SLOVENSKI STANDARD
SIST EN 1745:2012

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Zidovje in zidarski proizvodi - Metode za določanje projektnih (računskih) toplotnih lastnosti

Masonry and masonry products - Methods for determining thermal properties

Mauerwerk und Mauerwerksprodukte - Verfahren zur Bestimmung von wärmeschutztechnischen Eigenschaften

Maçonnerie et éléments de maçonnerie - Méthodes pour la détermination des propriétés thermiques

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ICS:

91.080.30	Zidane konstrukcije	Masonry
91.120.10	Toplotna izolacija stavb	Thermal insulation

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Masonry and masonry products - Methods for determining thermal properties

Maçonnerie et éléments de maçonnerie - Méthodes pour la détermination des propriétés thermiques

Mauerwerk und Mauerwerksprodukte - Verfahren zur Bestimmung von wärmeschutztechnischen Eigenschaften

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (EN 1745:2012) has been prepared by Technical Committee CEN/TC 125 “Masonry”, 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of an identical text or by endorsement, at the latest by October 2012, and conflicting national standards shall be withdrawn at the latest by October 2012.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 1745:2002.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

The following is a list of significant technical changes since the last edition:

— addition of Figure 1 to show the procedures and calculation possibilities;

— editorial improvement;

— extension of Annex B;

— adaption of Annex E;

— addition of Annex F;

— deletion of Annex ZA.

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, Croatia, 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, Turkey and the United Kingdom.

Introduction

This European Standard provides rules for the determination of dry and design thermal conductivity and thermal resistance values of masonry products and masonry.

It describes how dry thermal values are determined. It also describes the correction methods to derive design values from a dry value. The dry value is a characteristic of a masonry material, masonry unit or of masonry. On the basis of dry thermal conductivity values determination methods of design thermal values are given.

Three procedures (model S1 – S3) for the determination of dry thermal conductivity ($\lambda_{10,dry,unit}$) of solid masonry units are described and five procedures (model P1 – P5) for the determination of equivalent dry thermal conductivity ($\lambda_{10,dry,unit}$) of masonry units with formed voids and composite masonry units are described, see Figure 1.

For mortars according to EN 998-1 and EN 998-2, the models S1 – S2 can be used.

Additionally three procedures for the determination of thermal resistance are described. These procedures are:

— the use of tabulated *R*-values;

— the measurement of *R*-value;

— the numerical calculation of *R*-value.

The following major types of masonry units are covered by this European Standard:

— solid masonry units;

— masonry units with formed voids;

— composite masonry units.

In Figure 1, the different models and procedures are illustrated.

The design value of a product characteristic is the value determined for a specific application and for use in calculations.

Design thermal values are determined, according to the procedure given in this European Standard according to the intended application, environmental and climatic conditions, bearing in mind the purpose of this determination, such as:

— energy consumption;

— design of heating and cooling equipment;

— surface temperature determination;

— compliance with national building regulations;

— consideration of non-steady state thermal conditions in buildings.

