

ZONE

Provides information on the secondary HVAC distribution system characteristics specific to a thermal zone. Information includes air flow rate (supply air, exhaust air, and outside air), space temperature setpoint, thermostat characteristics, and maximum heating and/or cooling capacity. U-name is required.

Each zone is associated with one and only one SYSTEM command, which specifies the system to which the zone belongs. This applies to conditioned zones as well as unconditioned zones and plenum zones. Note that there must be a one-to-one match-up between the zones specified here and the spaces specified in the LOADS program. That is, for each SPACE command in LOADS there will be a corresponding ZONE command to represent a physically identical portion of the building.

Example input:

```

ZONE1-1 = ZONE
  TYPE                = CONDITIONED
  SPACE               = SPACE1-1
  DESIGN-HEAT-T       = 70.
  DESIGN-COOL-T       = 76.
  HEAT-TEMP-SCH       = "The Heating Temp Sch"
  COOL-TEMP-SCH       = "The Cooling Temp Sch"
  REHEAT-DELTA-T      = 40.
  HW-LOOP              = "Heating Loop"
  OA-FLOW/PER         = 15.
  SIZING-OPTION       = ADJUST-LOADS ..
    
```

TYPE

Takes a code-word that identifies the zone as being a conditioned space, an unconditioned space, or a plenum. Allowed code-words are:

- | | |
|---------------|--|
| CONDITIONED | The zone is heated and/or cooled depending on the type of system selected. |
| UNCONDITIONED | The zone is neither heated nor cooled. Examples are false ceiling spaces not used as return air plenums, attics, crawl spaces and garages. |
| PLENUM | <p>The zone is a plenum through which return air from the conditioned zones in the system passes. If the system has SYSTEM:RETURN-AIR-PATH = PLENUM-ZONES then one more zones in the system should have TYPE = PLENUM. The program calculates the cooling/heating loads and temperatures in the plenum zones as for other zones, except that the effect of return air flow through the plenum is considered in lieu of direct air supply.</p> <p>An above-ceiling space with return air passing through ducts in the space does not qualify as a plenum. Zonal systems (UHT, UVT, IU, FC, HP, and PTAC) do not allow plenums.</p> <p>In the program a plenum may have any characteristic of a zone, including windows, people, infiltration, etc., but not electrical equipment. See "Atrium as a Return Air Plenum" in the sunspace section of the <i>DOE-2.2 Topics</i>.</p> |

SPACE

Takes the U-name of a previously-defined SPACE command that describes the space that corresponds to this zone. This is a required keyword. Previously, the correspondence between SPACES in the LOADS input and ZONES in

the SYSTEMS input was specified by giving the SPACE and ZONE the same U-name. Now the SPACE and ZONE must have different U-names.

SIZING-OPTION

Takes a code-word that specifies how the size of the system equipment should be adjusted to account for temperature differences between unconditioned and conditioned spaces at start-up. Usually, SIZING-OPTION should be specified for each zone to get a more accurate air flow rate for the zone. Optionally, SIZING-OPTION could be specified only for ZONE:TYPE = CONDITIONED and could be allowed to default for ZONE:TYPE = UNCONDITIONED or PLENUM. In this case, you should still specify the DESIGN-HEAT-T and DESIGN-COOL-T for ZONE:TYPE = UNCONDITIONED or PLENUM, so that the peak heating and cooling loads of surrounding zones are appropriately modified.

Two effects that are important to the choice of SIZING-OPTION are the following:

- If the LOADS calculation temperature for the zone, given by LOADS:TEMPERATURE is between the zone's ZONE:DESIGN-HEAT-T and DESIGN-COOL-T values, the peak loads will be overestimated for cooling and heating. Consequently, the calculated air flow rate for the zone will not exactly correspond to the actual air flow rate necessary to meet the heat addition rate or heat extraction rate at the peaks.
- In the LOADS program, unconditioned spaces and plenums are assumed to be at constant temperature. In fact, the temperature is not constant because the temperature of an unconditioned zone is allowed to float and the temperature in a plenum is determined by the blend of return air temperatures and flow rates. As a result, there is no contribution to the peak loads of conditioned zones from interzone heat transfer with adjacent unconditioned zones.

