ANTICSS Project Deliverable D18 (D4.5):

Test Reports – Part 4: Domestic freezers and refrigerators-freezers

– final version –

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1 About the ANTICSS project

Objective of the research project 'Anti-Circumvention of Standards for better market Surveillance (ANTICSS)' is to assess and clearly define 'circumvention' in relation to EU Ecodesign and Energy labelling legislation and relevant harmonised standards.

The analysis of circumvention will be based on collecting and learning from cases of circumvention by literature research and dedicated expert interviews, as well as analysing existing EU Ecodesign and Energy labelling legislation and standardisation for possible loopholes. Also, the potential relation between circumvention and so called 'smart' products with specific embedded software will be addressed by the project. Alternative test procedures to better detect circumvention by testing shall be developed and through testing a certain number of appliances within the ANTICSS project, the impacts 'if' and 'how much' energy consumption and/or functional performance modifications could be ascribed to circumvention will be assessed.

Based on the results, ANTICSS will provide practical capacity building measures for key actors of market surveillance and test laboratories, support communication and collaboration platforms between major stakeholders and provide policy recommendations for policy makers and standardisation bodies to prevent future circumvention under EU Ecodesign and Energy labelling. ANTICSS project is also designed to provide reliability to manufacturers by specifying potentially vague legislation and standards which might be interpreted differently by market actors and some of them taking unfair advantages so far. By overall awareness raising on circumvention among stakeholders, ANTICSS is supporting an effective EU legislation enforcement and thus increasing acceptance and trust of market actors and civil society into the Ecodesign and Energy labelling legislation.

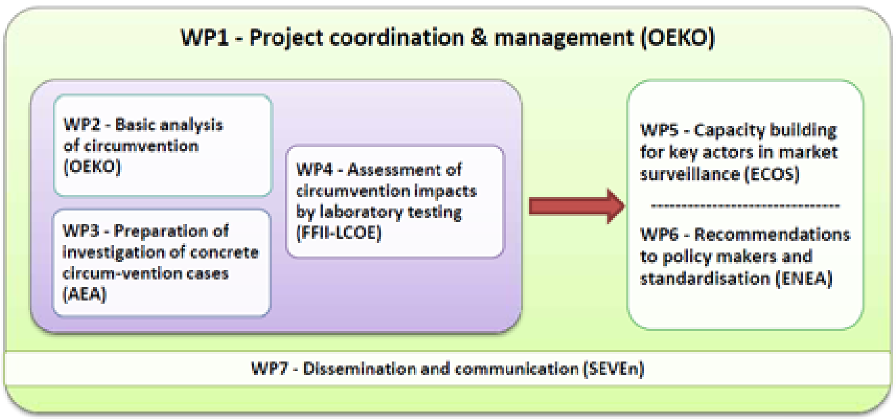

Figure 1-1: ANTICSS Work Packages

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2 ANTICSS definition of circumvention and jeopardy effects

For better understanding, first the underlying ANTICSS definitions of 'circumvention' and 'jeopardy effects' in relation to EU Ecodesign and Energy labelling legislation and related harmonised standards are presented. These definitions build the basis for the research within the ANTICSS project, namely the categorisation of collected suspect behaviour cases and the assessment of circumvention impacts in laboratory testing[1].

Definition of 'Circumvention'

„Circumvention is the act of designing a product or prescribing test instructions, leading to an alteration of the behaviour or the properties of the product, specifically in the test situation, in order to reach more favourable results for any of the parameters specified in the relevant delegated or implemented act, or included in any of the documentations provided for the product."

The act of circumvention is relevant only under test conditions and can be executed e.g.

a) *by automatic detection of the test situation and alteration of the product performance and/or resource consumption during test, or*
b) *by pre-set or manual alteration of the product, affecting performance and/or resource consumption during test or*
c) *by pre-set alteration of the performance within a short period after putting the product into service.*

Definition of 'Jeopardy effects'

"Jeopardy effects encompass all aspects of products or test instructions, or interpretation of test results, which do not follow the goal of the EU ecodesign and/or energy labelling legislation of setting ecodesign requirements and providing reliable information about the resource consumption and/or performance of a product. These effects may not be classified as circumvention, but become possible due to loopholes or other weaknesses in standards or regulations."

[1] Further details and examples can be found in the ANTICSS Deliverable D8 "Definition of 'circumvention' and 'jeopardy effects' in relation to EU Ecodesign and Energy labelling legislation", see https://www.anti-circumvention.eu/storage/app/media/uploaded-files/D08_ANTICSS_Final-definitions_circumvention.pdf

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3 Goal and general approach of this work package

Selection of product categories and cases for testing within ANTICSS

Objective of the current ANTICSS work package WP4 ("Assessment of circumvention impacts in laboratory testing") is to test product categories and cases initially categorised as circumvention or jeopardy effects according to the previous tasks of the project, see Table 3-1.

Table 3-1: Overview of cases tested in ANTICSS

Deliverable D18	Lot	Product category	Case
Part 1	ENER 1	Space heaters	Heaters 2 – Variable speed compressor
Part 2	ENER 5	Televisions	TV 1 – Setting of brightness TV 2/3 – Test loop recognition
Part 3	ENER 10	Room air conditioning	RAC 2 – 1) Defrost 2) Variable speed compressor
Part 4	ENER 13	Domestic freezers and refrigerators-freezers	COLD 2/4 – Multiple operation modes / holiday mode COLD 3 – Display is continuously activated
Part 5	ENER 14	Domestic dishwashers	DISH 1 – Separate bowl support DISH 2 – Specific pre-treatment before testing DISH 3 – Removal / alteration of accessories DISH 4 – Dishwasher with water tank
Part 6	ENER 14	Domestic washing machines	WASH 1.2 – Loading capacity WASH 3 – Hidden software
Part 7	ENER 16	Household tumble driers	DRIER 1 – Special preparation before testing DRIER 2 – Hidden Software
Part 8	ENER 22	Domestic ovens	OVEN 1 – Volume without shelf guides OVEN 2 – Maximum temperature in centre of oven OVEN 3 – Electronic control

Specific model selection procedure for testing appliances within ANTICSS

For each product category to be tested, three different appliance models were selected, and one unit of each model was purchased.

Disclaimer 1: The model selection procedure (see Deliverable D15: *Model selection procedure for alternative testing*[2]) was specifically targeted at finding appliances with a high probability of a circumvention behaviour. Therefore, the results of the tests within the ANTICSS project do not provide, and must not be considered as providing, a representative overview of the tested product categories on the market.

[2] https://www.anti-circumvention.eu/storage/app/media/D15_ANTICSS_Model-selection_final.pdf

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This selection procedure is preparatory to the achievement of the ANTICSS project objective that is learning how to improve current harmonised standards and Regulations in order to better detect and prevent circumvention in future.

Development and use of alternative test procedures within ANTICSS

For each of the cases, each model was tested according to the harmonized standard to measure the parameters of the Ecodesign and Energy label regulations of interest for the project.

Within ANTICSS, in addition, alternative test procedures have been developed (see Deliverable D14: *Alternative test methods and approaches to unmask circumvention under EU Ecodesign and Energy labelling*[3]) for the following goals:

- Analyse whether the suspected circumvention behaviour can be confirmed in laboratory tests through the application of the alternative test method, and
- Assess the magnitude of the impact of the circumvention in terms of effects on energy consumption and functional performance.

Disclaimer 2: The values declared for the compliance with the ecodesign and energy labelling requirements are measured with harmonised standards published in the EU Official Journal for the related Regulations. The use of other measurement methods – as for the ANTICSS alternative test methods – may lead to different results and cannot be used for compliance verification. Also, it was not proven in the project (and was not the task to do so) that the alternative test method does deliver results with the same repeatability and reproducibility as the test methodology of the harmonised standards.
Nevertheless, according to the ANTICSS project‘s experts the specifically chosen and well documented deviations of the ANTICSS test methods from the harmonized standards do not generally result into substantial deviations of the results from those obtained when tested according to the harmonised standard test conditions. Therefore, the ANTICSS project considers that the harmonised standard and the alternative test method as well as the achieved test results, although not usable for compliance verification, are in principle broadly comparable for the purposes of the project.

Interpretation of results based on the ANTICSS alternative testing procedures

The measurement results of the alternative test procedure are compared to the declared values as well as to the measurement results of the tests conducted using the harmonized standard.

The verification tolerances for market surveillance purposes related to the tested parameters as provided in the Ecodesign and Energy label regulations of the respective product category are used

[3] https://www.anti-circumvention.eu/storage/app/media/D14_ANTICSS_Alternative-test-procedures_final.pdf

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as a reference for determining the importance of the deviation between the results achieved under the "standard" and the "alternative" test conditions.

In general, if the deviation between the values obtained with the standard and the alternative test method exceeds the verification tolerance, the specific result of the alternative test is considered as being "different" from that of the harmonised standard and a possible indication for circumvention.

Disclaimer 3: The scope of the ANTICSS project is to define, detect the presence, and find ways to avoid in future 'circumvention' and jeopardy effects. The project is not meant to verify the compliance of the models selected for laboratory testing. In this respect in this report we have on purpose avoided to use expressions like "compliance verification" or "model compliance". When the results of laboratory testing conducted using a *harmonised standard* deviate more than the established verification tolerance from the declared values for the involved parameters the model is indicated as "non-conforming", in a contrary case the model is indicated as "conforming". Only the Market Surveillance Authorities partners of ANTICSS, to whom the test results are forwarded, will be in charge of any decision about launching, outside the project development, an action to verify the compliance of the models.

