SLOVENSKI STANDARD
SIST EN 15242:2007

01-november-2007

Prezraļ evanje stavb - Raļ unske metode za doloļ itev zraļ nih tokov v stavbah, vkljuļ no z infiltracijo

Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration

Lüftung von Gebäuden - Berechnungsverfahren zur Bestimmung der Luftvolumenströme in Gebäuden einschließlich Infiltration

Ventilation des bâtiments - Méthodes de calcul pour la détermination des débits d'air y compris les infiltrations dans les bâtiments

Ta slovenski standard je istoveten z: EN 15242:2007

ICS:

91.140.30	Prezraļ evalni in klimatski sistemi	Ventilation and air-conditioning

SIST EN 15242:2007 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15242

May 2007

ICS 91.140.30

English Version

Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration

Ventilation des bâtiments - Méthodes de calcul pour la détermination des débits d'air y compris les infiltrations dans les bâtiments

Lüftung von Gebäuden - Berechnungsverfahren zur Bestimmung der Luftvolumenströme in Gebäuden einschließlich Infiltration

This European Standard was approved by CEN on 26 March 2007.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 15242:2007: E

Contents

Page

Foreword

This document (EN 15242:2007) has been prepared by Technical Committee CEN/TC 156 “Ventilation for buildings”, the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by November 2007, and conflicting national standards shall be withdrawn at the latest by November 2007.

This standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/343), and supports essential requirements of EU Directive 2002/91/EC on the energy performance of buildings (EPBD). It forms part of a series of standards aimed at European harmonisation of the methodology for the calculation of the energy performance of buildings. An overview of the whole set of standards is given in CEN/TR 15615, Explanation of the general relationship between various CEN standards and the Energy Performance of Buildings Directive (EPBD) ("Umbrella document").

Attention is drawn to the need for observance of relevant EU Directives transposed into national legal requirements. Existing national regulations with or without reference to national standards, may restrict for the time being the implementation of the European Standards mentioned in this report.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

This standard defines the way to calculate the airflows due to the ventilation system and infiltration. The relationships with some other standards are as follows:

