

Questionnaire 1 (Clarification) for Renewal of Exemption 42 of Annex III (EUROMOT)

Table 1: Currently valid wording of exemption III-42

No.	Current exemption wording	Current scope and dates of applicability
III-42	<p>Lead in bearings and bushes of diesel or gaseous fuel-powered internal combustion engines applied in non-road professional use equipment:</p> <ul style="list-style-type: none"> - with engine total displacement \geq 15 litres; or - with engine total displacement $<$ 15 litres and the engine is designed to operate in applications where the time between signal to start and full load is required to be less than 10 seconds; or regular maintenance is typically performed in a harsh and dirty outdoor environment, such as mining, construction, and agriculture applications 	<p>Applies to category 11.</p> <p>Expires on 21 July 2024.</p>

Acronyms and Definitions

Cat.	Category, referring to the categories of EEE specified in Annex I of the current RoHS Directive 2011/65/EU
COM	European Commission
EEE	Electrical and electronic equipment
EU	European Union
Lead-free	Not containing lead in the applications in the scope of the exemption to be reviewed
Pb	Lead

1. Background

Bio Innovation Service, UNITAR and Fraunhofer IZM have been appointed¹ by the European Commission through for the evaluation of applications for the review of requests for new exemptions and the renewal of exemptions currently listed in Annexes III and IV of the RoHS Directive 2011/65/EU.

EUROMOT submitted a request for a 5 years renewal of the above exemption with the current wording and scope as detailed in the below table.

Table 2: Requested exemption renewal

No.	Requested exemption	Requested scope and dates of applicability
III-42	<p><i>Lead in bearings and bushes of diesel or gaseous fuel-powered internal combustion engines applied in non-road professional use equipment:</i></p> <ul style="list-style-type: none"> - <i>with engine total displacement \geq 15 litres;</i> <p><i>or</i></p> <ul style="list-style-type: none"> - <i>with engine total displacement $<$ 15 litres and the engine is designed to operate in applications where the time between signal to start and full load is required to be less than 10 seconds; or regular maintenance is typically performed in a harsh and dirty outdoor environment, such as mining, construction, and agriculture applications</i> 	<p><i>Applies to category 11.</i></p> <p><i>Expires on 21 July 2029 (2024 + 5 years)</i></p>

As result of a first review we identified that some information is missing. Against this background the questions below are intended to clarify some aspects concerning the request at hand.

We ask you to kindly answer the below questions until 6th November 2023 latest.

¹ Implemented through the specific contract 070201/2020/832829/ENV.B.3 under the Framework contract ENV.B.3/FRA/2019/0017



2. Questions

1. Could you please confirm that Table 2 correctly reflects the requested renewal of the exemption?

The proposed exemption renewal as outlined in Table 2 correctly reflects the requested renewal of the exemption.

2. What is the difference between maintenance and service? (Difference was made during Pack 11², but no definition/explanation was provided).

The terminology used during Pack 11 has been following the terminology outlined in the Machinery Regulation (EU) 2023/1230 where the following descriptions are made:

For the term “maintenance” there is no Regulatory definition outlined, however it is understood that it could be interpreted as a combination of the processes of cleaning and servicing. In this context servicing does not have a regulatory definition, however, from the description of the machinery requirements to allow for the servicing process it is interpreted that servicing is meant as the exchange of worn parts.

“2.4.6. **Maintenance**

2.4.6.1. Cleaning: The machinery or related product shall be designed and constructed to allow its easy and thorough cleaning without contamination of the environment.

2.4.6.2. Servicing: The machinery or related product shall be designed and constructed to facilitate the changing of worn parts without contamination of the environment.”