For models that turned out being non-conforming with the requirements of the Ecodesign and Energy label regulations according to the test results of the harmonized standard procedure, still the ANTICSS alternative test procedures were applied and test results of the harmonized and the alternative test procedure were analysed in terms of relevant deviations. The main purpose of the testing in ANTICSS is in fact the detection of possible circumvention, and this effect can well happen independently from the model compliance to the EU legislation requirements.

ANTICSS categorization of models and cases

The interpretation of the test results by the ANTICSS project team is based on the ANTICSS definitions of circumvention and jeopardy effects given in section 2. Different interpretations of the results within the project team are presented transparently. Further, the test results were also presented to the members of the ANTICSS Advisory Board[4] and their views were taken into account as well.

The following figure presents the underlying understanding for the categorisation of cases and tested models within ANTICSS.

[4] See https://www.anti-circumvention.eu/contacts/advisory-board

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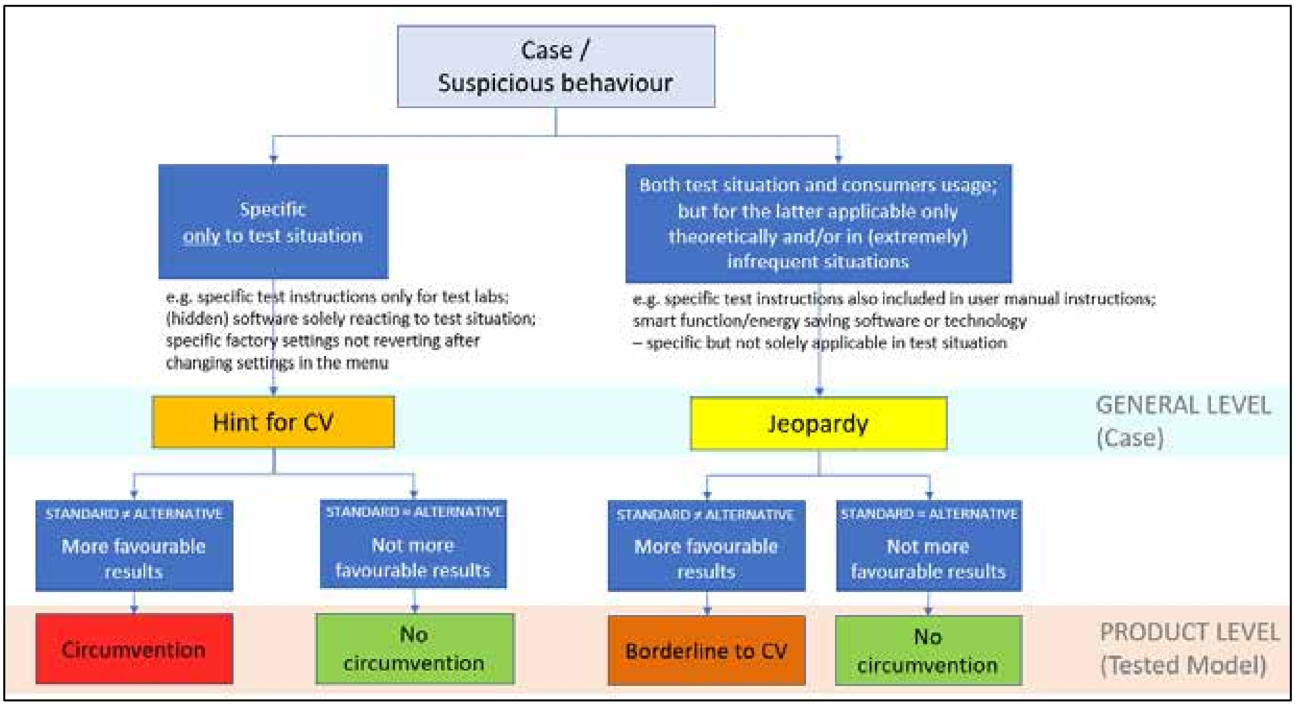

Figure 3-1: ANTICSS categorisation of cases and tested models to circumvention and jeopardy effects

ANTICSS differentiates between the general level ("Case") detected or reported, and the product level, i.e. the test results for the models tested within ANTICSS. Although the act of circumvention might not be found in the tested model (green), it might be considered still applicable to other models of the product category not tested in ANTICSS, i.e. the general case is still classified either as "jeopardy effect" (yellow) or "hints for circumvention" (orange).

- Cases specific *only* to the test situation are providing "hints for circumvention": i.e. cases indicating e.g. specific test instructions only for test labs, or (hidden) software solely reacting to the test situation, or specific factory settings not reverting after changing the settings in the menu. If the alternative test result of the tested model leads to relevant deviations of the standard test result, i.e. exceeding the verification tolerances for market surveillance purposes, the model is categorized as "circumvention".
- Cases that apply in both the test situation and consumers usage, but for the latter applicable only theoretically or in (extremely) infrequent situations are called "Jeopardy effects": e.g. specific test instructions which are also included in the user manual instructions, or smart functions / energy or resource saving software or technologies, being specific but not solely applicable in the test situation. If the alternative test result of the tested model leads to relevant deviations of the standard test result, i.e. exceeding the verification tolerances for market surveillance purposes, the model is categorized as "borderline to circumvention".

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According to the current ANTICSS definition of circumvention, these acts are not relevant only under test conditions, but still, the design of the product or the test instructions are utilized in a way to reach more favourable results specifically in the test situation.

Categorization as circumvention – depending on the illegality of the act?

Currently, most of the cases categorized as circumvention according to the definition of ANTICSS are "formally" not illegal. So far, a paragraph on circumvention not being allowed is only included in few Ecodesign regulations of the so called "winter package"[5]. Circumvention as included in these regulations, however, only cover products recognizing the test condition and reacting specifically by automatically altering their performance during the test, i.e. point a) of the ANTICSS definition of circumvention. This means that "formally", all cases falling under point b) and c) of the ANTICSS definitions of circumvention, as well as cases of point a) but applied in product categories not including the paragraph on circumvention in the Ecodesign regulation, are so far not illegal.

This is especially discussed for those cases where manufacturer's instructions shall be explicitly followed according to the harmonized standard and/or the legislation with the objective to deliver in tests accurate results in terms of *repeatability* (to get the same value again when measuring some time later) and *reproducibility* (to get the same or similar results measured in another laboratory). In ANTICSS, the general allowance of manufacturer's instructions is pointed out as potential weakness or loophole of the standard as it provides also the possibility for exploitation to achieve more favourable results specifically in the test. Again, this is "formally" not illegal. However, these acts correspond with the definitions of ANTICSS and thus are categorized as "circumvention" or "borderline to circumvention" if the exploitation becomes apparent.

Aim of the ANTICSS project is not judging the legality or illegality of the cases and tested models, but to provide the scientific basis (definitions, test results, potential impacts) for political decision makers to decide if the results are relevant to take them into account in the future development and revision of legislation and standards.

[5] Ecodesign regulations (EU) 2019/1781 (electric motors and variable speed drives); (EU) 2019/1783 (small, medium and large power transformers); (EU) 2019/1784 (welding equipment); (EU) 2019/2019 (refrigerating appliances); (EU) 2019/2020 (light sources and separate control gears); (EU) 2019/2021 (electronic displays); (EU) 2019/2022 (household dishwashers); (EU) 2019/2023 (household washing machines and household washer-dryers); (EU) 2019/2024 (refrigerating appliances with a direct sales function); (EU) 2019/424 (servers and data storage products)

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Conclusions and further proceedings based on the results of the ANTICSS alternative testing

Specific models that turned out being non-conforming with requirements of the Ecodesign and Energy label regulations according to the test results of the harmonized standard are reported to the Market Surveillance Authorities partners in the ANTICSS project for further follow up outside the development of the project.

The general results will be further fed into the next ANTICSS work packages as follows:

- Analysis on how the specific circumvention behaviour can be detected through laboratory testing, as basis for capacity building of MSAs in work package WP5 ("Capacity building for key actors in market surveillance");
- Development of strategies and guidelines on how preventing the specific types of circumvention through the revision/improvement of the EU legislation and the relevant harmonised standards in work package WP6 ("Conclusions from circumvention investigation and policy recommendations");
- Preparation of results and reports to be used for communication to stakeholders and the public in work package WP7 ("Dissemination and communications").

In the following sections, the results of testing the respective product category, cases and models within the ANTICSS project are described in detail.

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4 Test results – Product category "Domestic freezers and refrigerators-freezers"

The following table shows an overview of which of the three product models was tested for which of the cases initially categorized as hints for circumvention or jeopardy effect in work package WP3.

Table 4-1: Overview of cases and models tested in the product category refrigerators-freezers

	Model A	Model B	Model C
Case COLD2/4	Tested	Tested	Tested
Case COLD3	---	---	Tested

4.1 Case COLD2/4

4.1.1 Description of the case

In some frost-free refrigerator-freezers, there are two or more operation modes programmed. For the cases COLD 2 and 4 reported in Deliverable D14 (D4.1): *Alternative test methods and approaches to unmask circumvention under EU Ecodesign and Energy labelling*, there are two operating modes identified, namely the "normal" mode, which is mostly active when door openings are detected, and the "ECO" mode, which is activated when the door is kept closed for a longer period. The appliance is automatically switching between the modes according to the managing algorithm of this specific doors' behaviour.