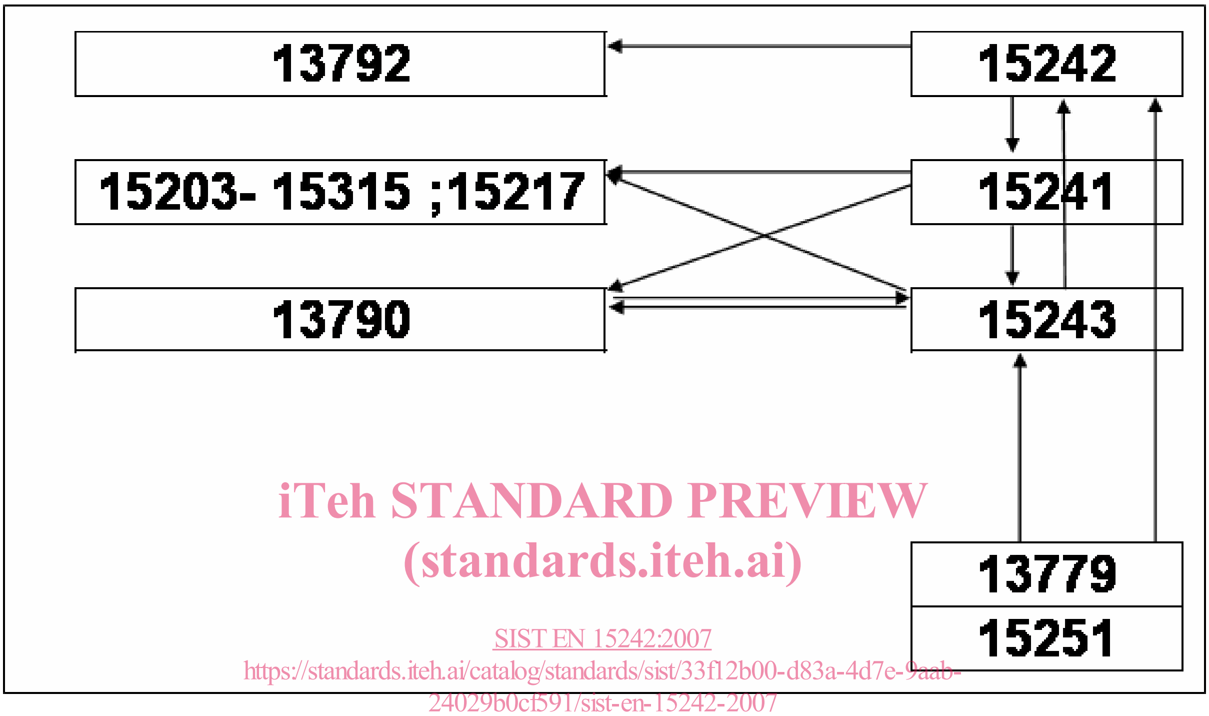


Figure 1 — scheme of relationship between standards

Table 1 — Relationship between standards

from	To	Information transferred	variables
15251	15243	Indoor climate requirements	Heating and cooling Set points
13779 15251	15242	Airflow requirement for comfort and health	Required supply and exhaust Air flows
15242	15241	Air flows	Air flows entering and leaving the building
15241	13792	Air flows	Air flow for summer comfort calculation
15241	15203- 15315 ;15217	energy	Energies per energy carrier for ventilation (fans, humidifying, precooling, pre heating), + heating and cooling for air systems
15241	13790	data for heating and cooling calculation	Temperatures, humilities and flows of air entering the building

15243	15243	Data for air systems	Required energies for heating and cooling
15243	15242	Data for air heating and cooling systems	Required airflows when of use
15243	13790	data for building heating and cooling calculation	Set point, emission efficiency, distribution recoverable losses, generation recoverable losses
13790	15243	Data for system calculation	Required energy for generation

EN titles are:

prEN 15217 *Energy performance of buildings — Methods for expressing energy performance and for energy certification of buildings*

prEN 15603 *Energy performance of buildings - Overall energy use and definition of energy ratings*

prEN 15243 *Ventilation for buildings — Calculation of room temperatures and of load and energy for buildings with room conditioning systems*

prEN ISO 13790 *Thermal performance of buildings — Calculation of energy use for space heating and cooling (ISO/DIS 13790:2005)*

EN 15242 *Ventilation for buildings — Calculation methods for the determination of air flow rates in buildings including infiltration*

EN 15241 *Ventilation for buildings — Calculation methods for energy losses due to ventilation and infiltration in commercial buildings*

EN 13779 *Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems*

EN 13792 *Colour coding of taps and valves for use in laboratories*

EN 15251 *Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*

The calculation of the airflows through the building envelope and the ventilation system for a given situation is first described (Clause 6). Applications depending on the intended uses are described in Clause 7.

The target audience of this standard is policy makers in the building regulation sector, software developers of building simulation tools, industrial and engineering companies.

1 Scope

This European Standard describes the method to calculate the ventilation air flow rates for buildings to be used for applications such as energy calculations, heat and cooling load calculation, summer comfort and indoor air quality evaluation.

The ventilation and air tightness requirements (as IAQ, heating and cooling, safety, fire protection…) are not part of the standard.

For these different applications, the same iterative method is used but the input parameter should be selected according to the field of application. For specific applications a direct calculation is also defined in this standard. A simplified approach is also allowed at national level following prescribed rules of implementation.

The method is meant to be applied to:

- Mechanically ventilated building (mechanical exhaust, mechanical supply or balanced system).
- Passive ducts.
- Hybrid system switching between mechanical and natural modes.
- Windows opening by manual operation for airing or summer comfort issues.

Automatic windows (or openings) are not directly considered here.

Industry process ventilation is out of the scope.

Kitchens where cooking is for immediate use are part of the standards (including restaurants..)

Other kitchens are not part of the standard.

The standard is not directly applicable for buildings higher than 100 m and rooms where vertical air temperature difference is higher than 15K.

The results provided by the standard are the building envelope flows either through leakages or purpose provided openings and the air flows due to the ventilation system, taking into account the product and system characteristics.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1507, *Ventilation for buildings — Sheet metal air ducts with rectangular section — Requirements for strength and leakage*

EN 1886, *Ventilation for buildings — Air handling units — Mechanical performance*

EN 12237, *Ventilation for buildings — Ductwork — Strength and leakage of circular sheet metal ducts*

EN 12792:2003, *Ventilation for buildings — Symbols, terminology and graphical symbols*

EN 13141-5, *Ventilation for buildings — Performance testing of components/products for residential ventilation — Part 5: Cowls and roof outlet terminal devices*

EN 13779, *Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems*

EN 14239, *Ventilation for buildings — Ductwork — Measurement of ductwork surface area*

EN 15251, *Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*

prEN 15255, *Thermal performance of buildings — Sensible room cooling load calculation — General criteria and validation procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12792:2003 and the following apply.

