ABSORPTANCE

specifies, as a decimal fraction, the solar radiation absorptance of an exterior surface of an EXTERIOR-WALL or ROOF; this keyword is not appropriate to INTERIOR-WALL, UNDERGROUND-WALL, or UNDERGROUND-FLOOR. The default is 0.70. The following table provides typical values for various exterior surfaces.

TABLE 2.3

Solar ABSORPTANCE for Various Exterior Surfaces (Clean)

Material	ABSORPTANCE	Paint	ABSORPTANCE
Aluminum, polished reflector sheet	0.12	Aluminum paint	0.40
Asphalt pavement, weathered	0.82	Black, flat	0.95
Brick, buff, light	0.55	Black, lacquer	0.92
Brick, red	0.88	Black, oil	0.90
Brick, Stafford blue	0.89	Black, optical flat	0.98
Brick, white glazed	0.25	Blue, azure lacquer	0.88
Cement, uncolored asbestos	0.75	Blue, dark	0.91
Cement, white asbestos	0.61	Blue, medium	0.51
Concrete, black	0.91	Blue-gray, dark	0.88
Concrete, brown	0.85	Brown, dark brown	0.88
Concrete, uncolored	0.65	Brown lacquer	0.79
Film, Mylar aluminized	0.10	Brown, medium	0.84
Felt, bituminous	0.88	Brown, medium light	0.80
Felt, bituminous, aluminized	0.40	Gray, dark	0.91
Gravel	0.29	Gray, light oil	0.75
Iron, white-on-galvanized	0.26	Green, lacquer	0.79
Lab vapor deposited coatings	0.02	Green, lacquer, dark	0.88
Marble, white	0.58	Green, light	0.47
Roof, white built-up	0.50	Green, medium dull	0.59
Roofing, green	0.86	Green, medium Kelly	0.51
Slate, blue-gray	0.87	Olive, dark drab	0.89
Tin surface	0.05	Orange, medium	0.58
Wood, smooth	0.78	Red, oil	0.74
		Rust, medium	0.78
		Silver	0.25
		White, gloss	0.25
		White, lacquer	0.21
		White, semi-gloss	0.30
		Yellow	0.57

The table above is a compilation of data from several sources including *Passive Solar Design Analysis* by J.D. Balcomb (DOE, Office of the Assistant Secretary for Conservation and Solar Energy, December 1979).

ROUGHNESS

is specified as a code-number that indicates the relative roughness of the exterior surface finish of an EXTERIOR-WALL or ROOF. This keyword is not appropriate to INTERIOR-WALL, UNDERGROUND-WALL, and UNDERGROUND-FLOOR. The code-numbers are given in the table below; default is 3.

TABLE 2.4

ROUGHNESS Code for Exterior Surface Finish

Surface Finish	Wall	Roof	Code-number
Rough	Stucco	Wood shingles or Built-up roof w/stones	1
	Brick or Plaster		2
	Concrete (poured)	Asphalt shingles	3*
	Clear pine		4
	Smooth plaster	Metal	5
Smooth	Glass Paint on pine		6

* 3 is the default value

Rules:

1. Either LAYERS or U-VALUE should be entered, but entering both, or neither, will generate an error message.
2. If LAYERS is specified, a transient heat transfer calculation is performed. It is recommended for all constructions except very lightweight ones.
3. If U-VALUE is specified, a steady-state heat transfer calculation is performed. It is recommended for very lightweight constructions.
4. The U-VALUE is used to calculate heat transfer through interior walls, floors, underground walls, and underground floors.

Example:

```
ROOF-1=CONSTRUCTION   LAYERS=RB-1-1 ..
WALL-1=CONSTRUCTION   LAYERS=WA-1-2 ..
FLOOR-1=CONSTRUCTION  U = 0.05 ..
```

GLASS-TYPE

This instruction is used to specify the type of glass used in a window.

