DOCUMENT NUMBER
CEN-CLC TC10/Sec/128/DC

CEN-CENELEC TC10
Material Efficiency Aspects for Ecodesign'

Secretary Enquiry (new work item 65685 / prEN 45554)

To: National Standardisation Bodies and Collaborating Partners

Secretary Enquiry

CEN/CLC European Standard

prEN 45554 - General method for the assessment of the ability to re-manufacture energy related products.

National Standardisation Bodies are invited to comment on the document. Comments can be considered only if form sheet (FormComments.doc) is used.

National Standardisation Bodies and Collaborating Partners shall upload their comments, as a reply to this document on the Collaboration tool, no later than 2017-11-15.

Remark

The common text (Introduction) has been discussed recently with all workgroup conveners. The outcome of this is not yet reflected in this version. This will be changed during the next CEN-CLC TC10/WG 04 Meeting.

prEN/TS/TR Reference Number (if available) :	
Database Work Item Number :	
English Title :	General method for assessing the ability to re-manufacture
French Title (if available):	
German Title (if available):	

1

Contents

Page

Foreword

TBD

Introduction

This standard, along with the standards of the CEN-CLC XXXXX series, has been developed under Mandate M/543 of the European Commission.

Topics covered in the CEN-CLC XXXXX series are inter alia, product durability, reparability, reusability, recyclability, recycled content, ability to remanufacture, and product lifespan. While various important topics in the context of material efficiency are covered in the standards of the CEN-CLC XXXXX series, other subjects of material efficiency, e.g. renewable resources, biodegradable plastics, light weighting and multi functionality, are not covered for the moment, despite their potential impact on material efficiency.

CEN, CENELEC and ETSI have been requested by M/543 to develop horizontal standards on fundamental principles, concepts, terminology or technical characteristics, relevant to a number of technical committees and of crucial importance to ensure the coherence of the corpus of standardisation documents. Generic standards developed under M/543 will be the baseline for future product publications covering a specific energy-related product (ErP) or group of related ErPs.

The primary addressee of the standards in the CEN-CLC XXXXX series are experts preparing product specific publications on the various covered topics.

Standardisation request M/543 has asked the European standardisation organisations CEN, CENELEC and ETSI to jointly draft new European standards and standardisation deliverables on material efficiency Aspects for energy-related products in support of implementation of the EcoDesign Directive (2009/125/EC). It is expected that increased focus on material efficiency aspects in the application of Directive 2009/125/EC should make a sizeable contribution to the transition towards a more circular economy.

More specifically, the standard presented here aims to…

1 Scope

This document deals with the assessment regarding the ability to remanufacture energy related products. Therefore, it is also applicable to the process relating to remanufacturing of energy related products. An energy related product is to be considered equal to a newly manufactured product after the remanufacturing process.

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.

BS 8887, *Design for manufacture, assembly, disassembly and end‑of‑life processing — Part 220: The process of remanufacture – Specification*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Significant Change

A change which is likely to influence safety or performance of an energy related product.

3.2 Refurbishment

The industrial process of returning a used product to a satisfactory working condition. No **significant change** is made during refurbishment.

NOTE to entry: Warranties can be granted to refurbished products but these are generally shorter than the legal warranties for new products.

3.3
Remanufacturing
The industrial process of inspecting, disassembling, cleaning, reprocessing, storing, reassembling and testing an energy related product in such a manner that the product is in a condition equal to a newly manufactured product. The remanufacturing process includes **significant changes** to the appliance.

3.4
Disassemble
Non-destructive taking apart of an assembled product into constituent components

3.5
Inspection
Determination and evaluation of the actual condition of the energy related product. Working in accordance with the manufacturer's inspection plan

3.6
Repair
To be aligned with WG 03

3.7
Accessibility
Ease or difficulty with which a part can be reached and cleared of all interferences, in order for it to be ready for disassembly

3.8
Durability/Wear Resistance
To be aligned with WG 02

3.9
Core
An used/discarded energy-related product that is used as input for a remanufacturing process.

3.10 Competent person
Who is capable of identifying existing and predictable hazards in the surroundings or working conditions, which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Note: This definition provide that a **competent person must have authority** to take prompt measures to eliminate hazards at the work site and have the experience to be capable of identifying these hazards. This is the reason a competent person is required under inspection requirements.

3.11 Qualified person
Who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

NOTE to entry: Refer to National requirements which may vary from country to country.

Note: This definition provide that a **qualified person** must have a recognized degree, certificate, etc., or extensive experience and ability to solve the subject problems, at the worksite.