The appliance of the reported suspicious case switches to the "ECO" mode during the energy consumption tests, since it reacts on the lack of door openings. In the case reported, the measured energy consumption is reduced by 12% when the "ECO" mode is activated. Possible differences of the "ECO" mode compared to the "normal" mode:

- Longer defrost interval (which reduces the energy consumption),
- Shorter defrost heater activation time (which reduces the energy consumption),
- Internal fans not running continuously (which reduces the energy consumption and the compartment temperatures measured differ at the same controller setting).

This most efficient mode is active during the conformity testing, while in real life "ECO" is only active for a more limited time, depending on the duration the door actually remains closed at home.

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Note: The new regulation (COMMISSION REGULATION (EU) 2019/2016) and the new standard (EN 62552-1,-2,-3:2020) include the possibility to have a variable defrost interval, i.e. the interval length between defrosts may vary. In the conformity documents, manufacturers are obligated to declare the type of defrost programmed in their appliances including the declared timings at 32°C ambient temperature. The type of defrosting is now considered in the calculations of the Annual Energy consumption (AE), i.e. in case the appliance is programmed with the variable defrost type, the length the defrost interval used for the AE calculation is based on a certain ratio between the minimum and maximum interval time programmed. The standard does not mention anything about multiple modes and which one to test. However, continuously measuring in the "normal" mode is not possible, since this mode results in the highest energy consumption of the appliance. On the other hand, if a mix of both modes ("normal" and ECO) is used for the interpolation procedure, it may generate incompatible results because the temperatures measured during ECO mode and normal mode at the same thermostat settings will differ.

4.1.2 Alternative testing procedure[6]

It is not possible for a test lab to select the operating mode for testing; therefore, the alternative test procedures are designed with the aim to trigger the controller to switch between its programmed operating modes by several aspects:

- Unstable input voltage,
- Door switch,
- Unstable ambient conditions or
- Internal temperature fluctuations.

For each of these aspects a procedure is proposed to check if multiple control modes are present.

Prior to the following alternative testing procedures, the following reference tests need to be conducted:

1. Installation of the appliance according to EN IEC 62552:2013
2. Log the temperatures and input power of the appliance.
3. Perform reference tests at standardized conditions:
    i. Energy consumption test
    ii. (Storage) Temperature test

Triggered by unstable input voltage

4. Use a non-stabilized mains power supply.
5. Log the temperatures and input power of the appliance.

[6] It is possible that modes are triggered by events or aspects not mentioned in this chapter and which are not yet discovered within the ANTICSS project. Therefore, during the testing, care needs to be taken not to limit testing only to the mentioned test procedures.

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6. Analyse the behaviour of the appliance. Some hints for checking are given below:
    a. Additional component activation
    b. Measured temperature spread inside the refrigerated compartments
    c. Defrost heater behaviour
    d. Component behaviour
    e. Other aspects…

Triggered by the door switch[7]

4. Bypass the door switch with a controllable switch unit, which makes it possible to simulate the door openings of the cabinet via software. Do not damage the cabinet's insulation or internal walls.
    i. In case this is not possible, perform the test with physical door openings. Preferably open the door just that it triggers the door switch in order to minimize the impact of cold air falling out of the compartment.
5. Simulate the amount of door openings for a number of times per hour via the software.
6. Make sure that all doors remain closed during the tests.
7. Perform the test at the same ambient condition as the reference tests.
8. Log the temperatures and input power of the appliance.
9. Analyse the behaviour of the appliance. Some hints for checking are given below:
    a. Additional component activation
    b. Measured temperature inside the refrigerated compartments
    c. Defrost heater behaviour
    d. Component behaviour
    e. Other aspects…

Triggered by unstable ambient conditions

4. Use unstable ambient conditions, preferably that the average ambient temperature of the test period is equal to the ambient temperature used during the reference tests. E.g.
    - Hour 1 to 4 of the test $T_{ambient\ alternative} = T_{ambient\ reference}$ - 5°C.
    - Hour 4 to 8 of the test $T_{ambient\ alternative} = T_{ambient\ reference}$ - 3°C.
    - Hour 8 to 12 of the test $T_{ambient\ alternative} = T_{ambient\ reference}$ - 1°C.
    - Hour 12 to 16 of the test $T_{ambient\ alternative} = T_{ambient\ reference}$ + 1°C.
    - Hour 16 to 20 of the test $T_{ambient\ alternative} = T_{ambient\ reference}$ + 3°C.

[7] Note that the STEP project conducted tests for refrigerators and refrigerator-freezers according to their own designed alternative test method. This method contains similarities with the alternative test method *Triggered by the door switch* designed within the ANTICSS project. More detailed information about the STEP project can be found at http://www.toptenuk.org/private/documentation/closing-the-reality-gap

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- Hour 20 to 24 of the test $T_{ambient\ alternative} = T_{ambient\ reference} + 5°C$.

5. Log the temperatures and input power of the appliance.
6. Analyse the behaviour of the appliance. Some hints for checking are given below:
   a. Additional component activation
   b. Measured temperature spread inside the refrigerated compartments
   c. Defrost heater behaviour
   d. Component behaviour
   e. Other aspects...

Triggered by internal temperature fluctuations

4. Introduce irregular fluctuating internal compartment temperatures by either:
   a. Physically opening the door of the appliance. Do this several times in a day. Make sure that the door switch is short circuited without interrupting the main controller algorithm or damaging the cabinets insulation, i.e. the appliance will not sense a physical door opening via the door switch.
   b. Install a heater inside the compartment and fluctuate the temperature by activating the heater randomly throughout the test.
5. Perform the test at the same ambient condition as the reference tests.
6. Log the temperatures and input power of the appliance.
7. Analyse the behaviour of the appliance. Some hints for checking are given below:
   a. Additional component activation
   b. Measured temperature inside the refrigerated compartments
   c. Defrost heater behaviour
   d. Component behaviour
   e. Other aspects...

Care should be taken when comparing the alternative test results to the results of the reference test. For example, during the *Triggered by internal temperature fluctuations* test method, the heat input of the heater to the compartment can be measured. Logically it is assumed that you can subtract the heat input from the measured energy consumption. However, the required work (electrical power) of the refrigerator to transport the introduced heat by the heater to the ambient is not 1:1, and it is impossible to determine what the exact ratio is. Therefore, the assumption that you can subtract the heat input directly from the measured energy consumption is not valid. Main goal of these alternative test methods, however, is to verify if the appliance is not operating in a different operating mode compared with the reference tests. The results of the alternative methods will also provide information to derive an estimation of the impact on the declared energy consumption for the different operating modes present.

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Modifications, improvements or clarifications to the initial alternative testing procedure

The initial alternative testing procedures as described above are included in the ANTICSS report "Alternative test methods and approaches to unmask circumvention under EU Ecodesign and Energy labelling" (Deliverable D14)[8]. In the following, further specifications are listed.

Since testing a household refrigerator consists out of various types of tests consuming a lot of time and resources, it is decided to reduce the number of tests to the bare minimum, in this case the energy consumption test. To even further reduce the testing time, the alternative test methods are only analysed for a single thermostat setting. As a result of this, a direct comparison of the measured values is not always possible and special attention needs to be taken on how to interpret the results. Next to this the above proposed test method "Triggered by internal temperature fluctuations" was not performed due to time constraints.

During the tests it was observed that extra clarification is required in order to perform the alternative tests properly. In the following paragraphs below more detailed information is shown.

Triggered by the door switch. During this test, the door switch could not be triggered by a switch unit because the routing of the electrical wiring of the door switch and/or position of the door switch is not accessible without damaging the cabinet exterior. However, at Model B it was possible to place a thick metal object between the door and the sensor to simulate a door opening without physically opening the door.

Unstable ambient conditions test. During testing it was noted that two out of the three appliances tested cannot maintain the same compartment temperatures when the ambient temperature was fluctuating. To have a proper comparison, the compartment temperatures should be the same for all ambient temperature tests. Since the compartment temperatures always will fluctuate for the same thermostat setpoint, an interpolation between two measurements with different thermostat setpoints should have been performed to achieve the same internal compartment temperature during all test. This would have meant more test points and thus a very time-consuming process. Therefore, only a single fixed thermostat setting is used for all the ambient temperatures. Furthermore, a carefully chosen measurement period should be selected to obtain data which is comparable. In general, the influence of a defrost or other variables (e.g. cold energy stored in the freezer load packages) should be avoided and only steady state conditions should be compared.

8 See https://www.anti-circumvention.eu/storage/app/media/D14_ANTICSS_Alternative-test-procedures_final.pdf

4.1.3 Summary of results

4.1.3.1 Model A

4.1.3.1.1 Standardized test results

The appliance is setup according to the harmonized standard and tested accordingly for the energy consumption. Table 4-2 below presents the result obtained during this test[9].