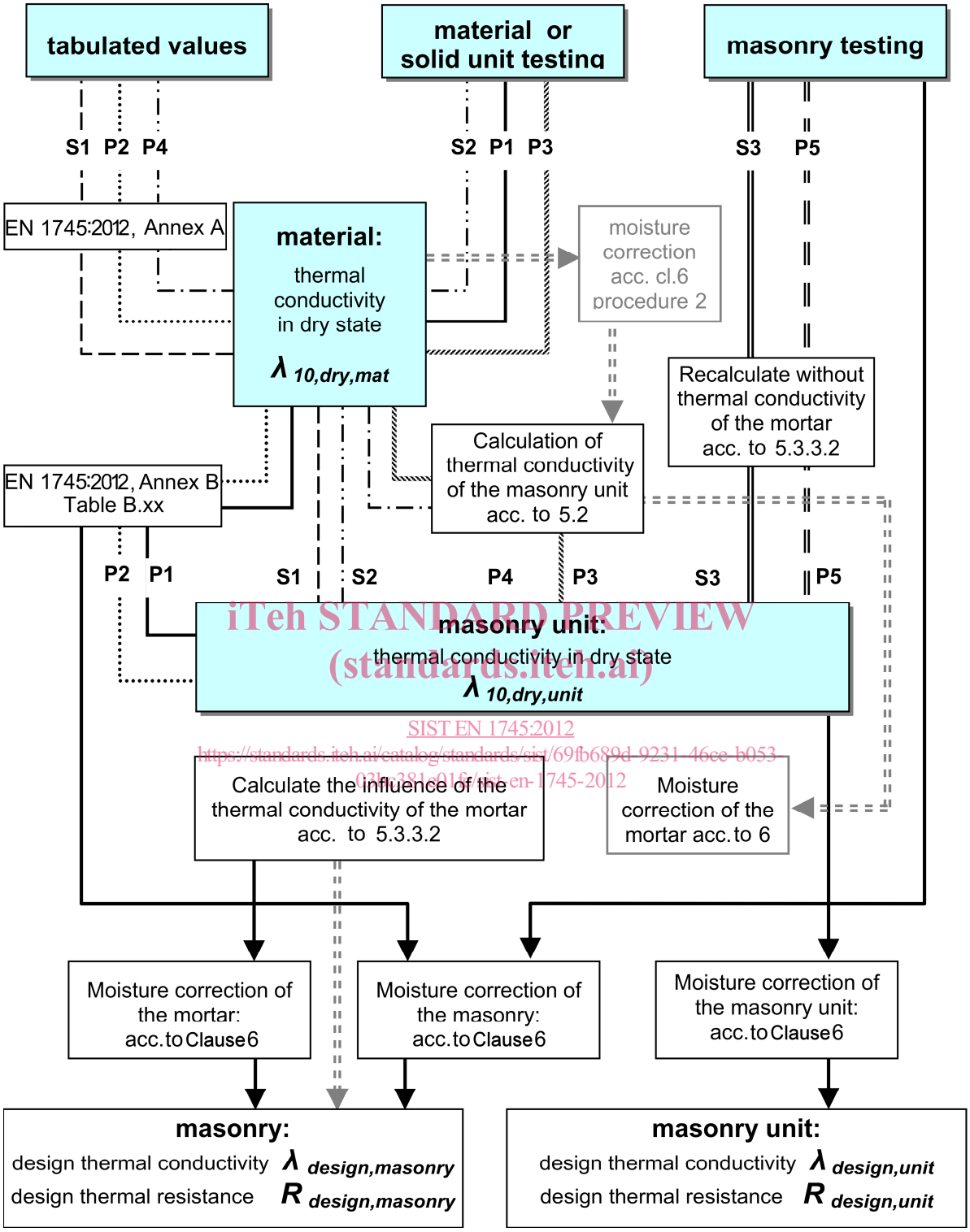


Figure 1 — Determination of thermal properties of masonry units and masonry

1 Scope

This European Standard specifies procedures for the determination of thermal properties of masonry and masonry products.

2 Normative references

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

EN 772-4, *Methods of test for masonry units — Part 4: Determination of real and bulk density and of total and open porosity for natural stone masonry units*

EN 772-13, *Methods of test for masonry units — Part 13: Determination of net and gross dry density of masonry units (except for natural stone)*

EN 1015-10, *Methods of test for mortar for masonry — Part 10: Determination of dry bulk density of hardened mortar*

EN 1934, *Thermal performance of buildings — Determination of thermal resistance by hot box method using heat flow meter — Masonry*

EN 1936, *Natural stone test methods — Determination of real density and apparent density, and of total and open porosity*

EN 12664, *Thermal performances of building materials and products — Determination of thermal resistance by means of guarded hot plate and heat flow meter methods — Dry and moist products of medium and low thermal resistance*

EN ISO 6946:2007, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method (ISO 6946:2007)*

EN ISO 7345:1995, *Thermal insulation — Physical quantities and definitions (ISO 7345:1987)*

EN ISO 10211, *Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations (ISO 10211)*

EN ISO 10456, *Building materials and products — Hydrothermal properties — Tabulated design values and procedures for determining declared and design thermal values (ISO 10456)*

3 Terms, definitions and symbols

For the purposes of this document, the following terms, definitions and symbols and those given in EN ISO 7345:1995 apply.

3.1 Terms and definitions

3.1.1
masonry
assemblage of masonry units laid in a specified pattern and joined together with masonry mortar

3.1.2
masonry product
masonry units, masonry mortars, rendering and plastering mortars

3.1.3
solid masonry unit
masonry unit containing no perforations except external indentations such as grip holes, grooves, etc.

