



Assistance to the Commission on Technological Socio-Economic and Cost-Benefit Assessment Related to Exemptions from the Substance Restrictions in Electrical and Electronic Equipment:

Study to assess renewal requests for 29 RoHS 2 Annex III exemptions [no. I(a to e -lighting purpose), no. I(f - special purpose), no. 2(a), no. 2(b)(3), no. 2(b)(4), no. 3, no. 4(a), no. 4(b), no. 4(c), no. 4(e), no. 4(f), no. 5(b), no. 6(a), no. 6(b), no. 6(c), no. 7(a), no. 7(c) - I, no. 7(c) - II, no. 7(c) - IV, no. 8(b), no. 9, no. 15, no. 18b, no. 21, no. 24, no. 29, no. 32, no. 34, no. 37]

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Disclaimer:

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26.0 Exemption 9: "Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution"

Declaration

In the sections that precede the "Critical Review" the phrasings and wordings of stakeholders' explanations and arguments have been adopted from the documents provided by the stakeholders as far as required and reasonable in the context of the evaluation at hand. Formulations have been altered in cases where it was necessary to maintain the readability and comprehensibility of the text. These sections are based exclusively on information provided by applicants and stakeholders, unless otherwise stated.

Acronyms and Definitions

CrVI	Hexavalent chromium
CrIII	Trivalent chromium
ECHA	European Chemicals Agency
EEE	Electrical and electronic equipment
ELV	End-of-life vehicle
EoL	End-of-life
EU COM	European Commission
RAC	Risk Assessment Committee
RV	Recreational vehicles
SEAC	Socio-Economic Analysis Committee
TMC	The Test and Measurement Coalition

26.1 Background

According to the applicant,¹⁴⁷⁰ absorption refrigerators are used in recreational vehicles (RV), marine applications, camping boxes and mobile cooling boxes for medical purposes¹⁴⁷¹ and generally in cases of restricted space e.g. for hotel minibars, in lodges and small apartments, because they operate silently and vibration-free. Absorption refrigerators can be run on different energy sources like electricity, kerosene or gas. Some products are designed to run on variable energy sources. The noiseless operation and the possibility to switch between the energy sources are the important performance criterion according to the applicant.

In absorption refrigeration, a heat source (e.g. gas or electricity) is used to separate the ammonia from the water that then enters the evaporator where the presence of hydrogen lowers the ammonia vapour pressure sufficiently to allow the liquid ammonia to evaporate. The evaporation of the ammonia extracts heat from the air, thereby lowering the temperature inside the refrigerator.¹⁴⁷² This is schematically shown in the following figure.

¹⁴⁷⁰ Dometic (2015a), Original Application for Exemption Renewal Request, submitted 20.01.2015, available under:

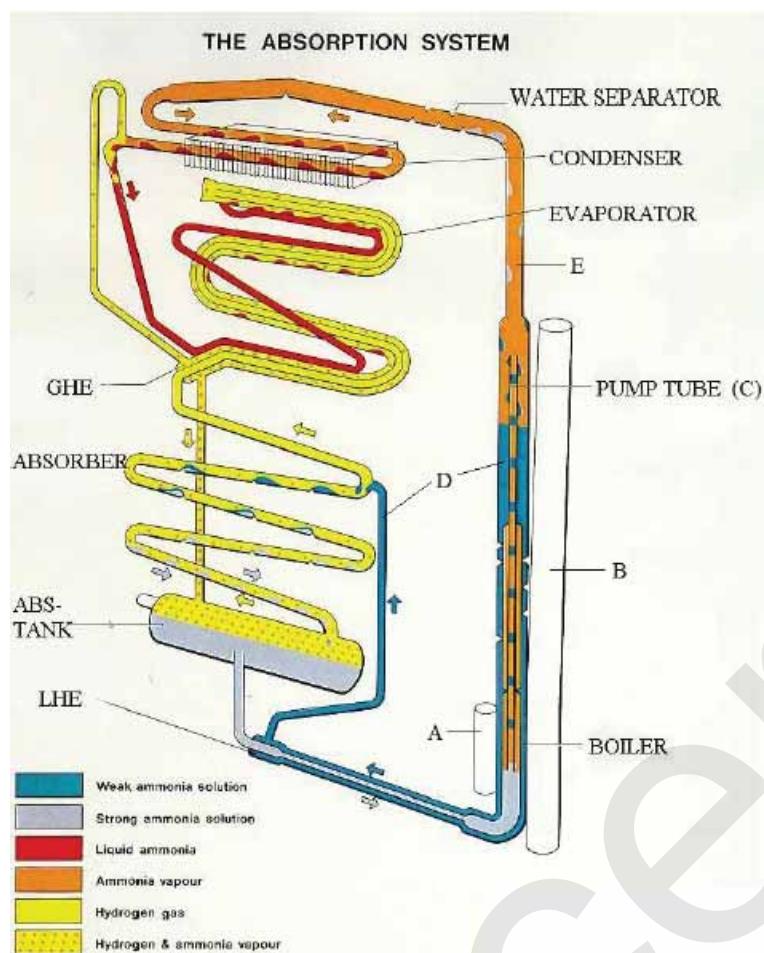
http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_9/9_150120_RoHS_V_Application_Form_Dometic.pdf

