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Quantitative criteria for the prevention of packaging – an alternative to the European standard EN 13428

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Contents

1 INTRODUCTION

The objective of this study is to critically analyse the existing European standard EN 13428:2004 "Packaging - Requirements specific to manufacturing and composition, Prevention by source reduction" and to supplement it with verifiable quantitative criteria for source reduction.

The insufficiency of the draft standard at that time was already ascertained in the course of a study commissioned by the Austrian Ministry of the Environment in 1999 and an alternative model was worked out. This has now been further developed and checked by assessing numerous product packages from several areas for suitability in practice.

The currently valid standard will be explained briefly in the following and its weaknesses described. When doing this, we will only consider the aspects concerning the minimisation of weight and/or volume of packages. The treatment of chemical substances will not be considered. The proposed alternative will be supplemented by several annexes that explain and illustrate the procedure. Additionally photographic documentation has been prepared containing approx. 60 products from several European countries, which shows that the proposed method provides good results and that the introduction of quantitative restrictions for packaging is possible and useful.

2 STANDARD: EN 13428: 2004

The standard **EN 13428:2004 "Packaging – Specific requirements for the production and composition / source reduction and packaging reduction"** lays down provisions for the most economical use of packaging materials. This, together with four other standards, must be applied in the context of the standard EN 13427.

The standard is based on an assessment and provides instructions for its implementation. Basically, this procedure resembles that of the standard groups EN ISO 9000 and EN ISO 14000.

The individual or organization placing a packaging on the market should be able to demonstrate that the criteria specified for the packaging are complied with using a minimum of packaging weight or packaging volume while safeguarding

- functionality of the entire distribution chain
- safety and hygiene for products and consumers
- acceptance by consumers.

"Prevention by source reduction" is defined as follows:
Process for the achievement of a minimum adequate weight and/or volume for identical requirements, of primary, secondary and/or tertiary packaging, when performance and user acceptability remain unchanged and/or adequate, thereby minimizing the impact on the environment.

The following required performance criteria for packaging that basically are of equal importance are identified as:

- *product protection*
- *packaging manufacturing process*
- *packing/filling process*
- *logistics (including transport, warehousing and handling)*
- *product presentation and marketing*
- *consumer/user acceptance*
- *information*
- safety
- *legislation*
- other issues.

The assessment should state for each relevant criterion whether this is a so-called "critical area", which means that no reduction of the packaging weight and/or packaging volume is possible under this criterion. If no critical area has been identified, it is assumed that there may be potential for further reduction at source.

The priority ranking of the performance criteria and the evaluation of a criterion as "critical area" shall be the task of the individual or organization placing the packaging on the market.

2.1 Critical review of the standard

A critical review of the standard is called for inasmuch as many criteria (e.g.: product presentation and marketing, manufacturing method for packaging) laid down by the individual or organization placing the packaging on the market as the purposes of packaging are given priority over the reduction of packaging weight and/or packaging volume

Under the assessment procedure, as soon as all requirements - even the subjective ones - with respect to packaging have been complied with, it is determined whether the sum total of all requirements could have been achieved with a reduced resource input.

The requirements concerning packaging primarily identified by the individuals or organizations placing the packaging on the market are not questioned at all.

The standard EN 13428:2004 assumes that a short evaluation of the packaging weight /packaging volume is carried out only after all (more or less important and partly also subjective) criteria of the individual or organization placing the packaging on the market have been complied with. For this reason, reduction at source ranks below all (even subjective) performance criteria in the hierarchy of priorities.

For example, the criteria of marketing and product presentation, too, are ranked above source reduction. Thus, it would be possible to place deceptive packaging units on the market, without infringing the standard, by emphasizing the subjective importance of product presentation.

The procedures taken from the standard series EN ISO 9000 ff and EN ISO 14000 are unsuitable for achieving verifiable results towards packaging reduction. These standard series were developed to document processes and, if necessary, identify weak points of such processes. However, in the present case it is less important to ascertain which process was used to develop a specific packaging than to render transparent in how far a packaging corresponds to the requirements of the EU Packaging Directive for minimum material input.

2.2 Suggestions for improvement of the existing standard

In the proposed alternative, an additional limit value will be introduced into the existing assessment for the ratio between the packaging surface and product volume. This limit value may only be exceeded in specially justified cases.

Packaging is used in most diverse areas of application. This diversity in all its variations cannot be fully overseen or regulated. For this reason, the assessment procedure is upheld despite its weaknesses. It is, however, complemented by a measurable and verifiable limit.

This limit is calculated to ensure that the overwhelming number of packages will be below this value and hence can be covered by the assessment procedure.

The task of the limit value is to enable an objective assessment for determining whether or not a packaging is exaggerated. Yet, the limit value can also be exceeded if special technical or practical justifications apply, which cannot be excluded or might possibly even be necessary for the following cases:

- Products with special protection requirements (e.g. delicate electronic appliances, glassware, hazardous substances),
- If it was the only way to comply with the statutory provisions
- If it was the only way to guarantee the safety of the consumer and the carrier

Furthermore, attention has also been paid to special geometrical shapes of the goods to be packed by calculating an individual limit. In the case of flat products that have very small volume (e.g. single sheets of paper) and very long products (e.g.: curtain rails), it is not possible to comply with the prescribed limit. In these cases, appropriate exceptions are provided. Even in the case of extremely small products, a minimum amount of area for information and handleability will be permitted primarily for products sold in self-service shops.

If the defined limit value is exceeded, the possibility of subjective evaluation is therefore largely eliminated; only the legal and technical performance criteria should apply.

Packaging that exceeds this limit is only deemed to be in compliance with the standard if there was no other way:

- to protect the contents,
- to comply with the statutory provisions
and/or
- to guarantee safety.

3 PROPOSED ALTERNATIVE TO THE STANDARD[1]

The proposed alternative consists of the existing standard and will be supplemented by the following models:

3.1 Ratio of packaging surface to the product volume and limit to be complied with

The ratio of the packaging surface to the volume of the contents is calculated according to formula (1):

$$\textbf{Factor (1)} = \frac{\sqrt[2]{surface\ of\ packaging\ [cm^2]}}{\sqrt[3]{volume\ of\ packed\ goods\ [cm^3]}} \qquad \text{Formula (1)}$$

The limit for factor (1) is 3.2.

Factor (1) = 3.2

The calculation of the packaging surface is described in section 3.1.2, and the calculation of the product volume in section 3.1.3.

The following procedures are to be applied for all dimensions and calculations: Dimensions must be made to exactly 0.1 cm. A minimum dimension of 0.1 cm is assumed for calculating the volume of very flat articles. Calculations must be made to 2 decimal places exactly.

A simple correlation between volume of packed goods and external volume of packaging would not take account of the geometrical specifics. The formula selected can thus be equally applied to all packaging sizes. Exceptions are necessary for a few product shapes and have already been planned. (See 3.2).

The following example shows how the surface/volume ratio changes with different packaging sizes whereas basic proportions remain the same. With unchanged proportions, the proposed formula always produces the same results, irrespective of the packaging size. This ensures a wide field of application irrespective of packaging size.