3.1.4
masonry unit with formed voids
masonry unit with a system of intentionally formed voids

3.1.5
composite masonry unit
masonry unit incorporating one or more layers of additional material to enhance performance

3.1.6
thermal value
common term for either the thermal conductivity [W/(m·K)] or the thermal resistance [m^2·K/W]

3.1.7
dry state
state after drying under conditions stated in the relevant standards

3.1.8
dry thermal value
value of a thermal property of a building material or product in a dry state determined according to this European Standard as a basis for the calculation of design thermal values

Note 1 to entry: The dry thermal value can be expressed as thermal conductivity or thermal resistance.

3.1.9
design thermal value
value of a thermal property of a building material or product under specific external and internal conditions which can be considered as typical of the performance of that material or product when incorporated in a building component or building

3.1.10
masonry thermal conductivity
value which is derived by dividing the thickness of a given masonry element by its thermal resistance excluding surface resistance

3.1.11
reference conditions
set of conditions identifying a state of equilibrium selected as the base to which the thermal values of building materials and products are referred

3.1.12
equivalent thermal conductivity
value derived by dividing the width of a masonry unit with formed voids or a composite masonry unit or masonry by its thermal resistance excluding surface resistance

3.2 Symbols

The order of the indices for thermal values is temperature, condition and subject

Symbol	Quantity	Unit
$\lambda_{10,dry,mat}$	thermal conductivity at an average temperature of 10 °C in dry state for the material	W/(m·K)
$\lambda_{10,dry,mas}$	thermal conductivity at an average temperature of 10 °C in dry state for the masonry	W/(m·K)
$\lambda_{10,dry,mor}$	thermal conductivity at an average temperature of 10 °C in dry state for the mortar	W/(m·K)
$\lambda_{10,dry,unit}$	thermal conductivity at an average temperature of 10 °C in dry state for the unit. For solid units the $\lambda_{10,dry,\ unit}$ is the same as $\lambda_{10,dry,\ mat}$ and for units with formed voids and composite units the $\lambda_{10,dry,\ unit}$ is the equivalent thermal conductivity.	W/(m·K)
$\lambda_{design,mas}$	design thermal conductivity for the masonry	W/(m·K)
$\lambda_{design,mor}$	design thermal conductivity for the mortar	W/(m·K)
$\lambda_{design,unit}$	design thermal conductivity for the unit	W/(m·K)
λ_i	individual measured or calculated thermal conductivity	W/(m·K)
R_i	individual measured thermal resistance	m^2·K/W
$R_{dry,mas}$	thermal resistance of masonry	m^2·K/W
$R_{design,mas}$	design thermal resistance of masonry	m^2·K/W
R_{si}, R_{se}	internal and external surface resistance	m^2·K/W
$R_{t,mas}$	the true thermal resistance of the masonry	m^2·K/W
a_{mor}	percentage area of mortar joint in the measured masonry	%
a_{unit}	percentage area of units in the measured masonry	%
d	thickness of the masonry	m
T	temperature	K
μ	water vapour diffusion coefficient	
c_p	specific heat capacity	J/(kg·K)
l	length of a masonry unit	mm
w	width of a masonry unit	mm
h_{unit}	height of a masonry unit	mm

h_{mor}	thickness of a mortar joint	mm
F_m	moisture conversion factor	
f_u	moisture conversion coefficient by mass	kg/kg
f_ψ	moisture conversion coefficient by volume	m^3/m^3
u	moisture content mass by mass	kg/kg
ψ	moisture content volume by volume	m^3/m^3
$U_{10,dry,mas}$	thermal transmittance of the masonry in dry state	$W/(m^2 \cdot K)$
U_{mas}	thermal transmittance of the masonry	$W/(m^2 \cdot K)$
U_{mor}	thermal transmittance of the mortar	$W/(m^2 \cdot K)$
U_{unit}	thermal transmittance of the units	$W/(m^2 \cdot K)$
P	fractile of population	%
$\rho_{g,dry}$	gross dry density	kg/m^3
$\rho_{n,dry}$	net dry density	kg/m^3
v	percentage of voids	%

3.3 Subscripts

10	average test temperature of 10 °C
dry	state after drying under conventional conditions as stated in the relevant standards
mas	masonry
mat	material
mor	mortar
unit	masonry unit

4 Procedures to determine $\lambda_{10,dry,\ unit}$-values for solid masonry units and $\lambda_{10,dry,mor}$-values for mortars

4.1 General

$\lambda_{10,dry,unit}$-values for solid masonry units and $\lambda_{10,dry,mor}$-values for mortars are identical to the $\lambda_{10,dry,mat}$-values. The $\lambda_{10,dry,mat}$-values of solid masonry units and of mortars can be determined from tests carried out on samples of the material or from tables or graphs which relate $\lambda_{10,dry,mat}$ to density or from determining the thermal transmittance (U_{mas}) of masonry built from masonry units and mortar. In all cases the $\lambda_{10,dry,mat}$-value is to be representative of the material.