3.1
building height
height of the building from the entrance ground level to the roof top level

3.2
vertical duct
duct or shaft, including flue or chimney, which is mainly vertical and not closed

3.3
building envelope leakage
overall leakage airflow for a given test pressure difference across building

3.4
building volume
volume within internal outdoor walls of the purposely conditioned space of the building (or part of the building)

NOTE This generally includes neither the attic, nor the basement, nor any additional structural annex of the building.

3.5
building air temperature
average air temperature of the rooms in the occupied zone

3.6
iterative method
calculation method that requires a mathematical solver to solve an equation by iteration

3.7
direct method
calculation method that can be applied manually

3.8
vent (or opening)
opening intended to act as an air transfer device

3.9
reference wind speed at site
wind speed at site, at a height of 10 m, in undisturbed shielding conditions

NOTE 1 Shielding is accounted for in the wind pressure coefficients.

NOTE 2 In some countries, the reference wind speed is taken as equal to the meteo data available for the site. If not, an appropriate method to extrapolate from the meteo wind speed to the reference wind speed at site should be used (see Annex A).

3.10
shielding
effect classified according to the relative height, width and distance of relevant obstacle(s) in relation to the building

3.11
natural duct ventilation system
ventilation system where the air is moved by natural forces into the building through leakages (infiltration) and openings (ventilation), and leaves the building through leakages, openings, cowls or roof outlets including vertical ducts used for extraction

3.12
mechanical ventilation system
ventilation system where the air is supplied or extracted from the building or both by a fan and using exhaust air terminal devices, ducts and roof /wall outlets

NOTE In single exhaust mechanical systems, the air have entered the dwelling through externally mounted air transfer devices, windows and leakages

3.13
airing
natural air change by window opening

NOTE In this standard, only single sided ventilation effects are considered which means that the ventilation effect due to this window opening is considered to be independent of other open windows or additional ventilation system flows.

3.14
ventilation effectiveness
relation between the pollution concentrations in the supply air, the extract air and the indoor air in the breathing zone (within the occupied zone). It is defined as

$$\varepsilon_{\mathrm{v}} = \frac{c_{\mathrm{ETA}} - c_{\mathrm{SUP}}}{c_{\mathrm{IDA}} - c_{\mathrm{SUP}}}$$

where:

ε_{v} is the ventilation effectiveness

c_{ETA} is the pollution concentration in the extract air

c_{IDA} is the pollution concentration in the indoor air (breathing zone within the occupied zone)

c_{SUP} is the pollution concentration in the supply air

NOTE 1 The ventilation effectiveness depends on the air distribution and the kind and location of the air pollution sources in the space. It may therefore have different values for different pollutants. If there is complete mixing of air and pollutants, the ventilation effectiveness is one.

NOTE 2 Another term frequently used for the same concept is “contaminant removal effectiveness”.

3.15
hybrid ventilation
hybrid ventilation switches from natural mode to mechanical mode depending on its control

4 Symbols and abbreviations

Symbol	Unit	description
A	m²	area
Asf	ad	Airtightness split factor (default value or actual)
$C_{ductleak}$	ad	Coefficient taking into account lost air due to duct leakages
C_p	ad	wind pressure coefficient
C_{rec}	ad	Recirculation coefficient
C_{syst}	ad	coefficient taking into account the component and system design tolerances
C_{use}	ad	Coefficient taking into account the switching on and off of fans
C_{cont}	ad	coefficient depending on local air flow control
irp	Pa	Internal reference pressure in the zone
Osf		Opening split factor (default value or actual)
q_v(dP)	curve or formula	airflow/pressure difference characteristic
q_v (dP)	curve or formula	partial air openings for altitude (z), orientation (or), tilt angle (Tilt)
q_v 4Pa,n or n50,n	L/s or m^3/h	external envelope airtightness expressed as an airflow for a given pressure difference, exponent
q_v 4Pa,n or n50,n	L/s or m^3/h	partial air tightnesss for altitude (z), orientation (or), tilt angle (Tilt)
$q_{v\text{-exh}}$	L/s or m^3/h	exhaust air flow according to EN 13779 (not extract)
$q_{v\text{-exh -req}}$	L/s or m^3/h	required exhaust air flow
$q_{v\text{-sup}}$	L/s or m^3/h	Supply air flow
$Q_{v\text{-sup-req}}$	L/s or m^3/h	required outdoor air flow
θe	°C	external (outdoor) temperature
θi	°C	internal (indoor) temperature
ρair	kg/m^3	Air volumetric mass
ρair ref	kg/m^3	Air volumetric mass at reference temperature
T	K	Absolute temperature
v_{meteo}	m/s	wind as defined by meteo at 10 m height
v_{site}	m/s	wind at the building
z_o	m	depends on terrain class

