USER GUIDE
«HEATY»
BUILDING HEAT LOAD CALCULATOR

0. INTRODUCTION

1. «Heaty» is a GUI tool for Windows, more specifically a building heat load calculator that implements the calculation procedure of the standard method described in the **European standard EN 12831-1:2017, §6**. This method includes a steady-state calculation of the design heat load of a building, of the separate building entities (e.g. apartments) within this building and of the individual heated spaces within each building entity. «Heaty» does not make the purchase of the standard superfluous; one needs the standard in conjunction with «Heaty» in order to enter the correct user input parameters.

2. Heat loss will depend on **climatic conditions** and therefore it will vary with geographic location and during the time of year.
The purpose of a design heat load calculation is to determine the heat loss under extreme, yet probable, weather conditions at a given geographic location. These exterior "design conditions", especially the external design temperature to be used, can be looked up in separate national annexes that European countries provide to supplement or override the European "core" standard EN 12831-1.

3. Besides the external temperature, heat loss from a building will also depend on **internal temperatures** within a building. Indeed, it's the temperature difference between interior and exterior that drives the heat through the building envelope.
Heated spaces within a building may have different desired temperatures, e.g. 20 °C in a living room and 24 °C in a bathroom. Table B.14 of EN 12831-1 lists different kinds of heated spaces along with their default internal design temperature (this table can be overridden in a national annex, see e.g. table NA.2 of the Belgian national annex).

4. The heat loss from a heated space isn't necessarily towards the outside environment (exterior) directly. A heated space at design conditions may also lose heat to other adjacent heated spaces with a lower internal design temperature (or gain heat from adjacent spaces with a higher internal design temperature), to adjacent unheated spaces, to an adjacent building entity, to an adjacent building or to the ground (if it is in contact with the ground). The design temperatures to select for adjacent unheated spaces, building entities and buildings and for the ground are also covered in the core standard (see table 7) or these can be looked up in the appropriate national annex.

5. The total design heat load of a heated space, a building entity or building is comprised of:

- **transmission heat loss** through building elements that enclose the heated space, building entity or building;
- **ventilation and infiltration heat loss** as cold exterior air is brought into the heated spaces, by purpose in case of hygienic ventilation or unwillingly through openings and cracks in the building envelope due to wind and/or stack effect.
- **additional heating-up power** to attain the desired internal temperature within a given time period after a temperature setback.

6. The calculation procedure of the standard method is based upon a hierarchal structure: at the top of the hierarchy is the **building**. A building can have one or more **building entities** (e.g. apartments in an apartment building). Each building entity can have one or more **ventilation zones**, but usually a building entity will consist of only one ventilation zone. EN 12831-1 defines a ventilation zone as "a group of rooms that are air-connected by design, either directly or indirectly (through other rooms in between)" and it further notes that, by design, there is no air transfer possible between ventilation zones.

Each ventilation zone within a building entity contains several **heated spaces** that are ventilated by the same ventilation system.

A heated space is surrounded by **building elements** (walls, windows, doors, floors, ceilings). EN 12831-1 makes the distinction between:

- building elements between the heated space under consideration and the exterior;
- building elements between the heated space under consideration and another adjacent heated space;
- building elements between the heated space under consideration and an adjacent unheated space;
- building elements between the heated space under consideration and the ground;
- building elements between the heated space under consideration and an adjacent building entity or another building.

1. CALCULATION OF THE DESIGN TRANSMISSION HEAT LOSS

1. Transmission heat loss is the heat that flows out of a heated space through the different building elements that surround this heated space.

2. Each category of building elements has two basic properties in common: area A [m^2] and thermal transmittance U [W/(m^2.K)]. Multiplying these two properties gives us a "basic" transmission heat transfer coefficient H [W/K] of the building element, i.e. the transmission heat loss of the building element per degree of temperature difference.
This basic coefficient may be fine-tuned by correction factors or terms. E.g. a blanket additional thermal transmittance ΔU_{TB} [W/(m^2.K)] may be added to U to account for thermal bridges in case of a building element that separates a heated space from the exterior. The resulting transmission heat transfer coefficient may also be multiplied by a correction factor $f_{U,k}$ to take into account the influence of building part qualities and meteorological conditions.

3. A noteworthy feature of the calculation method presented in EN 12831-1 is that transmission heat transfer coefficients of building elements are temperature adjusted.
This means that the actual transmission heat transfer coefficient is multiplied with a temperature adjustment factor, which allows to express the transmission heat loss through any building element as the product of the temperature adjusted transmission heat transfer coefficient of the building element and the difference between the internal design temperature of the heated space and the external design temperature, regardless of the actual temperature difference across the building element.

4. The most involved transmission heat transfer coefficient to calculate is the one of building elements that are in contact with the ground (i.e. floors). Firstly, the equivalent thermal transmittance $U_{equiv,k}$ of the building element in contact with the ground needs to be calculated. This value is then multiplied with the area of the floor, a correction factor $f_{GW,k}$ that takes the influence of ground water into account, a correction factor $f_{\theta ann}$ that takes the annual variation of the external temperature into account and finally the temperature adjustment factor $f_{ig,k}$.