[1] *The small text passages in italics are explanations concerning the text intended for a standard draft.*

Example:	*Product 1*	*Product 2*
*Dimensions of packaging L * W * H*	*10 cm * 10 cm * 8 cm*	*50 cm * 50 cm * 40 cm*
Surface of packaging	*520 cm^2*	*13,000 cm^2*
Volume of packaging	*800 cm^3*	*100,000 cm^3*
*Dimensions of packed goods L * W * H*	*8 cm * 8 cm * 6 cm*	*40 cm * 40 cm * 30 cm*
Volume of packed goods	*384 cm^3*	*48,000 cm^3*
Ratio surface/volume	*1.35*	*0.27*
Factor (1) according to *formula (1)*	*3.137*	*3.137*

*Examples show (see **annex A**: Examples) that the selected limit of 3.2 for the ratio between volume of contents / packaging surface is complied with by a large number of products.*
Wherever special protection of the contents is required, the additional packaging input must be justified in detail on a case-by-case basis.

The objective of the limit is to help avoid particularly lavish and (from a technical viewpoint) uselessly voluminous packaging (with large empty spaces inside). Moreover, suitable geometrical shapes are to be encouraged (e.g. yoghurt cups instead of flat bowls).

The formula selected favours shapes with surfaces as small as possible, which therefore also permit the economical use of packaging materials. The ratio between volume of packaging/volume of packed good does not produce these effects. Moreover, using the packaging volume as a comparative value would not take account of those parts of packaging that do not enclose any volumes, such as e.g. the cardboard backs of blister packaging units, folds, flanges, etc.

3.1.1 Distinctions between product and packaging

The following distinctions must be taken into account for the calculation of the factor (1):

- All additional articles packed with the main product (e.g.: manuals, spare parts) belong to the product and must be included in the calculation of the product volume.
- Components necessary for using the product (e.g.: metering devices, spice grinders, mascara brushes) belong to the product.
- In the case of *secondary packaging*[2] *or group packaging,* the sum total of the individual volumes of all *primary or sales packaging* is the criterion.

[2] The definitions of primary, secondary and repackaging can be referred to in the packaging directive: "Directive 94/62/EG of the European Parliament and Council of the 20th December 1994 on Packaging and Packaging Waste".

- In the case of *tertiary packaging or transport packaging* the sum total of the individual volumes of all *secondary packaging* or *group packaging* is the criterion.

Examples for these distinctions are ***given*** *in the* ***Annex B: Distinction between Product – Packaging***

3.1.2 Calculation of the packaging surface

When calculating the packaging surface, the surface of the outermost packaging must be used and calculated as exactly as possible. Since packaging corresponds to geometrical objects in most cases (e.g.: cuboids, cylinders), it is easy to be able to make an exact calculation.
In the case of complicated geometrical shapes, the entire surface is reduced to simple geometrical shapes, the individual surfaces are calculated and then added together. In this process, curves, small layers and unevenness on the surface (e.g.: burls, corrugations) can be approximated by means of geometrical shapes.

If there is any doubt about the compliance of the prescribed limit due to simplification of the surface, then the exact surface must be determined.

There are 2 distinctions between **packagings with openings**:

1. Only the product is behind the opening:
   If the product alone is behind the opening, then the surface of the window is not included in the calculation of the packaging surface.
2. There is more packaging behind the opening:
   If there is more packaging of the product behind the opening (e.g.: a bottle with liquid), then the surface of the window is included in the calculation of the packaging surface. The packaging surface that is behind it is not included in the calculation.

Calculation of **two-dimensional parts of packagings:**

In the case of parts of packaging units that do not contain any volume (e.g.: cardboard box for blister packaging units, flanges, folds, etc.), only the single surface (not front and back) is referred to for calculating the surface.

Examples for the calculation of the surface and special regulations are given in

Annex C: **Calculation of the Packaging Surface**

3.1.3 Calculation of the product volume

We must distinguish between piece goods and bulk goods when calculating volume.

Allocation to piece goods or bulk goods is always carried out based on the condition of the product at the time of sale e.g.: poured, sorted, jigsaw puzzle in pieces, kit consisting of component parts and not combined).

Distinctions between piece goods and bulk goods:

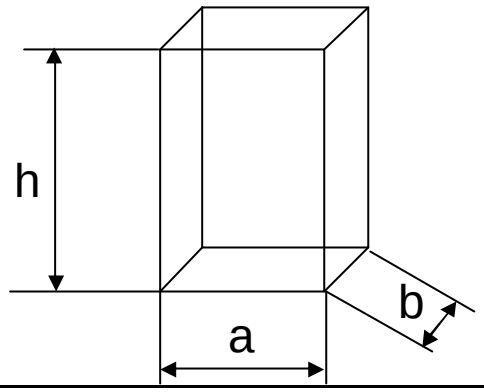
- Uncountable products or products that do not have any definite shape, such as powder, granular material, pastes or liquids, are regarded as bulk goods.
- Several homogenous or similar items (e.g.: crisps, sweets, components, nuts and bolds), which are not specified on the packaging and are not packaged in sorted form, are regarded as bulk goods.
- A single item or several evenly counted homogenous items (e.g.: screws, sweets) are regarded as piece goods up to a quantity of 19 pieces. From a quantity of 20 pieces, this is decided by the way they are arranged in the packaging. If these pieces are arranged orderly, they are regarded as piece goods, whereby loosely arranged items are regarded as bulk goods.
- Several different individual items (e.g.: in the case of toys: doll's clothing) are always evaluated according to the arrangement in the packaging. If these goods are arranged orderly, they are regarded as piece goods, whereby loosely arranged items are regarded as bulk goods.

3.1.3.1 Piece goods

In the case of piece goods, the volume of the piece goods is determined by using the outer edges or corners of the goods for volume calculation. These points must be wrapped by the smallest possible cuboid and the volume of this object must be used for determining the product volume.

Predefined geometric objects for calculation of volume:

- Cuboid with rectangular base



Cuboid with rectangular base

$$Volume\, V = a \times b \times h$$

$$Surface\, O = 2 \times (a \times b + b \times h + a \times h)$$

Fig. 1: Geometrical object for determining volume

A cuboid, with which the smallest value is calculated for the volume, must be selected.

In the case of several component parts, the volume of each part must be determined in this way and added up for the total volume.

Cavities in the product itself or which result due to the circumscription with the cuboid also belong to the volume of the product. The volume of a cable coil is determined, for instance, on the basis of the cuboid, which surrounds the external dimensions of the coil, irrespective of the empty space at its centre.

Examples for calculating the product volume can be referred to in ***Annex D:*** **Calculation of the Product Volume**

3.1.3.2 Bulk goods

The procedures described in the special standards for determining bulk density for powder, granular material etc. can be used for calculating the product volume. In this process, the bulk density or volume are always calculated according to loose pouring under defined conditions (also see: ÖNORM A 5561 Determination of settled and compacted apparent densities of powders and granulated materials, ISO 697 Surface active agents -- Washing powders -- Determination of apparent density -- Method by measuring the mass of a given volume, EN ISO 60 Plastics - Determination of apparent density of material that can be poured from a specified funnel). The measurement must relate to the bulk density immediately after filling the materials at the factory.