The allowed values of SIZING-OPTION are:

FROM-LOADS	The automatic sizing of equipment to heat or cool this zone will not consider effects (1) and (2), above.
ADJUST-LOADS	The automatic sizing of equipment to heat and cool this zone will consider Effects (1) and (2), above.

If ADJUST-LOADS is specified, three adjustments to the peak heating and cooling loads will be made:

- An adjustment to account for the difference between the zone's SPACE:TEMPERATURE value and the zone's ZONE:DESIGN-HEAT-T and DESIGN-COOL-T values.
- A steady-state adjustment to account for thermal conduction through the interior and exterior walls of the zone.
- An adjustment to infiltration loads.

MULTIPLIER

Number of zones that are identical to some specified zone and are assigned to the same system. For example, rather than describing ten identical or near-identical thermal zones, MULTIPLIER = 10 can be used on a single-zone. For a given zone, ZONE-MULTIPLIER and its corresponding SPACE:MULTIPLIER should be the same. If not specified, defaults to SPACE:MULTIPLIER

FLOOR-MULTIPLIER

Has the same meaning as SPACE:FLOOR-MULTIPLIER in the LOADS input, and defaults to its value if not specified in SYSTEMS. See description of SPACE:FLOOR-MULTIPLIER.

Airflow

The following keywords provide information on the flow of air into and out of each zone (supply air, exhaust air, and outside air).

Generally, all air quantities should be input at sea level because the program makes a correction for altitude. If you want to input air flow rates that have already been corrected for altitude you should set SITE-PARAMETERS:ALTITUDE = 0 in LOADS.

There are four different methods of specifying a zone's supply air flow rate:

- Specify ASSIGNED-FLOW,
- Specify AIR-CHANGES/HR; the flow is the larger of the default or this value,
- Specify FLOW/AREA; the flow is the larger of the default or this value,
- Allow the program to calculate the air flow rate based on peak heating/cooling load and difference between design supply air temperature and zone temperature. This calculation occurs when ASSIGNED-FLOW is not entered. If either AIR-CHANGES/HR or FLOW/AREA is specified, the design flow is the larger of the default or the specified flow.

Zonal / Single-duct systems

The following keywords apply to zonal systems and single-duct air terminals. They also apply to the *outlet* of a dual-duct or multizone air terminal.

ASSIGNED-FLOW

Design supply air flow rate for the zone. Use either ASSIGNED-FLOW or FLOW/AREA or AIR-CHANGES/HR. Note that FLOW/AREA or AIR-CHANGES/HR establish the minimum allowed design air flow; the actual design flow may be larger.

FLOW/AREA

The minimum design supply air flow rate to the zone per unit floor area. Use either ASSIGNED-FLOW or FLOW/AREA or AIR-CHANGES/HR. Note that FLOW/AREA or AIR-CHANGES/HR establish the minimum allowed design air flow; the actual design flow may be larger.

AIR-CHANGES/HR

The minimum design supply air flow rate to the zone expressed as the number of times per hour that the flow rate replaces the total volume of air in the zone. Use either ASSIGNED-FLOW or FLOW/AREA or AIR-CHANGES/HR. Note that FLOW/AREA or AIR-CHANGES/HR establish the minimum allowed design air flow; the actual design flow may be larger.

TERMINAL-TYPE

For single-duct variable-air volume systems, takes a code-word that specifies the type of terminal serving the zone. The same type of terminal box does not have to be used for the entire system. For example, a PIU system will typically contain a mixture of fan powered terminal boxes and regular VAV or constant-volume reheat units. Allowed code-words are:

SVAV	Regular VAV or constant-volume box. ("SVAV" stands for "Standard Variable Air Volume.")
SERIES-PIU	The fan draws air from both the secondary and primary air streams; the blower runs all the time.
PARALLEL-PIU	The fan draws air from the secondary air stream only; the blower runs intermittently.