u-name	is a mandatory entry for this command in order to reference the GLASS-TYPE in a WINDOW instruction.
LIKE	may be used to copy data from a previously u-named GLASS-TYPE instruction.
PANES	Number of panes of glass; the code numbers are 1, 2, or 3 for single-, double-, or triple-pane, respectively. The default is single-pane.
SHADING-COEF	is the ASHRAE shading coefficient of the glass. This keyword value is a number between 0.0 and 1.0, and there is no default. When SHADING-COEF is entered, the program will first calculate the solar heat gain using transmission and absorption coefficients for clear, 1/8" thick, single-pane, double-strength sheet glass. This solar heat gain is then multiplied by the value of SHADING-COEF to determine the resultant solar heat gain. Thus, resultant solar heat gain = SHADING-COEF x (solar heat gain for standard glass). The shading coefficient depends in general not only on the type of glass, but also on whether blinds, shades, draperies, etc., are used with the window. To simulate operable shading devices, you may assign a SHADING-SCHEDULE to a window (see WINDOW command). The resultant solar heat gain each hour will then be multiplied by the schedule value. For shading coefficient values of different glazing types with and without shading devices, see manufacturers' data sheets or the *ASHRAE 1989 Handbook of Fundamentals*, pp.27.26,27.30-33..
GLASS-CONDUCTANCE	is the conductance of the total window except for the outside film coefficient. The conductance given in glass manufacturers' data sheets usually includes the outside air film resistance for a windspeed of 7.5 mph (summer) or 15 mph (winter). The following table can be used to obtain the corresponding value of GLASS-CONDUCTANCE. For example, if U (7.5 mph) = 0.64 Btu/ft^2-hr-$^\circ$F, then GLASS-CONDUCTANCE = 0.79 (by interpolation).

Note: if GLASS-CONDUCTANCE is not specified, it will default to 1.470 for PANES=1, 0.574 for PANES=2, and 0.304 for PANES=3.

For U-Values of different glazing types, see manufacturers' product data sheets, or the ASHRAE *1989 Handbook of Fundamentals*, pp.27.16-17.

Example:

```
IG-1-1=GLASS-TYPE  PANES=2  SHADING-COEF=.45  ..
```

TABLE 2.5

Correspondence between glass manufacturers U-Value (including outside air film) and DOE-2 GLASS-CONDUCTANCE value (excluding outside air film) All values are in Btu/ft^2-hr-°F.

Summer U-Value (7.5 mph windspeed)	GLASS-CONDUCTANCE	Winter U-Value (15 mph windspeed)	GLASS-CONDUCTANCE
0.1	0.10	0.1	0.10
0.2	0.21	0.2	0.21
0.3	0.33	0.3	0.32
0.4	0.45	0.4	0.43
0.5	0.59	0.5	0.55
0.6	0.73	0.6	0.68
0.7	0.89	0.7	0.81
0.8	1.05	0.8	0.95
0.9	1.23	0.9	1.09
1.0	1.43	1.0	1.24
1.1	1.64	1.1	1.40
1.2	1.87	1.2	1.57
1.3	2.13	1.3	1.74

SPACE–CONDITIONS

The primary use of this subcommand is to define the internal loads in the space. The subcommand, and its associated keywords and code-words, specify the conditions that are appropriate to a space (or to groups of spaces) in the building (any value listed here may be overridden in a SPACE instruction by re-entry of the keyword with a different value). The conditions refer to people, lighting, process equipment, and infiltration. The conditions are primarily specified as a function of their maximum values and their schedules. The conditions can be varied in time and amount via the use of schedules that contain fractional value inputs.

Before specifying the input data for SPACE–CONDITIONS, you should understand some of the logic built into the DOE-2 Program. All of the energy sources associated with a particular space do not necessarily affect the heating and cooling loads of that SPACE. Some energy sources contribute all of their energy to the space and other energy sources contribute from 0 to 100% of their energy to the space.

1. *All* of the energy associated with people, task lighting, and infiltration is assumed to enter the space.

2. Only *part* of the energy associated with the other heat sources in the SPACE (overhead lighting, process equipment, and process utilities) enters the SPACE. The energy that does not enter the space is consumed by a product or process, is added to the return air duct or plenum, or is exhausted from the space. The portion of energy that enters the space, versus the portion that does not enter the space, can be controlled by you through the use of the LIGHT–TO–SPACE keyword and the "sensible and latent" keywords.

   That portion of the energy that does not enter the space has no effect upon the subsequent sizing of HVAC equipment in the SYSTEMS simulator. That energy demand is, however, added to the demands made on the equipment, or purchased utilities, in the PLANT simulator. It is not chargeable to the secondary HVAC system.

