I-W CONS=AIRWALL NEXT-TO WEST-ZONE1 INT-WALL-TYPE = AIR
      W=PCTAIR TIMES 21.21 H = 9 ..

$OUTSIDE WALL
SZEW = E-W CONS=EXTWALL WIDTH = NS-DIM HEIGHT = 9 ..
WINDOW WIDTH = NS-DIM ..

$*****$
WEST-ZONE1 = SPACE LIKE EAST-ZONE1
      AZIMUTH = 270 ..

$CEILING
I-W CONS=CEILING NEXT-TO WEST-PLN1 AREA = EW-AREA TILT = 0 ..
$FLOOR
I-W CONS = PLNFLOOR
      Y = PCTFLRPLN TIMES 15 H = PCTFLRPLN TIMES 15
      W = EW-DIM NEXT-TO WEST-PLN1 TILT = 180 ..
U-F CONS = SLAB
      Y = 15 TILT = 180 AREA = EW-DIM TIMES 0.5 ..

$PARTITIONS
I-W CONS=PARTITION NEXT-TO INTERIOR1 W=PCTPART-EW H=9 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR1 INT-WALL-TYPE = AIR
      W=PCTAIR-EW H=9 ..

$OUTSIDE WALL
WZEW = E-W CONS=EXTWALL WIDTH = EW-DIM HEIGHT = 9 ..
WINDOW WIDTH = EW-DIM ..

$*****$
INTERIOR1 = SPACE
      SHAPE = BOX
      WIDTH = INT-NS-DIM
      HEIGHT = 9
      DEPTH = INT-EW-DIM
      AZIMUTH = 0
      SPACE-CONDITIONS = ZONE-CONDITIONS
      INF-METHOD = NONE
      NUMBER-OF-PEOPLE = INT-AREA TIMES 0.00363636 $ 1 person/275 sq.ft.
      FLOOR-MULTIPLIER = NO-OF-FLOORS ..

I-W CONS=CEILING NEXT-TO INTERIOR-PLN1 LOCATION=TOP ..
I-W CONS=PLNFLOOR NEXT-TO INTERIOR-PLN1 W=PCTFLRPLN-INT
      H = INT-EW-DIM TILT = 180 ..

$*****$
NORTH-PLN1 = SPACE
      AREA = NS-AREA
      VOLUME = NS-AREA TIMES 4
      ZONE-TYPE = PLENUM
      FLOOR-MULTIPLIER = NO-OF-FLOORS ..

E-W CONS=EXTROOF M=PCTROOFEXP TILT = 0 W = NS-ROOF H = NS-ROOF ..
E-W CONS=EXTWALL WIDTH = NS-DIM HEIGHT = 4 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR-PLN1 INT-WALL-TYPE = AIR
      WIDTH = INT-NS-DIM H = 4 ..

$*****$
EAST-PLN1 = SPACE LIKE NORTH-PLN1
      AZIMUTH = 90
      AREA = EW-AREA

```

```

VOLUME = EW-AREA TIMES 4 ..

E-W CONS=EXTROOF M=PCTROOFEYP TILT = 0 W = EW-ROOF H = EW-ROOF ..
E-W CONS=EXTWALL WIDTH = EW-DIM HEIGHT = 4 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR-PLEN1 INT-WALL-TYPE = AIR
      WIDTH = INT-EW-DIM H = 4 ..

$*****$
SOUTH-PLEN1 = SPACE LIKE NORTH-PLEN1
      AZIMUTH = 180 ..

E-W CONS=EXTROOF M=PCTROOFEYP TILT = 0 W = NS-ROOF H = NS-ROOF ..
E-W CONS=EXTWALL WIDTH = NS-DIM HEIGHT = 4 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR-PLEN1 INT-WALL-TYPE = AIR
      WIDTH = INT-NS-DIM H = 4 ..

$*****$
WEST-PLEN1 = SPACE LIKE EAST-PLEN1
      AZIMUTH = 270 ..

E-W CONS=EXTROOF M=PCTROOFEYP TILT = 0 W = EW-ROOF H = EW-ROOF ..
E-W CONS=EXTWALL WIDTH = EW-DIM HEIGHT = 4 ..
I-W CONS=AIRWALL NEXT-TO INTERIOR-PLEN1 INT-WALL-TYPE = AIR
      WIDTH = INT-EW-DIM H = 4 ..

$*****$

INTERIOR-PLEN1 = SPACE
      SHAPE = BOX
      AREA = INT-AREA
      WIDTH = INT-NS-DIM
      DEPTH = INT-EW-DIM
      HEIGHT = 4
      ZONE-TYPE = PLENUM
      FLOOR-MULTIPLIER = NO-OF-FLOORS ..

E-W CONS=EXTROOF M=PCTROOFEYP LOCATION = TOP ..

BUILDING-RESOURCE HW-SCHEDULE = SERVICE-HW
      HOT-WATER = 29201 ..
$ HOT WATER AT 175 BTU/PERSON-HR FOR 166.9 PEOPLE, FROM TABLE 11-6 $

$*****$

$LOADS-REPORT VERIFICATION = (LV-A,LV-B,LV-C)
$ SUMMARY = (LS-A,LS-B,LS-C,LS-D) ..

END ..
COMPUTE LOADS ..

$-----$
$ SYSTEMS INPUT $
$-----$
INPUT SYSTEMS ..
TITLE LINE-2 = *PACKAGED VAV SYSTEM * ..