In the case of larger parts that are measured as bulk goods (e.g. screws, jigsaw puzzle parts, sweets), the bulk density should also be calculated on the basis of the standards mentioned above and used for calculating the volume.

3.1.3.3 Provision for systematically packed bulk goods

If several component parts are packed systematically (e.g.: spaghetti, fertiliser rods) instead of being poured loosely, then the smallest cuboid that contains all the component parts with optimum arrangement (= the smallest complete surface of the circumscribed substance) must be used for calculating the volume instead of the bulk density.

3.1.3.4 Products without any definite shape

In the case of liquids, pastes and other substances that have no definite shape, the actual volume of the packed goods is used (no circumscription of a predefined shape by means of cuboids). This volume is frequently specified on the packaging. If there are no volume specifications, the product is emptied into a measuring jug and the volume is determined in this way.

3.2 Exemptions

The limit for the factor (1) of 3.2 cannot be used for all products. Therefore, exemptions are necessary in the following cases:

1. The product is so small that no manageable sales packaging can be produced at reasonable costs (see chapter: 3.2.1).
2. At least one component part has a special geometrical shape (see chapter: 3.2.2).

Only point 1 can apply in the case of loosely poured bulk goods and products that have no fixed ratio of surface to volume (liquid, pastes, etc.). In the case of a packaging surface larger than 150 cm², the limit value of 3.2 must always be complied with.

3.2.1 Packaging surface = 150 cm²

Packagings with a surface area of up to 150 cm ² are exempted from complying with the limit value.
This ensures the handling and identification of very small products, particularly for self-service markets.

3.2.2 Individual limit value for very flat and / or very long products

In the case of objects that deviate considerably from the basic shape of sphere / cube (e.g.: envelopes, CDs, florescent lamps) the limit value for factor (1) of 3.2 can no longer be maintained after a certain aspect ratio. Hence, an individual limit value is determined for very flat and very long products (ILS or ILM).

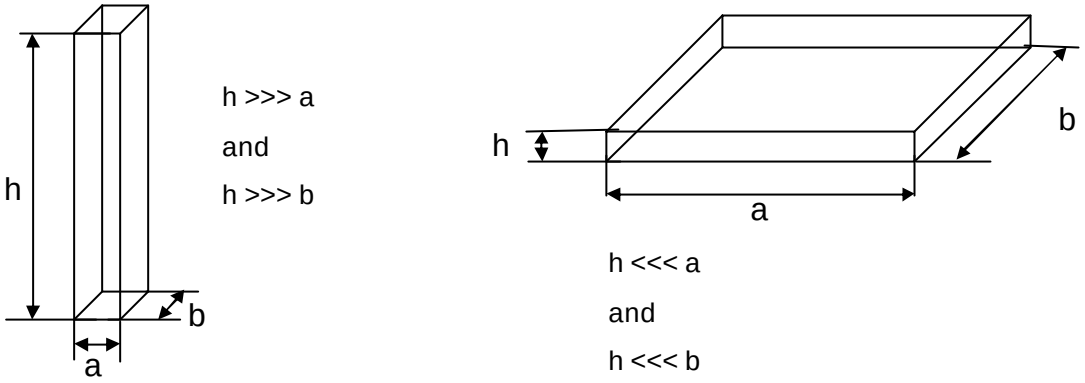


Fig. 2: Special cases: long and flat products

It is necessary here to distinguish whether the product is a single item or whether it consists of several parts.

3.2.2.1 Individual limit value for single items (ILS)

The ratio of the **product surface** to **product volume** of the product is determined according to formula (2):

$$\text{Factor (2)} = \frac{\sqrt[2]{surface\,of\ the\ packed\ good\ (SINGLE\,item)\,[cm^2]}}{\sqrt[3]{volume of\ the\ packed\ good\ (SINGLE\,item)\,[cm^3]}} \quad \text{formula (2)}$$

If the factor (2) is > 2.8, then the individual limit value for single items (ILS) applies to the packaging of this product according to formula (3).

$$\text{ILS} = Factor(2) \times 1.15 \quad \text{formula (3)}$$

If the factor (1) < ILS packing is permitted!

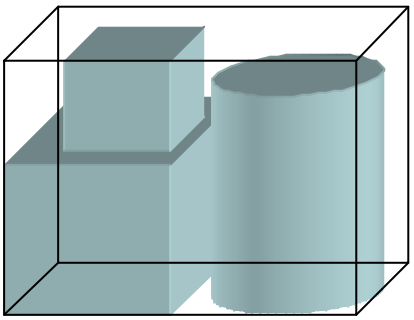
The surface of the cuboid that was circumscribed for the volume calculation is used as the value for the "surface of the packed product" in formula (2).
Attention: In formula (1), the "packaging surface" is used in the counter, which, in contrast to the "surface of the packed product", must be determined exactly.

3.2.2.2 Individual limit value for products consisting of several items (ILM)

If, according to formula (2) for the ratio of product surface to product volume, the factor (2) of **at least one single component** is > 2.8, then the individual limit value (ILM) must be calculated according to formula (4) and (5).

$$\text{Factor (3)} = \frac{\sqrt[2]{surface\ of\ the\ packed\ SINGLE\ items\ [cm^2]}}{\sqrt[3]{volume of\ the\ packed\ SINGLE\ items\ [cm^3]}} \qquad \text{formula (4)}$$

The "surface of the packed single items" in formula (4) must be determined so that the smallest cuboid containing all single items in optimum arrangement (= the smallest total surface of the circumscribed object) is used (see following Fig.). The volume of the packed single items corresponds to the sum of the circumscribed cuboid of each single item (corresponds to the same value as the denominator in formula (1)).



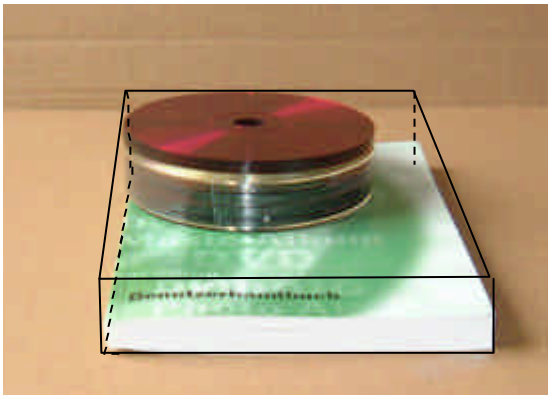


Fig. 3: Optimal arrangement for determining the product surface in the case of single items (piece goods)

If the factor (3) is > 2.8, then the individual limit value for several items ILM applies to the packaging according to formula (5):

$ILM = Factor(3) \times 1.15$ formula (5)

If the factor (1) < ISM packing is permitted!