INDUCED-AIR-ZONE

For the PIU system only, takes the U-name the zone from which the PIU zone takes its secondary air. This is a required keyword if `TERMINAL-TYPE = SERIES-PIU` or `PARALLEL-PIU`. Usually, the `INDUCED-AIR-ZONE` is a core zone served by a non-PIU terminal (zones with PIU boxes will usually be exterior zones that use heat reclaimed from the core zone. An exception would be a zone (such as a classroom) where the primary concern is air movement, not energy efficiency. In such a case, a corridor could be specified as the `INDUCED-AIR-ZONE` even though there is no heat is reclaimed from it. The program treats this situation in the same way as it does when a core plenum is at a temperature lower than the exterior zone. Caution: the `INDUCED-AIR-ZONE` should not be a zone with `ZONE:TYPE = PLENUM`.

MIN-FLOW-RATIO

Minimum allowable zone air supply flow rate, expressed as a fraction of design flow rate. Applicable to variable-volume type systems only. This keyword also appears in the `SYSTEM` command, where it is a system level keyword that applies to all zones in the system. Here, it is a zone level keyword that applies only to this zone, allowing different `MIN-FLOW-RATIO`s for each zone. `MIN-FLOW-RATIO` can be scheduled using `ZONE:MIN-FLOW-SCH`.

If the sum of the `MIN-FLOW-RATIO`s of all the zones times the design flow rate is less than the specified outside air flow rate, there is implied 100 per cent outside air operation at, and possibly above, the zone `MIN-FLOW-RATIO`. In other words, it may be necessary for the system to operate at 100% outside air at very low airflows in order to satisfy the ventilation requirements.

If `THERMOSTAT-TYPE = REVERSE-ACTION` is not specified, zone `MIN-FLOW-RATIO` is also the flow rate fraction in the heating mode. The VAV box will modulate its airflow between the top and bottom of the cooling setpoint throttling range, and be at the minimum flow at all temperatures below the cooling throttling range. Care must be taken to specify a reasonable `MIN-FLOW-RATIO` in this case. Depending on the value of the `MIN-FLOW-RATIO`, the system may not have enough reheat capacity. Additionally, the introduction of a small amount of (low velocity) warm air at the ceiling level may cause temperature stratification problems in many buildings. To avoid this, the `THERMOSTAT-TYPE` should be `REVERSE-ACTION`, or an `HMIN-FLOW-RATIO` can be specified to establish a higher flow ratio during heating.

For dual-duct systems, `MIN-FLOW-RATIO` is the flow ratio at the outlet of the mixing box, and should be specified only if the box has a controller measuring air flow at the outlet. `HMIN-FLOW-RATIO` and `CMIN-FLOW-RATIO` specify the minimum air flows at the inlets to the mixing box (hot and cold decks, respectively). You should refer to the discussion of these keywords in the `SYSTEM` command for more information.

MIN-FLOW/AREA

Minimum air flow per square foot of floor area. An alternative way of specifying `ZONE:MIN-FLOW-RATIO`. The program will take this value, multiply by the floor area of the zone to determine the minimum air flow allowable, and divide by the peak cooling air flow to determine `MIN-FLOW-RATIO`. The `MIN-FLOW-RATIO` is then used in the hourly simulation. If you allow the program to determine the design heating air flows, the design heating air flow will be at least this value.

MIN-FLOW-SCH

Takes the U-name of a schedule of TYPE = FRAC/DESIGN whose values are values of minimum flow ratio. This schedule will override the specified or calculated value of MIN-FLOW-RATIO unless the schedule value is -999. In this case the specified or calculated value of MIN-FLOW-RATIO, which is found on report SV-A for each zone, is used for that hour. This schedule can be used with a value of 1.0 during warmup periods and -999 for other hours to simulate VAV boxes that are fully open during warmup.