Dometic (2015c), Dometic GmbH, Analysis of Alternatives and Socio-Economic Analysis, available under <http://echa.europa.eu/documents/10162/0783ee3a-7de9-45ec-a72a-c1689ee49e09>

¹⁴⁷¹ For e.g. transportation of vaccine and blood according to Dometic (2015c)

¹⁴⁷² Op. cit. Dometic (2015c)

Figure 26-1: Absorption cooling system schematic



Source: Dometic (2015c)

Hexavalent chromium (CrVI) acts as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators. According to the applicant¹⁴⁷³, CrVI is used to create a thin and tight layer on the interior surface of the steel tubes to protect them from the cooling solution that contains corrosive ammonia. The cooling system is comprised from carbon steel because of its strength and its good welding- and cold-working properties.

Dometic has submitted a request for the renewal of Ex. 9:

"Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution"

Dometic requests an extension of the exemption for another three years in order to finalize substitution with an alternative corrosion inhibitor in the absorption refrigerator

¹⁴⁷³ Op. cit. Dometic (2015a)

range of products falling under RoHS. According to the applicant¹⁴⁷⁴, most of the products used in the lodging industry and in private homes are covered by the RoHS Directive. The applicant¹⁴⁷⁵ states that products falling under the RoHS Scope belong to category 1.

The applicant further explains that products for recreational vehicles (RV) and marine applications with absorption technology are most often specifically designed for that purpose and thus fall outside of the scope of RoHS. Several products for RV fall within the scope of the ELV-directive.¹⁴⁷⁶ A corresponding exemption is available under the ELV Directive (2000/53/EC, Annex II, Ex. 14) and is formulated as follows:

"As an anti-corrosion agent of the carbon steel cooling system in absorption refrigerators in motorcaravans up to 0,75 weight % in the cooling solution except where the use of other cooling technologies is practicable (i.e. available on the market for the application in motor caravans) and does not lead to negative environmental, health and/or consumer safety impacts".

26.1.1 History of the Exemption

During the last revision of Exemption 9, the same wording was proposed as under the ELV Directive mentioned in the para above.¹⁴⁷⁷ It was understood that research and development of alternatives for CrVI was still underway and required additional time. Furthermore, alternative cooling technologies such as thermoelectric refrigeration and compressor refrigeration that do not need CrVI were discussed during the last revision. At the time, Dometic stated that for some areas of use compressor-based alternatives are available. However, being noisier than absorption refrigerators, this may be a health concern for some consumers. Though noise could possibly be mitigated through design changes, it was further understood that small-scale compressor-based refrigerators are only available for a small number of applications, starting with approximately 80 l, and thus not suited as e.g. built-in minibars of approximately 40 l. Thus it was concluded at the time that such compressor-based units cannot be used as alternatives on the system level to eliminate the need for absorption refrigerators using CrVI as a corrosion resistance agent. The renewal of the exemption was therefore recommended, resulting in the exemption currently listed in Annex III.

¹⁴⁷⁴ Dometic (2015b), Answers to Clarification Questions, submitted 13.08.2015, available under:
http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_9/20150813_Ex_9_Dometric_replay_on_questions.pdf

¹⁴⁷⁵ Op. cit. Dometic (2015a)

¹⁴⁷⁶ Op. cit. Dometic (2015b)

¹⁴⁷⁷ Gensch, et al. (2009), Carl-Otto Gensch, Oeko-Institut e. V., et al. 20 February 2009, Adaptation to scientific and technical progress under Directive 2002/95/EC: Final Report. With the assistance of Stéphanie Zangl, Rita Groß, Anna Weber, Oeko-Institut e. V. and Otmar Deubzer, Fraunhofer IZM.
http://ec.europa.eu/environment/waste/weee/pdf/final_report1_rohs1_en.pdf

26.1.2 Amount of Hexavalent Chromium Used under the Exemption

Dometic¹⁴⁷⁸ states that the average amount of CrVI used for a typical refrigerator model is around 2 grams.

Regarding the amount of substance entering the EU market annually through the application for which the exemption renewal is requested, Dometic estimates:

"approximately 200 kg per annum referring to units produced by Dometic."

This is understood to be relevant only for products that Dometic considers to fall under RoHS (i.e., used in lodging industry and private homes), which are part of its manufacture.

Dometics' total annual use of CrVI for its whole product range (also including products with a gas running heater and a high boiler temperature) is estimated at 700 kg/year.¹⁴⁷⁹

26.2 Description of Requested Exemption

According to the applicant¹⁴⁸⁰, sodium chromate (a hexavalent chromium compound) functions as a corrosion inhibitor in the carbon steel structure of the cooling unit in absorption refrigerators. The cooling solution consists of ammonia, water, sodium chromate and hydrogen gas, retained at a sufficient pressure to condense ammonia at the ambient temperature. To allow a long service life of the sealed cooling system, the sodium chromate in the cooling solution protects the steel pipes from interior corrosion that would arise in the presence of the corrosive ammonia.

