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1st Questionnaire Exemption No. 9b (renewal request)

Exemption for „Lead in bearing shells and bushes for refrigerant-containing compressors for heating, ventilation, air conditioning and refrigeration (HVACR) applications“

Abbreviations and Definitions

HVACR	Heating, Ventilation, Air Conditioning, and Refrigeration
Pb	Lead

Background

The Oeko-Institut together with Fraunhofer IZM has been appointed by the European Commission within a framework contract[1] for the evaluation of exemptions to be included in or deleted from Annexes III and IV of the new RoHS Directive 2011/65/EU (RoHS 2).

Emerson Climate Technologies has submitted an amendment request for exemption 9b with a different wording which narrows the scope of the exemption as follows:

> *“Lead in bearing shells and bushes for refrigerant-containing compressors, with a stated electrical power input of only 9 kW or lower for the HVACR industry, with expiry date three years after the publication of the amended RoHS Annex”.*

The information Emerson Climate Technologies has submitted has been reviewed and as a result we have identified that there is some information missing and have formulated the following questions for clarification concerning your request before we start the targeted consultation.

Questions

1. Please provide the third party assessment (mentioned on page 12 of the application) as a separate document. The icon in the submitted PDF does not provide access to the document.

   Please find attached “Preliminary report on bearing constituents.”

2. According to Emerson’s application, key materials and substances for substitution are e.g. PTFE, Molybdenum Disulfide, Calcium Fluoride, Aluminium Oxide, Carbon fibres, copper and iron. Emerson states that these substitutes “*have passed our reliability testing in compressors above 9 kW of electrical power input across various compressor models.* […] *The testing for compressors below 9 kW of electrical power input continues with the same range of substitutes.*”
   Please explain why these substitutes cannot yet be applied in the smaller compressors with

[1] Contract is implemented through Framework Contract No. ENV.C.2/FRA/2011/0020 led by Eunomia

a stated electrical power input of only 9 kW or lower, for which this exemption is requested, detailing what technical challenges that hinder their application.

The technical challenges that hinder the application of lead-free bearing materials for products in the range of less than 9 kW input power are broadly explained on Page 2, Section 3 of Emerson's Exemption Application. The following paragraphs endeavor to explain the rationale in a more explicit manner:

i. The compressors in this smaller size range use a much smaller volume enclosure (steel shell) and logically use smaller individual components (smaller crankshafts, smaller pistons, smaller bearings, etc.). This design space constraint causes many functional challenges. Two aspects related to bearings will be described. An hydrodynamic oil film within the bearings is essential for acceptable performance. Designing of oil delivery systems within this smaller internal volume to permit adequate transport of oil to the bearings is constrained by the smaller internal volume. Moreover, the result of the smaller product size is the use of smaller bearings and bushes because the design space is obviously more limited. Secondly, smaller bearings have smaller surface areas in contact with the rotating counter-face (mating) surfaces. A smaller area cannot handle as much loading as a larger bearing (such as bearings in compressor products greater than 9 kW power, for example). The consequence of a reduced bearing area is that it tends to concentrate forces producing higher unit loading (higher average pressure). This, in turn, creates more demanding operating conditions where lubricity and friction become exceptionally important. So, identifying and qualifying the optimal lead-free bearing material for products less than 9 kW input power is, in general, more difficult and time consuming.
ii. The <9 kW input power product range represents over an order-of-magnitude greater global usage relative to the larger >9kW compressor models. These smaller compressors are typically used in residential and commercial air conditioning and refrigeration applications and are subject to a much wider distribution and variety of applications with many OEM's and in many regions of the world. There are many different compressor models and derivatives using a variety of different refrigerants and lubricants which must be tested and approved for each OEM application before they can be released for production. Application proliferation of this magnitude causes longer overall qualification times relative to the larger (>9 kW) product lines. Moreover, in many of these OEM applications, the customer requires long field pilot testing trials as a means to understand the reliability in a real-life application prior to fully approving a major design change, such as the removal of lead in bearings.
iii. Lastly, the supply-chain for lead-free bearings is not yet robust enough to accommodate the larger global use demands. There are two aspects to this general concern: 1.) The lead-free bearing compositions are relatively new-to-the-world and several bearing suppliers are still in the process of developing optimal manufacturing methods. This is quite normal for a new technology to take a protracted amount of time to mature. As a result, the ability of the lead-free bearing industry to consistently satisfy global demands is not well understood and represents a risk. 2.) Each bearing material supplier has his own proprietary lead-free formulation (or composition). In the relative short term, it is impossible to qualify all bearing supplier's lead-free compositions for all compressor