3.12 Reprocessing

NOTE to entry: **Reprocessing** can include activities such as repair, rework, replacement of worn parts, and upgrade of soft-/hardware.

4 General considerations

Qualified persons for **remanufacturing** shall be the only responsible persons conducting the necessary steps to accomplish **remanufacturing**.

To facilitate **remanufacturing** it is considered to be beneficial to avoid welding and/or application of adhesives on **energy related products** where possible.

For all remanufacturing process steps, it is preferable that;

a) the **qualified person** in charge of the remanufacturing process or individual process step has manuals on how to perform the remanufacturing steps,

b) the energy-related products are safe to go through the remanufacturing steps and do not include hazardous substances, and

c) the product complexity and number of parts, number of materials used in the energy-related product are reduced to make all remanufacturing steps run smoothly.

It is essential to consider that neither safety nor performance is impaired when starting the **energy related product** after performed **remanufacturing**. Mechanical damage shall also be avoided during every process step.

Strict rules of procedure shall be applied during every process step to ensure to neither impair the appliance's safety nor performance.

4.1 Legal Aspects

The ability to remanufacture is subject to legal constraints which the **competent person** has to assess. For some product classes, e.g. medical devices, it is mandatory to be a licensed manufacturer, i.e. a registration with the national authority is necessary and also the device itself needs registration. This applies also to remanufactured devices and so the ability to remanufacture is restricted to licensed remanufacturers. Even if the remanufacturer is licensed, the **competent person** has to analyse whether the remanufactured device can be placed on the market under the license of the original device or whether a new license must be obtained.

For some product classes, additional requirements on the quality management system and certification to it are required, e.g. medical devices, devices used in explosive atmospheres or devices to be incorporated in aircrafts. The **competent person** has to evaluate the suitability of the QM system and the QM certificates before remanufacturing such cores.

The competent person has to decide whether the remanufactured device will be placed on the market under the original brand name or under the brand of the remanufacturer. In case it is intended to use the original brand name a permit of the brand holder must be obtained. In case it is intended to use the remanufacturer's brand name, the **competent person** has to ensure that no patent rights or other property or trademark rights of the OEM are violated when placing the remanufactured device on the market.

4.2 Quality management

The dis/-reassembly process shall be documented by giving for every part/module a certain number and file this electronically to ensure in case one part cannot be repaired and no spare is available, or a substitution of the competent person takes place during the process that the reassembly takes place without disturbance.

4.3 Work instruction

To ensure proper **remanufacturing** proper work instruction for disassembly, cleaning, **reprocessing**, storage reassembly and testing shall be provided to ensure that a **qualified person** for mechanical/electrical hazard can perform the work in adequate way and to ensure that throughout the process no damage takes place which could impair its safety and performance.

4.4 General considerations for the remanufacturing process

To assess the ability to remanufacture, the ability of the seven process steps of remanufacturing needs to be assessed. These process steps are:

4.4.1 Inspection

Inspection shall take place to verify identification parameters, and verify the **accessibility and condition** to the **energy related product parts/modules**. In a next step, the product parts/modules shall be inspected to ensure that the **remanufacturing** process is still possible.

4.4.2 Disassembly

The obtained **energy related product parts/modules** shall be **disassembled** to the needed level to perform the necessary work for the **remanufacturing** process. The remanufacturer shall also ensure that it is with given instructions possible for the **competent persons** to identify, handle, access, and separate parts and modules.

4.4.3 Cleaning

The **disassembled energy related product** shall be cleaned as defined by applicable instructions

Note to entry: Cleaning can include Disinfection of the core which can be necessary during every disassembly step.

4.4.4 Reprocessing

The damaged/error containing parts shall be **reprocessed** according to work instructions given. If the damaged/error containing parts show at early stage e.g. via **inspection** that safety and/or performance would be impaired by conducting this step, then no reprocessing/replacement shall take place. Strict rules of procedure shall be applied to ensure to neither impair the appliance's safety nor performance.

4.4.5 Storing

If the tested **part/module** is not immediately further processed, then storage needs to take place in accordance with requirements deemed appropriate for the **energy related product/module/part** to ensure e.g. ingress of water or similar which could impair safety and/or performance. Strict rules of procedure shall be applied to ensure to neither impair the appliance's safety nor performance.

4.4.6 Reassembly

Core parts, reassessed parts and new parts are reassembled to a remanufactured product. Reassembling shall take place in the strict order as given in work instructions. The reassembly process shall be transparently documented to ensure traceability.

