LOADS

Introduction

The LOADS section of DOE-2 calculates the heating and cooling loads of a building, assuming a fixed indoor air temperature.* The loads components can be divided into two classes, external and internal.

External components are the loads due to heat conduction through walls, heat conduction through windows, infiltration through windows and walls, and solar gain through windows.

Internal components are the loads due to people, lights, and equipment inside the building.

The program first calculates the external load components for all the windows and doors on a wall, then for all the walls in a space. The wall loads are then combined into the total external load for the space. Next, the program calculates the internal load components for the space and combines them, giving the total internal load for the space. The external and internal loads are combined to give the total load for the space. Finally, the space loads are summed, giving the total building load for the hour.

LOADS calculates the heating and cooling loads using ASHRAE algorithms. For the load calculations it is assumed that no HVAC equipment is operating and that each space remains at a user-specified constant temperature. Therefore, the hourly load calculated by LOADS is the energy required to maintain a constant space temperature without the effects of ventilation air.

The building hourly loads are a function of many parameters, including

building latitude
building longitude
building altitude
building location--time-zone
building orientation
hourly ambient dry-bulb temperature
hourly ambient wet-bulb temperature
hourly atmospheric pressure
hourly windspeed
hourly wind direction
hourly insolation
schedules for occupants
schedules for lighting
schedules for equipment
hourly infiltration rate
size of exterior, interior, and underground surfaces
construction of exterior, interior, and underground surfaces
position of exterior, interior, and underground surfaces.

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* In this Section it is assumed that precalculated weighting factors will be used. For a discussion of alternatives see p.III.143 of the DOE-2 *Reference Manual (2.1A)*.

LOADS Input Instructions

Limitation on Number of Commands

The maximum number of Loads Description Language (LDL) commands that the program can accept in a single run is as follows:

Command	Maximum Number	
BUILDING-LOCATION	1	
CONSTRUCTION	64	
DAY-SCHEDULE	300	
DOOR	64	
EXTERIOR-WALL/ROOF	300	
GLASS-TYPE	32	
INTERIOR-WALL	512	
LAYERS	64	
LOADS-REPORT	1	
RUN-PERIOD	1	*
SCHEDULE	100	
SPACE	128	
SPACE-CONDITIONS	50	
TITLE	5	**
u-names	352	***
UNDERGROUND-FLOOR	64	
UNDERGROUND-WALL	64	
WEEK-SCHEDULE	200	
WINDOW	200	

Description of LOADS Input Instructions

The following section describes all LDL input instructions that are required to run the LOADS program.

INPUT

The input data for the LOADS program begins with the instruction:

```
INPUT LOADS ..
```

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* 1 command specifying up to 15 periods

** This maximum number refers to the number of keyword values, not the number of instructions.

*** The use of the nested scheduling technique, described in the BDL section of this manual, will result in the use of at least three of these u-names for each SCHEDULE specified. You specify one u-name for the SCHEDULE and the balance of the u-names are internally specified by the LDL program. Also, specifying a code-word for a MATERIAL, a LAYERS, or a CONSTRUCTION in the DOE-2 Preassembled Library results in the use of one u-name, internally specified by the LDL program. The same is true when specifying output reports by code-word (LV-A, LS-A, etc.).

RUN–PERIOD

The RUN–PERIOD command is used to specify the initial and final dates of the desired simulation period. The initial date is the first date of the simulation, given in the form: month day year. The LDL code-words that specify the names of the months are given below. The day and year are specified as numbers with a separator (blank or comma) on each side. The final date is the last simulation date, specified in the same manner as the initial date.

The code-words for the months are:

JAN	FEB	MAR	APR	MAY	JUN
JUL	AUG	SEP	OCT	NOV	DEC

u-name — is not allowed

Rules:

1. A RUN–PERIOD instruction must be entered for a LOADS program run.
2. Only one RUN–PERIOD instruction is permitted with up to 15 THRUs.
3. The initial and final dates specified in any one computer run must all be in the same year. The final date must be equal to or later than the initial date.
4. The day number cannot be greater than the number of days in the month associated with that date (in other words, SEP 31 1978 is not valid).

   Note: The year of the RUN–PERIOD should ordinarily be the year of the data on the weather tape being used. The program and the weather tapes assume a 365 day year, even for leap years. For more information on this, see HOURLY–REPORT instruction, pp.II.32-33 of the *Reference Manual (2.1A)*.