HMAX-FLOW-RATIO

For a reverse-action VAV terminal, specifies the ratio of the maximum heating airflow to the cooling airflow. This keyword also has an equivalent keyword at the SYSTEM level.

MIN-FLOW-CTRL

Allows the choice of method used to set the hourly minimum VAV box flow fraction. If the MIN-FLOW-SCH, CMIN-FLOW-SCH or HMIN-FLOW-SCH are specified, their hourly specified values will always be used, for the appropriate VAV box minimum flow setting, unless the hourly scheduled value is -999 even if MIN-FLOW-CTRL is specified.

FIXED/SCHEDULED (Default) This codeword instructs the program to model VAV boxes as having a fixed or scheduled minimum. A fixed minimum is used unless a minimum flow fraction schedule is specified through the use of MIN-FLOW-SCH, CMIN-FLOW-SCH or HMIN-FLOW-SCH.

DCV-RESET-UP/DOWN This codeword instructs the program to model VAV boxes that have their minimum flow fraction reset either upwards (raised) or downwards (lowered) due to demand controlled ventilation determined zone minimum OA flow rate requirements. The program calculates the zone minimum OA requirement and sets the zone VAV box minimum damper position hourly. Each zone OA requirement is calculated based upon the hourly maximum of either OA-CFM/PER (times the NUMBER-OF-PEOPLE adjusted by the hourly PEOPLE-SCHEDULE) or a minimum OA ventilation rate. The zone minimum OA ventilation rate is either MIN-OUTSIDE-AIR if specified or the maximum of OA-CHANGES (times the zone VOLUME/60), OA-FLOW/AREA (times the zone AREA.)

DCV-RESET-UP This codeword instructs the program to model VAV boxes that have their minimum flow fraction reset upwards (raised) due to demand controlled ventilation determined zone minimum OA flow rate requirements. The program calculates the zone minimum OA requirement and sets the zone VAV box minimum damper position upwards hourly if that is necessary; otherwise the minimum is set at the design value. Each zone OA requirement is calculated based upon the hourly maximum of either OA-CFM/PER (times the NUMBER-OF-PEOPLE adjusted by the hourly PEOPLE-SCHEDULE) or a minimum OA ventilation rate. The zone minimum OA ventilation rate is either MIN-OUTSIDE-AIR if specified or the maximum of OA-CHANGES (times the zone VOLUME/60), OA-FLOW/AREA (times the zone AREA.)

DCV-RESET-DOWN This codeword instructs the program to model VAV boxes that have their minimum flow fraction reset downwards (lowered) due to demand controlled ventilation determined zone minimum OA flow rate requirements. The program calculates the zone minimum OA requirement and sets the zone VAV box minimum damper position downwards hourly if that is necessary; otherwise the minimum is set at the design value. Each zone OA requirement is calculated based

upon the hourly maximum of either OA-CFM/PER (times the NUMBER-OF-PEOPLE adjusted by the hourly PEOPLE-SCHEDULE) or a minimum OA ventilation rate. The zone minimum OA ventilation rate is either MIN-OUTSIDE-AIR if specified or the maximum of OA-CHANGES (times the zone VOLUME/60), OA-FLOW/AREA (times the zone AREA.)

Dual-duct systems

The following keywords apply to the *inlets* of a dual-duct or multizone air terminal. Similar keywords apply to the *outlet* of the same terminal, and are described above.

CMIN-FLOW-RATIO

For dual-duct and multizone systems, this is the minimum air flow ratio of the controller that modulates the cold duct damper at the inlet of the mixing box. See SYSTEM:CMIN-FLOW-RATIO for more information. This keyword defaults to the value specified for the system.

CMIN-FLOW/AREA

Minimum cooling air flow per unit floor area. An alternative way of specifying ZONE:CMIN-FLOW-RATIO. If you allow the program to determine the zone design cooling air flows, the zone design cooling air flow will be at least this value if CMIN-FLOW-RATIO has not been specified.