   When the program attempts to automatically size equipment in the PLANT simulator, it adds all of the space heating/cooling loads, all of the space process loads, and the building-level utility loads (elevators, exterior lighting, and domestic hot water) and then sizes the equipment accordingly to meet the total. This way, the total utility demands for the building will be correct and the secondary HVAC system will not be charged with energy that rightfully belongs to the process in the building. Only that portion of the process load that enters the spaces as a heating/cooling load will show up in the secondary HVAC system.

   It is important that all of the lighting, equipment, and utilities supplied to a space, for whatever reason, be included in the SPACE–CONDITIONS or SPACE instruction. This includes process equipment and process utilities. If any loads are omitted, the HVAC equipment may be properly sized but the PLANT equipment will probably be undersized. Do not, however, include the HVAC equipment items (fans, coils, etc.) because they are addressed separately by the program. Also, do not include building level loads such as domestic hot water, elevators, etc. because these loads are not associated with any particular space but rather are associated with the entire building.

   You should pay close attention when specifying SCHEDULEs. It cannot be overemphasized how important this is. All the SCHEDULEs associated with SPACE–CONDITIONS, except INF–SCHEDULE, default to the off mode of operation.

This means that even though the maximum output of the equipment, lights, etc. has been specified, the equipment and lights will not be turned on, unless you specify this mode of operation in the SCHEDULEs. Naturally, if you fail to turn the equipment and lights on, the simulation will be faulty.

SPACE-CONDITIONS	To sum up, SPACE-CONDITIONS tells LOADS that the data to follow specify the temperature, floor weight, zone type, infiltration, and internal loads of a space.
u-name	must be specified for this instruction in order for it to be referenced in the SPACE command.
LIKE	may be used to copy data from a previously u-named SPACE-CONDITIONS instruction.
TEMPERATURE	is the space air temperature that will be used in the LOADS simulation. *This is a list with only one value* midway between the heating and cooling setpoints (DESIGN-HEAT-T and DESIGN-COOL-T, respectively) in SYSTEMS. If a zone is unconditioned, TEMPERATURE should be an estimated average temperature for the zone. The default is 70°F, and the range is from 0.0 to 120.0°F. Example: TEMPERATURE = (73) (If the parentheses are omitted, e.g. TEMPERATURE = 73, an error message results.)
PEOPLE-SCHEDULE	is the u-name of the schedule for space occupancy as a function of time. Schedule inputs are fractions of the maximum NUMBER-OF-PEOPLE. If PEOPLE-SCHEDULE is not entered, the schedule value will default to zero, and will therefore simulate the space with *no* people.
AREA/PERSON	is an alternative keyword to NUMBER-OF-PEOPLE; however, AREA/PERSON is the preferred keyword to use. AREA/PERSON defaults to 100 sqft per person.
NUMBER-OF-PEOPLE	is the maximum number of people occupying a space during the simulation. The actual number of people present in the space during any given hour is the value assigned to this keyword multiplied by the fractional value assigned for that hour (see PEOPLE-SCHEDULE). The default is 0 and the range is from 0 to 10000.
PEOPLE-HEAT-GAIN	is the combined maximum latent and sensible heat gain per person to the space. The balance between latent and sensible heat is calculated by the program. The keyword value is varied with respect to time and quantity of people by the PEOPLE-SCHEDULE and NUMBER-OF-PEOPLE or AREA/PERSON. The range is from 350.0 to 2000.0 Btu/hr-

person. The default is zero; therefore, a value must be input or the alternative method of specifying people heat gain, by inputting PEOPLE–HG–LAT and PEOPLE–HG–SENS, should be used. For typical values for different degrees of activity, see the ASHRAE *1989 Handbook of Fundamentals*, Table 3, p.26.7.

PEOPLE–HG–LAT

is the maximum latent heat gain per person to the space by the occupants. The default is 0.0, and the range is from 0.0 to 2000.0 Btu/hr-person.

PEOPLE–HG–SENS

is the maximum sensible heat gain per person to the space by the occupants. The default is 0.0, and the range is from 0.0 to 2000.0 Btu/hr-person.