If the factor (3) is = 2.8, then the predefined limit value of 3.2 applies to the packaging of all single items regardless of how large the factor (2) of a single item is.

Examples for calculating the individual limit value (ILS or ILM) are shown in ***Annex E: Exemptions***

3.3 Summary

In Figure 4, the entire process for assessing packagings is clearly shown and compared with the existing standard.

In both cases, the assessment is carried out first. If no critical area is discovered regarding the performance criteria specified, a redesign of the packaging to reduce the packaging surface must be carried out in both cases.

If a critical area is discovered, the limit value is checked in the proposed alternative as a supplement to the existing standard. At the same time, the factor (1) is determined and compared with the limit value of 3.2.

If the limit value is exceeded, a check is made with regard to the exemptions.

If no exemption applies, it is necessary to check whether the package is required in the existing size because of product protection, consumer safety or legal stipulations. Otherwise, the packaging must be redesigned.

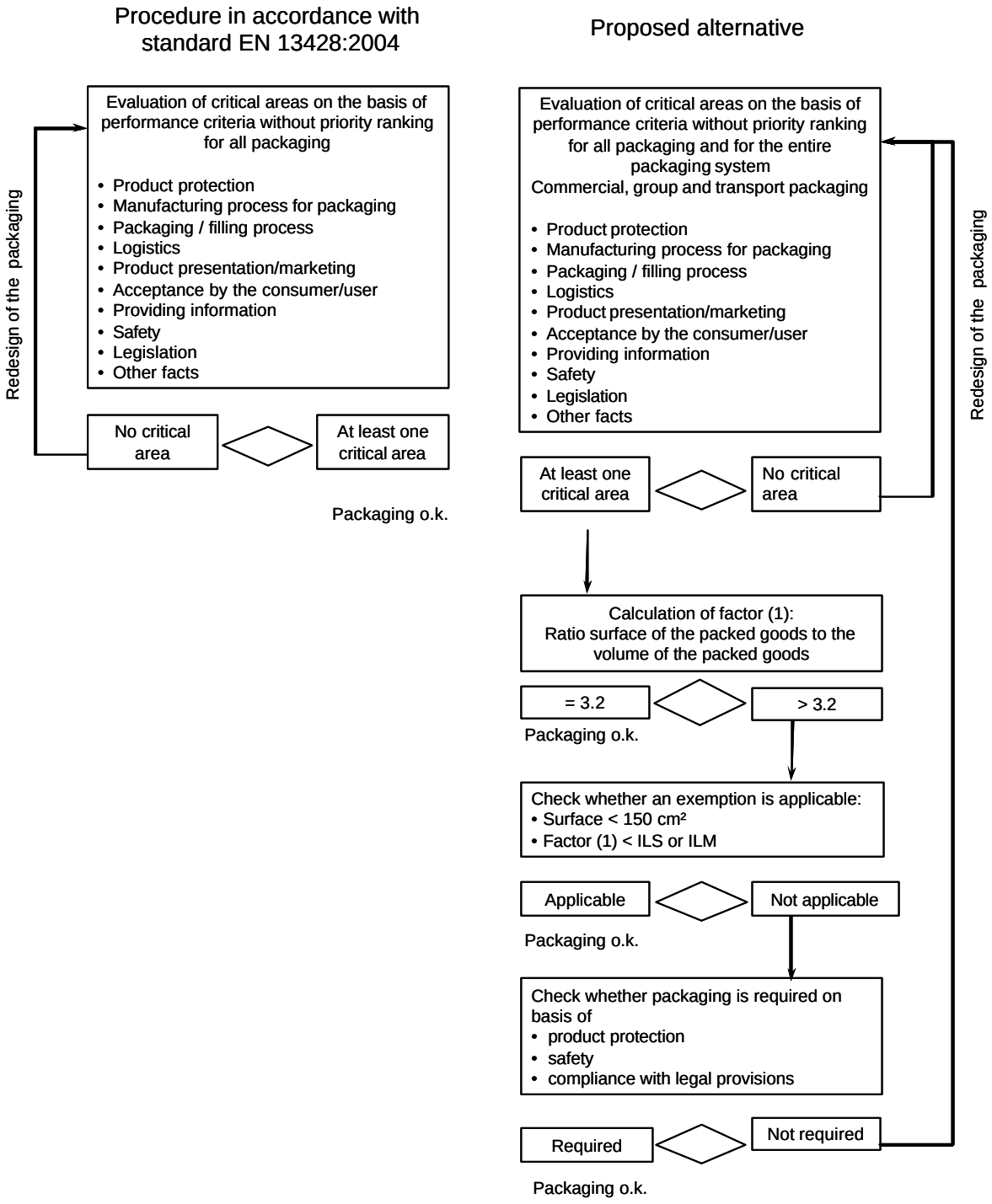


Fig. 4: Flow chart for assessing packaging by means of assessment and limit value

ANNEX A: EXAMPLES

The calculation of the factor (1) is explained in detail below in the following example.

Spar: Baking paper

The **packaging surface** is determined from the surface of the cuboid with the following external dimensions:
Cuboid: a = 40.5; b = 4.8; h = 4.8
Packaging surface = 823.68 cm²

The product is circumscribed by a cuboid with the following external dimensions:
cuboid: a = b = 4.7; h = 38
Product volume = 839.42 cm³

Factor (1) = $\frac{\sqrt[2]{surface\ of\ the\ packaging\ [cm^2]}}{\sqrt[3]{volume\ of\ the\ packaged\ goods\ [cm^3]}} = \frac{\sqrt[2]{823.68\ [cm^2]}}{\sqrt[3]{839.42\ [cm^3]}}$ **= 3.04**

Factor (1) = 3.04 < 3.2 thus the packaging is permitted

Commercial packaging units used in daily consumption

Brand	Product	Quantity	Remark	Volume [cm³]	Surface [cm²]	Factor (1)
Anker	Breadcrumbs	400g	Bulk goods	650	611	**2.85**
Bad Ischler	Salt	500g	Bulk goods	305	360	**2.82**
Kotany	Pepper, black	48g	Bulk goods	346	390	**2.81**
Aro	Bee's honey	500g	Liquid	386	377	**2.67**

Anker / crumbs

Bad Ischler / salt

Kotany / pepper

Aro / bee's honey

Brand	Product	Quantity	Remark	Volume [cm³]	Surface [cm²]	Factor (1)
Alpenmilch	Milk	1 Litre	Liquid	1000	686	**2.62**
Römerquelle	Mineral water	1.5 Litres	Liquid	1500	860	**2.56**
Spar	Bio-cider vinegar	500ml	Liquid	500	482	**2.76**
ILIADA	Olive oil	500ml	Liquid	500	567	**3.00**
Mazola	Corn oil	500ml	Liquid	500	444	**2.65**
Kikkoman	Soya sauce	150ml	Liquid	150	248	**2.97**
Natreen	Sweetener	125ml	Liquid	125	219	**2.96**
Kotany	Chilli grinder	50g	Content +grinder	128	186	**2.71**
Fuchs	Chillies	25g	Bulk goods	149	193	**2.62**