CMIN-FLOW-SCH

Takes the U-name of a schedule (with TYPE = FRAC/DESIGN) of hourly values of CMIN-FLOW-RATIO. See SYSTEM:CMIN-FLOW-RATIO for more information.

HFLOW/AREA

Similar to FLOW/AREA. If specified, the maximum heating air flow for the mixing box will be set to this value if it results in a larger than HAIR-CHANGES/HR and HASSIGNED-FLOW has not been specified.

HAIR-CHANGES/HR

Similar to AIR-CHANGES/HR. If specified, the maximum heating air flow for the mixing box will be set to this value if it results in a larger value than HFLOW/AREA and HASSIGNED-FLOW has not been specified.

HASSIGNED-FLOW

Similar to ASSIGNED-FLOW. If specified, the maximum heating air flow for the mixing box will be set to this value.

HMIN-FLOW-RATIO

Minimum hot duct air flow ratio. Intended primarily for dual-duct and multizone systems but also has a special meaning for single-duct VAV systems. Does at the zone level what SYSTEM:HMIN-FLOW-RATIO does at the system level. See SYSTEM:HMIN-FLOW-RATIO for a complete description. Defaults to the value specified for the system.

HMIN-FLOW/AREA

Minimum heating air flow per unit floor area. An alternative way of specifying ZONE:HMIN-FLOW-RATIO. If you allow the program to determine the zone design heating air flows, the zone design heating air flow will be at least this value if HMIN-FLOW-RATIO has not been specified.

HMIN-FLOW-SCH

Takes the U-name of a schedule (with TYPE = FRAC/DESIGN) of hourly values of HMIN-FLOW-RATIO.

MIN-FLOW-SOURCE

For a dual-duct or multizone system, takes a code-word that specifies the source of the makeup air used by the outlet controller when the total supply air flow falls below ZONE:MIN-FLOW-RATIO. See SYSTEM:MIN-FLOW-SOURCE for a complete description. Defaults to the value specified for the system.

COLD-DUCT	Causes the makeup air to be drawn from the cold duct.
HOT-DUCT	Causes the makeup air to be drawn from the hot duct.
SNAP-ACTING	Causes the makeup air to be drawn from the hot duct during the heating mode and from the cold duct during the cooling mode. When in the deadband, the makeup air is drawn from whichever duct was last active. Note that a snap-acting controller, together with a large ZONE:MIN-FLOW-RATIO, may cause the zone temperature to oscillate back and forth between the heating and cooling setpoints

Outside-Air Ventilation

The following keywords describe the outside air ventilation requirements of a zone. If specified, these keywords take precedence over specifying outside air at the SYSTEM level.

OA-FLOW/PER

Minimum flow rate of outside ventilation air per person at peak occupancy. OUTSIDE-AIR-FLOW, described below, takes precedence over this input. Although the specified quantities may be modified by the program for the sake of consistency, the flow of outside ventilation air is an uninterrupted flow as long as the fans are operating. The outside ventilation air quantity is not determined by the design space heating or cooling demands except when an economizer is specified. Use either OUTSIDE-AIR-FLOW or OA-FLOW/PER or OA-CHANGES or OA-FLOW/AREA.

OA-CHANGES

Minimum flow rate of outside ventilation air for the zone expressed in terms of the number of times per hour that this flow rate would replace the total volume of air in the zone. OUTSIDE-AIR-FLOW, described below, takes precedence over this input. Although the specified quantities may be modified by the program for the sake of consistency, the flow of outside ventilation air is an uninterrupted flow as long as the fans are operating. The outside ventilation air quantity is not determined by the design space heating or cooling demands except when an economizer is specified. Use either OUTSIDE-AIR-FLOW or OA-FLOW/PER or OA-CHANGES.