Dometic¹⁴⁸¹ states that they have searched for alternatives to CrVI *"for decades"* and that their tests included solutions such as coatings, substrate materials and altering design parameters. Dometic¹⁴⁸² further explains that they have identified an alternative corrosion inhibitor, which has reached successful laboratory results:

"This inhibitor, named inhibitor #7, was found to be able to protect the carbon steel tubing from corrosion after 3 years of continuous circulation and it was consequently selected for further testing."

Dometic considers inhibitor #7 as a candidate to replace CrVI, with an acceptable expected life time, performance and safety level. However, some tasks need to be completed before inhibitor #7 can be used on a large scale.

¹⁴⁷⁸ Op. cit. Dometic (2015a)

¹⁴⁷⁹ Op. cit. Dometic (2015c)

¹⁴⁸⁰ Op. cit. Dometic (2015a)

¹⁴⁸¹ Op. cit. Dometic (2015c)

¹⁴⁸² Op. cit. Dometic (2015a)

26.3 Applicant's Justification for Exemption

According to Dometic, a renewal of the exemption for three years is needed in order to complete the following tasks that are needed to ensure a long service life of the absorption refrigerators:¹⁴⁸³

- *"Finalising and extension of field tests and increased testing of some specific models.*
- *Redesign of our cooling units to decrease the boiling temperature and minimising the risk for corrosion inside the tubes. This is an extensive work as we have close to 100 different models of cooling units in production.*
- *Design and installation of factory equipment for inhibitor #7. This important step includes also reliability testing of inhibitor #7 in combination with the new equipment."*

In order to use sodium chromate in minibars Dometic has applied for an exemption under the RoHS directive for a period of 3 years, until 2019.¹⁴⁸⁴

Dometic considers the minibars to fall under RoHS and characterises them as products with low boiler temperatures (<180°C). It is understood from the information provided by Dometic that the heater in products with low boiler temperature is exclusively run on electricity.

According to Dometic¹⁴⁸⁵, *"products with higher boiler temperatures are mostly (but not exclusively) included in the RV and medical box product groups. Coincidentally these products are used in a harsher environment than products with lower operating temperature. They are exposed to considerable variation in outside temperature, vibration and they are on discontinuously."* It is understood that these applications run on other energy sources than electricity (e.g. gas) or are able to run on variable energy sources. According to Dometic, for products with higher boiler temperature, the whole cooling unit has to be redesigned.

The timeline for the substitution strategy for the different products specified by boiler temperature is depicted in Section 26.3.3.

The identity of the possible substitute is not revealed by Dometic. Dometic¹⁴⁸⁶ indicates that the alternative corrosion inhibitor "inhibitor #7" is a mixture containing an inorganic salt and stabilisers.

¹⁴⁸³ Op. cit. Dometic (2015a)

¹⁴⁸⁴ Op. cit. Dometic (2015c)

¹⁴⁸⁵ Op. cit. Dometic (2015c)

¹⁴⁸⁶ Op. cit. Dometic (2015c)

26.3.1 Environmental Arguments

Dometic¹⁴⁸⁷ states that a closed-loop system exists for the absorption refrigerators and the refrigerant:

"The products are at end-of-life recycled as other refrigerators in a step 1 process (reclaim of refrigerant) and step 2 (shredding and material separation). The total recycling rate is more than 95%."

According to Dometic,¹⁴⁸⁸ the disassembling of the absorption refrigerators is specified through a recycling manual¹⁴⁸⁹, which states that *"The cooling unit should be emptied by an authorized recycling company".*¹⁴⁹⁰ Absorption refrigerators in recreational vehicles have to be removed and handled separately before shredding the complete vehicle.¹⁴⁹¹

Dometic¹⁴⁹² explains that they have developed recycling equipment together with another company, Herco, to reclaim cooling media from absorption fridges.¹⁴⁹³ This equipment enables reclaiming a minimum of 95% of the refrigerant. Dometic¹⁴⁹⁴ states that the reclaimed refrigerant is to be treated as hazardous waste.

Dometic notes that at end-of-life, less CrVI is recovered than initially applied: In the formation of the very thin and tight corrosion protective layer of chromium oxide (Cr_2O_3) on the interior tube surface, CrVI is reduced to less toxic trivalent chromium (Cr(III)).¹⁴⁹⁵ If the layer is damaged, it will be replenished by the sodium dichromate available in the solution. Dometic¹⁴⁹⁶ estimates that *"90% of Cr(VI) is reduced to Cr(III) in the first 2-3 years of operating time. At the end of the product lifetime it can therefore safely be assumed that, more than 75% of the Cr(VI) has been consumed."*

¹⁴⁸⁷ Op. cit. Dometic (2015a)

¹⁴⁸⁸ Dometic (2016a), Dometic (2016), Answers to 2nd round of Clarification Questions, submitted 13.01.2016.

¹⁴⁸⁹ <http://www2.dometic.com/FileOrganizer/1-international/x-environment/Environmental%20Documents/Recycling%20Manuals/English/Manual-Recycling-Hotel.pdf>

¹⁴⁹⁰ For the authorization of such companies, Dometic states that "an important element in this authorization is the harmonized standards that have been developed under WEEE-Labex and are now transformed into EN-standards. EN 50574 (Collection, logistics & treatment requirements of end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons) sets up detailed requirements for the end-of-life treatment of cooling appliances including absorption fridges."