TABLE 1
Overview of the input parameters that «Heaty» needs in order to calculate the transmission heat transfer coefficient for each type of building element

Symbol in EN 12831-1	Symbol in «Heaty»	Description
Building element directly to exterior [EN 12831-1 §6.3.2.2]		
A_k	A	surface area of the building element
U_k	U	thermal transmittance of the building element
ΔU_{TB}	dU_tb	blanket additional thermal transmittance for thermal bridges; see EN 12831-1, Annex B.2.1 for default values or NBN EN 12831-1 ANB:2020 NA.5.1
$f_{U,k}$	f_U	correction factor for the influence of building part qualities and meteorological conditions; see EN 12831-1, Annex B.2.2 for default values or NBN EN 12831-1 ANB:2020 NA.5.2

Table 1 continued...

Symbol in EN 12831-1	Symbol in «Heaty»	Description
Building element to adjacent heated space within the same building entity [EN 12831-1 §6.3.2.3 + §6.3.2.5]		
A_k	A	surface area of the building element
U_k	U	thermal transmittance of the building element
$\theta_{int,a}$	T_adj	temperature of the adjacent heated space, i.e. the internal design temperature of the adjacent heated space
Building element to adjacent unheated space or neighboring building [EN 12831-1 §6.3.2.3 + §6.3.2.5]		
A_k	A	surface area of the building element
U_k	U	thermal transmittance of the building element
f_1	f1	adjustment factor for the difference between the temperature of an adjacent space and the external design temperature; see EN 12831-1, Annex B.2.4 for default values – optional parameter: if left empty, T_adj will be used.
	T_adj	temperature of the unheated space if known or temperature of neighboring building (= annual mean external temperature if greater than 5 °C else 5 °C or see NBN EN 12831-1 ANB:2020 NA.5.6)
Building element in contact with the ground [EN 12831-1 §6.3.2.4]		
A_k	A	surface area of the building element
U_k	U	thermal transmittance of the building element
$f_{\theta ann}$	f_dT_an	correction factor taking into account the annual variation of the external temperature; see EN 12831-1, Annex B.2.3 for default values or NBN EN 12831-1 ANB:2020 NA.5.3
$f_{GW,k}$	f_gw	correction factor taking into account the influence of ground water; see EN 12831-1, Annex B.2.3 for default values or NBN EN 12831-1 ANB:2020 NA.5.3
A_G	A_g	area of the floor slab; see EN 12831-1, Annex E

Table 1 continued...

Symbol in EN 12831-1	Symbol in «Heaty»	Description
P	P	exposed periphery of the floor slab; see EN 12831-1, Annex E
ΔU_{TB}	dU_tb	blanket additional thermal transmittance for thermal bridges; see EN 12831-1, Annex B.2.1 for default values or NBN EN 12831-1 ANB:2020 NA.5.1
z	z	depth of the top edge of the floor slab below ground level
Building element adjacent to building entity [EN 12831-1 §6.3.2.3 + §6.3.2.5]		
A_k	A	surface area of the building element
U_k	U	thermal transmittance of the building element
θ_u	T_adj	internal temperature of the adjacent building entity considered to be unheated; see EN 12831-1, Annex D or NBN EN 12831-1 ANB:2020 AN.5.4 and AN.5.6 for default values

Notes:

The equivalent thermal transmittance $U_{equiv,k}$ of a building element in contact with the ground is calculated by «Heaty» behind the scenes according to the formula's in Annex E of EN 12831-1.

The temperature adjustment factor for each type of building element is calculated by «Heaty» behind the scenes according to EN 12831-1 §6.3.2.5.

In heated spaces with heigh ceilings (≥ 4 m), the temperature adjustment factor also takes into account the difference between the internal design temperature of the heated space and the mean surface temperature of a building element (EN 12831-1 §6.3.8.2). In order to be able to calculate the mean surface temperature of a building element, «Heaty» needs some more information about the heated space. If the height of the room is less than 4 m, it is assumed that the mean surface temperature of a building element equals the internal design temperature of the heated space.

TABLE 2

Overview of the input parameters that «Heaty» needs in order to calculate the design transmission heat loss of a heated space

Symbol in EN 12831-1	Symbol in «Heaty»	Description
$\theta_{int,i}$	T_i_d	internal design temperature of the heated space
h_k	h_r	mean height of the heated space above floor level; if there are significantly differing floor levels in a room, the area-weighted mean floor height may be set as floor level
$h_{occup,i}$	h_occ	height of the occupied zone in the room; see EN 12831-1, Annex B.2.6
$G_{\theta,air,i}$	gT_a	air temperature gradient of the heat emission system in the room; see EN 12831-1, Annex B.2.6, Table B.3
$\Delta\theta_{surf,k}$	dT_s	correction term to allow for differing air and surface temperatures (e.g. increased floor or wall temperatures due to illumination, radiant heaters, floor heating); see EN 12831-1, Annex B.2.6, Table B.3

5. Once the heat transfer coefficients of the building elements enclosing each of the heated spaces within a building entity can be calculated, «Heaty» can calculate **the design transmission heat loss of the building entity** by first calculating and then taking the sum of:

1. the transmission heat loss through building elements of heated spaces directly in contact with the exterior,
2. the transmission heat loss through building elements of heated spaces in contact with adjacent unheated spaces,
3. the transmission heat loss through building elements of heated spaces in contact with adjacent building entities, and
4. the transmission heat loss through building elements of heated spaces in contact with the ground.