4.2 $\lambda_{10,dry,\ mat}$-values for solid masonry units and mortars

4.2.1 Model S1. Determination of $\lambda_{10,dry,unit}$-values from tabulated $\lambda_{10,dry,mat}$/net dry density relation

Tabulated $\lambda_{10,dry,mat}$-values for different materials used for masonry products are given in Annex A, differentiated by material and dry density. This annex also contains values for the water vapour diffusion coefficient, the specific heat capacity and the moisture conversion coefficient.

These tabulated values are valid for materials where there is factory production control of the net dry density but no directly measured λ-values. $\lambda_{10,dry,mat}$ - values are given as 50 % and 90 % fractiles (P).

4.2.2 Model S2. Determination of $\lambda_{10,dry,unit}$-values based on $\lambda_{10,dry,mat}$/net dry density curve

4.2.2.1 General

To determine a $\lambda_{10,dry,mat}$-value from a $\lambda_{10,dry,mat}$/net dry density relationship the following procedure shall be used:

4.2.2.2 Test specimens

Test specimens shall be in accordance with the requirements of EN 12664. Care should be taken that the test specimens are representative of the masonry product itself.

NOTE An appropriate way to ensure this is to cut specimens from masonry units.

4.2.2.3 Conditioning of specimens

Normally masonry materials are tested in a dry condition. It is also possible to carry out tests in a moist condition (e.g. conditioned to constant mass in an environment of (23 ± 2) °C and 50 % ± 5 % relative humidity), in which case the measured value has to be converted to the dry state following one of the procedures given in Clause 6.

4.2.2.4 Test measurement

The reference test method is given in EN 12664. The test shall be carried out at a mean temperature of 10 °C.

Alternative test methods, which may require different test specimens and different conditioning methods, may be used, if the correlation between the reference test method and the alternative method can be given.

4.2.2.5 Establishing a product related $\lambda_{10,dry,mat}$ /net dry density-curve

Three items of information are necessary for this determination procedure:

1) the tabulated $\lambda_{10,dry,mat}$ /net dry density-correlation for the given material (see Annex A);

2) the product net dry density range, which can be derived either from the production history or from the net dry density tolerances which are given in the relevant product standards;

3) at least three individual test measurements of the net dry density and λ_i , on material which is representative for the current material produced. The measurements of net dry density and λ shall be carried out on the same specimens. The three tests have to be carried out on specimens from different production batches to represent the manufactured product net dry density range. These three measurements are used to determine the distance of the individual $\lambda_{10,dry,mat}$ /net dry density-curve, for a defined production, from the tabulated $\lambda_{10,dry,mat}$ /net dry density curve.

Determine the measured λ_i-value as prescribed in 4.2.2.1 to 4.2.2.3 and calculate the arithmetic mean value of the 3 λ_i -results.

Measure the net dry density of each of the three samples following the procedure prescribed in EN 772-4 or EN 772-13 or EN 1015-10 and calculate the arithmetic mean value of the 3 results.

Then use the following procedure.