LIGHTING–SCHEDULE

is the u-name of the schedule for space overhead lighting. Schedule inputs are fractions of maximum lighting energy input (see LIGHTING–KW or LIGHTING–W/SQFT; see also LIGHTING–TYPE and LIGHT–TO–SPACE). If not specified, the LIGHTING–SCHEDULE value will default to zero. This will result in simulation with no lighting, even if lighting is specified by keywords LIGHTING–KW or LIGHTING–W/SQFT, etc.

LIGHTING–TYPE

takes a code-word that specifies the type of overhead lighting used in the space. The following table shows the code-words that can be used. The default is SUS–FLUOR.

Code-word	LIGHTING–TYPE
SUS–FLUOR	Suspended fluorescent
REC–FLUOR–NV	Recessed fluorescent — not vented
REC–FLUOR–RV	Recessed fluorescent vent to return air
REC–FLUOR–RSV	Recessed fluorescent vent to supply and return air
INCAND	Incandescent
SUSPENDED	Incandescent

For mixed types of lighting within the same space, the recommended procedure is to select the dominant type and adjust the percentage of heat produced by the lighting, using the LIGHT–TO–SPACE keyword below.

LIGHTING–KW

is the maximum amount of electrical energy required to operate the main or overhead lights within the space. It is *not necessarily* the sensible heat added by the lights to the space (see LIGHT–TO–SPACE). The actual space lighting energy required by the space during any given hour is the value assigned to this keyword multiplied by the fractional value assigned for that hour (see LIGHTING–SCHEDULE). The default is 0.0, and values can range from 0.0 to 200 kW.

If both LIGHTING-KW and LIGHTING-W/SQFT are specified, the program adds the values.

Note that the values for LIGHTING-KW and LIGHTING-W/SQFT are amounts of electricity consumed by lamps *and* ballasts.

LIGHTING-W/SQFT

is an alternative method (to LIGHTING-KW) for specifying the maximum overhead, or general, lighting energy use. The dimensions are watts of lighting energy use per square foot of space floor area. The default is 0.0, and values can range from 0.0 to 10 W/ft^2. The actual overhead lighting energy required by the SPACE during any given hour is the value assigned to this keyword multiplied by the square feet in the space multiplied by the fractional value assigned for that hour (see LIGHTING-SCHEDULE).

Note that there is a distinction between the amount of illumination produced and the power consumed for incandescent and fluorescent lighting (the keywords describe the power consumed). Thus, if the same values of LIGHTING-KW or LIGHTING-W/SQFT are specified for an incandescent light and for a fluorescent light, the amount of illumination from the fluorescent light will be approximately twice that from the incandescent light. The distribution of the energy for these two is approximately given by the following table.

Type of Energy	Fluorescent percent	Incandescent percent
Visible light	19	10
Infrared	31	72
Convection-conduction	36	18
Ballast	14	0

LIGHT-TO-SPACE

is the fraction, if any, of the lighting energy that is added to the space energy balance as a sensible heat gain. The remaining energy is added (in SYSTEMS) to the ductwork if RETURN-AIR-PATH = DUCT. The default is 1.0 for SUS-FLUOR, REC-FLUOR-NV, and INCAND; 0.8 for REC-FLUOR-RV and REC-FLUOR-RSV. See also *Supplement (2.1E), p.2.81, "Distribution of Heat from Lights".*

Note: When specifying any zonal system (that is, if SYSTEM-TYPE in SYSTEMS equals UHT, UVT, HP, TPFC, FPFC, TPIU, FPIU, or PTAC) the value of LIGHT-TO-SPACE is automatically set equal to 1.0.

TASK-LIGHT-SCH

is the u-name of the schedule for task lighting in the space. A task light is any small lamp, such as a desk lamp, that would have a different schedule of use than the main space overhead lighting. Schedule inputs are fractions of maximum task lighting energy input (see TASK-LIGHTING-KW or TASK-LT-W/SQFT). If the TASK-LIGHT-SCH is not input, the schedule value will default to zero and no task lights will be simulated.