¹⁴⁹¹ Global ISDS system for car recycling:

http://civd.adm.in/fileadmin/civd/images/technik/Dismantling_Manual_CIVD_for_IDIS_evo4-1.pdf

¹⁴⁹² Op. cit. Dometic (2016a)

¹⁴⁹³ <http://www.herco-qmbh.com/en/products/cooling-unit-recycling/ammonia-based-chillers/>

¹⁴⁹⁴ Op. cit. Dometic (2015a)

¹⁴⁹⁵ Op. cit. Dometic (2015c)

¹⁴⁹⁶ Op. cit. Dometic (2015c)

26.3.2 Socio-economic Impact of Substitution

Dometic¹⁴⁹⁷ states in its renewal request that the substitution will have an economic impact in light of the increase in direct production costs and the increase in overhead. In the context of the RoHS Directive, Dometic did not provide further detail; however, additional details are available in an application that Dometic submitted to ECHA in the application for authorisation under REACH for the use of sodium chromate as an anticorrosion agent.¹⁴⁹⁸

26.3.3 Road Map to Substitution

As mentioned above, Dometic plans to finalize the substitution within three years and therefore applies for a renewal of exemption 9 for this duration. Dometic¹⁴⁹⁹ states that this timeline only applies to those products that are – in the opinion of Dometic – within the scope of RoHS. Dometic considers the products that are used, for instance, in the lodging industry and in private homes to fall under the RoHS Directive.

For the whole product range, Dometic¹⁵⁰⁰ plans to phase out the existing inhibitor gradually depending on application: The first products that will be placed on the market in 2018 with the substitute (i.e. CrVI-free) will be products running with electrical heater in low boiler temperature applications (140-180°C), which are typical for a minibar. To complete substitution in such units, the cooling unit needs to be re-designed and a boiler temperature management system needs to be introduced. These changes require some development and testing planned to be completed by 2018. According to Dometic¹⁵⁰¹, the tasks already listed in bullet points under Section 26.3 have to be carried out in order to ensure reliable and safe products (field tests, redesign of cooling unit models, development of appropriate factory equipment).

The timeline for other products that Dometic considers to be outside the scope of RoHS can be found in Dometic's application for authorisation under REACH.¹⁵⁰² According to Dometic¹⁵⁰³, the products with higher boiler temperatures need more work before the new inhibitor can replace sodium chromate because the cooling units need to be

¹⁴⁹⁷ Op. cit. Dometic (2015a)

¹⁴⁹⁸ Dometic (2015c), Dometic (2015c), Dometic GmbH, Analysis of Alternatives and Socio-Economic Analysis, available under <http://echa.europa.eu/documents/10162/0783ee3a-7de9-45ec-a72a-c1689ee49e09>

Regarding the application for authorization, see also section 26.5.1.

¹⁴⁹⁹ Op. cit. Dometic (2015b): "Most of the products covered by the RoHS Directive are used in lodging industry and in private homes. Products for recreational vehicles (RV) and marine applications with absorption technology are most often specifically designed for that purpose and thus fall outside of the scope of RoHS. Several products for RV fall within the scope of the ELV-directive."

See section 26.5.5 for the discussion on the scope of the exemption.

¹⁵⁰⁰ Op. cit. Dometic (2015b)

¹⁵⁰¹ Op. cit. Dometic (2015a)

¹⁵⁰² Op. cit. Dometic (2015c)

¹⁵⁰³ Op. cit. Dometic (2015c)

redesigned and new safety equipment has to be included. According to Dometic¹⁵⁰⁴, "products with higher boiler temperatures are mostly (but not exclusively) included in the RV and medical box product groups." Dometic¹⁵⁰⁵ explains that technical challenges arising for these product groups are also due to the more diverse operating conditions, e.g. varying ambient temperature, vibration and more frequent starts and stops.

Dometic¹⁵⁰⁶ makes a distinction within the products with higher boiler temperatures, and plans a gradual product launch from 2025 on. The complete phase out is envisaged by 2029 by Dometic.

26.4 Stakeholder Contributions

A single contribution was made during the stakeholder consultation regarding Ex. 5(b). The Test and Measurement Coalition (TMC)¹⁵⁰⁷ includes the seven leading companies in the sector representing roughly 60% of the global production of industrial test and measurement products. It is TMC's understanding that, according to the RoHS Directive, the exemptions listed in Annex III and Annex IV for which no expiry date has been specified, apply to sub-category 9 industrial with a validity period of 7 years, starting from 22 July 2017. This is also said to be explained in the RoHS FAQ.¹⁵⁰⁸ TMC, thus does not interpret the current exemption evaluation related to Exemption 9 to concern category 9 industrial equipment, for which the exemptions evaluated in the study "RoHS evaluations Pack 9" are understood to remain valid, and has thus have not provided exemption specific information.