$-----$ OPERATING SCHEDULES TABLE 11-3 -----$

OFFICE-FAN = SCH THRU DEC 31,
      (MON,FRI) (1,6) (0)
      (7,18) (1)
      (19,24) (0)
      (SAT) (1,7) (0)
      (8,14) (1)
      (15,24) (0)
      (SUN) (1,24) (0)
      (HOL) (1,24) (0)

```

OFFICE-HEAT = SCH THRU DEC 31,
 (MON,FRI) (1,6) (55)
 (7,18) (70)
 (19,24) (55)
 (SAT) (1,7) (55)
 (8,14) (70)
 (15,24) (55)
 (SUN) (1,24) (55)
 (HOL) (1,24) (55) ..

OFFICE-COOL = SCH THRU DEC 31,
 (MON,FRI) (1,6) (99.)
 (7,18) (75)
 (19,24) (99)
 (SAT) (1,7) (99)
 (8,14) (75)
 (15,24) (99)
 (SUN) (1,24) (99)
 (HOL) (1,24) (99) ..

\$----- ZONE DESCRIPTION ----- \$

NORTH-ZONE1 = ZONE
 DESIGN-HEAT-T = 70
 HEAT-TEMP-SCH = OFFICE-HEAT
 DESIGN-COOL-T = 75
 COOL-TEMP-SCH = OFFICE-COOL
 THERMOSTAT-TYPE = REVERSE-ACTION
 THROTTLING-RANGE= 5.0
 OA-CFM/PER = 15 ..

EAST-ZONE1 = ZONE LIKE NORTH-ZONE1 ..
 SOUTH-ZONE1 = ZONE LIKE NORTH-ZONE1 ..
 WEST-ZONE1 = ZONE LIKE NORTH-ZONE1 ..
 INTERIOR1 = ZONE LIKE NORTH-ZONE1 ..

NORTH-PLEN1 = ZONE ZONE-TYPE = PLENUM ..
 EAST-PLEN1 = ZONE ZONE-TYPE = PLENUM ..
 SOUTH-PLEN1 = ZONE ZONE-TYPE = PLENUM ..
 WEST-PLEN1 = ZONE ZONE-TYPE = PLENUM ..
 INTERIOR-PLEN1 = ZONE ZONE-TYPE = PLENUM ..

\$----- SYSTEMS DESCRIPTION ----- \$

AC-NORTH = SYSTEM
 SYSTEM-TYPE = PVAVS \$ TABLE 11-7, SYSTEM #4 \$
 MIN-SUPPLY-T = 55
 MAX-SUPPLY-T = 105
 ZONE-NAMES = (NORTH-ZONE1,NORTH-PLEN1)
 FAN-SCHEDULE = OFFICE-FAN
 RETURN-AIR-PATH = PLENUM-ZONES
 COOLING-EIR = 0.333 \$ TABLE 8.3-1, COP=3.0 \$
 COOL-CONTROL = WARMEST
 SUPPLY-STATIC = 3.0 \$ TABLE 11-7 \$
 RETURN-STATIC = 0.6 \$ TABLE 11-7 \$
 SUPPLY-EFF = 0.45 \$ TABLE 11-7 \$
 RETURN-EFF = 0.25 \$ TABLE 11-7 \$
 HEAT-SET-T = 105
 REHEAT-DELTA-T = 30
 OA-CONTROL = TEMP
 FAN-CONTROL = INLET
 FAN-PLACEMENT = BLOW-THROUGH
 PLENUM-NAMES = (NORTH-PLEN1)
 ..

AC-EAST = SYSTEM LIKE AC-NORTH ZONE-NAMES = (EAST-ZONE1,EAST-PLEN1)
 PLENUM-NAMES = (EAST-PLEN1) ..

```

AC-SOUTH   = SYSTEM LIKE AC-NORTH  ZONE-NAMES = (SOUTH-ZONE1,SOUTH-PLN1)
                                           PLENUM-NAMES = (SOUTH-PLN1) ..
AC-WEST    = SYSTEM LIKE AC-NORTH  ZONE-NAMES = (WEST-ZONE1,WEST-PLN1)
                                           PLENUM-NAMES = (WEST-PLN1) ..
AC-INTERIOR = SYSTEM LIKE AC-NORTH  ZONE-NAMES = (INTERIOR1,INTERIOR-PLN1)
                                           PLENUM-NAMES = (INTERIOR-PLN1) ..

$-----$
$SYSTEMS-REPORT  VERIFICATION = (SV-A)
$                SUMMARY = (SS-A,SS-B,SS-F) ..

END ..
COMPUTE SYSTEMS ..

$-----$
INPUT PLANT ..

DHWBLR = PLANT-EQUIPMENT
        TYPE           = DHW-HEATER
        INSTALLED-NUMBER = 1
        MAX-NUMBER-AVAIL = 1
        SIZE            = -999 ..

BOILER = PLANT-EQUIPMENT
        TYPE           = HW-BOILER
        SIZE           = -999
        INSTALLED-NUMBER = 1
        MAX-NUMBER-AVAIL = 1 ..

PLANT-PARAMETERS
        DHW-HIR          = 1.3 $ 77% EFFICIENT $
        DHW-HEATER-FUEL  = NATURAL-GAS
        BOILER-FUEL      = NATURAL-GAS
        HW-BOILER-HIR    = 1.25 $ TABLE 8.3-8 $
        HCIRC-HEAD       = 60 $ TABLE 11-7, NOTE 12 $
        HCIRC-DESIGN-T-DROP = 30 $ TABLE 11-7, NOTE 12 $ ..

PLANT-REPORT SUMMARY = (PS-A,PS-B,BEPS) ..
END ..
COMPUTE PLANT ..

##fileprefix /user0/d3f057/office/
##include econ.inp
##include econ2.inp

STOP ..

```

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