4.4.7 Testing

Tests specified for the energy related product shall be conducted to verify that original performance and safety specifications are met, including all mandatory safety updates.

4.5 General considerations for the product properties of remanufacturing

Every process step is linked to one or more product properties which allow the assessment of the remanufacture ability of a product.

Remanufacturing process step / Product Property	Inspection	Disassembly	Cleaning	Reprocessing	Storing	Reassembly	Testing
Ease of identification/verification	X	X			X	X	X
Ease of access	X	X	X	X		X	
Ease of dis-/reassemble		X		X		X	
Wear resistance	X	X	X	X	X	X	X

4.5.1 Ease of identification

For inspection, it is crucial that the products are designed so that accurate inspections can be made at an early stage. In order to determine which of the product parts have failed, the product must be easy to inspect. For inspection, disassembly and testing clear markings of where the access points are, shall be used to be able to find them fast and easy. In addition, for inspection and storing it is also important to be able to identify what kind of **core** that have been retrieved to the remanufacturing facility. Furthermore, it should be easy to verify the condition of the core in order to understand what parts that needs to be reprocessed.

4.5.2 Ease of access

For ***inspection***, ***disassembly***, **reprocessing**, ***cleaning***, ***reassembly*** and ***testing*** it is important to access the points necessary for these steps. The access points should and easily accessed with the equipment necessary to use e.g. test equipment, screwdrivers, hands.

Annex A.1 shows a method to assess the accessibility of a product.

4.5.3 Ease of re-/disassemble

For ***disassembly***, ***reprocessing*** and ***reassembly*** this means that the **core** and its parts should to be easy to handle. The parts need to be to separable from each other to make the disassembly fast. For reassembly, parts should be easy to align.

Annex A.2 shows methods to assess the ability to re-/disassemble of a product.

4.5.4 Wear resistance

The core and its parts should be wear resistant towards all treatment necessary during the remanufacturing steps i.e. ***inspection***, ***cleaning***, ***disassembly***, ***reprocessing***, ***storing***, ***reassembling*** and ***testing***. It should be able to be disassembled, cleaned and reassembled without breaking.

4.6 General considerations for the assessment of remanufacturing

This standard only describes a general method for assessing the ability to remanufacture. The specific levels need to be decided on for each industrial sector/**energy related product** since there are great variations.

To be able to assess whether a product can be remanufactured, all remanufacturing process steps (Chapter 4.1.1 – Chapter 4.1.7) need to be executable by a **qualified person** for electrical and/or mechanical and/or other applicable hazards. Mechanical and electrical strength tests need to be conducted which are given in the latest applicable harmonised standards to verify whether a **remanufacturing** is feasible.

NOTE to entry: For household and similar **energy related products** e.g. the tests are given in EN 60335-1 and the applicable part -2 product specific safety standards.

Each process step has to be assessed according to the assessment of its product properties. The assessment can be graded from a scale from 1 to 5 where 1 is the lowest score and 5 is the highest score. To reach the ability to remanufacture the step-scores need to be added up, e.g. 3 + 1 + 2 + 5 +1 + 2 + 3 = 17.

An assumption can also be that if any of the step-scores is zero then also the ability to remanufacture is in general zero, i.e. if one of the remanufacturing steps cannot be performed – remanufacturing cannot be performed, in general.

5 Additional Considerations

5.1 Placing on the Market

If remanufacturing is conducted to an energy related product, it is considered to be equal to a new product placed on the market with all applicable responsibilities. Therefore, the applicable safety tests such as electrical and mechanical strength tests, leakage tests, overcurrent tests et al. which are mandatorily given in the applicable safety standards and performance standards need to be conducted to ensure that neither safety nor performance are impaired.

NOTE: Equal to new also means new CE marking

However, when a refurbishment is conducted to an energy related product where during process whether design nor composition are changed in a significant way, then only basic safety checks per appropriate recurring tests for electrical and other applicable safety, depending on the type of product, are conducted.

5.2 Warranty

If an **energy related product** is remanufactured, then the responsible remanufacturer shall issue an equal warranty for the complete **energy related product** as if he is placing it at that point of time on the market. He shall take care of conducting all necessary safety and performance tests which are necessary to place a product on the market including the appropriate Technical Documentation as asked for the appropriate **energy related product**.

If an **energy related product** is refurbished, the warranty given by the responsible refurbisher shall issue an equal or improved warranty for the **parts/modules** and shall ensure the proper function of the complete **energy related product**, especially with regards to safety and performance. The appropriate Technical Documentation as asked for the appropriate **energy related product** shall be made available.