OUTSIDE-AIR-FLOW

The minimum flow rate of outside ventilation air for the zone. Alternatively, or additionally, outside air flow rate may be specified by the keywords OA-FLOW/PER and OA-CHANGES (or by SYSTEM:MIN-OUTSIDE-AIR). The program calculates outside air flow rate based on each entry and normally uses the larger value except if it sees data entry for OUTSIDE-AIR-FLOW, which overrides other values. Note that specifying outside ventilation air at the zone level takes precedence over specifying it at the system level. Although the specified quantities may be modified by the program for the sake of consistency, the flow of outside ventilation air is an uninterrupted flow as long as the fans are operating. The outside ventilation air quantity is not determined by the design space heating or cooling demands except when an economizer is specified. Use either OUTSIDE-AIR-FLOW or OA-FLOW/PER or OA-CHANGES.

OA-FLOW/AREA

This keyword allows the specification of a minimum zone outside air (OA) flow rate per unit of zone floor area. The use of OUTSIDE-AIR-FLOW will override the value of this keyword. The maximum of values resulting

from OA-FLOW/AREA, OA-FLOW/PER, and OA-CHANGES will be used unless an over-ride value for OUTSIDE-AIR-FLOW is specified.

Zone Fans

The following keywords apply only to the circulating air fans of powered induction units (SYSTEM:TYPE = PIU).

ZONE-FAN-RATIO

ZONE-FAN-RATIO times the design primary air flow rate gives design flow rate of the PIU fan for ZONE:TERMINAL-TYPE = SERIES-PIU or PARALLEL-PIU. If both ZONE-FAN-FLOW and ZONE-FAN-RATIO are specified, ZONE-FAN-FLOW takes precedence. Defaults to 1.0 for ZONE:TERMINAL-TYPE = SERIES-PIU. There is no default for ZONE:TERMINAL-TYPE = PARALLEL-PIU; in this case, ZONE-FAN-RATIO or ZONE-FAN-FLOW must be input.

ZONE-FAN-FLOW

The design capacity of the PIU fan. If TERMINAL-TYPE = SERIES-PIU or PARALLEL-PIU, you can size the fan with this keyword. If neither ZONE-FAN-RATIO nor ZONE-FAN-FLOW is specified, the program will size the fan. For ZONE:TERMINAL-TYPE = SERIES-PIU this is a straightforward process: The blower is sized to the maximum flow rate determined from ZONE-AIR:ASSIGNED-FLOW, AIR-CHANGES/HR or FLOW/AREA, or it is sized by the program from design-day peak heating and cooling loads. For ZONE:TERMINAL-TYPE = PARALLEL-PIU, if ZONE-FAN-FLOW is not input, the blower is sized from the heating peak. The ZONE-level air flow keywords are assumed to refer to the primary air from the central system. It is recommended that you explicitly size the fans, since the use of the heating peak to size the parallel PIU might result in a ridiculously small fan.

ZONE-FAN-KW/FLOW

The power of the fan per unit flow rate for ZONE:TERMINAL-TYPE = SERIES PIU or PARALLEL-PIU.

ZONE-FAN-T-SCH

Required if ZONE:TERMINAL-TYPE = PARALLEL-PIU. Takes the U-name of a schedule (TYPE = TEMPERATURE) that gives the zone temperature at which the terminal blower turns on. This temperature must be above the heating range.

Exhaust Airflow and Fans

This set of keywords defines exhaust at the zonal level. If zonal exhaust requires more outside air than specified for ventilation, exhaust will take precedence.

Exhaust flow may be made up from outside air introduced at the air handler, or from air infiltration directly into the zone (EXHAUST-SOURCE).

- If the exhaust make-up is from infiltration, then the exhaust fan operates independently of the system's supply fan.
- Otherwise, the program will force the exhaust fan to be off whenever the supply fan is off. In addition, system outside air requirements and the minimum terminal airflow in VAV systems will be subject to exhaust requirements.

EXHAUST-FLOW

Flow rate of the zone's exhaust fan. This entry can be omitted if there is no exhaust from the zone, if there is only central exhaust by way of the system return, or if the exhaust tracks the supply flow (see AIRFLOW-TRACKING).