Indices used in the documents

Index	Explanation	Index	Explanation
sup	Concerns supply air as defined in EN 13779	comb	Concerns combustion
exh	Concerns exhaust air as defined in EN 13779	comp	Concerns each component
req	“required” : values required to be achieved	inlet	Concerns each air inlet
leak	Values of the variable for leakages	passiveduct	Concerns passive duct
outdoorleak	Values of the variable for outdoor leakages	airing	Concerns airing through windows
AHUleak	Values of the variable for leakages in the Air Handling Unit (AHU)	stack	Concerns stack effect
ductleak	Values of the variable for leakages in ductwork	duct	Values of the variable for the duct
inf	Concerns infiltrations	wind	Values of the variable due to wind
diff	Difference between supply and exhaust	sw	Stack and wind
infred	Infiltration reduction		

5 General approach

The air flows are calculated for a building, or a zone in a building.

A building can be separated in different zones if:

— The different zones are related to different ventilation systems (e.g. one ventilation system is not connected to different zones).

— The zones can be considered as air flow independent (e.g. the air leakages between two adjacent zones are sufficiently low to be neglected, and there is no possibility of air transfer between two zones).

The most physical way to do the calculation is to consider the air mass (dry air) flow rate balance. Nevertheless it is also allowed to consider the volume flow rate balance when possible.

Cases where using the mass flow rate is mandatory are:

— air heating systems,

— air conditioning systems.

The formulas in Clause 6 and 7 are given for volume flow rates.

The input data are the ventilation system air flows and the airflows vs pressure characteristics of openings (vents) and leakages.

The output data are the airflows entering and leaving the building through

— Leakages,

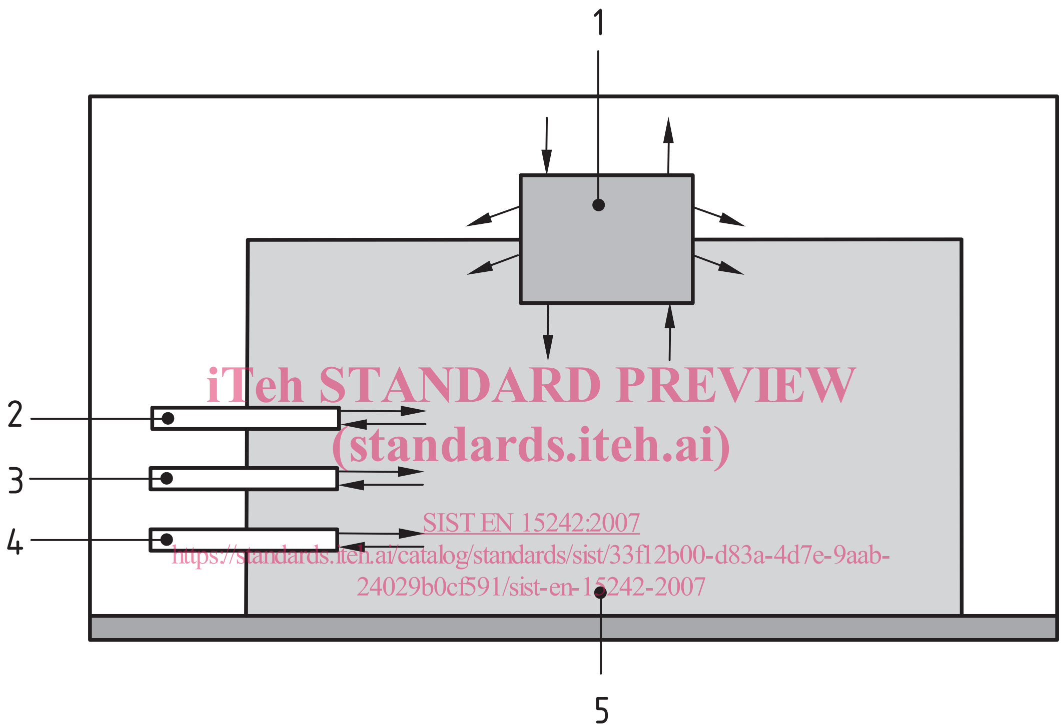
— Openings (vents…),

— Windows opening if taken into account separately,

— Ventilation system, including duct leakages.

Air entering the building/zone is counted positive (air leaving is counted negative).