Milk, water, vinegar, olive oil, Mazola

Soya sauce, sweetener, chilli grinder, Chillies

Brand	Product	Quantity	Remark	Volume [cm³]	Surface [cm²]	Factor (1)
NÖM	Curd cheese	250g	Bulk goods	263	351	**2.93**
aro	Coffee filter	100 pieces	As piece	637	665	**3.00**
Spar	Baking paper	1 piece	Piece	839	824	**3.04**

Curd cheese


Coffee filter


Baking paper

Different packaging units of the same product

Economy bulb from OSRAM

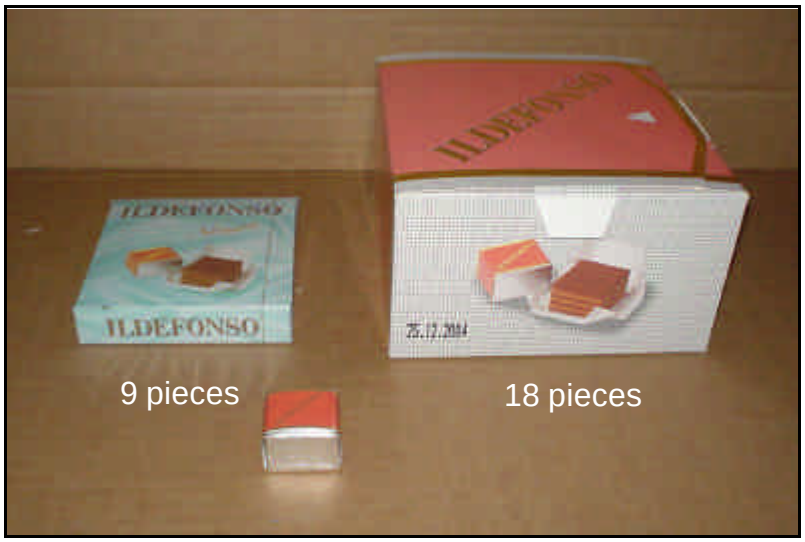
The bulb is sold by one manufacturer in various packaging units. The packaging shown on the right corresponds to the proposed alternative; the packaging shown on the left (for the same product) would not meet the requirements of "Source reduction".

The same product is packed once in a cardboard box: factor (1) = 2.64 (on the right in the picture) and once in a kind of blister packaging: factor (1) = 3.96.

The cardboard packaging falls far short of the limit value (1), whereas the very large-surface plastic packaging exceeds this considerably. In addition to the space-saving packaging, a window is also included in the cardboard box that reduces the packaging surface.

Ildefonso: Nougat cubes

The small cardboard packaging (in the picture on the left) contains 9 nougat cubes and achieves a factor (1) of 3.16.
The large box (in the picture on the right) contains 18 pieces and has a factor (1) of 4.69. The large packet would have to contain 57 nougat cubes to remain below the limit value.



Mirabell: Salzburger Mozarttaler

Bag with 7 Mozarttaler: factor (1) = 3.40
Packet with 5 Mozarttaler: factor (1) = 4.49

Packet with 5 Mozarttaler


Bag with 7 Mozarttaler

Even though none of these two packaging units reach the limit value in this case, the packaging has a considerably "lower impact on resources" by means of bag. If 9 Taler were packed in the bag instead of 7, the limit value would be exceeded. 14 Taler would have to be packed in the packet in order to stay below the limit value.

Osram: small halogen lamp

The small lamp with a volume of 3.4 cm² (circumscribed cuboid of 1 cm x 1 cm x 3.4 cm) is packed once in a cardboard box with a surface area of 70 cm² and once in blister packaging with a surface area of approx. 400 cm².

Cardboard packaging: factor (1) = 5.58
Blister packaging: factor (1) = 13.30

Even though the limit value is exceeded in both cases, the cardboard packaging would comply with the proposed alternative due to the special regulation for small packaging (surface = 150cm²), whereas the blister packaging does not comply with this special regulation and far exceeds the limit value.

Note: The blister packaging consists of a hollow body along the black broken line by means of which the large surface is achieved.

If the packaging was shortened along the red dotted line and the hollow body was reduced to the cylinder over the lamp, the special regulations for small packaging would easily be maintained.

Admissible and inadmissible arrangements

It is suggested to use the packaging surface as the size for the consumption of packaging material. The intended reduction at source should thus be achieved by reducing the packaging surface by means of more suitable geometrical shapes. On the other hand, poor arrangements are prevented by the formula, as in the example of the stock cube.

Manner: Chocolate bananas

In both packaging units there are 24 chocolate bananas of the same size.
The packet on the left is higher and achieves a factor (1) = 2.59
The packet on the right is very flat and achieves a factor (1) = 3.26

Maggi: Vegetable soup stock cube

Product: 12 pieces. Stock cube:
Cuboid for 1 piece: a = 3.6 cm; b = 2.4 cm; h = 1 cm (V = 8.64 cm³)
Product volume: (12 pieces) = 103.68 cm³

Packaging: cuboid: a = 15.7 cm; b = 7.5 cm, h = 1.1 cm
Packaging surface = 286.54 cm²

Factor (1) = 3.60

Even though the packaging does not seem to be oversized (see black line in the picture), the factor (1) is still far above the permissible limit value of 3.2.

Is a special regulation applicable?
Before the special regulations for several component parts can be applied as described in chapter 3.2.2.2, the factor (2) must be > 2.8 for at least one component. A stock cube with the dimensions (3.6 cm x 2.4 cm x 1 cm) has the factor (2) = 2.64 and the special regulation thus has no effect.
The packaging must therefore be assessed as impermissible in this case.

Das Problem is the poor arrangement:

Poor arrangement

Arrangement: flat: 7.2 cm x 14.4 cm x 1cm

Optimum arrangement

7.2 cm x 4.8 cm x 3 cm

Possible packaging:
In this example, a permissible packaging is very easily possible if the 12 stock cubes are arranged in 3 layers one above the other.
Product: cuboid: 7.2 cm x 4,8 cm x 3 cm
Product volume = 103.68 cm³
Packaging: cuboid: 8 cm x 5 cm x 3.5 cm
Packaging surface = 171 cm²
Factor (1) = 2.78

ANNEX B: DISTINCTION BETWEEN PRODUCT – PACKAGING

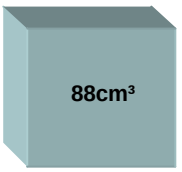
Necessary components such as metering devices, spice grinders, mascara brushes, for example, are calculated for the product application.

Example: OLAZ, moisturizing cream

The metering device belongs to the product.

Product volume : **Packaging surface :**

Metering device:
Circumscribe by means of cuboid:



+

Cream: (50ml)
According to product specification

Total: 138cm³

Cylinder:
r = 2.4
h = 9.8

Effects on the factor (1) when the metering device is included:
The values in brackets do not include the metering device.