Example:

1. This instruction would run the LOADS program for one year:

   ```
   RUN–PERIOD    JAN 1 1979 THRU DEC 31 1979 ..
   ```

2. To run the LOADS program for January and February to study the winter heating peak, and for June and July to study the summer cooling peak, the LDL input instruction would be:

   ```
   RUN–PERIOD    JAN 1 1979  THRU  FEB 28 1979
                 JUN 1 1979  THRU  JUL 31 1979 ..
   ```

BUILDING–LOCATION

The BUILDING–LOCATION command is used to specify the location and orientation of the building and other miscellaneous information about it.

u-name — is not allowed.

LATITUDE — is the angular distance from the plane of the equator to the origin of the building coordinate system. It is specified in positive degrees for the northern hemisphere and negative degrees for the southern hemisphere. The allowable range is −66.5 to 66.5 degrees. If not entered here, the value will be taken from the weather tape.

LONGITUDE — is the angular distance from the prime meridian to the origin of the building coordinate system. It is specified in either positive degrees (west) or negative degrees (east) from −180.0 to +180.0. If not entered here, the value will be taken from the weather tape.

ALTITUDE — is the distance of the origin of the building coordinate system above (positive) or below (negative) mean sea level. The default is 0.0, and the allowable range is −1000.0 to 20000.0 feet. **Note**: if you want to input air flow rates and not have the program adjust them for altitude, ALTITUDE should be set to zero.

TIME–ZONE — for a building location is specified by the number of time zones, each 1 hour from the next, from the prime meridian. The values range from −1 to −12 for zones east of the prime meridian and from 1 to 12 for zones west of the prime meridian. If not entered here, the value will be taken from the weather tape. The following table identifies the TIME–ZONE values within the United States by common time zone names.

Time Zone	TIME–ZONE Value	Time Zone	TIME–ZONE Value
Atlantic	4	Mountain	7
Eastern	5	Pacific	8
Central	6	Yukon	9
Hawaii	10		

DAYLIGHT–SAVINGS — means that one 23-hour day occurs in the spring and one 25-hour day occurs in the fall. The building schedules are adjusted accordingly with respect to solar noon. The entry is a code-word, either YES (the default) or NO, that communicates your desire for daylight saving time.

HOLIDAY

The LOADS program can calculate holiday loads using different schedules than for normal weekdays. The code-word YES (the default) gives the holidays; NO gives no holidays. The following table identifies the holiday list. You can change the holiday list using the ALT–HOLIDAYS command; see Supplement (2.1E).

National Holidays of the United States
New Years Day JAN 1 (unless on Saturday or Sunday) JAN 2 if a Monday
Martin Luther King's Birthday Third Monday in JAN
Washington's Birthday Third Monday in FEB
Memorial Day Last Monday in MAY
Fourth of July JUL 3 if a Friday JUL 4 (unless on Saturday or Sunday) JUL 5 if a Monday
Labor Day First Monday in SEP
Columbus Day Second Monday in OCT
Veterans Day NOV 10 if a Friday NOV 11 (unless on Saturday or Sunday) NOV 12 if a Monday
Thanksgiving Fourth Thursday in NOV
Christmas DEC 24 if a Friday DEC 25 (unless on Saturday or Sunday) DEC 26 if a Monday
New Years Day (con'd) DEC 31 if a Friday