Table 4-2: Model A: Result of the energy consumption test according to the harmonized standard

		Declared	Measured	Deviation from declared
Energy consumption	[kWh/year]	173	197.83	+14.4%

The result is not conforming to the COMMISSION DELEGATED REGULATION (EU) No 1060/2010, since the measured deviation for the energy consumption is more than 10% which is used for the verification tolerance.

4.1.3.1.2 Alternative test method results

4.1.3.1.2.1 Fluctuating voltage supply

The test is performed with the exact same configuration of the refrigerator during the standard energy consumption test, while only changing the power supply to the appliance. The power grid available in the Netherlands is used as power supply. The voltage fluctuation band width of the grid is shown in the table below.

[9] More detailed reference is made to Re/genT report number 20236/AN02/V1

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Table 4-3: Model A: Fluctuating voltage supply test results

		standardized testing	alternative test method	Difference
Thermostat setting		3/-21	3/-21	
Defrost interval	[hours]	>72	>72	
Defrost heater activation	[min]	24	22.2	-7.5%
Input power off cycle	[W]	1.0	1.0	0.0%
Average fresh food temperature	[°C]	3.6	3.6	0.0K
Average freezer temperature	[°C]	-19.6	-19.6	0.0K
Voltage range	[V]	231.0 - 232.7	233.0 - 242.8	
Average voltage	[V]	231.9	238.3	
Average input power	[W]	23.5	23.7	1.0%
Average input power steady state (no defrost)	[W]	22.2	22.4	1.1%

Based on the tests performed, Model A is not reacting differently when being supplied with the grid power from the Netherlands.

4.1.3.1.2.2 Triggered by the door switch: Physical door openings

The test is performed with the same configuration of the refrigerator as during the standard energy consumption test. At random times the fresh food door is opened, twice a day. The results of the alternative test method presented are taken from a complete operating cycle[10]. Prior to this cycle a total of 4 door openings are performed.

[10] The operating cycle of this appliance is the time from the initiation of a defrost to 72 hours after it.

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Table 4-4: Model A: Physical door opening test results

		standardized testing	alternative test method	Difference
Thermostat setting		3/-21	3/-21	
Defrost interval	[hours]	>72	>72	
Defrost heater activation	[min]	24	23.4	-2.5%
Input power off cycle type 1	[W]	1.0	1.0	0.0%
Input power off cycle type 2	[W]	-	3.0	
Average fresh food temperature	[°C]	3.6	3.8	0.2K
Average freezer temperature	[°C]	-19.6	-19.6	0.0K
Average input power	[W]	23.5	23.5	0.1%
Average input power steady state (no defrost)	[W]	22.2	22.3	0.5%

The defrost interval and the defrost heater activation as well as most other parameters did not change due to the physical door openings compared to the standard testing. However, during the alternative test method, another input power value ("input power off cycle type 2") was measured during the off cycle only. The increase occurs immediately after a door opening and lasts for 15 minutes only. It is unknown which component is activated during this period, but most likely it is an internal fan running during this off cycle. Based on the difference between the average inputs it can be concluded as neglectable.

4.1.3.1.2.3 Fluctuating ambient conditions

The test is performed with the exact same configuration of the refrigerator during the standard energy consumption test. The ambient temperature is varying over time and for each ambient temperature a steady state measurement is saved and used for the analysis. The thermostat settings are not adjusted during the test.
In Figure 4-1 the average input power of the cabinet during the measurement period is set out to the left axis. The average compartment temperatures measured are set against the right axis. The horizontal axis represents the ambient temperature.

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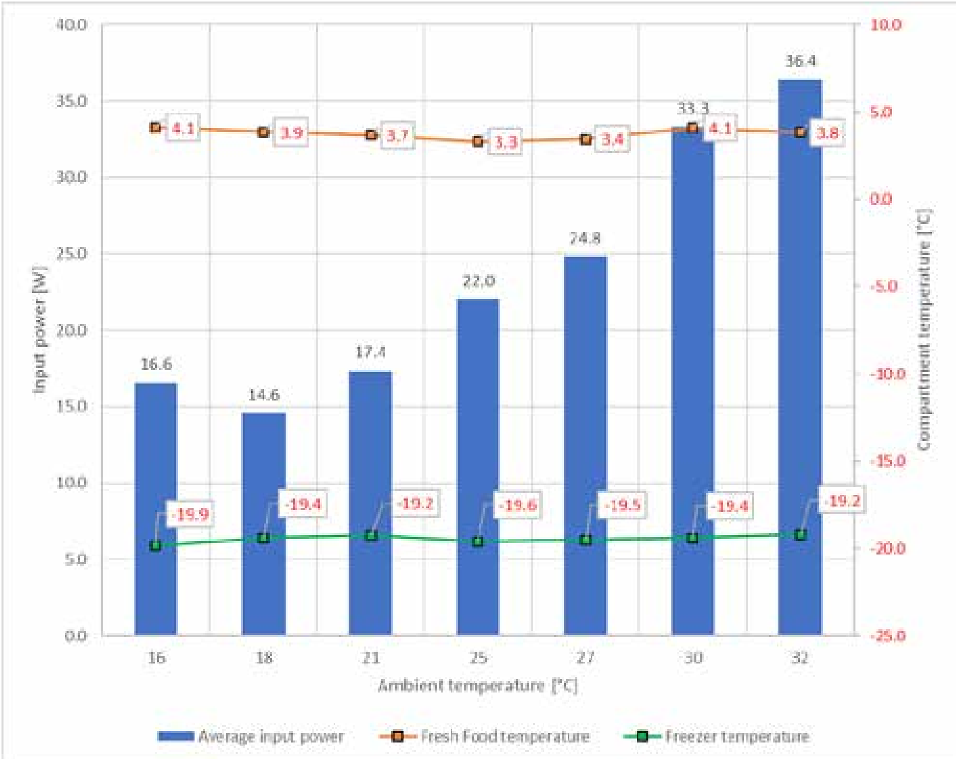
Figure 4-1: Model A: Fluctuating ambient conditions test results



The figure shows a remarkable behaviour at 16°C ambient temperature. The average input power of the appliance at this ambient is 13.7 % higher compared to the results at an ambient of 18°C. In general, it is expected that the average input power would follow the same trend as seen between the ambient temperatures of 18°C and 32°C in case the compartment temperatures are kept roughly at the same values. The graph shows some deviations of the compartment temperatures between the ambient temperatures, but an increase of the input power of 13.7% is unlikely to be caused by the slightly lower freezer temperature (-19.9°C) measured.
Furthermore, the increase between 27°C and 30°C is larger than expected.

To analyse the behaviour of the appliance in more detail the average input power is split up in three parts, namely;

- The input power when the fresh food compartment is cooling.
- The input power when the freezer is cooling.
- The input power during the off cycle.

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Figure 4-2: Model A: Detailed overview input power at fluctuating ambient conditions

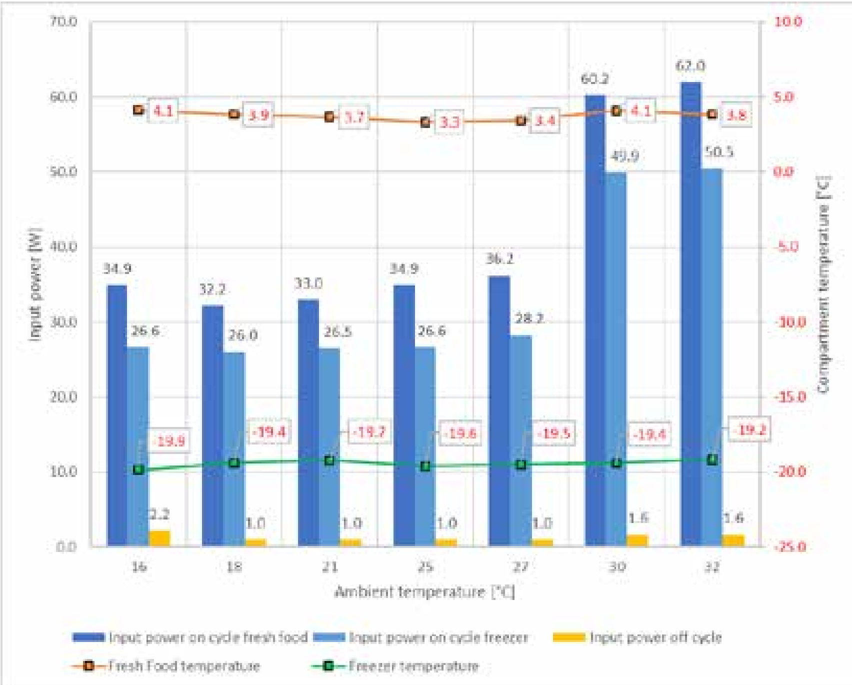

Figure 4-2 clearly shows the cause of the discrepancies at 16, 30 and 32°C ambient temperatures.

Starting with the 16°C ambient test the following is observed compared to the standard energy consumption test conditions:

- Input power during the off cycle increases by 1.2 W.
- Input power during the fresh food on-cycles is slightly higher than expected.

This observation could indicate that a component is activated more often compared to the standard energy consumption testing conditions. However, based on the available data it is not possible to determine this component.

For the 30 and 32°C ambient the following is observed:

- Input power during the off cycle increases by 0.6 W.
- Input power during the on cycles is significantly higher.