Product volume:
Volume of the contents: 50 ml = **50 cm³**
Cuboid (metering device)**:** a = b = 4.7 cm; h = 4 cm; (88 cm³)
Total volume = 138 cm³ (only 50 cm³ without metering device)

Tiegel:

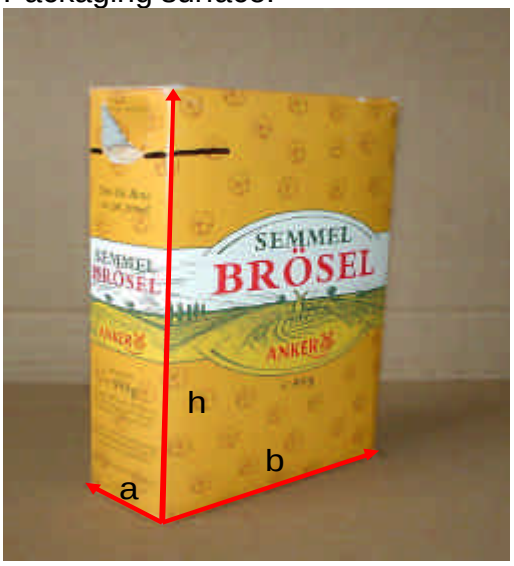
Packaging surface:
Cylinder: r = 2.4 cm; h = 9.8 cm
Surface: = 184 cm²

Factor (1) = 2.62
(3.68 without including the metering device)

ANNEX C: CALCULATION OF THE PACKAGING SURFACE

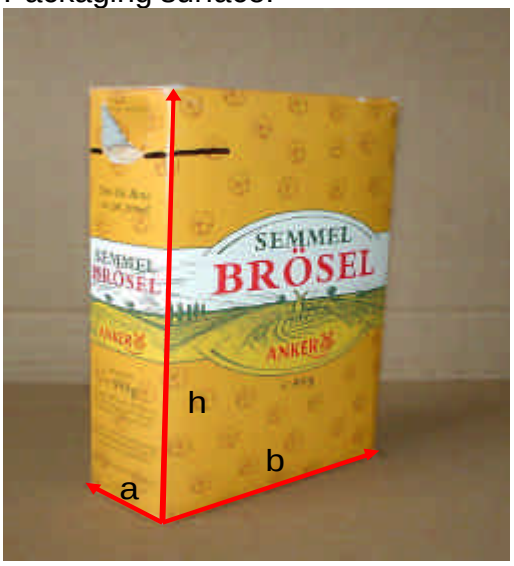
The geometrical body surface of the packaging is used for calculating the packaging surface.

Packaging surface:



Cuboid:
O = 2 x (a x b + a x h + b x h)

Packaging surface:



Cylinder:
O = 2 x r² x **p** + 2 x r x **p x h**

Packaging units with a complicated surface must be broken down into geometrical bodies. The total surfaces of these component parts form the entire surface.

Cylinder:
Nappe and base
(R = 1.5 H = 3)
+
Frustum:
Nappe
(R_1 = 4.4 H_1= 16.7
R_2 = 1.5 H_2 = 5.7)
+
Cylinder:
Nappe and base
(R = 4.4 / H = 20)

Total surface: 860 cm²

Cylinder:
Nappe and base
(R = 1.3 H = 3)
+
Frustum :
Nappe
(R_1 = 2.5 H= 3.5
R_2 = 1.3)
+
Cylinder:
Nappe and base
(R = 2.5 / H = 8)

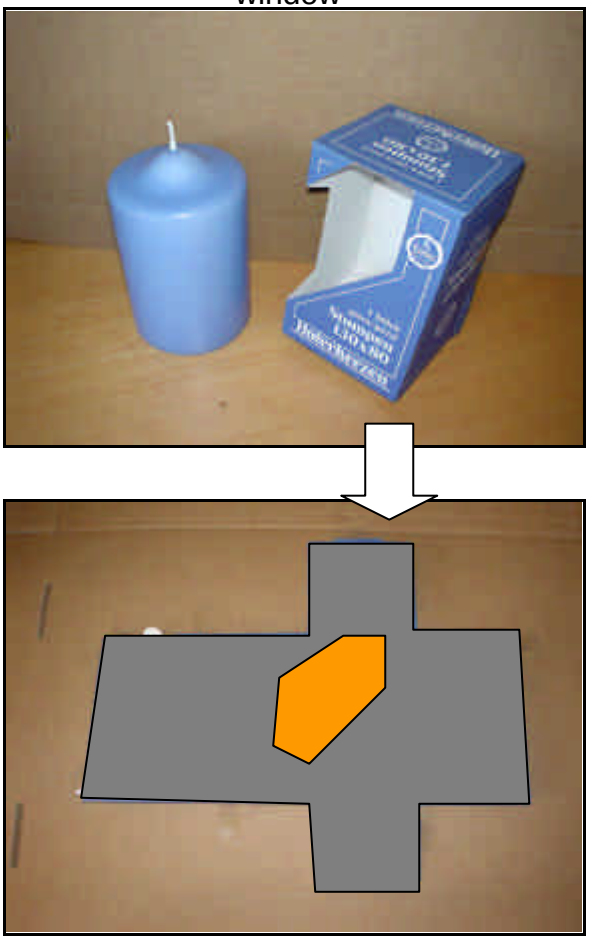
Total surface: 219 cm²

Curves, slight unevenness and small layers can be disregarded. In the case of narrow results, the surface must be calculated exactly.

Special case: Opening in the packaging

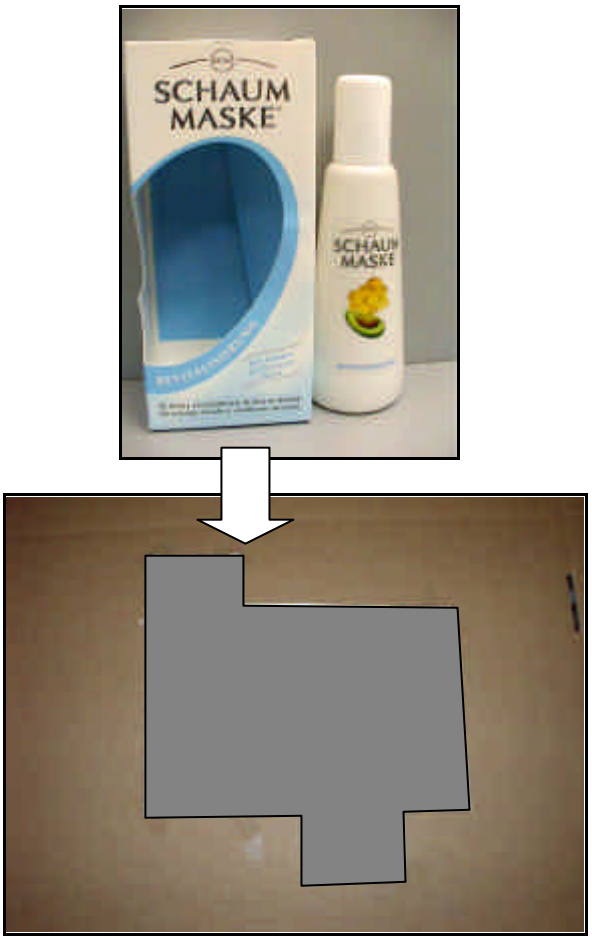
If the product is directly behind the opening, then the opening is taken into account in the calculation of the surface (see left row of pictures).
If there is further packaging behind the opening, then the opening is disregarded in the calculation of the surface (the opening is mentally closed).