AZIMUTH

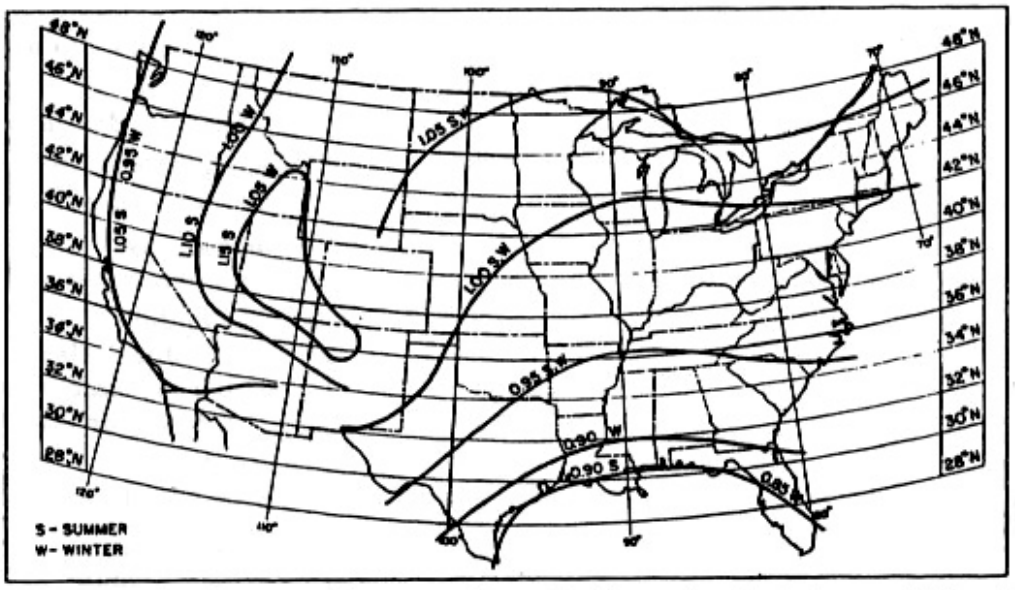
orients the building relative to the direction of true north. This entry is the angle between true north and the Y-axis of the building. The azimuth is expressed in degrees from 0 to 360° (clockwise as seen from above) or 0 to –360° (counter-clockwise as seen from above). The default is 0.0. Changing this angle has the effect of rotating the building about its z-axis (vertical axis).

GROUND–T

is a list of the local mean ground temperatures for each month. The values should be in degrees Fahrenheit, and in a twelve-element list format. If not entered here, these data will be taken from the weather tape. The range is from -100.0 to 150.0°F.

CLEARNESS–NUMBER

is a list of the local monthly clearness numbers for each month of the year. This is applicable when the clearness numbers on the weather file being used are not appropriate. The allowable range is from 0.5 to 1.2. Table below is reprinted from ASHRAE Trans., Vol. 64, p. 67.



GROSS–AREA

is the gross floor area (outside dimensions) of the conditioned space of the building. The range is from 0.0 to $10^7 ft^2$. Its default is the sum of the floor areas of all conditioned spaces. This keyword is used only for the BEPS (Estimated Building Energy Performance) Report in PLANT, which gives building energy use in KBtu/sqft-gross area/year.

Rules:

1. One and only one BUILDING–LOCATION instruction must be entered for each separate LOADS program run. It should be input before any commands that describe the building or anything associated with it (e.g., SPACE or CONSTRUCTION).
2. If GROUND–T and CLEARNESS–NUMBER are not input, the values will be taken from the weather file.
3. If LONGITUDE, LATITUDE, or TIME–ZONE are not specified, the values will be taken from the weather file.

Example:

```
BUILDING–LOCATION   LATITUDE = 42.0     LONGITUDE = 88.0
                    ALTITUDE = 610      TIME–ZONE = 6
                    AZIMUTH = 0         HOLIDAY = YES ..
```

LAYERS
tells LOADS that the data to follow identify the layers of material that are in a construction, the order of the layers, and the layer thicknesses. It tells the LDL Processor to calculate the response factors for the wall.

u-name

is required for this instruction. It is referenced in a CONSTRUCTION instruction.

INSIDE–FILM–RES

specifies the combined convective and radiative air film resistance for the inside wall surface. The default of .68 hr-ft^2-°F/Btu is an appropriate value for vertical walls. For horizontal surfaces, such as ceilings and floors, the suggested inside-film-resistance can be found in the following table. Because only one value is allowed for each surface, you should decide which is more important, cooling or heating. The allowable range is from 0.0 to 40.0 hr-ft^2-°F/Btu.

	Cooling	Heating
Ceilings	Heat Flowing Downward .92	Heat Flowing Upward .61
Floors	Heat Flowing Upward .61	Heat Flowing Downward .92

If you cannot decide which is more important, cooling or heating, the default value of .68 can be used. For exterior walls and roofs, the outside-film-resistance is calculated by the program depending on windspeed. For interior walls, the air film described in INSIDE–FILM–RES is the film on the side of the wall that is in the SPACE where the wall is specified. For the calculation of the U-Value for an INTERIOR–WALL, the INSIDE–FILM–RES is duplicated on the other surface (opposite side).

MATERIAL

identifies a list of DOE-2 pre-specified material code-words (see Appendix D). The number of elements in the list is the number of layers in the construction. For an *exterior wall*, the sequence of elements in the list is the sequence of the material layers in the exterior wall, starting with the exterior layer and ending with the interior layer. Reversing this sequence can notably affect the thermal performance of a wall.