models, so one must pick-and-choose the select-few suppliers to qualify to meet RoHS deadlines. This, in turn, limits the amount of suppliers, and hence, the amount of available lead-free bearing production capacity. However, with more time, this problem is expected to diminish because the industry-approved supply-base will naturally expand and more and more lead-free bearing compositions will be broadly accepted and approved. Hence, more supplier development time is needed to create a robust and confident supply-stream. Three years is anticipated to be sufficient to accomplish this.

3. A similar exemption under the ELV Directive (200/53/EC) (entry 4b Annex II on lead in bearing shells and bushes in engines, transmissions and air conditioning compressors) expired 1 July 2011.[2] Please explain why substitutes for lead in automotive applications do not provide a possible candidate at present for substituting Pb in bearings and bushes used in refrigerant-containing compressors, with a stated electrical power input of only 9 kW or lower, to the HVACR industry.

Substitutes for lead in the automotive industry may be a possible solution in some cases, however stationary air conditioning and refrigeration compressors are unique in that the range of running times is generally between 50,000 and 100,000 hours where automotive runtime life is typically 3,000 hours. This difference in design life expectancy and engineering qualification testing may be plausible reasons why lead substitutes used in the automotive industry may not be comparable within compressor expectations. However, lead substitutes are not the sole justification of our extension request, as outlined in our answer above (#2). As outlined in section 3 of our extension request, OEM testing, qualification of suppliers and production implementation timelines and the derivation of products are all considered to be supply chain and technical challenges pertaining to compressors with a stated electrical power input of 9Kw or lower.

4. Please explain in more details how the implementation of substitutes for smaller compressor products is foreseen in the supply chain e.g. in form of a roadmap.
    a. What phases are needed to allow the implementation of substitutes in products to be placed on the market and how much time is needed for each phase?
    b. Which testing has been completed, which validation processes? Etc.
    c. Please specify why you request the extension of the exemption for three years.

Please see below excel sheet. If needed, we could confidentially disclose which are the actual products behind the product family codes F1.1 to F4.2

[2] See the latest version of Annex II to Directive 2000/53/EC (ELV Directive); http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013L0028&from=EN

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								Requested Extension Period					
				2015		2016		2017		2018		2019	
Product Family	Power Range [kW]	Qty of Compressor Models	Refrigerant	Jan - Jun	Jul -Dec	Jan - Jun	Jul -Dec	Jan - Jun	Jul -Dec	Jan - Jun	Jul -Dec	Jan - Jun	Jul -Dec
F1.1	1,9 - 8,3	336	R410A (*)										
			HFO-Blends										
			HC										
F1.2	2,4 - 7,9	382	R404A (*)										
			HFO-Blends										
			CO2										
			HC										
F2.1	1,5 - 5,7	295	R410A (*)										
			HFO-Blends										
			HC										
F1.2	1,4 - 4,4	239	R404A (*)										
			HFO-Blends										
			CO2										
			HC										
F3.1	0,9 - 3,9	201	R410A (*)										
			HFO-Blends										
			HC										
F3.2	1,2 - 2,5	97	R404A (*)										
			HFO-Blends										
			CO2										
			HC										
F4.1	1,0 - 5,9	250	R410A (*)										
			HFO-Blends										
			HC										
F4.2	1,2 - 4,5	75	R404A (*)										
			HFO-Blends										
			CO2										
			HC										

(*) Activity A completed

Activity Code

A	Test of Technological Features (see 1.) and 2.) of 7(B) on page 9 of ECT's Exemption request)
B	Compressor Reliability tesing (see 3.) of 7(B) on page 9 of ECT's Exemption request)
C	Validate Manufacturing Process
D	Production Change-Over
E	Supply Chain Change-Over

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5. Are you aware of other manufacturers that supply refrigerant-containing compressors, with a stated electrical power input of only 9 kW or lower, to the HVACR industry? Please state names of other manufacturers.

   Bitzer and Tecumseh are important European manufacturers of refrigerant compressors.