Making available and placing on the market of products is clearly defined in the European Union and special attention shall be given to their definition within the newest Edition of the EU Blue Guide.

6 Marking

All appliances are marked with CE to show presumption of conformity to market surveillances with regards to all applicable safety and performance Directives and Regulations. Additional documentation, which also includes communication, is under consideration and is dealt with in cooperation with CEN-CLC TC 10 WG 6.

Annex A
Informative

Assessment of remanufacture

A1. Assessment of accessibility

To evaluate the **accessibility** (I_{Acc}) of a product the following formula shall be used

$$I_{Acc} = -(log_2 \frac{\Delta X}{X} + log_2 \frac{\Delta Y}{Y} + log_2 \frac{\Delta Z}{Z})$$

Whereas X, Y, Z define the largest dimensions of the component and $\Delta X, \Delta Y, \Delta Z$ represent the accessible range along the X, Y, Z - axis while disassembling the energy related product.

A1. Assessment of the ability to re-/disassemble

a. Disassembly sequence and depth

The disassembly sequence is the sequence of steps needed to remove a component from a product. This analysis of disassembly sequences is fundamental to facilitate the disassembly of key components from products:

1. Critical components can be labelled in the progressive removal order.
2. Different strategies to disassemble a component from products can be compared in terms of disassembly steps.
3. Optimal disassembly sequences can be for instance found through process simulation or on through the analysis of their relative accessibility and importance.

The disassembly sequence depth is the number of minimum steps required to remove a component from a product and it is obtained by applying an iteration of steps:

- Step1: Every component that can be removed are set at Level 1 and a list of remaining components is made
- Step2: Every component that can be removed are set at Level +1 and a list of remaining components is made
- Step3: Go back to Step2.

b. Disassembly index

The disassembly depth of a component is a normalised index calculated based on the number of components to be removed, the fastener types and difficulty coefficients.

Using the minimum number of fasteners is a key principle in design for disassembly. Different fastener types may indeed require different unfastening tools, different access directions and different disassembly configurations, which would ultimately result in an increase in the disassembly effort.

The parameter is calculated with the following equation:

$$\boldsymbol{dd = dd_n + \beta \cdot dd_f = \frac{1 + n_D}{n} + \beta \cdot \frac{\sum_{k=1}^{h} \propto_k \cdot f_{Dk}}{f}}$$

Where:

- dd is the disassembly index of a component
- $(1 + n_D)$ is the number of all the components to be removed (including the component whose disassembly index is being evaluated),
- n is the total number of components,
- h is the number of fastener types
- f_{Dk} is the number of fasteners of the k^{th} type to be removed,
- f is the total number of fasteners in the system,
- α_k is the difficulty of disassembling a k^{th} type fastener (Allowing for values of the coefficients α_k in the interval [0, 1], $\alpha_k = 1$ indicates the maximum difficulty of disassembly),
- β is a coefficient (β > 1) which takes into account the greater weight of the second term dd_f with respect to the first dd_n.

The index dd can assume values from 0 to 1+β, with the maximum value expressing the maximum disassembly depth. This occurs when, in order to remove a component, it is necessary to disassemble all the fasteners and all the other components present in the system.

The index dd of a specific component can be compared to the maximum disassembly depth of the analysed system, obtaining for each component the normalized value:

$DD_i = dd_i / dd_{MAX}$.

c. Time for disassembly (eDiM)

The eDiM method requires information about product components and adopted fasteners that can be directly verified within the product. The tasks necessary to disassemble a particular component/product are listed in eDiM and reference time values are associated to each of them, representing the effort needed to perform such operation. The eDiM report includes a database of common disassembly tasks which can be adapted, extended and/or updated.

The overall eDiM, measured in time units, is calculated by summing all contributions associated to a determined disassembly sequence. Subjectivity is reduced when single disassembly activities are measured and standard values quantified, as done in MOST.

As shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**, a spreadsheet can be used to calculate the eDiM. The first five columns of the table contain the data required to compute the time taken to complete the six categories of disassembly tasks:

1. Components are listed in Column 1 in the order of disassembly. If components are attached by different connectors, they can be repeated in the column.

2. Connector types used are listed in Column 2 in the order in which they should be unfastened to remove the different components. An example is provided in table 2**Fehler! Verweisquelle konnte nicht gefunden werden.** to show different connector types and their main characteristics.