The slightly increase during the off cycle is most likely caused by the same component as during the 16°C ambient test. The significant increase of the on-cycle input power is a result of the compressor running in a higher speed. That the compressor speed increases at warmer ambient temperatures is in line with the thermodynamic theory, however this effect is not considered while determining the energy consumption of the appliance during the conformity tests for the current regulations and related harmonised standard.

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4.1.3.2 Model B

4.1.3.2.1 Standardized test results

The appliance is setup according to the harmonized standard and tested accordingly for the energy consumption. Table 4-5 below presents the result obtained during this test[11].

Table 4-5: Model B: Result of the energy consumption test according to the harmonized standard

		Declared	Measured	Deviation from Declared
Energy consumption	[kWh/year]	216	211.70	-2.0%

The result is in conformity with the COMMISSION DELEGATED REGULATION (EU) No 1060/2010, since the measured energy consumption is less than the declared value.

4.1.3.2.2 Alternative test method results

4.1.3.2.2.1 Fluctuating voltage supply

The test is performed with the exact same configuration of the refrigerator during the standard energy consumption test, while only changing the power supply of the appliance. The stabilized power supply is changed with the power grid available in the Netherlands. The voltage fluctuation band width of the grid is shown in the table below.

[11] More detailed reference is made to Re/genT report number 20237/AN03/V1

Table 4-6: Model B: Fluctuating voltage supply test results

		standardized testing	alternative test method	Difference
Thermostat setting		8/-16/3	8/-16/3	
Defrost interval	[hours]	Not constant	Not constant	
Defrost heater activation	[min]	15.6	14.4	-7.7%
Input power off cycle	[W]	0.5	0.5	0.0%
Average fresh food temperature	[°C]	5.3	5.2	-0.1K
Average freezer temperature	[°C]	-17.5	-17.5	0.0K
Average chill temperature	[°C]	1.8	1.8	0.0K
Voltage range	[V]	231.3 - 232.4	233.6 - 243.3	
Average voltage	[V]	232.1	239.2	
Average input power[12]	[W]	26.2	26.0	-0.7%
Average input power steady state (no defrost)[13]	[W]	22.8	22.6	-0.8%

Based on the tests performed, Model B is not reacting differently when being supplied with the grid power from the Netherlands.

4.1.3.2.2.2 Triggered by the door switch: Non-physical and physical door openings

The test is performed with the same configuration of the refrigerator as during the standard energy consumption test. The test is performed twice, first with non-physical door openings by tricking the fresh food door switch, results shown in Table 4-9, and the second time with physical door openings of the freezer compartment only, results shown in Table 4-10. The results presented in both tables, except for the defrost interval value, are taken over a period from the initiation of a defrost until 30 hours later. During the non-physical door openings, the door switch is tricked twice a day for a period of 4 days.

[12] Measurement period is 30 hours starting from an initiation of a defrost.
[13] Measurement period is 24 hours starting 6 hours after an initiation of a defrost.

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Table 4-7: Model B: Non-physical door opening test results

		standardized testing	alternative test method	Difference [-]
Thermostat setting		8/-16/3	8/-16/3	
Defrost interval	[hours]	34.9	47.6	+36.4%
Defrost heater activation	[min]	15.0	12.6	-16.0%
Input power off cycle type 1	[W]	0.5	0.5	0.0%
Average fresh food temperature	[°C]	5.2	5.4	+0.1K
Average freezer temperature	[°C]	-17.5	-17.5	0.0K
Average chill temperature	[°C]	1.8	1.7	-0.1K
Average input power	[W]	25.8	24.6	-4.5%
Average input power steady state (no defrost)[14]	[W]	22.5	21.6	-3.9%

The results in Table 4-7 from the alternative testing do not deviate too much from the results of the standard energy consumption test. However, remarkable is that the defrost interval fluctuates in the opposite direction as expected, i.e. the duration of the defrost interval is even increased under alternative testing with non-physical door openings, although one might have rather expected decreased defrost intervals. For the other parameters, the behaviour of the appliance is in line with the standard energy consumption test.

[14] Neglecting the first 6 hours after the start of a defrost.

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Table 4-8: Model B: Physical freezer door opening test results

		standardized testing	alternative test method	Difference [-]
Thermostat setting		8/-16/3	8/-16/3	
Defrost interval	[hours]	34.9	35.0	+0.3%
Defrost heater activation	[min]	15.0	13.8	-8.0%
Input power off cycle type 1	[W]	0.5	0.5	0.0%
Average fresh food temp.	[°C]	5.2	5.3	+0.1K
Average freezer temperature	[°C]	-17.5	-17.4	-0.1K
Average chill temperature	[°C]	1.8	1.8	0.0K
Average input power	[W]	25.8	25.3	-1.8%
Average input power steady state (no defrost)	[W]	22.5	22.0	-2.5%

For the physical door opening, as shown in Table 4-10, Model B shows similar behaviour as during the standard energy consumption test. The results indicate that the appliance is not altering its control behaviour due to physical door openings of the freezer compartment.

4.1.3.2.2.3 Fluctuating ambient conditions

The test is performed with the exact same configuration of the refrigerator during the standard energy consumption test. The ambient temperature is varying over time and for each ambient temperature a steady state measurement is saved and used for the analysis. The thermostat settings are not adjusted during the test.

In Figure 4-3 the average input power of the cabinet during the measurement period is set out to the left axis. The average compartment temperatures measured are set against the right axis. The horizontal axis represents the ambient temperature.

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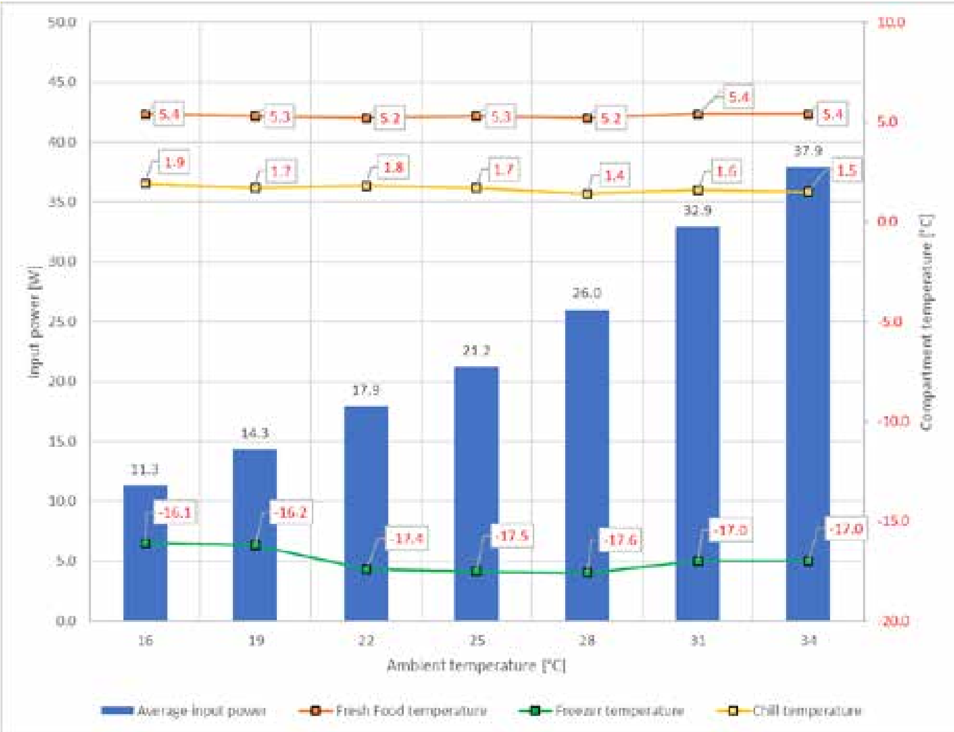
Figure 4-3: Model B: Fluctuating ambient conditions test results



The trend of the power consumption is in line with the expectations. The average of the results is shown below in Table 4-9.

Table 4-9: Model B: Overview table of the fluctuating ambient conditions test

		Single testing point	Average of all testing points	Difference [-]
Average input power	[W]	21.2	23.1	+8.8%
Ambient temperature	[°C]	25	25	

When averaging all measurements, the average input power increases by 8.8% compared to the single point tested. To analyse the difference in more detail, the average input power is split up in three parts, namely;

- The input power when the fresh food compartment is cooling.
- The input power when the freezer is cooling.
- The input power during the off cycle.