After the consultation, other manufacturers of absorption refrigerants placing their products on the EU market were contacted in order to establish if some or all of these other manufacturers support the exemption request, or alternatively do not need the requested exemption renewal. Three manufacturers were urged to provide a statement. However, only Thetford actively provided information on their product range and substitution efforts.¹⁵⁰⁹

Thetford stated that their product portfolio differs from Dometic: It is limited to recreational vehicle absorption refrigerators and does not include minibar applications.¹⁵¹⁰ Thetford's absorption cooling units are manufactured in the USA. According to Thetford "All absorption refrigerators currently on the market use sodium

¹⁵⁰⁴ Op. cit. Dometic (2015c)

¹⁵⁰⁵ Op. cit. Dometic (2015b)

¹⁵⁰⁶ Op. cit. Dometic (2015c)

¹⁵⁰⁷ Test & Measurement Coalition (2015), Contribution by Test & Measurement Coalition, submitted 19 October 2015, available under

http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_9/Exemption_1_a-e_General_Contribution_Test_Measurement_Coalition_package_9_exemptions_20151016.pdf

¹⁵⁰⁸ p. 26; http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf

¹⁵⁰⁹ Thetford (2016a), Information provided by Thetford by Email, submitted 9 February 2016 and Thetford (2016b), Information provided by Thetford by Email, submitted 16 February 2016.

¹⁵¹⁰ <http://www.thetford-europe.com/product-category/refrigerators/>

chromate as a corrosion inhibitor as far as we are aware." Thetford already indicated during the last revision in 2009 that they were in the process of starting up a research project to investigate alternatives for the substitution of CrVI.

As for the scope of the exemption and its duration, Thetford¹⁵¹¹ is of the opinion that RoHS is as applicable to RV specific refrigerators as it is to generic household refrigerators. Thetford argues that any extension of exemption 9 should cover all relevant applications, and allow enough time to cover substitution or elimination for all these applications.

As for end-of-life, Thetford¹⁵¹² also claims to have a closed loop system operated by third party waste management service operators so that the refrigerant is removed and treated as hazardous waste.

26.5 Critical Review

26.5.1 REACH Compliance - Relation to the REACH Regulation

Appendix A.1.0 of this report lists various entries in the REACH Regulation annexes that restrict the use of CrVI in various articles and uses.

Sodium chromate (CAS 7775-11-3; EC 231-889-5) is included in REACH Annex XIV in light of its being identified as carcinogenic (category 1B), mutagenic (category 1B) and toxic for reproduction (category 1B).¹⁵¹³

Dometic GmbH and Dometic Hűtőgépgyártó és Kereskedelmi Zrt. submitted an application for authorisation under REACH for:

*"the use of sodium chromate as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75% by weight (Cr6+) in the cooling solution".*¹⁵¹⁴

Dometic GmbH in Germany and Dometic Hűtőgépgyártó és Kereskedelmi Zrt. in Hungary produce absorption refrigerators in Europe and would thus not be able to use sodium chromate without an authorisation after the sunset date of this substance specified in Annex XIV as 21 September 2017.

The application of authorisation covers the whole product range of absorption refrigerators produced in Europe: minibars, refrigerators for recreational vehicles and medical cold equipment. Dometic plans to phase out sodium chromate stepwise beginning with the electrically operated refrigerators. The phase out is planned to be

¹⁵¹¹ Op. cit. Thetford (2016b)

¹⁵¹² Op. cit. Thetford (2016b)

¹⁵¹³ Entry No 22 in Annex XIV, sunset date 21/09/2017, latest application date 21/03/2016;
<http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/recommendation-for-inclusion-in-the-authorisation-list/authorisation-list/-/substance-rev/62/term>

¹⁵¹⁴ <http://echa.europa.eu/addressing-chemicals-of-concern/authorisation/applications-for-authorisation-previous-consultations/-/substance-rev/10106/term>

finalized in 2029. According to Dometic¹⁵¹⁵, absorption refrigerators that operate with gas and therefore have higher boiler temperatures need more technical development before the new inhibitor can replace sodium chromate (e.g. re-design of the cooling units, new safety equipment).

On 1 February 2016, ECHA's Risk Assessment Committee (RAC) and Socio-Economic Analysis Committee (SEAC) published its opinion recommending the requested authorisation to be granted with a review period scheduled within 12 years.¹⁵¹⁶ Assuming the authorisation is granted sodium chromate could still be manufactured and used in EU manufacture. In the opinion, the following condition for authorisation is noted:

*"SEAC recommends that after the end of 2019 as described in the application, the authorisation of the use of sodium chromate is limited to the high boiler temperature product range only."*¹⁵¹⁶

Assuming that the authorisation is approved, the renewal of the RoHS exemption would not be understood to weaken the protection afforded by REACH.

Entries 28, 29 and 30 of REACH Annex XVII also apply to sodium chromate. These entries require that specified substances "*Shall not be placed on the market, or used: as substances; as constituents of other substances; or in mixtures, for supply to the general public when the individual concentration in the substance or mixture*" is above a certain threshold.

Though one could argue that these entries do not restrict the presence of specified substances in articles, in which case they would not apply to the use of Dometic (since the refrigerator is an article), it is not completely clear how to interpret these restrictions. In the products at hand, sodium chromate is used as a constituent in a mixture which is enclosed within the cooling system. Though the consultants assume that the legislator mainly had in mind the provision to the public of substances and mixtures in containers that can be opened to allow use of the substance at hand, the derogations to these entries suggest otherwise. Paragraph 2 of this entry excludes some articles from this restriction, among others specifying in (c)(second item) that the restriction shall not apply to "*fuels sold in closed systems (e.g. liquid gas bottles)*". In this sense the legislator would need to confirm whether the application at hand would be restricted through these entries or not.