The term “service” has also been used in the meaning of putting into service, according to the following definition:

*“ ‘**Putting into service**’ means the first use, for its intended purpose, in the Union, of machinery or related products”.*

3. In your request in the scope of Pack 11 you stated: «[...] *for dirt and contamination that can occur when engines are manufactured (but can be avoided) and during servicing, repairs and rebuilds (where dirt cannot be*

² Cf. Öko-Institut,
https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_11/RoHS_Pack-11_final_report_20161220_with_French_.pdf

avoided).».³ What kind of service and maintenance is performed in the field without bringing the equipment to an appropriate workshop, where dirt could be avoided?

EUROMOT applications include high value and large dimension equipment that cannot be removed from operation or site easily or on a regular basis. Equipment can weigh several tonnes and great effort is taken when placing it in operation, with an expectation that it will stay on site for decades.

It has to be also considered that some locations, such as remote mine sites and natural disasters locations, are not easily accessible from a logistic point of view. In these instances, communications and challenging weather conditions make the removal of those pieces of equipment unviable.

In the case of unexpected failure, highly critical pieces of equipment, such as auxiliary power generators, must be serviced on site to limit disruption of operations. Similarly, for periodic maintenance activities of larger pieces of equipment with an expected lifetime of decades, maintenance must be performed on site to ensure that disruption of operation is reduced as much as possible.

Requiring that the machine is moved to an appropriate workshop and then returned to site might take months or even up to years depending on the location of the site. Considering that such equipment is often highly specific and in most cases unique in their kind, if transfer to an appropriate workshop was required, this might result in shut down of operation for unsustainable lengths of time.

4. You state in your renewal request that testing and development are ongoing but need more time. You provided examples for research activities regarding lead-free alternatives of two bearing manufacturers. According to their website, EUROMOT have 37 members and 11 additional member brands, and three organizations support the exemption request: The Truck & Engine Manufacturers Association have 30 members, the EUROPGEN ASSOCIATION 22 members and the Nationals Association of Manufacturers have 14 000 members.
 - a. Have there been any new developments for lead-free bearings since your last exemption request in 2015 that were or are discussed in scientific research and other literature or developed by producers?

Bearing manufacturers are continually reviewing lead-free alternatives and where bearing schemes look to be promising, testing is undertaken. Since the original exemption application, it has been possible to replace lead bearings and bushing on smaller displacement engines in many applications, typically already out of

³ Cf. EUROMOT, Caterpillar,
https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_11/Request_2016-1/RoHS_Lead_Bearings_Exemption_Request_Form_EUROMOT_2015-07-27.pdf



scope of exemption. Multiple alternatives have been investigated by EUROMOT members since the last exemption application as possible alternatives for lead in bearings. The following materials have been investigated:

- Copper alloy,
- SnAl bearing⁴,
- Lead free brome bearing (with and without Bi addition),
- Lead free multi-layer materials,
- Multi-layer materials with additional coatings,
- Polymer coated bearings consisting of PFAS materials, (currently under evaluation for Restriction under REACH).
- Aluminium bushes

Comparative tests with lead containing bearings have been completed both in laboratory and in the field. However, the results have shown significant increased sensitivity to impurities in oil, a reduction in seizure resistance and debris tolerance and significant increases in catastrophic early life failures. In some applications the lead-free materials have also been seen to be less flexible, resulting in fracture of the bearing.

- b. Did you test all of these in the period between the last and the current exemption request?

EUROMOT members have highlighted the materials presented in the response to Question 4a as being investigated or still under research as possible alternatives. As specified in the exemption renewal submission in greater detail, testing of alternatives requires multiple extensive steps for the successful implementation of a viable lead-free alternative.

There are a number of key parameters to evaluate during the testing. EUROMOT is currently assessing the following: fatigue strength, wear resistance, corrosion resistance, cavitation resistance, embeddability/conformability, seizure robustness, debris robustness.

Additionally, specific conditions related to the operation environment are also under assessment. Examples include: wear characteristics under a range of loads, tolerance to oil degradation and contamination, impact of manufacturing tolerances (conformability and effect of changes to oil film thickness), tolerance to cold temperature and limited lubrication during start-up.