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Figure 4-4: Model B: Detailed overview input power at fluctuating ambient conditions

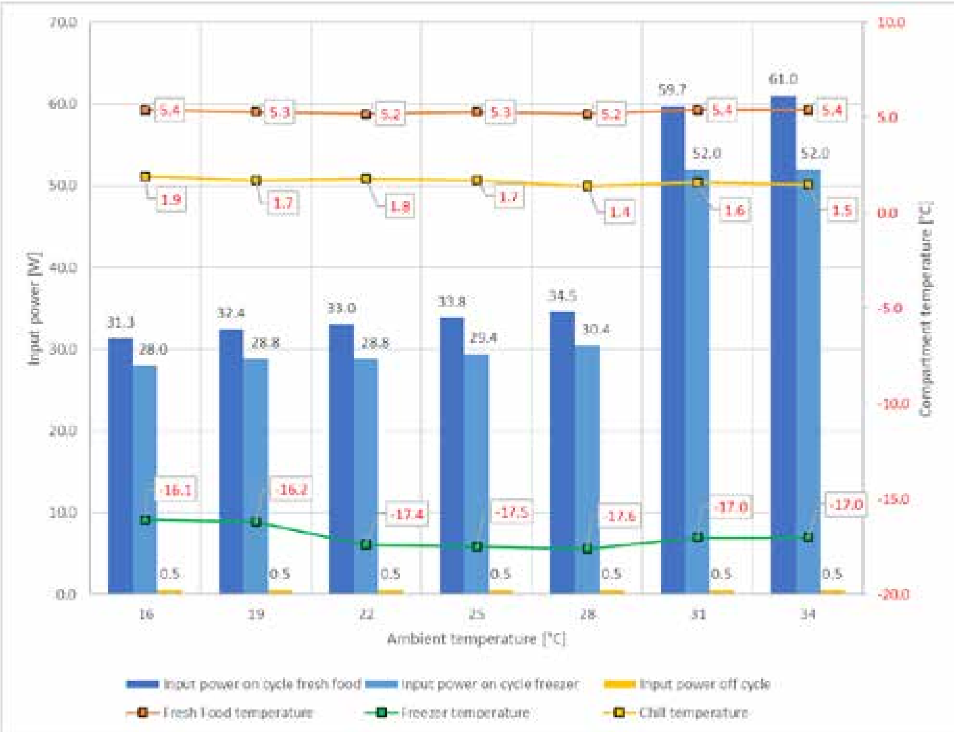

Figure 4-4 indicates that at the higher ambient temperatures the compressor speed increases compared to the lower ambient temperatures. The higher compressor speed also reduces the efficiency of the appliance which is in line with the deviation noted in Figure 4-3. That the compressor speed increases at warmer ambient temperatures is in line with the thermodynamic theory, however this effect is not considered while determining the energy consumption of the appliance during the conformity tests for the current regulations and related harmonised standard.

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4.1.3.3 Model C

4.1.3.3.1 Standardized test results

The appliance was setup according to the harmonized standard and tested accordingly for the energy consumption. Table 4-10 below presents the result obtained during this test[15].

Table 4-10: Model C: Result of the energy consumption test according to the harmonized standard

		Declared	Measured	Deviation from declared
Energy consumption	[kWh/year]	149	168.63	+13.2%

The result is not conforming to COMMISSION DELEGATED REGULATION (EU) No 1060/2010, since the measured energy consumption deviation is more than 10% which is used for the verification tolerance.

4.1.3.3.2 Alternative test method results

4.1.3.3.2.1 Fluctuating voltage supply

The test is performed with the exact same configuration of the refrigerator during the standard energy consumption test, while only changing the stabilized power supply to the power grid available in the Netherlands. The fluctuation bandwidth of the grid is shown in the table below.

[15] More detailed reference is made to Re/genT report number 20238/AN04/V1

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Table 4-11: Model C: Fluctuating voltage supply test results

		standardized testing	alternative test method	Difference
Thermostat setting		3/-25/level 5	3/-25/level 5	
Defrost interval	[hours]	> 72	> 72	
Defrost heater activation	[min]	16.2	19.2	+18.5%
Input power off cycle	[W]	1.4	1.4	0.0%
Average fresh food temperature	[°C]	3.2	3.2	0.0K
Average freezer temperature	[°C]	-23.6	-23.5	+0.1K
Average chill temperature	[°C]	0.7	0.9	+0.2K
Voltage range	[V]	230.8 - 233.1	233.6 - 243.6	
Average voltage	[V]	232.0	239.0	
Average input power[16]	[W]	24.9	25.5	+2.2%
Average input power steady state (no defrost)[17]	[W]	24.0	24.2	+0.8%

Based on the tests performed, Model C does not react differently when being supplied with the grid power from the Netherlands. Although the defrost heater is activated for a longer period (+18.5%), the resulting deviations of the average input power (2.2%) and the average input power at steady stage (0.8%) are negligible.

4.1.3.3.2.2 Triggered by the door switch: Physical door openings

The test is performed with the same configuration of the refrigerator as during the standard energy consumption test. The results presented below are taken over a time period starting with the initiation of a defrost until 40 hours later. The fresh food door is opened twice a day for 4 consecutive days.
The results presented below contain the last 2 days of door openings.

[16] Measurement period is 72 hours starting from an initiation of a defrost.
[17] Measurement period is 24 hours starting 6 hours after an initiation of a defrost.

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Table 4-12: Model C: Physical door opening test results

		standardized testing	alternative test method	Difference
Thermostat setting		4/-22/level 3	4/-22/level 3	
Defrost interval	[hours]	> 72	> 72	
Defrost heater activation	[min]	14.4	11.4	-20.8%
Input power off cycle type	[W]	0.8	2.8	+250%
Average fresh food temperature	[°C]	3.3	3.4	+0.1K
Average freezer temperature	[°C]	-19.9	-20.2	-0.3K
Average chill temperature	[°C]	0.6	0.2	-0.4K
Average input power	[W]	22.0	23.8	+7.8%
Average input power steady state (no defrost)[18]	[W]	20.8	23.0	+10.7%

In general, the controlling algorithm is not impacted by door openings.
However, there is still an increase of energy consumption measured during the door opening period compared with the reference tests. This is due to the activation of the display when door openings are detected. More detailed information is available in chapter 4.2 where the effect of the display is analysed separately in Case COLD3.

4.1.3.3.2.3 Fluctuating ambient conditions

The test is performed with the exact same configuration of the refrigerator during the standard energy consumption test. The ambient temperature is varying over time and for each ambient temperature a steady state measurement is saved and used for the analysis. The thermostat settings are not adjusted during the test.

In Figure 4-5 the average input power of the cabinet during the measurement period is set out to the left axis. The average compartment temperatures measured are set against the right axis. The horizontal axis represents the ambient temperature.

[18] Neglecting the first 6 hours after the start of a defrost.

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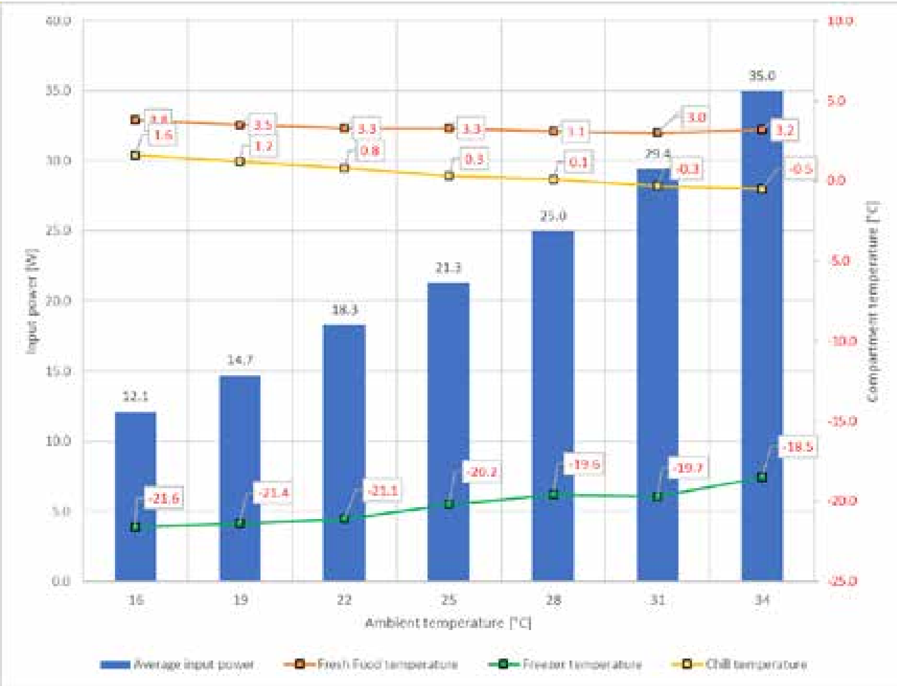
Figure 4-5: Model C: Fluctuating ambient conditions test results



A remarkable trend shown in the figure above is that the measured compartment temperatures (freezer the most, but also the other compartments) are fluctuating relatively a lot when the ambient temperature is changing. Since all measurements are performed with the same thermostat setting it would be reasonable to expect only a small deviation in the measured temperatures. However, the figure shows that the deviation is up to 3K for the freezer compartment temperature, which is unexpected. Furthermore, the appliance shows a complicated variable speed compressor control algorithm and therefore the input powers are not analysed due to the variance in these measured powers for each ambient temperature.
In Table 4-13, the average of all ambient tests is compared with a single ambient test point.

Table 4-13: Model C: Overview table of the fluctuating ambient conditions test

		Single testing point	Average of all testing points	Difference
Average input power	[W]	21.3	22.3	+4.5%
Ambient temperature	[°C]	25	25	

Based on the available data it is not possible to provide a statement about the behaviour of the appliance for this test, but it tends that the average input power of the appliance is not reacting noticeably different when the ambient temperature fluctuates.

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4.1.4 Conclusions about case COLD2/4

Multiple trigger events were tested, and the behaviour of the cabinets analysed. An overview of these tests and their outcome are presented in Table 4-14.