Chromium VI also features in entry 47 REACH Annex XVII, where the use in cement is restricted. This is not considered to be relevant for absorption refrigerators.

¹⁵¹⁵ Op. cit. Dometic (2015c)

¹⁵¹⁶ ECHA RAC SEAC (2016), ECHA's Committee for Risk Assessment (RAC) and Committee for Socio-economic Analysis (SEAC) (2016), Opinion on an Application for Authorisation for Sodium chromate use: The use of sodium chromate as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0.75% by weight (Cr₆₊) in the cooling solution, Consolidated version, 1 February 2016; <http://echa.europa.eu/documents/10162/5a39678c-4e9a-42bc-878c-8997c74caeba>

If the ECHA RAC SEAC recommendations to grant the authorisation for sodium chromate are to be followed, and assuming that Entries 28 through 30 do not apply, it can be considered that the requested RoHS exemption renewal would not weaken the environmental and health protection afforded by the REACH Regulation. In this case an exemption could therefore be granted if other criteria of Art. 5(1)(a) apply. The option that one of the restrictions addressed above and its implications on a possible exemption are discussed below in Section 26.5.6.

26.5.2 Scientific and Technical Practicability of Substitution

Dometic provides information according to which they plan to phase-out the use of CrVI from the entire product range, starting with the products understood to be the least technically challenging. It is understood that the first products applying the substitute shall be the absorption refrigerators with low boiler temperatures running exclusively with electricity. Dometic estimates the tasks to adapt these products to take three years. Dometic is confident that it shall meet this timeline:

"Our tests for the substitution alternative are still positive in relation to the main part of the products covered by RoHS (low boiler temperature applications – see below). We are currently making significant investments into production equipment in order to be able to meet the time line. In parallel there are still tests ongoing.

There is of course an existing risk that our following tests involving new production equipment and large quantities of products will fail. Should this happen we will have to renew the application to extend the exemption. However, we are very committed to the change when technically viable and given this we do not want to extend the exemption period longer than necessary."

It is understood that the substitution in products with higher boiler temperature still needs basic evaluation and technical development. In 2015, Dometic stated that the "*validation studies of inhibitor #7 function in higher boiler temperatures are ongoing.*" The launch of first products applying the substitute in higher boiler temperature conditions is planned by Dometic for 2025. This time frame is longer than the maximum validity period possible for category 1 products under RoHS.

It further appears that other manufacturers are yet to achieve substitution in their absorption refrigerators and that they also need more time to complete the substitution tests and to achieve substitution in products to come on the market (e.g. Thetford).

To summarize, the consultants can follow that the development of substitutes has progressed, however also that implementation requires additional time in order to ensure the reliability of the substitute before it can come onto the market in absorption refrigerators.

26.5.3 Environmental Arguments

As already explored in Section 26.3.1, from information provided by Dometic, the consultants can follow that absorption refrigerators are recycled and that the cooling system with the cooling solution containing the CrVI is collected by recyclers with separate equipment.

This information suggests that possible environmental emissions related to End-of-Life (EoL) would be controlled, when the products are disposed of properly. Further information related to other environmental aspects was not provided.

26.5.4 Stakeholder Contributions

The contribution submitted by Test & Measurement Coalition raises a legal question as to the availability of the current exemption to category 9 equipment. Regardless of TMC's claims as to the availability of Annex III exemptions to sub-category 9 industrial for 7 years starting in 22.7.2017, in the case of exemption 9 the wording formulation limits its applicability to the anticorrosion agent applied in carbon steel cooling systems of absorption refrigerators. These products are understood to be a product, which as stated by the applicant fall under category 1 and not under category 9. Thus from a practical perspective, in the consultants' opinion, sub-category 9 industrial equipment would not benefit from the exemption directly.

26.5.5 The Scope of the Exemption

Dometic have requested the exemption for products that Dometic interprets to be in the scope of the RoHS Directive: These are mainly the low boiler temperature applications, where the heater is exclusively run on electricity. According to Dometic,¹⁵¹⁷ "most of the products covered by the RoHS Directive are used in lodging industry and in private homes. Products for recreational vehicles (RV) and marine applications with absorption technology are most often specifically designed for that purpose and thus fall outside of the scope of RoHS. Several products for RV fall within the scope of the ELV-directive."

Generally speaking in article 2(4)(c) the RoHS Directive excludes "equipment which is specifically designed and is to be installed, as part of another type of equipment that it is excluded or does not fall within the scope of this Directive..". The consultants assume that Dometic interprets the applicability of RoHS to its products on this basis. For example, where absorption refrigerators are specifically designed and are to be installed in caravans, this interpretation would mean that the equipment would be excluded from RoHS.