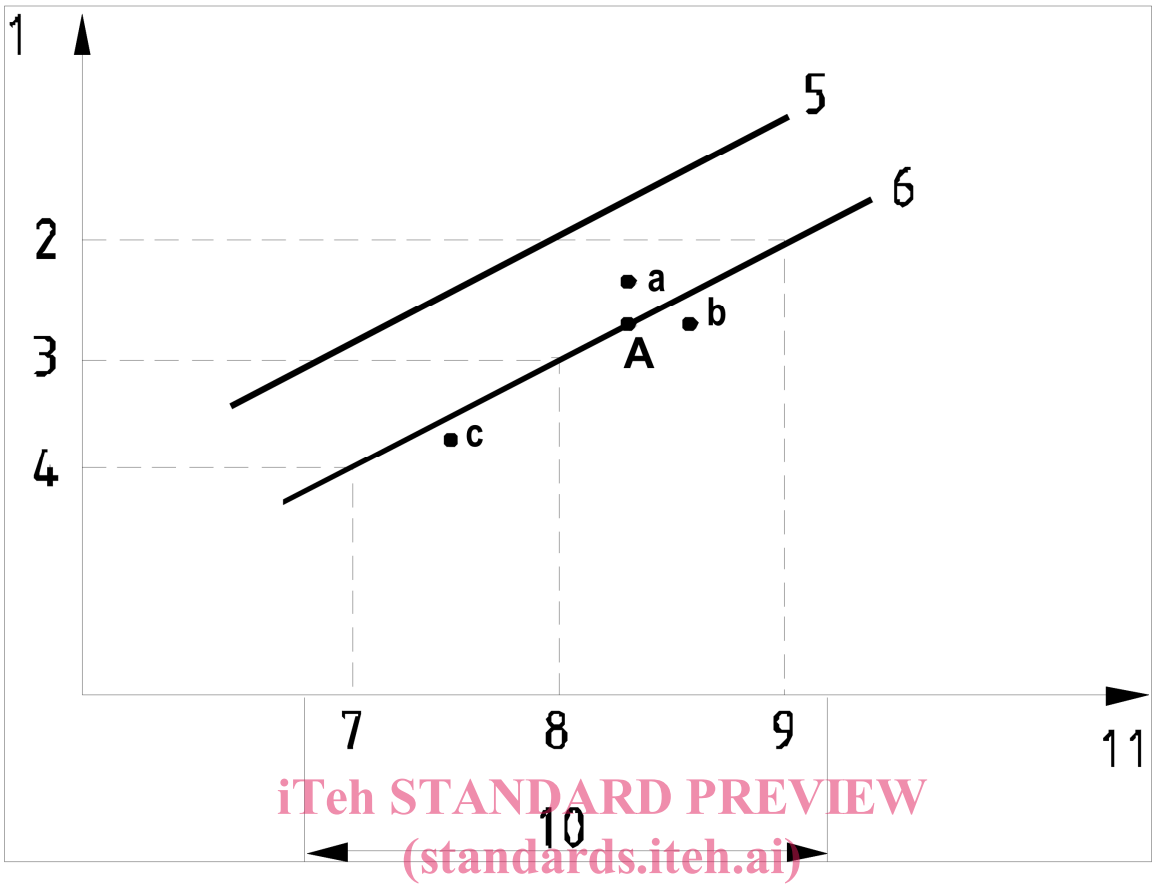
Through the point A representing mean thermal conductivity and mean net dry density draw a λ/net dry density-curve parallel to the general $\lambda_{10,dry,mat}$ /net dry density-curve obtained from plotting the tabulated λ- and net dry density-values for the product (material) given in Annex A.

Derive the mean λ-value of the product from the average net dry density. Derive the upper and lower limit values as the values that represent 90 % and 10 % of the manufactured product under consideration density range with a confidence level of 90 % according to EN ISO 10456.

Use the product related $\lambda_{10,dry, mat}$ /net dry density-curve to determine the $\lambda_{10,dry,mat}$-value related to the mean net dry density the manufacturer is confident to achieve.

Express the $\lambda_{10,dry,unit}$-values for solid masonry units or the $\lambda_{10,dry\ mor}$-values for mortars as the mean $\lambda_{10,dry\ mat}$-value together with the difference between the limit and the mean value.

Figure 2 shows this process in the form of a graph.



Key

1 $\lambda_{,10,dry,mat}$ (W/m·K)
2 upper limit λ value
3 mean λ value
4 lower limit λ value
5 curve resulting from tabulated values (Annex A)
6 parallel curve drawn through point A (mean of the single values a, b, c)
7 10 % of production of the product under consideration
8 mean net dry density
9 90 % of production of the product under consideration
10 product density range
11 net dry density (kg/m^3)

Figure 2 — Derivation of the material $\lambda_{10,dry,mat}$-value

NOTE For factory production control purposes thermal conductivity may be controlled from the net dry density of the material, see Annex E.

4.2.3 Model S3. Procedures to determine $\lambda_{10,dry,unit}$-values from determining the thermal transmittance (U_{mas}) of masonry built from solid masonry units and mortar

To determine a $\lambda_{10,dry\ unit}$-values from test measurements of the thermal transmittance of masonry built from masonry units and mortars, the procedure in 5.3.3 shall be used.