THICKNESS — identifies a list that gives the thickness, in feet, for each material in the construction and overrides the thickness in the immediately preceding MATERIAL instruction. The allowable range is from 0.0+ (a value greater than 0.0) to 10.0 ft.

Rules:

1. The outside air film coefficient of an exterior wall or roof should not be specified as a layer because it is calculated by the LOADS program as a function of surface roughness and windspeed.
2. The list identified by MATERIAL and THICKNESS must have a one-to-one correspondence. For example, the first material listed in MATERIAL has a thickness equal to the first value listed in THICKNESS.
3. Both lists (MATERIAL and THICKNESS) must have the same number of elements.
4. A list element must be included in THICKNESS for layers specified by a RESISTANCE, but it is a dummy variable, used only to make the list length match with the MATERIAL list length.
5. For an exterior wall or roof, both lists start with the outside layer.
6. Maximum list length for MATERIAL and THICKNESS is 9 elements each.
7. Not all LAYERS can be specified by RESISTANCE (for MATERIAL) only. At least one must be specified as a transient type layer.

Example:

```
WA-1-2=LAYERS    MATERIAL=(WD01,PW03,IN02,GP01) ..

RB-1-1=LAYERS    MATERIAL=(RG01,BR01,IN22,WD01) I-F-R .76 ..
```

CONSTRUCTION

This instruction is used to specify the construction characteristics and properties of an exterior wall, exterior floor, roof, interior wall, interior floor, ceiling, underground wall, underground floor, or non-glass door.

u-name	*must* be specified for this instruction in order to reference this CONSTRUCTION in a subsequent EXTERIOR–WALL, ROOF, INTERIOR–WALL, UNDERGROUND–WALL, UNDERGROUND–FLOOR, or DOOR instruction.
LIKE	may be used to copy data from a previously u-named CONSTRUCTION instruction.
LAYERS	entry for this keyword is the *u-name* of a previously defined (and entered) LAYERS instruction. This identifies the characteristics of the CONSTRUCTION and specifies heat transfer calculation by the *dynamic*, or delayed technique.
U–VALUE	may be used as a less accurate alternative to LAYERS when the construction has little heat capacitance, and the heat flow is not delayed. A steady-state, or "quick" calculation technique is used. For interior surfaces the U-VALUE should include both film coefficients. For exterior surfaces only the inside film coefficient should be included since the outside film coefficient is calculated hourly as a function of surface roughness and windspeed. The range is from 0.0 to 20.0 Btu/hr-ft^2-°F. Table 2.1 shows typical U-Values for some low-heat capacity walls.

TABLE 2.1

Example U-Values for Constructions
With Low Heat Capacity

	U-Value
Exterior Walls*	
1/2" Wood sheathing, studs, 1/2" gypsum board	0.35
Metal siding on 1/2" plywood, studs, 1/2" gypsum board	0.38
Stucco on 3/4" pine, studs, 1/2" gypsum board	0.34
Roofs*	
Wood shingles on 1/2" plywood, 2 x 8 studs, 1/2" gypsum board	0.28
Built-up roof on plywood deck, 2 x 8 studs, 1/2" gypsum board w/acoustical tile	0.27
Interior Walls and Floors**	
Gypsum board, 1/2", on either side of metal studs	0.32
Hardwood flooring on 1/2" deck, 2 x 8 floor joists, subfloor, tile (ceiling to space below)	0.20

* Includes inside surface air film.
** Includes inside surface air film on both sides.

Slab doors are also defined as a U-Value CONSTRUCTION. The table below gives some typical U-Values for doors.

TABLE 2.2

Coefficients of Transmission (U-Values) for Slab Doors (Btu/hr-ft^2-°F)

Door Type	Thickness	No Storm Door	Storm Door w/Wood	Storm Door w/Metal
Solid Wood	1 in.	0.64	0.30	0.39
	1.25 in.	0.55	0.28	0.34
	1.5 in.	0.49	0.27	0.33
	2 in.	0.43	0.24	0.29
Steel	1.75 in.			
	A	0.59	—	—
	B	0.19	—	—
	C	0.47	—	—

A = Mineral fiber core (2 lb/ft^3).
B = Solid urethane core with thermal break.
C = Solid polystyrene core with thermal break.

For additional information on U-Values, please see pp.III.80-85 of the *Reference Manual (2.1A)*.