In this respect, Dometic¹⁵¹⁸ states: "a) For the 2015 sales approximately 7 % of our products designed for recreational vehicles (RV) have been sold in after-market. Remaining 93 % have been sold in B2B direct to RV producers. It should however here be

¹⁵¹⁷ Op. cit. Dometic (2015b)

¹⁵¹⁸ Op. cit. Dometic (2016)

highlighted that the major sales in after-market is not to private customers. We estimate that only less than 10 % of the sales in after-market is to private customers for product replacement and as do-it-yourself installations. The vast majority of the after-market sales is to professional companies providing installation. The absorption refrigerators for RV do have the option of running on several energy sources, and the installation of gas burner systems must only be carried out by certified personnel. Furthermore, the installation of a safe exhaust system is necessary to avoid flue gases into the living compartment. Due to this the installations made by private customers are limited. b) All Dometic absorption refrigerators designed for RV have electrical functions. One or two electrical heaters are assembled for running the refrigerator when electricity is available."

Thetford as another manufacturer of absorption refrigerators in RVs, however disagrees and claims that exemption 9 applies to RV specific refrigerators as it does to generic household refrigerators.

In this respect, the consultants believe that there may be room for interpretation regarding this issue. For example, in the case of units manufactured for caravans, it is understood that most units are originally installed as part of the vehicle before its sale, whereas in some cases units are purchased separately and possibly installed by the user. To begin with, this means that the same units are available both to manufacturers of caravan vehicles as well as on the open market (i.e. available to the public), where it is not straightforward to conclude that they would only be used for their intended purpose (i.e., to be installed in vehicles).

A more important aspect however seems to be the fate of such units at end-of-life, both in the case where the unit itself reaches EoL as well as in the case that the vehicle reaches EoL. In both of these cases it is understood that the unit would be dismantled from the vehicle and transferred to EoL treatment. When this is done by a vehicle dismantling facility, it is assumed that the unit is subsequently sent directly to a suitable recycler. In parallel, when the dismantling is done by the end-user, it is assumed that the unit would be seen as EEE and would be transferred to a Waste-EEE handling facility, subsequently also reaching a suitable recycler. Though the fate in both cases may be similar, the allocation of the unit at EoL to the EEE waste stream would suggest that the scope of articles falling under the RoHS Directive may be wider than suggested by Dometic. As it is assumed that in any case articles would be sent to treatment by a recycler of other refrigeration units (i.e., EEE recycler and not ELV recycler), the consultants conclude that the RoHS restrictions should apply as their original intention was to prevent and limit the presence of certain substances in the EEE waste stream. All the more so as the RoHS Directive restricts the use of additional substances in comparison with the ELV Directive. This logic is all the more applicable to units used for medical purposes, as long as they would not be excluded for example as large scale fixed installations (see Article 4(2)(e)). This is assumed as, medical devices fall under the scope of the RoHS Directive in any case. That said, it should be noted that only medical devices falling under the scope of the Medical Devices Directives (see RoHS Article 3(21-23)) would be considered as medical devices (Cat. 8) under RoHS, with others still falling

under Cat. 1. Even if refrigeration units would be covered by these Directives, the applicability of the RoHS restrictions would only be delayed in comparison with articles of category 1.

To conclude, the consultant interprets that a wider range of absorption refrigerators would be under the scope of the RoHS Directive and would need to comply with the substance restrictions, provided they have at least one electrical function and can thus be considered as EEE according to the Article 3(1 and 2) definitions.

26.5.6 Exemption Wording Formulation

Taking into account the considerations in the scope of the exemption as discussed above and the road map for substitution as provided by Dometic, a split of the exemption is proposed in light of the stepwise approach to substitution communicated by Dometic.

The consultants understand that CrVI shall be phased out within three years in the low boiler temperature applications that are run only on electrical supply in stable and favourable ambient conditions. An exemption for such applications would thus only require a three years duration as originally requested by the applicant. The proposed split of the exemption was discussed with the applicant to ensure a precise wording.

As a criterion to distinguish the different applications, it was discussed with the applicant if the boiling temperature could be used as e.g. done in Dometic's application for authorization under REACH because the internal corrosion increases significantly with the boiling temperature. However Dometic¹⁵¹⁹ stated that the boiling temperature varies significantly with the ambient conditions and the heat load of the cooling unit and that market control of boiling temperature would be difficult. The consultants proposed to describe the first split of the exemption via the energy source ("*absorption refrigerators designed to operate with electrical heater only*"). This is also understood to be a practicable solution from a market surveillance perspective.

Dometic¹⁵²⁰ then proposed a shorter duration for this split of the exemption for 2 ½ year until 1 January 2019. Though the consultants understand that Dometic assumes that this period shall suffice, possibly giving it a short termed advantage over competitors when the exemption expires, the consultants do not support this change. In the past review, industry requested to renew the exemption for additional 5 years, anticipating that substitution would be completed within this period. It is observed that the research and development of substitutes required additional time, currently leading to the request of an additional period. Dometic now request to shorten the exemption duration by 6 months. The consultants do not see this period as significant, whereas it shall provide a short termed margin for implementing substitutes, should the process be a bit longer than expected. The consultants propose to keep the original three years to ensure that substitution is reached by at least one manufacturer at this time so that a further

¹⁵¹⁹ Dometic (2016b), Dometic (2016b), email communication, submitted 12.02.2016

¹⁵²⁰ Dometic (2016c), Dometic (2016c), email communication, submitted 22.02.2016.

extension of this exemption in 2019 is not necessary. However if the EU COM sees this differently, the duration could be shortened, ending on 1 January 2019.