6. Once the heat transfer coefficients of all the building elements enclosing each of the heated spaces within a building can be calculated, «Heaty» can calculate **the design transmission heat loss of the whole building** by first calculating and then taking the sum of:

1. the transmission heat loss through building elements of heated spaces directly in contact with the exterior,
2. the transmission heat loss through building elements of heated spaces in contact with adjacent unheated spaces or neighboring buildings, and
3. the transmission heat loss through building elements of heated spaces in contact with the ground.

Note that «Heaty» performs the calculations dynamically, which means that each time the configuration of the hierarchical building structure is modified, e.g. by adding a new heated space, modifying a heated space or deleting a heated space, the whole building structure is immediately updated.

2. CALCULATION OF THE DESIGN VENTILATION HEAT LOSS

1. Within the standard method of EN 12831-1 a general calculation model is presented for the calculation of the design ventilation heat losses applicable to the most common ventilation systems (natural and mechanical, fan-assisted ventilation, balanced and unbalanced ventilation, additional combustion air in case of open flue heaters). The method also incorporates infiltration through leakages in the building envelope. The calculation procedure is set out in §6.3.3.3 of the standard.

2. While the standard's calculation method for the design transmission heat loss of a heated space is fairly easy to grasp, this is not quite the case for calculating the design ventilation heat loss. It takes several intermediate steps, using empirical formulas, to finally arrive at the design ventilation heat loss of a heated space. In Annex A of the user guide a schematic overview of these calculation steps is presented. Each formula of standard EN 12831-1 is represented by a block with the input parameters to the formula on the left side and the output of the formula on the right side of the block.

The calculation chain starts at step 1 and moves to each of the following steps until step 12 is reached. At this final step the outcome is the design ventilation heat loss of the heated space we are looking for. The output at certain intermediate steps may be used as input parameter to several of the following steps as indicated in the overview.

The input parameters marked yellow in the overview are input parameters the user has to enter at the level of the ventilation zone. Input parameters that are marked light-blue are input parameters the user has to enter at the level of the heated space. Input parameters marked orange can be calculated by «Heaty» and therefore don't need to be entered by the user.

Default values or methods to calculate the user input parameters may be given in the annexes to the standard or in a separate national annex. In the overview it is mentioned where information about the values of specific input parameters can be found in the standard.

- In the 1st step the air volume flow rate through ATDs in the ventilation zone of which the heated space is part of, is calculated given a pressure difference of 50 Pa between indoor and outdoor.

- In the 2nd step an adjustment factor is calculated taking an additional pressure difference into account in case ventilation is unbalanced.

- In the 3th step the air volume flow into the ventilation zone due to additional infiltration is calculated as the sum of (1) the infiltration air volume flow through leakages in the building envelope at 50 Pa, which can be measured with an air tightness measurement ("blower door test") of the building, and (2) the separate air volume flow through the ATDs at 50 Pa as determined in the 1st step. This sum is then adjusted by the product of the adjustment factor calculated in the 2nd step and the volume flow factor.

- In the 4th step the total external air volume flow through the building envelope (including any ATDs) of the ventilation zone is calculated: it is the sum of (1) the difference between ventilation exhaust (including any combustion air) and supply air and (2) the air volume flow due to additional infiltration as calculated in the 3th step.

- In the 5th step the authority (the share) of the ATDs in the total air volume through the building envelope is determined. With this parameter, the air volume through the building envelope is then divided into two components:

– in the 6th step the external air volume flow through leakages in the building envelope into the ventilation zone is calculated, and

– in the 7th step the external air volume through ATDs is calculated.

- In the 8th step the total external air volume flow into the ventilation zone due to infiltration through leakages (step 6) and through ATDs (step 7) is distributed across the heated spaces of the ventilation zone. The distribution depends on the ratio of the considered room envelope's area to the ventilation zone envelope's area and also depends on the ratio of the design air volume flow through ATDs of the room being considered to the design air volume flow through all ATDs of the ventilation zone.

- In the 9th step *the external air volume flow through the envelope* of only the heated space under consideration is deduced based on a combination of (1) the additional infiltration air volume flow determined in step 3, (2) the total air volume flow through the building envelope of the ventilation zone determined in step 4 and (3) the external air volume flow in the heated space through leakages and ATDs determined in step 8.

- In the 10th step *the technical ventilation air volume flow* in the heated space is determined. It is the maximum of the ventilation air volume flow that flows into the heated space (supply air and transfer air) and the ventilation air volume flow that flows out of the heated space (exhaust air and combustion air).