Comparative testing with lead on scratch seizure testing and test to failure is also completed where the material has shown promising characteristics.

- c. Did only two of the many members and supporters research and test lead-free alternatives? If not, please provide more examples of their research. If yes, please let us know why only two manufacturers

⁴ Daniel W. Gebretsadik, Jens Hardell, Braham Prakash "Seizure behaviour of some selected Pb-free engine bearing materials under lubricated condition" Tribology International, Volume 111, July 2017, Pages 265-275

engaged in research and development activities to find lead-free alternatives

More than two EUROMOT manufacturers have been researching and testing lead-free alternatives.

As mentioned in the response to Question 4b, numerous manufacturers are carrying out assessments to ascertain the properties of potential alternatives as well as how the alternatives would react to a range of operational environments.

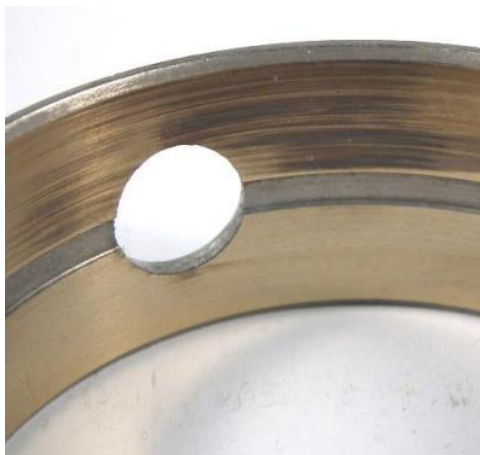
Outside of the previously mentioned two manufacturers, a specific example of testing carried out includes pilot testing of lead-free rods and mains for a number of applications. However, numerous seizures have required a reversion to the use of leaded main bearings. Due to the highly critical application of such bearings, additional time is required to further investigate the reasons for such seizures.

It is known from experience that lead-free bearings are more sensitive to stress from heat and dust. Therefore, more time to test and validate the use of lead-free bearings in engines and the exemption is still required. Further verification is needed to understand fully why the seizures are happening and how the substitution can be done safely for all applications.

Another example is possible lead-free alternative currently under testing to substitute lead bronze bushing. The first test was performed with aluminium bushes (steel back and AlSn20Cu) and showed cavitation next to the oil holes (testing conditions were: thermal shock run and 1500 h release run)



Second test runs with lead free bronze (steel back and CuSn10Bi8Zn3): thermal shock run (no cavitation) however the 1500h release run test is still ongoing.



Another EUROMOT member have been completing some testing and evaluations for main bearings for different engine platforms and all future engine programs are striving to be lead free for the powertrain bearings: crank bearings, rod bearings, piston pin bushings (where applicable). There are efforts on some of the current platforms to transition away from the leaded bearings with some platforms being partial lead-free.

- d. Could you please let us know a roadmap for your research and development activities now and in the coming years?

Lead-free alternative development can be divided in three steps:

- Lead-free materials need to be recognised. Starting with determining the lead-free applications and identifying both the alternatives and the supply chain, through to producing engineering standards documentation.
- Start of preliminary testing. Simulation and bench testing needs to be completed by suppliers, benchmark testing and test cell testing completed by manufacturers.
- Real world testing. Carried out through on-vehicle testing by manufacturers, and through customer prototype testing.

It is expected that the developing process is currently at the preliminary testing stage and that 5 years are still expected to develop the alternative as a viable solution. However, it has to be taken under consideration that failure at any point could result in redesign and a return to the beginning of the cycle.

- e. Considering the fact that not all manufacturers have the same resources available: are the tests of one bearing manufacturer representative for others?

It is of relevance to take under consideration that EUROMOT manufacturer's products feed into multiple downstream applications and industry fields, therefore the number of manufacturers and trade associations that require the continued use of EUROMOT

products is vast, as correctly emphasised by the number of trade associations supporting the Exemption renewal.