It has to be noted that this first split of the exemption would also be in line with the recommendation of ECHA RAC SEAC¹⁵²¹ where SEAC recommends the authorisation for the use of sodium chromate be limited to the high boiler temperature product range only after 2019.

As for the products with higher boiler temperatures, though the applicant has not requested a separate renewal for these articles, it is the opinion of the consultants that it is not conclusive if indeed all other articles are excluded from the scope of RoHS or not. From the additional information it is understood that substitution is underway in these articles, but expected to take a longer period. It would therefore be recommended to provide an exemption for a longer term for such applications, in order to reliably ensure substitution.

26.5.7 Conclusions

Article 5(1)(a) provides that an exemption can be justified if at least one of the following criteria is fulfilled:

- their **elimination or substitution** via design changes or materials and components which do not require any of the materials or substances listed in Annex II is scientifically or technically impracticable;
- the **reliability** of substitutes is not ensured;
- the total negative **environmental, health and consumer safety impacts** caused by substitution are likely to outweigh the total environmental, health and consumer safety benefits thereof.

From the available information it is observed that a substitute has become available as such. However, redesign and testing of absorption refrigerators is still in process and shall require at least a few more years. The implementation of the substitute is expected to differ for various applications of the product range of absorption refrigerators (i.e., those operated only with electrically powered heaters and those operated with other sources of energy), depending overall on the boiler temperature. The consultants appreciate the applicant's proposal of a shorter time frame of three years for low boiler temperature applications. However, as some products with higher boiler temperatures may fall under the scope of RoHS, a split of the exemption is proposed in order to differentiate the technical practicability of substitutes and to ensure its reliability in different applications, including where this is expected to take more than three years.

To conclude against the Article 5(1)(a) criteria:

¹⁵²¹ Op. cit. ECHA RAC SEAC (2016)

- Research conducted by Dometic did not result in reliable possibilities via design changes, coatings or materials; however an alternative anti-corrosion agent has been developed.
- Establishing the reliability of the identified substitute needs additional time to complete further testing, the re-design of components in different models and the development of factory equipment for absorption refrigerators with a heater running exclusively on electricity in low boiler temperature applications (140-180°C). Substitution in other applications with a higher boiler temperature is expected to require a longer period. The time frame indicated by Dometic for these products to be launched on the market is 2025. However, exemptions for category 1 devices can only be granted for up to five years, at which time a revision of the further need of the exemption for these applications would allow evaluating whether inhibitor #7 has been successfully applied as a substitute or whether additional time would be needed.

26.6 Recommendation

It can be understood that a substitute has been discovered, however that additional time is needed to allow a phase-out of CrVI where used as anti-corrosion agent in absorption refrigerator units. This time shall allow necessary redesign of equipment and the completion of reliability testing and may differ for various units understood to be part of the product range. Assuming that the REACH authorisation requested by Dometic shall be granted and assuming that Entries 28-30 of REACH Annex XVII do not apply to sodium chromate when used as a cooling solution in the carbon steel structure of absorption refrigerator cooling units, the consultants conclude that the exemption is justified based on the Article 5(1)(a) criteria. In this case, the consultants recommend splitting the current exemption to differentiate between different products according to the time estimated to be required to complete substitution as follows:

Exemption 9	Duration*
<i>Hexavalent chromium as an anticorrosion agent applied in carbon steel cooling systems of absorption refrigerators of applications:</i>	
(I) <i>designed to operate with electrical heater only, with up to 0,75 % by weight in the cooling solution;</i>	
(II) <i>designed to operate with variable energy sources;</i>	
(III) <i>designed to operate with other than an electrical heater</i>	
	<i>For Cat. 1: 21.7.2019 (three years)</i>

Should the REACH authorisation requested by Dometic not be granted, the RoHS exemption could only be granted until the 21.9.2017 (i.e. the sunset date specified in REACH Annex XIV) so as not to weaken the protection afforded by the REACH Regulation. In this case the consultants would recommend maintaining the current formulation as both product groups are expected to still need the exemption until this date.

Should Entries 28-30 of REACH Annex XVII apply in this case, the renewal of an exemption would weaken the protection afforded by the REACH Regulation and thus could not be granted according to Article 5(1)(a).

The consultants' do not see a need to grant the exemption to Cat. 8 and Cat. 9 equipment, as the exemption formulation clearly limits the applicability to products falling under Cat. 1. Nonetheless, as for exemptions listed in Annex III, for which an expiration date is not specified, it is understood that from a legal point of view, they shall be valid for applications of Cat. 8 and Cat. 9 for up to 7 years. This validity period is understood to start from the dates specified in Article 4(3), from when these categories come into the scope of the Directive. Thus, if from a formal-legal point of view the original formulation of the exemption needs to remain valid for these categories for the specified duration, the following formulation would be recommended:

Exemption 9	Duration*
(III) Hexavalent chromium as an anticorrosion agent of the carbon steel cooling system in absorption refrigerators up to 0,75 % by weight in the cooling solution	For Cat. 8 and 9: 21 July 2021; For Sub-Cat. 8 in-vitro: 21 July 2023; For Sub-Cat 9 industrial: 21 July 2024

26.7 References Exemption 9

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