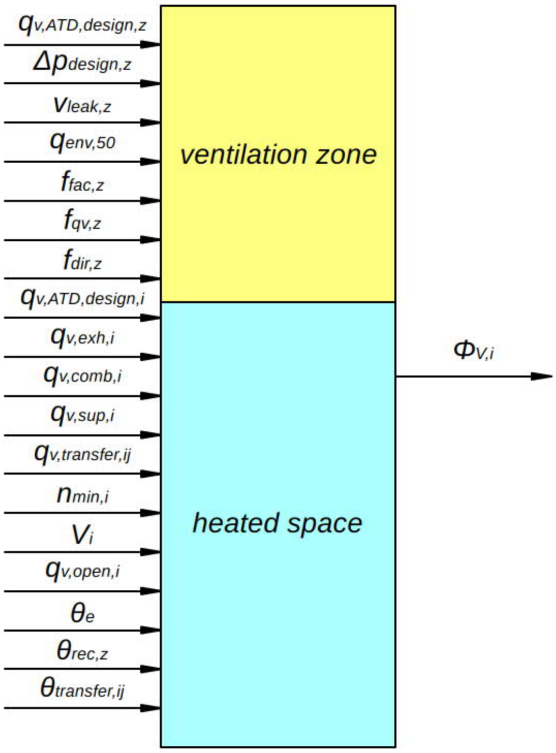
Air volume flow through ATDs (and through leakage openings in the building envelope) is excluded from the technical ventilation air volume flow, as it is included in the air volume flow calculated in the 8th step, from which the external air volume flow through the envelope of the heated space is then deduced in the 9th step.

• In the 11th step *the minimum required ventilation air volume flow* is calculated needed to sustain adequate air quality in the room.

• In the 12th and final step the design ventilation heat loss is calculated from the air volume flows calculated in step 9 to step 11, and additionally also the possible air volume flow through large openings if present.

The formula for calculating the design ventilation heat loss contains three terms. The first term considers the sum of the external air volume flow through the envelope of the heated space and the air volume flow that may enter through large openings into the heated space. It also considers the difference between the minimum required air volume flow with respect to air quality and the technical air volume flow determined in step 10. The formula then takes the greatest of these two flows. This air volume flow is then being considered as the air volume flow that enters the heated space directly from outdoors, which is multiplied with the temperature difference between the internal air temperature of the heated space and the external design temperature.
The second term considers the air volume flow that is supplied to the heated space by the ventilation system through air inlets (not ATDs) in the heated space, which is multiplied with the temperature difference between the internal air temperature of the heated space and the supply air temperature after the heat recovery device (if present).
The third term considers the air volume flow entering the heated space from another, adjacent space (= air transfer), which is multiplied with the temperature difference between the internal air temperature of the heated space and the internal air temperature in the other space.

3. The schematic overview shown in Annex A can be reduced into one single "black box" with on the left side the user input parameters that «Heaty» needs in order to be able to calculate the design ventilation heat loss of a heated space.



The user input parameters at the level of a ventilation zone will be shared by all heated spaces that belong to this ventilation zone.

 # TABLE 3
Overview of the input parameters that «Heaty» needs at the level of the ventilation zone in order to calculate the design ventilation heat loss of a heated space

Symbol in EN 12831-1	Symbol in «Heaty»	Description
$q_{v,ATD,design,z}$	V_ATD_d	design air volume flow of the ATDs in the zone; see EN 12831-1, Annex B.2.12
$\Delta p_{design,z}$	dp_ATD_d	design pressure difference of the ATDs in the zone; see EN 12831-1, Annex B.2.12
$v_{leak,z}$	v_leak	pressure exponent; see EN 12831-1, Annex B.2.13

Table 3 continued...

Symbol in EN 12831-1	Symbol in «Heaty»	Description
$q_{env,50}$	q_env_50	air permeability (or air change rate) at a pressure difference of 50 Pa between interior and exterior (cf. air tightness measurement) with any ATDs closed or sealed; see EN 12831-1 §6.3.3.4 and EN 12831-1, Annex B.2.10
$f_{fac,z}$	f_fac	adjustment factor for the number of (wind) exposed facades of the zone; see EN 12831-1, Annex B.2.15
$f_{qv,z}$	f_V	volume flow factor of the zone; see EN 12831-1, Annex B.2.11
f_{dir}	f_dir	factor for the orientation of the zone; see EN 12831-1, Annex B.2.14
f_{iz}	f_iz	ratio between the minimum air volume flow of a single heated space and the air volume flow of the entire zone; see EN 12831-1, Annex B.2.9; this parameter will actually be used by «Heaty» to calculate the design ventilation loss of the entire ventilation zone

Notes:

ATD stands for “Air Terminal Device”. EN 12831-1 defines an ATD as an air out- or inlet that allows air transfer between external air and internal air (external ATD) or between separate rooms (internal ATD). Within the context of the standard, the term refers only to passive devices (e.g. air grilles) allowing air flow through a building element; it does not include air out- or inlets of a mechanical, fan-assisted ventilation system.

If the design volume flow of each single ATD or for each room with ATDs is known, the volume flow for the ventilation zone $q_{v,ATD,design,z}$ is simply the sum of the design flows $q_{v,ATD,design,i}$ of the rooms that are part of the ventilation zone under consideration.

In case the total design flow for a ventilation zone $q_{v,ATD,design,z}$ should be known in advance, the design flow of a room with ATDs $q_{v,ATD,design,i}$ can be estimated with:

$$q_{v,ATD,design,i} = \frac{V_i}{\sum_i V_i} q_{v,ATD,design,z} \qquad (1)$$

V_i in the numerator is the internal volume of the room under consideration, while the denominator is the sum of the internal volumes of all rooms with ATDs in the ventilation zone. If neither of both design flows should be known in advance, the design volume flow for the ventilation zone can be estimated with:

$$q_{v,ATD,design,z} = 0{,}3\left[1/hr\right]V_z \tag{2}$$

with V_z the total internal volume of the zone, i.e. the sum of the internal volumes of all rooms in the ventilation zone, with or without ATDs.