TASK-LIGHTING-KW

specifies the maximum electrical energy required for task lighting. All of this energy is added to the space. The default is 0.0, and the range is from 0.0 to 200.0 kW. The actual task lighting energy required in the SPACE during any given hour is the value assigned to this keyword multiplied by the fractional value assigned for that hour (see TASK-LIGHT-SCH). If both TASK-LIGHTING-KW and TASK-LT-W/SQFT are specified, the program adds the values. LIGHT-TO-SPACE is not appropriate to this keyword because 100% of task lighting energy goes to the space.

TASK-LT-W/SQFT

is an alternative keyword for TASK-LIGHTING-KW and is based on watts of task lighting per square foot of floor area of the space. The default is 0.0, and ranges from 0.0 to 10.0 W/ft^2. LIGHT-TO-SPACE is not appropriate to this keyword because 100% of task lighting energy goes to the space.

EQUIP-SCHEDULE

is the u-name of the schedule for space equipment operating schedule. Schedule inputs are fractions of maximum equipment energy input (see EQUIPMENT-KW or EQUIPMENT-W/SQFT). If the EQUIP-SCHEDULE is not input, the schedule value will default to zero and no space equipment loads will be simulated.

EQUIPMENT-KW

is the maximum amount of energy required to operate electrical equipment within the space and is *not necessarily* the sensible and/or latent heat added by the equipment to the space (see EQUIP-SENSIBLE and EQUIP-LATENT). The default is 0.0 and the range is from 0.0 to 200.0 kW. The actual equipment energy required by the space during any given hour is the value assigned to this keyword multiplied by the fractional value assigned to that hour (see EQUIP-SCHEDULE). The amount of equipment energy added to the space, if any, may be specified by its components (see EQUIP-LATENT and EQUIP-SENSIBLE). If both EQUIPMENT-KW and EQUIPMENT-W/SQFT are specified, the program adds the values.

EQUIPMENT-W/SQFT

is an alternative keyword for EQUIPMENT-KW and is based on watts of equipment energy per square foot of floor area of the space. The default is 0.0 and the range is from 0.0 to 100.0 W/ft^2.

EQUIP-SENSIBLE — is the fraction of EQUIPMENT-KW, if any, that is added to the space energy balance in the form of sensible heat. The sum of EQUIP-SENSIBLE and EQUIP-LATENT must not exceed 1.0; range is 0.0 to 1.0.

EQUIP-LATENT — is the fraction of EQUIPMENT-KW that is added to the space energy balance in the form of latent heat. The sum of EQUIP-LATENT and EQUIP-SENSIBLE must not exceed 1.00. The default is 0.0. If neither EQUIP-SENSIBLE nor EQUIP-LATENT is specified, all heat from equipment will be considered sensible.

The keywords SOURCE-TYPE, SOURCE-BTU/HR, SOURCE-SCHEDULE, SOURCE-SENSIBLE, and SOURCE-LATENT, described below, must be considered as a group. SOURCE, in this context, implies a utility demand, not equipment. Depending upon how the source is specified, it may or may not result in a space heating/cooling load. Also, a source may or may not result in a utility load on PLANT. It is possible to specify only one source per space.

SOURCE-TYPE — is used when there are internal heating or cooling loads caused by a source other than people, lights, or equipment. The possible code-words for this keyword are:

GAS — The load will contribute to the natural gas use budget in PLANT. Examples include natural gas for ovens, kilns, dryers, etc. GAS is the default.

ELECTRIC — The load will contribute to electricity use budget in PLANT. Examples include electricity for cooking, electroplating, battery charging, etc.

HOT-WATER — The load will contribute to the hot-water budget (natural gas or fuel oil) in PLANT. This load will be reported as a domestic or service hot water load. The HOT-WATER loads will be passed to any *domestic* hot water heater defined in the PLANT-EQUIPMENT command.

PROCESS — Load will *not* contribute a utility load on PLANT (e.g., cooling load caused by a self-contained, portable energy source or other industrial processes). Examples of this type of load are gasoline powered fork trucks, oxyacetylene welders, wood stoves, bottled gas equipment, etc. You should sum up all the PROCESS loads in the zone, be they electrical, gas, hot water, solar, nuclear, etc. and express the total in Btu/hr. This total value should be expressed with the keyword SOURCE-BTU/HR. The portion of the total PROCESS load that enters the zone as a heating or cooling load is then specified by using the SOURCE-LATENT and

Note that the italicized words in the left column are *code-words*, not keywords.