Table 4-14: Overview of the tests results of all appliances

	Model A	Model B	Model C
Fluctuating voltage supply test			
Physical door opening test			Jeopardy effect (cf. case COLD3)
Fluctuating ambient conditions test	Missing representativeness of the standard	Missing representativeness of the standard	Undisclosed

For the *fluctuating voltage supply test*, no circumvention has been detected for the tested Models, i.e. the deviations of the standard and alternative test results are not relevant. The deviations found for the *physical door opening test* in Model C are further analysed in chapter 4.2, which discusses the COLD3 case.

The *fluctuating ambient conditions test* shows two possible effects on the energy consumption of the appliance. At relative higher and lower ambient temperature conditions the appliance starts to act differently by;

- Increasing the compressor speed at warmer ambient temperatures, resulting in an overall electrical efficiency decrease of the appliance.
- Increasing the activation time of an unidentified component when the ambient condition is colder or warmer than the ambient temperature during the energy consumption test.

The increase of the compressor speed is a result that the required cooling capacity increases at higher ambient temperatures. It is in line that at cold ambient temperatures the speed is lower compared to the warmer ambient temperatures. With a variable speed compressor, manufacturers have the possibility to optimize the energy efficiency of the appliance for multiple ambient conditions while fixed speed compressors can only be optimized at one ambient condition. However, since the declared energy consumption is only measured at one ambient condition it cannot take into account any required higher compressor speeds at warmer ambient temperatures compared to the ambient temperature of the standard energy consumption test. For the second point observed, it is quite possible that some components need to be activated more often to achieve the desired performance at lower ambient temperatures. For example, an internal fan needs to be activated more often to achieve a better temperature distribution.

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Based on these two points the alternating behaviour is rated as missing representativeness of the standard. It is positive that the appliance is optimized at several ambient conditions, but according to the conformity tests only one ambient temperature needs to be tested for the energy consumption value.

Regarding the applicability of the proposed alternative tests methods, in general, the resources and/or time required to identify multiple operating modes is extensive. Especially when detailed analysis is required to provide a statement about the operating modes. Technical experts are required to proper analyse the alternative test results and to make a statement if a certain alteration of the behaviour is acceptable or overexaggerated. An additional aspect that can increase the testing time is when there is no evidence of a possible trigger action causing suspicious behaviour. In case the trigger is identified the amount of resources can be reduced by only focussing to analyse this known behaviour. Additional time can be further reduced by combining multiple tests. The matrix below shows an overview of which tests, discussed in this chapter, can be combined. Note that by combining tests it will be harder to identify the trigger of any alteration of the operating algorithm of the appliance.

Table 4-15: Matrix of possible test combinations

	Fluctuating ambient	Fluctuating voltage	Physical door openings
Fluctuating ambient	X	X	
Fluctuating voltage	X	X	
Physical door openings			X

Overall, it is recommended to perform at least the (physical) door openings alternative test method after the standardized energy consumption testing to look for any circumvention. Although the models tested in ANTICSS did not show relevant results in the alternative test methods, experiences[19] from standardized testing, outside the ANTICSS project, showed that some appliances acted differently when the door switch was triggered. If the appliance is not alternating the control logic within a few days on aspects like change in temperature distribution throughout the cold compartments and/or increased component activation activities, it is most likely that the control logic will remain the same. However, in case the appliance reacts on the (physical) door openings, it is recommended to perform more extensive and detailed testing on the appliance to obtain an estimation of the impact of the alternating behaviour.

[19] Apart from the ANTICSS testing, Re/genT has conducted extensive standard tests on domestic household refrigerators. Any strange behaviour noted during these standard tests was mostly triggered by door openings.

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4.2 Case COLD3

4.2.1 Description of the case

In the case initially reported to ANTICSS, for certain appliances the display of a controller is activated each time the door is opened and remains active for a longer period unless it is switched-off by pressing a button. The display cannot be deactivated permanently. The user manual states that the energy consumption increases when the display of the controller is lid up. According to the standard ‘the refrigerating appliance shall be set up as in service in accordance with the manufacturer’s instructions.’ It is most likely that the consumer will not continuously repeat the extra action required to obtain the declared energy consumption. Since the user manual states that you need to turn off the display to save energy, it has to be done also under test. Note that this requirement is not in conflict with the standard and is therefore allowed. However, it is disputable if the consumer will follow this procedure to save energy.

The tested Model C deviates on some points compared to this initial case description; details are described below, see section “Modifications, improvements or clarifications to the initial alternative testing procedure”.

4.2.2 Alternative testing procedure

The increased annual energy consumption due to the continuous activation of the display will be calculated by the following formula.

$$AE_{increased} = AE_{conformity\ test} + \frac{E_{display} \times 24 \times X}{1000}$$

Where

- $AE_{increased}$ is the annual energy consumption considering the display input power [kWh/year]
- $AE_{conformity\ test}$ is the annual energy consumption measured during the conformity tests [kWh/year]
- $E_{display}$ is the input power of the display [W]
- X is the amount of days it is estimated that the display is activated [-]

$E_{display}$ is measured during an off cycle of the cooling system, while switching the display on and off. The difference of the measured input power is accounted to the display.

The purpose of this alternative testing method is to evaluate impact on additional energy consumption of the display that has to be turned off under standard testing but will rather be continuously activated in daily use.
Note: The above proposed alternative testing method is in general also applicable for the product category domestic freezers and refrigerators-freezers.

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Modifications, improvements or clarifications to the initial alternative testing procedure

The initial alternative testing procedure as described above is included in the ANTICSS report “Alternative test methods and approaches to unmask circumvention under EU Ecodesign and Energy labelling” (Deliverable D14)[20]. In the following, further specifications are listed.

The appliance tested deviates on some points compared to the appliance in the case description. The appliance used for alternative testing does not have a functionality to turn off the display immediately. The appliance only has a parameter which controls whether the display remains on or is turned off after 24 hours without door detection. The consumer can only set if it will or will not turn off after 24 hours; it is not possible to increase or shorten this time in the settings.

The user manual states to leave the “screen switch-off function” in the pre-set value in order to save energy. In another paragraph a statement was made that in case the pre-set switch-off function is disabled the energy consumption will slightly increase.

1.6 Saving energy

- Pay attention to good ventilation. Do not cover ventilation holes or grids.
- Always keep the fan air slits clear.
- Do not install the appliance in direct sunlight, next to an oven, radiator or similar.
- Energy consumption is dependent on the installation conditions, e.g. ambient temperature (see 1.2) . If the ambient temperature deviates from the standard temperature of 25°C, the energy consumption may differ.
- Open the appliance for as short a time as possible.
- The lower the temperature is set the higher the energy consumption.
- Arrange the food in an organised way (see 1) .
- Keep all food properly packed and covered. This prevents frost from forming.
- Only take food out for as long as necessary so that it doesn't warm up too much.
- Inserting warm food: allow to cool down to room temperature first.
- Thaw frozen food in the refrigerator.
- Use the holiday function if you intend to be away for an extended period.
- Leave the default setting of the screen switch-off function. This switches the screen off after 24 hours, (see 5.1.5) .

5.1.5 Set screen brightness

Under *Display* you can set the brightness of the Status screen, the time until the Status screen darkens and you can have the screen switch off without opening the door after 24 hours.

If the screen switch off pre-set when it is delivered from the factory is switched off, the amount of energy use increases slightly.

▶ Press *Display*.

▶ Set the Status screen brightness from levels 1 to 5: Press navigation arrows.

▶ Set the time before the screen darkens, from 30 seconds to 10 minutes: Press navigation arrows.

▶ Enable/disable screen auto switch-off after 24 hours: Press status button On/Off if required.

Figure 4-6: Model C: Extract of the user manual regarding the “screen switch-off” function

20 See https://www.anti-circumvention.eu/storage/app/media/D14_ANTICSS_Alternative-test-procedures_final.pdf

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4.2.3 Summary of results

4.2.3.1 Model C

4.2.3.1.1 Standardized test results

The appliance was set up according to the harmonized standard and tested accordingly for the energy consumption. Table 4-16 below presents the result obtained during this test[21].

Table 4-16: Model C: Result of the energy consumption test according to the harmonized standard

		Declared	Measured	Deviation from declared
Energy consumption	[kWh/year]	149	168.63	+13.2%

The measured energy consumption represents $AE_{conformity\ test}$ of the formula given in chapter 4.2.2.

The result is not conforming to COMMISSION DELEGATED REGULATION (EU) No 1060/2010, since the measured energy consumption deviation is more than 10% which is used for the verification tolerance.

4.2.3.1.2 Alternative test method results

After the standardized tests, the fresh food compartment door was opened once to activate the display and measure the input power of it. In the graph below the input power of the appliance and measured temperatures are plotted, and at Time = 0 the door was physically opened.