The air volume flow through an ATD will depend on the pressure difference across the ATD. For design calculations it may be assumed that the pressure difference at which the design volume flow passes through an ATD ($\Delta p_{design,z}$) is equal to 4 Pa (EN 12831-1, Annex B.2.12).

The pressure exponent $v_{leak,z}$ allows to calculate the air volume flow through an ATD at pressure differences that deviate from the design value. Default value for the pressure exponent is 0,67 (EN 12831-1, Annex B.2.13).

The air permeability $q_{env,50}$ is a measure of the air tightness of a building and of course will have an influence on the ventilation heat loss of a building. This quantity can be measured in case of an existing building by an air tightness measurement (“blower door test”), otherwise a reasonable default value should be selected: see EN 12831-1, Annex B.2.10.

 # TABLE 4

Overview of the input parameters that «Heaty» needs at the level of the heated space in order to calculate the design ventilation heat loss of a heated space

Symbol in EN 12831-1	Symbol in «Heaty»	Description
$q_{v,ATD,design,i}$	V_ATD_d	design air volume flow of the ATDs in the room; see EN 12831-1, Annex B.2.12
$q_{v,exh,i}$	V_exh	exhaust air volume flow from the heated space

Table 4 continued...

Symbol in EN 12831-1	Symbol in «Heaty»	Description
$q_{v,comb,i}$	V_comb	air volume flow exhausted from the heated space that has not been included in the exhaust air volume flow of the ventilation system; typically, but not necessarily, combustion air if an open flue heater is present
$q_{v,sup,i}$	V_sup	supply air volume flow into the heated space
$q_{v,transfer,ij}$	V_trf	transfer air volume flow into the heated space if there is internal air transfer from one space to another
$n_{min,i}$	n_min	minimum air change rate required for the heated space for reasons of air quality/hygiene and comfort; see EN 12831-1, Annex B.2.10, Table B.7
V_i	V_r	internal volume of the heated space
$q_{v,open,i}$	V_open	external air volume flow into the heated space through “large openings”; see EN 12831-1, Annex G
$\theta_{rec,z}$	T_sup	temperature of the supply air volume flow into the heated space after passing heat recovery (see EN 12831-1 §6.3.3.7) or after passive preheating; in case of active preheating, which requires power from a heat generator, it should be the temperature of the air before preheating
$\theta_{transfer,ij}$	T_trf	temperature of the transfer air volume flow into the heated space from another space; in case the room height of the other space is less than 4 m, it is equal to the internal design temperature of the other space, otherwise, it is equal to the mean air temperature of the other space (see EN 12831-1 §6.3.8.3)
$\Delta\theta_{rad}$	dT_rad	correction factor to allow for differing air and operative temperatures; see EN 12831-1, Annex B.2.6 – this parameter is used by «Heaty» to calculate the mean internal air temperature in the heated space if its room height is greater than or equal to 4 m

Notes:

The air volume flows $q_{v,ATD,design,i}$, $q_{v,exh,i}$, $q_{v,sup,i}$ and $q_{v,transfer,ij}$ can be present in case of a mechanical ventilation system. Two categories of mechanical ventilation systems have widespread use:

1. Mechanical exhaust ventilation systems: fresh, exterior air enters a “dry” room (living room, bedroom,...) through ATDs ($q_{v,sup,i}$ = 0, but $q_{v,ATD,design,i}$ > 0). This air is then transferred through internal ATDs towards “wet” rooms (toilet, bathroom, kitchen,...), ($q_{v,transfer,ij}$ > 0) where it is extracted through air outlets by the aid of a fan-assisted exhaust system, that discharges the polluted room air back into the outdoor environment ($q_{v,exh,i}$ > 0).
2. Mechanical supply and exhaust ventilation systems: fresh, exterior air is blown into “dry” rooms by a fan-assisted supply air system ($q_{v,sup,i}$ > 0 and $q_{v,ATD,design,i}$ = 0). This air is then transferred through internal ATDs towards “wet” rooms (toilet, bathroom, kitchen,...), ($q_{v,transfer,ij}$ > 0) where it is extracted through air outlets by the aid of a fan-assisted exhaust system, that discharges the polluted room air back into the outdoor environment ($q_{v,exh,i}$ > 0).

“Large openings” are defined by EN 12831-1 as openings that are kept open for significant periods over the day on a regular basis; usually, but not necessarily, doors or gates (e.g. in logistics and industrial halls). A method for estimating the external air volume through large openings is presented in annex G of EN 12831-1.

To retrieve the supply air temperature after heat recovery in a mechanical supply and exhaust ventilation system, one must know the efficiency of the heat recovery of the ventilation system under design external conditions ($\eta_{rec,z}$). When the heat recovery efficiency $\eta_{rec,z}$ is known the supply air temperature to the heated spaces in a zone can be estimated as:

$$\theta_{rec,z} = \theta_e + \eta_{rec,z}\left(\theta_{exh,z} - \theta_e\right) \qquad (3)$$

with $\theta_{exh,z}$ the temperature of the exhaust air at the heat recovery device, which can be estimated with:

$$\theta_{exh,z} = \frac{\sum_i \left(q_{v,exh,i} \cdot \theta^*_{int,i}\right)}{\sum_i q_{v,exh,i}} \qquad (4)$$

with $\theta^*_{int,i}$ the mean internal air temperature of the considered room.