The product is directly behind the window



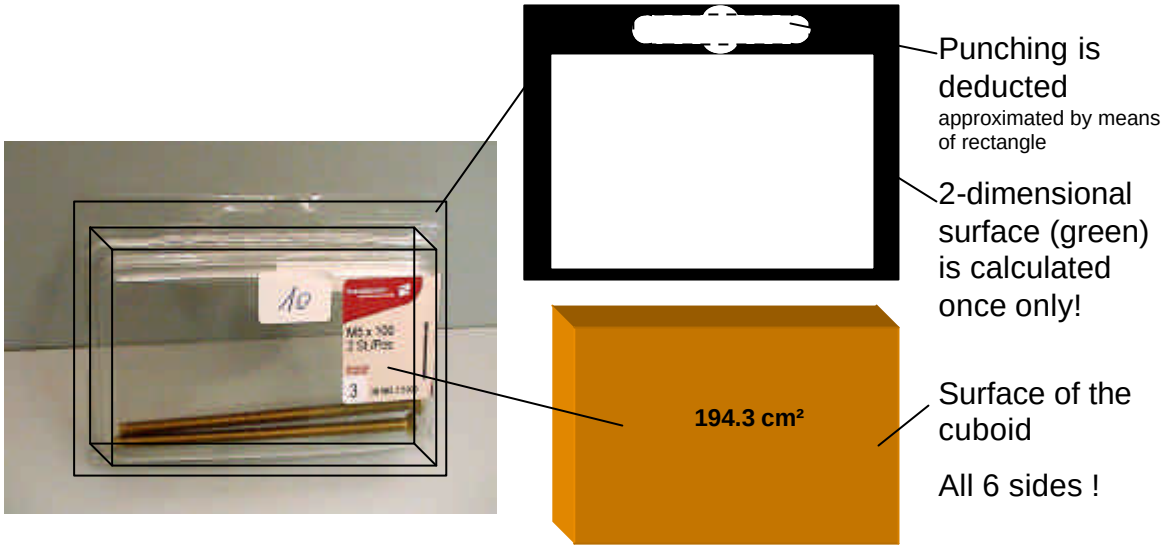
Surface = cuboid surface – window surface (red)

Further packaging is behind the window



Surface = whole cuboid

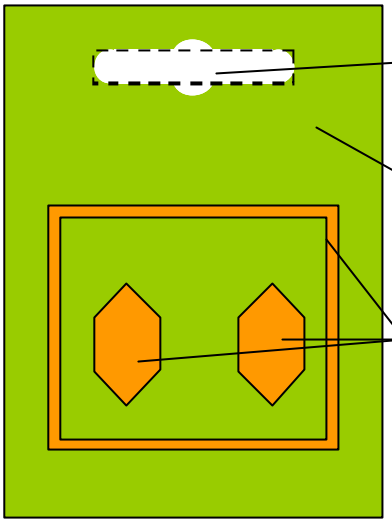
Special case "2-dimensional surfaces": Parts of packaging that have no volume are calculated once only:



Packaging surface: (consists of cuboid and 2-dimensional surface)
Cuboid: a = 10.5 cm; b = 6.5 cm; h = 1.7 cm
O = 2 x (10.5 x 6.5 + 6.5 x 1.7 + 10.5 x 1,7) = 194.3 cm²
2-dimensional surface: 12 cm x 9 cm – 10.5 cm x 6.5 cm (cuboid) – 3.5 cm x 0.8 cm (hole for suspending) =
Packaging surface: 231.25cm²

When determining the packaging area, the area of the cuboid is calculated fully with all 6 sides, the area of the two-dimensional surface (green), which extends all round, is calculated once only.

Packaging surface



Punching is deducted

approximated by means of rectangle

Green area is calculated once only.

Red volume areas are calculated with the total surface

Green area: (8 x 12) – (4 x 0.7) – (6.5^2 - 5.9^2) -2 x (2.3 x 1.4) =
= 96 – 2.8 – 7.44 – 6.44 = 79.32 cm^2
Red volume area: 4 x (4 x 6.2 x 0.3) + 4 x (2.3 x 1.4) + 4 x (1.4 x 1.6) + 8 x (1 x 1.4) = 29.76 + 12.88 + 8.96 + 11.2 = 62.8 cm^2
Total surface: 142.12

In the case of the packaging in the above example, the area marked in green is calculated once only because no volume is included here. The red areas include a volume and are therefore to be regarded as volume areas and the total surface must be calculated.
The sum of both surfaces is the total surface.

Even in the case of bags, the upper part that includes no volume is calculated once only:

The upper part (above the red lines) is calculated once only. This corresponds to the area that can be opened when the bag is cut off at the red line. (See below)

The lower part of the bag produces a cuboid without an overlap:
Cuboid: 3 cm x 8 cm x 14 cm
Surface: 356 - 24 (overlap) = 332 cm²

The upper part (the part cut off) spreads over a 2-dimensional area of 11 cm x 8 cm. This area of 88 cm² is calculated once only.

Totals surface:
332 + 88 = **420cm²**

ANNEX D: CALCULATION OF THE PRODUCT VOLUME

To **calculate the product volume**, a cuboid is circumscribed around the product (piece goods, arranged bulk goods) and the volume of the circumscribed object is calculated.

Coffee filter:

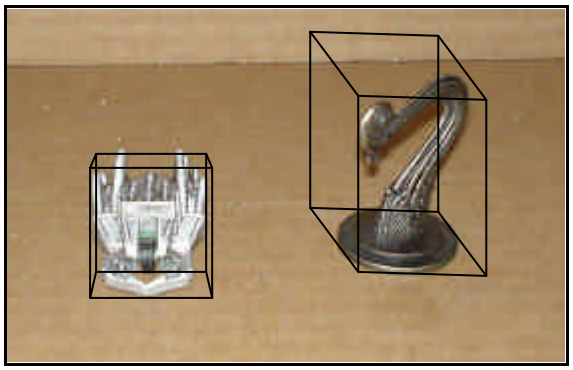
The smallest possible cuboid is circumscribed around the coffee filters.

The volume of the cuboid is equivalent to the product volume.

Candle and lamp:

The smallest possible cuboid is circumscribed and its volume calculated.

The volume of the cuboid is equivalent to the product volume.



Each smallest cuboid is circumscribed even in the case of complicated shapes. The cavities that remain free are disregarded when defining the product volume.

The total volume of the cuboid always counts as the product volume.