3. The number of connectors of the same type in a component are specified in Column 3.

4. The number of any manipulations needed to access a connector are listed in Column 4. This could for instance be the case of a product that has to be turned upside down to remove the connector.

5. Information on the ease of identification of the connector is contained in Column 5. Two categories, visible and hidden, are presented in table 2**Fehler! Verweisquelle konnte nicht gefunden werden.**.

6. The type of tool required for disconnecting the fasteners is listed in Column 6. Tools can be selected from a predefined list. The box is left empty if no tool is required.

The time needed for the disassembly process is estimated through the last seven columns based on the information provided in the first six columns and the MOST reference time values.

7. Column 7 indicates the time needed to change tools defined in column 6. This is calculated based on the information on connectors provided in MOST, from which it can be determined whether a tool is required for disconnecting that type of connector.

8. Column 8 indicates the time needed to identify connectors. This is calculated using the information provided in Column 5 and the reference time values.

9. Column 9 indicates the time needed for product manipulation. This is calculated using the number of manipulations reported in Column 4 and the reference time values.

10. Column 10 indicates the time needed for positioning tools, in relation to the type of connectors used. This is calculated by multiplying the connectors specified in Column 3 by the reference time values for tool positioning.

11. Column 11 indicates the time needed for disconnecting the fasteners. This is calculated by multiplying the fasteners indicated in Column 3 by the reference time values for disconnecting the corresponding type of fastener.

12. Column 12 indicates the time needed for removing components. This is calculated once per component.

13. The overall eDIM for a set of components is assessed in Column 13 as sum of time values reported in columns 7 to 12.

The eDiM method is presented here as a method to estimate the time for disassembly, however the method could be used as well to estimate the time for reassembly, the sum of the two would allow the estimation of the total time needed for replacing one or more components.

364 **Figure 1 Generic eDiM calculation sheet for N components**

1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
Disassembly sequence of components	Disassembly sequence of connectors of components	Number of connectors	Number of product Manipulations	Identifiability (0,1)	Tool Type	Tool Change (s)	Identifying (s)	Manipulation (s)	Positioning (s)	Disconnection (s)	Removing (s)	eDiM (s)
1...												
2...												
...												
...												
...												
N												

365

366 **Table 1 Proposed MOST sequences for the disconnection of fasteners**

Connectors	Connector characteristics	Tool	MOST sequence	TMU	Time (s)
Screw	Length < 2 X diameter (D)				
Type 1	Screw D <= 6 mm	Power tool	|L3|	30	1.1
Type 2	Screw 6 mm < D < 25mm	Power tool	|L6|	60	2.2
Type 3	Screw D <= 6 mm	Screwdriver	|L10|	100	3.6
Snapfit					
Type 1	Force < 5 N	Hand	|L1|	10	0.4
Type 2	5 < Force < 20 N	Screwdriver	|L3|	30	1.1
Type 3	20 N < Force	Screwdriver	|L6|	60	2.2
Hinge					
Type 1	Force <5 N	Hand	|L1|	10	0.4
Type 2	5 N < Force < 20 N	Hand	|L3|	30	1.1
Type 3	20 N < Force	Hand	|L6|	60	2.2
Cable Plug					
Type1	Force < 5 N	Hand	|L1|	10	0.4
Type2	5 N < Force < 20 N	Hand	|L3|	30	1.1
Type3	20 N < Force	Hand	|L6|	60	2.2
Clamp					
Type1	Force < 5 N	Hand	|L1|	10	0.4
Type2	5 N < Force < 20 N	Hand	|L3|	30	1.1
Type3	20 N < Force	Screwdriver	|L6|	60	2.2
Tape					
Type1	Force < 5 N	Hand	|L1|	10	0.4
Type2	5 N < Force < 20 N	Hand	|L3|	30	1.1
Type3	20 N < Force	Hand	|L6|	60	2.2

367

Table 21 Example of table of reference values (time) for standard disassembly tasks based on MOST sequences

Disassembly task	Description	Sequence	TMU	Time (s/task)
Tool Change	Fetch and Put back	|A1B0G1|+|A1B0P1|	40	1.4
Identifying	Localising connectors			
	Visible are > 0.05 mm^2			0
	Hidden: visible are < 0.05 mm^2	|T10|	100	3.6
Manipulation	Product handling to access fasteners	|A1B0G1|+|L3 |	50	1.8
Positioning	Positioning tool onto fastener	|A1B0P3A0|	40	1.4
Removing	Removing separated components	|A1B0G1| + |A1B0P1|	40	1.4

Bibliography

[1] Under consideration.

[2]