The temperature difference that drives the ventilation heat loss depends on the mean internal air temperature of the heated space, which can be assumed equal to the internal design temperature of the heated space if the room height is less than 4 m. Otherwise, the mean internal air temperature of the heated space is to be calculated according to §6.3.8.3 of EN 12831-1. In order to make this calculation, a correction term $\Delta\theta_{rad}$ is taken into account that represents the temperature difference between the operative room temperature (i.e. the indoor temperature that a human senses) and the actual room air temperature. Its value depends on the type of heat emission system: see EN 12831-1, Annex B.2.6, table B.3.

When this correction term, together with the air temperature gradient, the room height and the height of the occupied zone (see already table 2), is passed to «Heaty», the program is able to calculate the mean internal air temperature of the room.

Note that, if $\theta_{transfer,ij}$ applies to an adjacent space whose room height is 4 m or higher, the mean internal air temperature should first be calculated by the user himself.

4. Once the design ventilation loss of all heated spaces in a ventilation zone are calculated, the final design ventilation loss of the ventilation zone will also be known at the same time. As already mentioned, «Heaty» performs the calculations dynamically: each time the configuration of the hierarchical building structure changes, the design losses will be changed accordingly. In the same manner, when all ventilation zones within the building are configured, the final design ventilation loss of the building entities and the building as a whole will also be known.

3. CALCULATION OF ADDITIONAL HEATING-UP POWER

1. EN 12831-1 points out that oversizing the heat generator should be avoided due to higher energy consumption (higher standby losses, more on/off-cycles,...) and therefore, that it is highly recommended that the heating-up power or the acceptable period of time required for the heating-up is agreed between contractor and client.

Nevertheless, intermittently heated spaces can require additional heating-up power to attain the desired internal design temperature after a temperature setback within a given time period.

2. EN 12831-1 presents a simplified approach to estimate the heating-up power in Annex F. Two methods are presented: one based on the length of the setback period, the other based on the temperature drop during setback.

The first method is applicable if the following conditions are fulfilled:

– the building has a high standard of thermal insulation,
– the room height is small (≤ 3,5 m),
– the temperature drop during setback is limited to 5 K (by means of temperature control).

If these conditions are not met or when the temperature drop during setback is known, the second method can be used.

In the first method four parameters, viz. setback or disuse period, air change rate during setback, thermal storage capacity of the building mass and required heating-up time, determine the specific heating-up power (i.e. the thermal power per unit of floor area): see EN 12831-1, Annex F, Table F.1. A grey mark indicates that for the selected parameters the internal temperature will very likely drop by 5 K or more and a high specific power results. Values that exceed 100 W/m² are indicated with >100; in such cases the additional heating-up power will likely be at least of the same magnitude as the design heat load without additional heating-up power and alternative options should be considered, like allowing more time for heating-up; if this is not done, the additional heating-up power may surely lead to oversizing the heat generator.

In the second method, the setback or disuse period is replaced by the temperature drop during setback. The other three parameters remain. From Table F.2 the estimated specific heating-up power can be read for a selection of the four parameters.

If the temperature drop during setback is unknown it can be estimated using formula F.1 in Annex F.

3. Once the specific heating-up power of a heated space is determined, it can be passed to «Heaty» –user input parameter q_hu–, which will calculate the additional heating-up power required for this heated space based on the floor area of the room.

4. When all heated spaces in the building entities and in the building are configured, the final heating-up power of the building entities and the building will also be determined at the same time by «Heaty».

4. USING «HEATY»

Climate data

The first thing to do when you begin a new project, is to set the climate data for the specific geographical location, by clicking the button «Set Climate Data...». A dialog appears in which three parameters must be set:

1. T_e_d = the external design temperature
2. T_e_an = the annual average external temperature
3. T_e_min = the average minimal external temperature during the coldest month

Building the hierarchical building structure

At startup there is only a building item visible in the tree view (on the right side of the main window):

– You can modify its name, by entering a name in the «Edit name» entry and pressing the Enter- or Return-key.

– You can add a building entity under the building, by entering a name for the building entity in the entry «Add building entity» and pressing the Enter- or Return-key.

- If you select the building entity in the tree view, another panel «Building Entity» will become visible at the left side of the main window, allowing you to edit the name of the building entity or to add a ventilation zone under the building entity. It is also possible to remove the building entity from the building by clicking the button «Delete Building Entity». This will remove the whole building entity including its children from the tree.

- To add a ventilation zone the building entity, enter a name for it in the entry «Add ventilation zone» and press the Enter- or Return-key.
  A dialog will appear in front of the main window, where you can enter the values for the user input parameters of the ventilation zone. Where possible reasonable default values are suggested according to EN 12831-1. If the «Submit»-button is clicked, the ventilation zone will be added to the tree under the building entity that was previously selected.

- When the ventilation zone is selected in the tree view, another panel «Ventilation Zone» now becomes visible at the left side of the main window. Within this panel there is a button that allows you to modify the currently selected ventilation zone, should you have made a mistake when setting the user input parameters. Another button allows you to remove the ventilation zone and all of its children from its building entity.