Classification: Piece goods/bulk goods

Examples for bulk goods (without solid form):

Breadcrumbs (powder)


Quark (pastes)


Liquids


Tea

The volume is either defined here by labelling on the packaging units (in the case of liquids) or by converting the bulk density defined immediately after filling by means of the weight specified on the packaging.

Examples for orderly arranged bulk goods:


Spaghetti


Coffee filters

Clips

Even though these products would belong to bulk goods due to the number of pieces (>19), the volume is not converted by the bulk density because of the orderly arrangement. Instead, the entire product is regarded as one part and is circumscribed by means of the smallest possible cuboid.

Examples for products that are packed loosely poured, but are to be calculated as piece goods because of their low number of pieces (<19) are as follows:


2 screws


7 Mozarttaler in bag


Small parts

In these cases, a cuboid is circumscribed around each component part and the sum of this cuboid results in the total volume of the product.

ANNEX E: EXEMPTIONS

Examples for packaging units with a surface = 150 cm²

All packaging units of products in the pictures below are smaller than 150 cm² and are therefore exempted from the regulation. The ratio between the packaging surface and product volume does not make any difference.

Examples for the exemptions in the case of flat or long products

Osram: Fluorescent lamp (single item)

The **packaging surface** is the result of the sum of the 4 individual peripheries (the packet has a trapezoidal cross-section) minus the openings:
Packaging surface = 1287.35 cm²

The **product** is circumscribed by a cuboid with the following dimensions: cuboid: a = b = 2.5 cm; h = 121 cm
Product volume = 756.25 cm³

$$\text{Factor (1)} = \frac{\sqrt[2]{surface\ of\ the\ packaging\ [cm^2]}}{\sqrt[3]{volume\ of\ the\ packed\ good\ [cm^3]}} = \frac{\sqrt[2]{1287.35\ [cm^2]}}{\sqrt[3]{756.25\ [cm^3]}} = 3.94$$

Factor (1) 3.94 > 3.2

Exemption: (according to section: 3.2.2.1 , for single items)
With the calculation of factor (2), the "surface of the packed goods“ must be determined. To do this, the same cuboid is taken that was used for determining the volume:
Cuboid: a = b = 2.5 cm; h = 121 cm
Surface of the packed goods = 1222.5

$$\text{Factor (2)} = = \frac{\sqrt[2]{surface\ of\ the\ packed\ good\ (SINGLE\ item)\ [cm^2]}}{\sqrt[3]{volume\ of\ the\ packed\ good\ (SINGLE\ item)\ [cm^3]}} = \frac{\sqrt[2]{1225.35\ [cm^2]}}{\sqrt[3]{756.25\ [cm^3]}}$$

Factor (2) = 3.84 is larger than 2.8 and thus the individual limit value ILS is applied according to formula (3) in this case.
Individual limit value ILS = factor (2) * 1.15 = 4.42

Factor (1): 3.94 < 4.41 ILS, individual limit value and thus the packaging for this product is permissible.

Example for the exemption in the case of several single items

CD Recording Software

Distinctions: 22 single items altogether, in orderly arrangement➔ piece goods
Counted as product: 21 items. CD, 1 user manual,

Product volume:
Cuboid (manual): a = 15 cm; b = 21 cm; h = 1.2 cm (V = 378 cm³)
Cuboid (1 CD): a = 12 cm; b = 12 cm; h = 0.1 cm (V = 14.4 cm³)
Total volume = 680.4 cm³

Packaging surface:
Cuboid: a = 40 cm; b = 25.5 cm; h = 6.5 cm
Surface = 2891.5 cm²

Factor (1) = $\frac{\sqrt[2]{surface\ of\ the\ packaging\ [cm^2]}}{\sqrt[3]{volume of\ the\ packed\ good [cm^3]}} = \frac{\sqrt[2]{2891.5\ [cm^2]}}{\sqrt[3]{680.4\ [cm^3]}} =$ **6.11**

Exemptions: (several single items)
Check whether the factor is (2) > 2.8 for at least one single item:
CD: product surface is calculating with the same cuboid that was also used for the product volume:
Cuboid (1 CD): a = 12 cm; b = 12 cm; h = 0,1 cm
Surface = 292.8 cm
Volume = 14.4 cm³

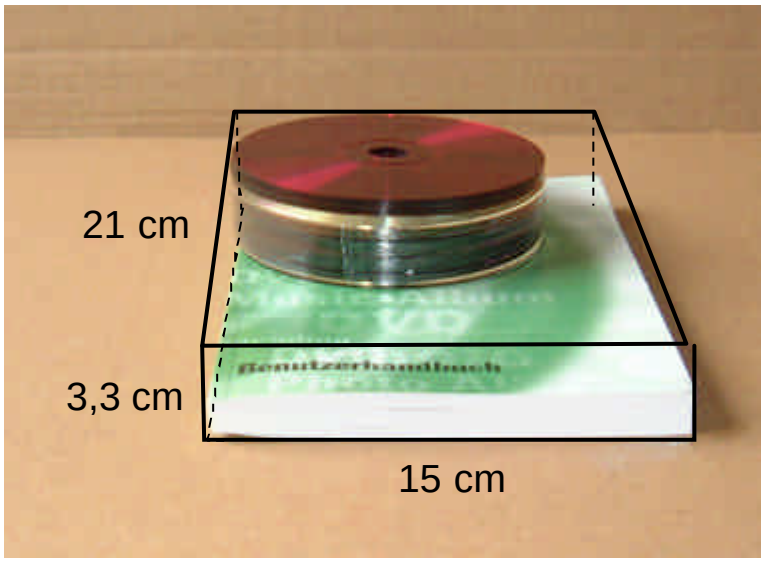
CD: factor (2) = $\frac{\sqrt[2]{292.8\,[cm^2]}}{\sqrt[3]{14.4\,[cm^3]}}$ = 7.03 (>2.8)

Since these are several single items, the individual limit value ILM must be determined according to formula (4) and (5).

Factor (3) $= \frac{\sqrt[2]{surface\ of\ the\ packed\ SINGLE\ items\,[cm^2]}}{\sqrt[3]{volume of\ the\ packed\ SINGLE\ items\,[cm^3]}}$ formula (4)

The "surface of the packed single items“ in formula (4) must be determined in such a way that the smallest cuboid, which covers all the single items when arranged optimally (= the smallest total surface of the circumscribed object), must be used. The volume of the packed single items is equivalent to the sum of the circumscribed cuboid of each single item (corresponds to the same value as the denominator in formula (1)).

Optimum cuboid (see figure) for surface calculation in formula (4):



Optimum cuboid: a = 21 cm; b = 15 cm; h = 3.3 cm
Surface of the packed goods = 867.60 cm²
Volume as above = 680.4 cm³

Factor (3) = $\frac{\sqrt[2]{867.6\,[cm^2]}}{\sqrt[3]{680.4\,[cm^3]}}$ **= 3.35 > 2.8 therefore the individual limit value ILM applies according to formula (5) = 3.85**

Factor (1): 6.11 > 3.85 ILM (therefore not permissible)