[21] More detailed reference is made to Re/genT report number 20238/AN04/V1

Figure 4-7: Model C: Temperatures and input power measured

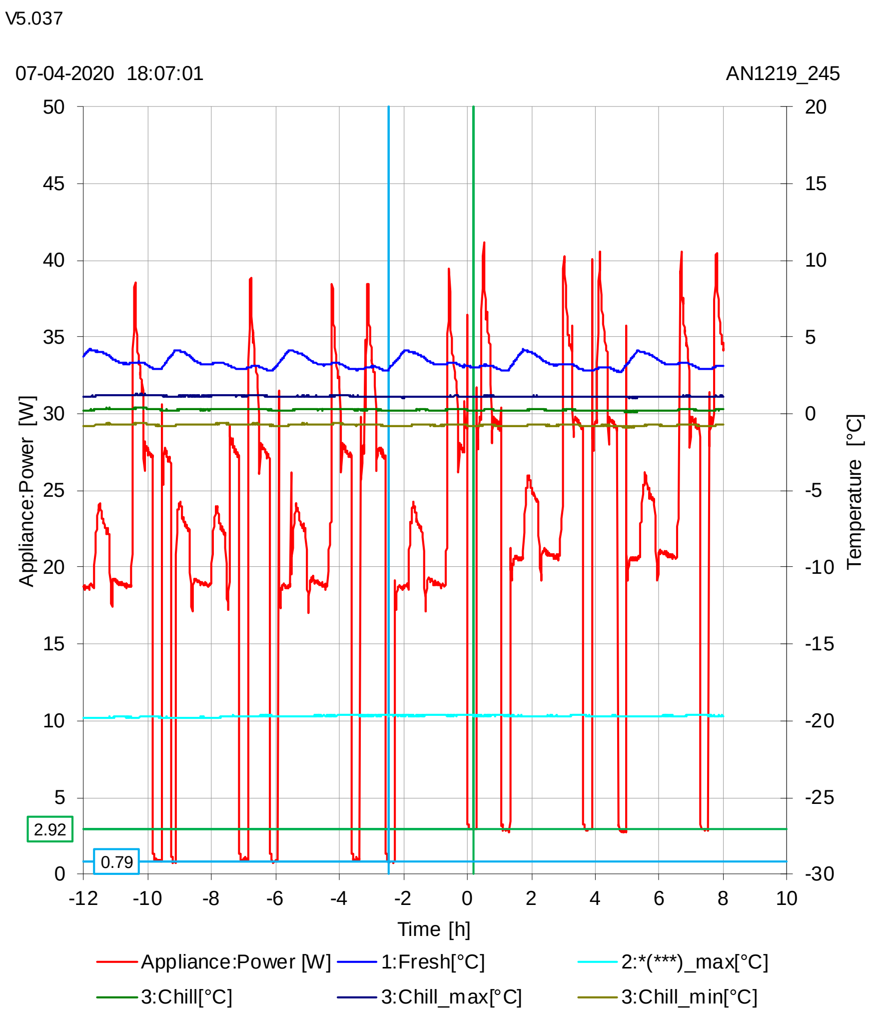

Figure 4-7 shows that the trend of the temperature is identical as before the door opening as well as the input power signal, not considering the overall approximate 2W increase. Therefore, it can be concluded that the operating algorithm of the appliance is not immediately affected by a door opening, except that the display is enabled for 24 hours, and thus the change in input power can be accounted entirely to this display.

The increase of the input power signal caused by the display is determined during the off cycles[22] of the appliance, in order to minimize the number of components activated and avoid the dynamic behaviour of the cooling system. The display darkening has been set to 10 seconds, i.e. the input power of the display is measured "on-darkened".

[22] Off cycle is the period when the compressor cooling system is not cooling down the appliance.

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The following input power values in Table 4-17 are read during the off cycle in Figure 4-7.

Table 4-17: Input power values during the off cycle of the appliance

		Before door opening	After door opening	Difference
Input power	[W]	0.8	2.9	**2.1W**

The display input power is estimated at 2.1W, since the difference measured is assumed to represent the display input power only.

The formula from chapter 4.2.2 will be using 2.1W as $E_{display}$ and the measured $AE_{conformity\ test}$ of 168.63 kWh/year from chapter 4.2.3.1.1. Further, it is assumed that the consumer is, on average, 20 days per year away from home with the display then switched-off after 24 hours without door openings.

$$AE_{increased} = 168.63 + \frac{2.1 \times 24 \times 345}{1000} = 186.02 \frac{kWh}{year}$$

The results show an additional energy consumption of 17.39 kWh/year due to the display that cannot be switched-off manually. This is an increase of 10.3% compared to the standard testing value. Considering the values of the alternative method, the energy efficiency class would change into A++ instead of A+++. However, it has to be noted that the results under the standard testing conditions deviate by 13.2% from the declared values, resulting in non-conformity of this model for the energy consumption under standard testing.

Table 4-18: Model C: Case COLD3 – Results energy consumption

	Declared	Standard testing conditions	Alternative method	Standard vs. declared	Alternative vs. declared	Alternative vs. standard
Energy consumption [kWh/year]	149	168.63	186.02	13.2%	24,8%	10,3%
Energy Efficiency Index	18.0	20.3	22.4			
Energy efficiency class	A^{+++}	A^{+++}	A^{++}			

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4.2.4 Conclusions about case COLD3

According to regulation (EU) 1060/2010 the verification tolerance for market surveillance purposes concerning energy consumption is 10%. If the 10% are used as a reference for determining how important the deviation between the standard and the alternative procedure for these parameters is it can be concluded that the difference between the values obtained in the standard and the alternative procedure is relevant.

During the conformity testing, the display is not activated. Therefore, it is not included in the results used for the label calculation. The consumer cannot disable it permanently and after activation the display will be automatically disabled only after 24 hours of the last door opening.

The incentive for having the display activated is to have a digital clock on the refrigerator. In case the consumer is away for a longer period, the cabinet can save energy by disabling the display after 24 hours. However, during the harmonized tests, the doors are not opened for a period far exceeding the 24 hours period. As result of the controller algorithm the display is automatically switching off during the standard testing. Therefore, the appliance operates as if the consumer is not at home and in order to save energy it deactivates the display. In respect to this, the measured and declared energy consumption represents only the most efficient mode of the appliance.

According to the flow chart (see section 3, Figure 3-1), this case at the general level, i.e. an energy saving function – both applicable in the test situation and consumers usage, but the latter only applicable in infrequent situations, was initially categorized as "jeopardy effect" according the definition included in chapter 2 of this report:

"Jeopardy effects encompass all aspects of products or test instructions, or interpretation of test results, which do not follow the goal of the EU ecodesign and/or energy labelling legislation of setting ecodesign requirements and providing reliable information about the resource consumption and/or performance of a product. These effects may not be classified as circumvention, but become possible due to loopholes or other weaknesses in standards or regulations."

For the tested Model C, the deviations of the standard and alternative test results are relevant which leads to the ANTICSS categorisation of "borderline to circumvention".

In general, this alternative test method is relatively easy to perform and does not cost a lot of extra resources and time but will slightly increase in case the display activation time is unknown. Then it is necessary to determine this value in order to make a judgement about the impact of the behaviour.

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4.3 Summary of results of this product category

The following tables provide a summary of the results of cases and models tested in the product category domestic freezers and refrigerator-freezers.

ANTICSS standard test results

Both Models A and C are non-conforming with the requirements of energy consumption test of the Ecodesign and Energy labelling regulations, whereas Model B is conforming to the requirements of the Ecodesign and Energy labelling regulations according to the harmonized standard test.

Table 4-19: Overview of the standard test results of cases and models tested in the product category domestic freezers and refrigerator-freezers

Standard test	Model A	Model B	Model C
Standard test[23]	**Not conforming**	Conforming	**Not conforming**

ANTICSS alternative test results

For Case COLD2/4, the general case, i.e. the energy saving function "ECO" or “holiday mode”, activated when the door is kept closed for a longer period, is classified as “jeopardy effect” as this function applies both in the test situation (no door openings under standard test) and in consumer usage but for the latter applicable only in rather infrequent situations. For the tested Models A and B, no circumvention has been detected, i.e. the deviations of the standard and alternative test results are not relevant. For Model C, the physical door opening test under Case COLD2/4 provided relevant deviations between the standard and alternative test which are related to Case COLD3 and therefore were further analysed there.

For Case COLD3, the general case, i.e. the energy saving function of a display automatically switched off only after a period of 24 hours of no door openings, is classified as “jeopardy effect” as this function applies both in the test situation (no door openings under standard test) and in consumer usage but for the latter applicable only in rather infrequent situations. Model C automatically disables the display only after 24 hours without door openings, without any possibility to disable it at an earlier time. For the tested Model C, the deviations of the standard and alternative test results are relevant which leads to the ANTICSS categorisation of “borderline to circumvention”.

[23] Not the complete set of standard tests are performed. The conforming and non-conforming only relates to the energy consumption test result.

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Table 4-20: Overview of the ANTICSS alternative test results of cases and models tested in the product category domestic freezers and refrigerator-freezers

Alternative test	Model A	Model B	Model C
Case COLD 2/4			Door opening test, cf. Case Cold 3
Case COLD 3	Not tested	Not tested	

ANTICSS colour legend:

General level (Case)	Product level (tested Model)	
Yellow: Jeopardy effect	Green:	No Circumvention
Orange: Hints for Circumvention	Dark orange:	Borderline to circumvention
	Red:	Circumvention

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Czech Republic: SEVEn - SEVEn, the Energy Efficiency Center, z.u.
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Portugal: ASAE - Autoridade seguranca alimentar e economica
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ANTICSS Project Deliverable D18 (D4.5):

Test Reports – Part 4: Domestic freezers and refrigerators-freezers

ANNEX: Test laboratory report

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