- In the same way as before, a heated space can be added to the ventilation zone. Enter a meaningful name for the heated space in the entry «Add heated space» and press the Enter- or Return-key.
  A dialog will appear in front of the main window, where you can enter the values for the user input parameters of the heated space and where you can define the building elements that enclose the heated space.

– To add a building element to a heated space, choose the appropriate tab and fill in the user input parameters. Click the «Add»-button to add the building element to the heated space. The added building elements are shown in a list. Should you have made a mistake when configuring one of the building elements, it can be selected in the list and deleted by clicking the «Delete»-button, which also removes it from the heated space. To re-add this building element without the mistake, it should be completely reconfigured first and then added again by clicking the «Add»-button.
When all building elements are added to the heated space and all user input parameters of the heated space are entered, you can click the «Submit»-button to add the heated space to the currently selected ventilation zone and the dialog will close.

– When you click a heated space in the tree view, another panel «Heated Space» will become visible on the left side of the main window. There you can change the name of the currently selected heated space, click the button «Modify Heated Space...» to go back to the input dialog, or click the button «Delete Heated Space» to remove it from the tree.

Project menu

From the project menu you can:

– start with a new project
– open an existing project
– save the current project
– export the current project as a CSV-file that can be opened in any spreadsheet program
– set your preferences
– leave the program

Preferences

When «Preferences» is selected in the project menu, a dialog comes up that allows you to change the default paths were projects and export files are stored and allows you to change the default units of the quantities that are used throughout the program.

Units

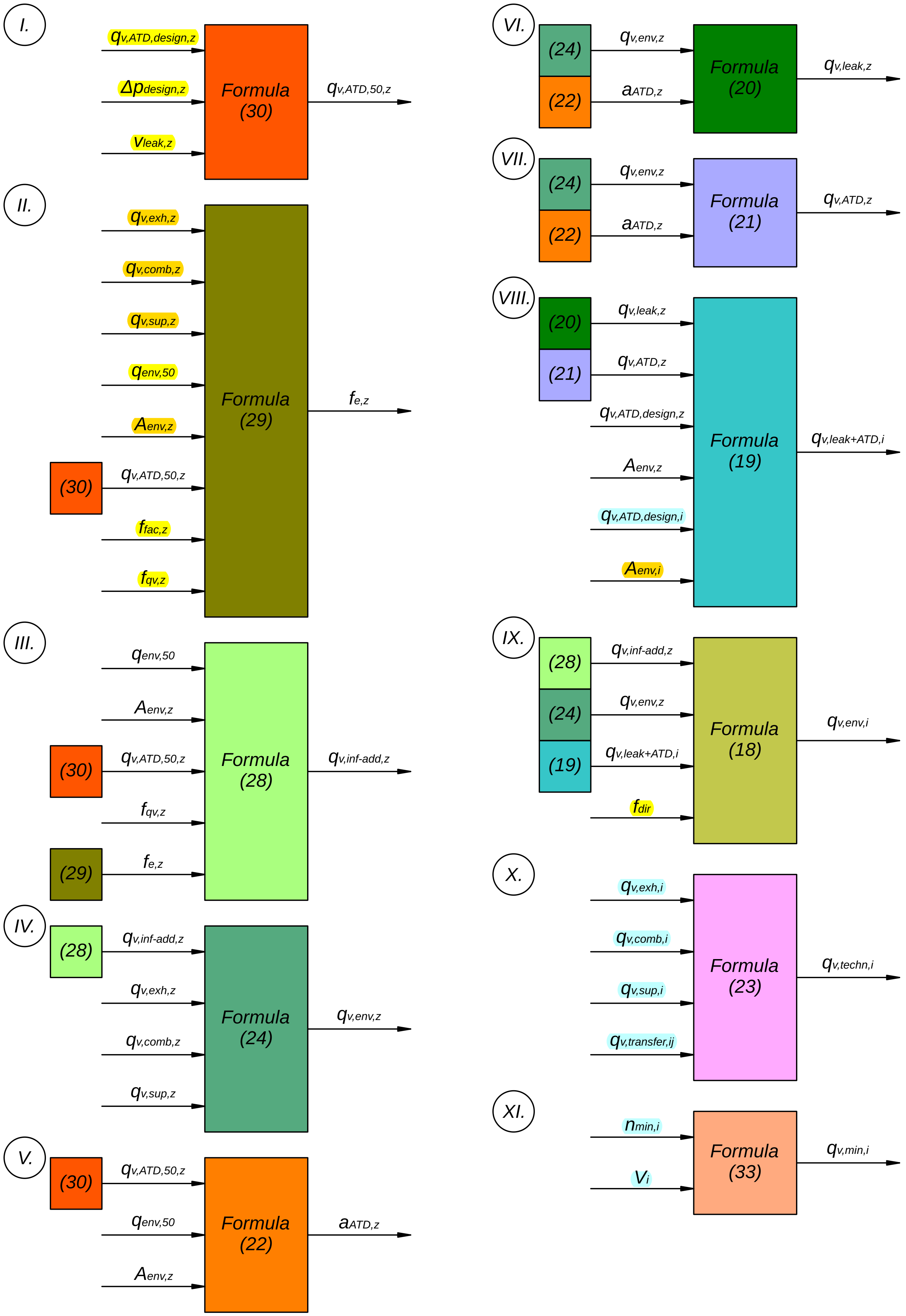
«Heaty» uses a software library called «Pint» for working with units. To keep things simple at the programming side, «Heaty» has retained the way in which units are entered in «Pint». The most important thing to notice is the power operator, which is indicated by `**`; e.g. m² is entered as `m ** 2`.