A number of the main technical challenges are common to manufacturers, such as fatigue strength, wear resistance, corrosion resistance, cavitation resistance, embeddability/conformability, seizure robustness and debris robustness. However, depending on the end application EUROMOT manufacturers might have different system requirements and may require differing levels of performance in the above characteristics.

Therefore, if considering the steps of the roadmap identified in question 4.d, it can be assumed that the first two steps, the need for Lead-free materials to be recognised and the start of preliminary testing, can be generally representative of EUROMOT technical requirements. However, the final step, real world testing, will be highly dependent on the end use and therefore it is likely to vary for different manufacturers depending on the specific system qualification testing necessary to ensure correct and reliable operation.

5. In the exemption request you state that lead is used as an overlay coating and alloying element. Therefore, the consultants propose an adaptation of the current exemption wording according to Table 3.

Table 3: Proposed exemption renewal

No.	Requested exemption	Requested scope and dates of applicability
III-42	<p><i>Lead as an overlay coating and alloying element in bearings and bushes of diesel or gaseous fuel-powered internal combustion engines applied in non-road professional use equipment:</i></p> <ul style="list-style-type: none"> - <i>with engine total displacement ≥ 15 litres; or</i> - <i>with engine total displacement < 15 litres and the engine is designed to operate in applications where the time between signal to start and full load is required to be less than 10 seconds; or regular maintenance is typically performed in a harsh and dirty outdoor environment, such as mining, construction, and agriculture applications</i> 	<p><i>Applies to category 11.</i></p> <p><i>Expires on 21 July 2024 + X</i></p>

X can be maximum 5 years.

Please comment on this proposal explaining clearly any obstacles you see if you do not agree to the proposal.



EUROMOT would suggest retaining the wording suggested in Table 2:

“Lead in bearings and bushes of diesel or gaseous fuel-powered internal combustion engines applied in non-road professional use equipment:

- *with engine total displacement \geq 15 litres; or*
- *with engine total displacement < 15 litres and the engine is designed to operate in applications where the time between signal to start and full load is required to be less than 10 seconds; or regular maintenance is typically performed in a harsh and dirty outdoor environment, such as mining, construction, and agriculture applications”*

The suggested change aims at accommodating instances in which the two applications are used separately.

For a period of validity of 5 years.

It is deemed that the suggested change to the wording may create misunderstanding on the substances covered by the exemption as lead is used as an alloying element as well and not in its pure form. A change of the wording to *“Lead as an overlay coating and alloying element”* might be misunderstood as applicable to only the use of 100% lead concentration in overlay coatings.

Please note that answers to these questions will be published as part of the evaluation of this exemption request. If your answers contain confidential information, please provide a version that can be made public along with a confidential version in which proprietary information is clearly marked.

We ask you to kindly provide the information in formats that allow copying text, figures and tables so that they can be included into the review report.

3. References

Baron et al. (2022): Study to assess 2 RoHS new exemption requests: #1 for lead in bearings and bushes of professional-use non-road equipment engines; #2 for lead in solders used to construct and connect to Peltier thermal cyclers used for in-vitro diagnostic analysers that use polymerase chain reaction (Pack 11) – Final Under the Framework Contract: Assistance to the Commission on technical, socio-economic and cost-benefit assessments related to the implementation and further development of EU waste legislation Author(s): Carl-Otto Gensch, Yifaat Baron, Otmar Deubzer, Oeko-Institut e. V. (Pack 11). retrieved from https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_11/RoHS_Pack-11_final_report_20161220_with_French_.pdf. [Accessed: 22.09.2023.]

EUROMOT, Caterpillar (2015): Exemption Request Form, retrieved from https://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_Pack_11/Request_

2016-1/RoHS_Lead_Bearings_Exemption_Request_Form_EUROMOT_2015-07-27.pdf [Accessed: 22.09.2023]