The general scheme is shown in Figure 2:



Key

1 ventilation

2 window opening

3 opening

4 leakage

5 internal reference pressure

Figure 2 — General scheme of a building showing the different flows involved

The resolution scheme is as follows:

1. Establish the formulas giving the different air flows for a given internal reference pressure
2. Calculate the internal reference pressure *irp* balancing air flows in and air flow out
3. Calculate the air flows for this internal reference pressure

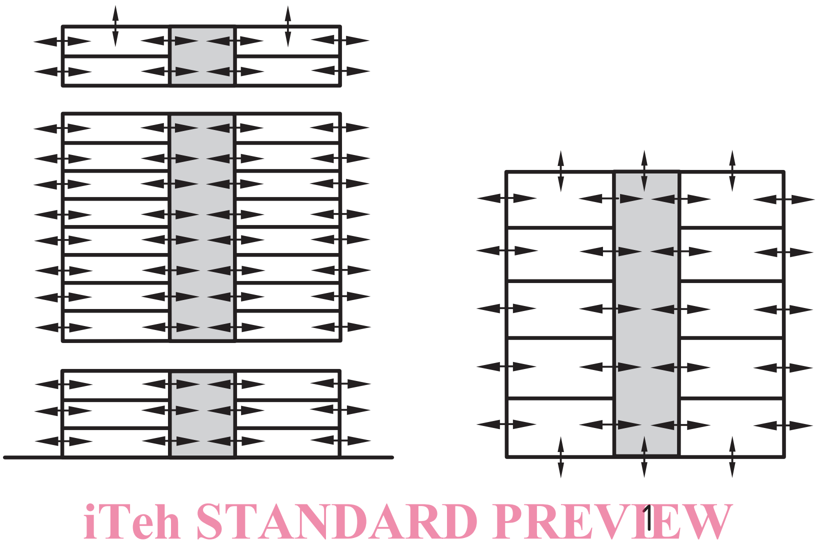
The internal partition of a building is based in general on the following:

i) divide the building between zones

Different zones are considered as having no, or negligible air flow between them

ii) Describe each zone as sub zones connected to a common connection sub zone (in general it will be the circulations and hall spaces) if necessary (a zone can be also only one room)

The general scheme (called afterwards the n+1 approach) is shown in Figure 3.



Key

1 map

Figure 3 — General scheme for air flow pattern description

This scheme is a simplification of the more general one taking into account all possible connections.

It can be furthermore simplified depending on the application (see application clauses).

6 Instantaneous calculation (iterative method)

6.1 Basis of the calculation method

An iterative method is used to calculate the air handling unit air flow, and air flow through envelope leakages and openings for a given situation of:

— Outdoor climate (wind and temperature),

— Indoor climate (temperature),

— System running.

This clause explains the different steps of calculation.

1. Calculation of mechanical ventilation

2. passive duct for residential and low size non-residential buildings

3. Calculation of infiltration/exfiltration

4. combustion air flow fire places both for residential and non residential if necessary. Combined exhaust for ventilation and heating appliance ? Laundry

5. Calculation of additional flow for window openings

6. Overall airflow

6.2 Mechanical air flow calculation

6.2.1 Introduction

The ventilation is based on required air flow (either supplied or extract in each room) which is defined at national level, assuming in general perfect mixing of the air.

To pass from these values to the central fan, the following coefficients (and impacts) shall be taken into account:

1) C_{use}: coefficient corresponding to switching on (C_{use}=1) or off (C_{use}=0) the fan

2) ε_V: local ventilation efficiency

3) C_{cont}: coefficient depending on local air flow control

4) C_{syst}: coefficient depending on inaccuracies of the components and system (adjustment…etc)

5) C_{leak}: due to duct and AHU leakages

6) C_{rec}: recirculation coefficient, mainly for VAV system

6.2.2 Required air flow $q_{v\text{-}sup\text{-}req}$ and $q_{v\text{-}exh\text{-}req}$

For each room, $q_{v\text{-}sup\text{-}req}$ and $q_{v\text{-}exh\text{-}req}$ are respectively the air flow to be provided or exhausted according to the building design, and national regulations.

6.2.3 C_{use} coefficient

This coefficient simply describes the fact of switching on-off the fan (or eventually different level from design one).

It is related to health and energy issues, and to the building or room occupation and occupant behaviour. For health issues, and for building where ventilation can be stopped or reduced during unoccupied periods, it is recommended (and can be mandatory at national level), to start the ventilation before the start of the occupancy period in order to purge the building, and to keep it for some time and the beginning of the unoccupied period. For energy issues, it can be useful to keep the ventilation during unoccupied period (night cooling) if it is energy efficient.

6.2.4 Ventilation effectiveness ε_V

It is related to the concentration in the extract air, and the one in the breathing zone.

For efficient system ε_V can be higher than 1.

In case of short circuit system ε_V can be lower than 1.