Besides using the default units that can be set under «Preferences», it is also possible to enter other equivalent units for the quantities in the input dialogs used for setting climate data, configuring a ventilation zone or heated space.

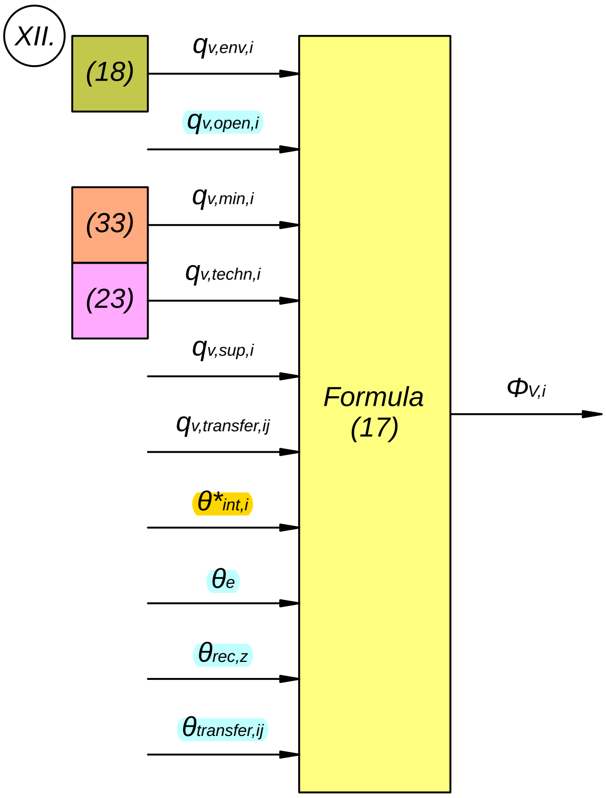
* * *

ANNEX A

Schematic overview of the calculation of the design ventilation heat loss of a heated space according to EN 12831-1, §6.3.3.3



ANNEX A


XII.
(18)
(33)
(23)
q v,env,i
q v,open,i
q v,min,i
q v,techn,i
q v,sup,i
q v,transfer,ij
θ* int,i
θ e
θ rec,z
θ transfer,ij
Formula (17)
Φ V,i

ANNEX A

Symbol	Meaning	Default values / Calculation
$q_{v,ATD,design,z}$	design air volume flow of the ATDs in the ventilation zone	Annex B.2.12
$\Delta p_{design,z}$	design pressure difference of the ATDs in the ventilation zone	Annex B.2.12
$v_{leak,z}$	pressure exponent	Annex B.2.13
$q_{v,ATD,50,z}$	air volume flow into the ventilation zone through ATDs @ 50 Pa	
$q_{v,exh,z}$	exhaust air volume flow from the ventilation zone	
$q_{v,comb,z}$	combustion air volume flow into the ventilation zone	
$q_{v,sup,z}$	supply air volume flow into the ventilation zone	
$q_{env,50}$	specific air permeability of the envelope @ 50 Pa	Annex B.2.10
$A_{env,z}$	envelope surface of the zone	
$f_{fac,z}$	adjustment factor for the number of exposed facades	Annex B.2.15
$f_{qv,z}$	volume flow factor	Annex B.2.11
$f_{e,z}$	adjustment factor taking into account the additional pressure difference due to unbalanced ventilation	
$q_{v,inf\text{-}add,z}$	air volume flow through additional infiltration into the ventilation zone	
$q_{v,env,z}$	external air volume flow into the ventilation zone through the building envelope	
$a_{ATD,z}$	ATD authority of the ATDs in the zone	
$q_{v,leak,z}$	external air volume flow into the ventilation zone through leakages	
$q_{v,ATD,z}$	external air volume flow into the ventilation zone through ATDs	
$q_{v,ATD,design,i}$	design air volume flow of the ATDs in the room	Annex B.2.12
$A_{env,i}$	envelope of the room	
$q_{v,leak+ATD,i}$	external air volume flow into the room through leakages and ATDs	
$f_{dir,z}$	orientation factor	Annex B.2.14
$q_{v,env,i}$	external air volume flow into the room through the envelope	
$q_{v,exh,i}$	exhaust air volume flow from the room	
$q_{v,comb,i}$	combustion air volume flow exhausted from the heated space	
$q_{v,sup,i}$	supply air volume flow of the room	
$q_{v,transfer,ij}$	transfer air volume flow into the room from an adjacent room	
$q_{v,techn,i}$	technical air volume flow of the room	
$n_{min,i}$	minimum air change rate of the room	Annex B.2.10
V_i	internal air volume of the room	
$q_{v,min,i}$	minimum air volume flow of the room	
$q_{v,open,i}$	external air volume flow through large openings in the building envelope for the room	Annex G
$\theta^*_{int,i}$	internal air temperature of the room	
θ_e	external design temperature	
$\theta_{rec,z}$	temperature of the supply air into the zone after passing heat recovery if any	
$\theta_{transfer,ij}$	temperature of the transfer air from an adjacent room into the room	
$\Phi_{V,i}$	ventilation heat loss of the room	