

Study for the analysis of impacts from RoHS2 on non-road mobile machinery without an on-board power source, on windows and doors with electric functions, and on the refurbishment of medical devices

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2.0 Non-Road Mobile Machinery in the Context of RoHS

2.1 Abbreviations

CECE	The Committee for European Construction Equipment
CEMA	The Agricultural Machinery Industry in Europe
Cr VI	Hexavalent Chromium
EEE	Electrical and Electronic Equipment
EUROMOT	The European Association of Internal Combustion Engine Manufacturers
EUROPGEN	The European Generation Set Association
GENSETS	Generation sets
LSFI	Large Scale Fixed Installation
NAM	The National Association for Manufacturers
NRMM	Non-road mobile machinery
Pb	Lead
PTO	Power Take Off (of a vehicle)
OEM	Original Equipment Manufacturer
RoHS 2	Directive 2011/65/EU
SME	Small and Medium Enterprises

2.2 Introduction

With the coming into force of Directive 2011/65/EU (RoHS 2), an open scope has been adopted concerning products that need to comply with the substance restrictions as well as with other administrative obligations. To accommodate this change, the new Category 11 was added to Annex I of the Directive, which lists the relevant product categories that are in scope.

Category 11 is specified as “Other EEE [electrical and electronic equipment] not covered by any of the categories listed above”. This means that any EEE that does not fall under categories 1-10 and was understood to be excluded from RoHS 1 is now in the scope of RoHS 2. In cases where such equipment falls under the EEE definition and does not benefit from one of the Article 2(4) exclusions, it would need to comply with the substance restrictions as with other RoHS obligations.

Non-road mobile machinery (NRMM) is excluded from the scope of RoHS 2 via Article 2(4)(g), with Article 3(28) providing a definition for NRMM to clarify what types of equipment could benefit from this provision (see detail in Section 2.3). However

stakeholders have raised concern that in some cases, the formulation of this exclusion results in very similar types of equipment being regulated inconsistently.

The definition of non-road mobile machinery in Article 3(28) requires an on-board power source. According to industry, the same type of equipment is however available with and without an on-board power source (e.g. professional floor cleaning machines). The identical EEE with external power source (cable) is currently in scope despite the similarities of such devices to models that are not in scope (with an on-board power source). Concern has been raised that compliance in such cases may result in significant costs.

The Commission has thus found it necessary to perform a review of the impacts of RoHS 2 on NRMM, to understand the scope of the problem and possible options for resolving it, possibly through exemptions.

This study has thus attempted to review products which may be affected and to assess manufacturers' technical or procedural problems with RoHS compliance of NRMM. Analysis was also aimed at understanding where in the product and in the supply chain the problems can be located and tackled.

2.3 Legal Background

According to Article 3(1) of RoHS:

“,electrical and electronic equipment’ or ‘EEE’ means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1,000 volts for alternating current and 1,500 volts for direct current;”

Article 3(2) further details that:

“for the purposes of point 1, ‘dependent ‘ means, with regard to EEE, needing electric currents or electromagnetic fields to fulfil at least one intended function;”

In light of the addition of an open-scope, all products and devices covered by these definitions are understood to be in the scope of RoHS and to be required to comply with the various obligations stipulated in the legal text. EEE that is newly in scope and that does not fall under categories 1-10 of Annex I of the Directive is thus understood to fall under category 11, which refers to other EEE not covered by any of the other categories.

In parallel, Article 2(4) provides a number of exclusions for specific types of equipment. These are the only types of EEE which are excluded and do not need to comply with the Directive. Among others, non-road mobile machinery (NRMM) is excluded from the scope via Article 2(4)(g):

“(non-road mobile machinery made available exclusively for professional use;”

Article 3(28) explains that:

“non-road mobile machinery made available exclusively for professional use’ means machinery, with an on-board power source, the operation of which requires either mobility or continuous or semi-continuous movement between a succession of fixed working locations while working, and is made available exclusively for professional use.”

However according to stakeholders there are certain types of professional equipment for which some models shall be equipped with an on-board power source, with others having an external source and thus equipped with a cable. In cases where such equipment is almost identical, there is concern that compliance with the substance restrictions may result in substantial costs. As shall be explained below, information provided by stakeholders has allowed identifying three product groups with the above mentioned problem.

Other stakeholders have provided information concerning certain product groups of professional equipment which are mobilized in between working locations but currently do not benefit from the RoHS NRMM exclusion as the equipment is not operated during mobilization. One example is generating sets (GENSETs) which are mounted onto trailer trucks to allow their transport from one location to another. GENSETs are often excluded through Article 2(4)(e) as large scale fixed installations (LSFI) in light of their size and their permanent use at a fixed location. However, in cases where the equipment is mobilized, such as when used for disaster relief purposes, the same equipment cannot benefit from the LSFI exclusion in light of its mobility. Though the equipment is understood to be non-road mobile machinery it would not be covered by the NRMM exclusion, based on the Article 3(28) definition, as the equipment is not mobile when in use but rather in between uses.

LSFI are defined by Article 3(4) as:

“‘large-scale fixed installation’ means a large-scale combination of several types of apparatus and, where applicable, other devices, which are assembled and installed by professionals, intended to be used permanently in a pre-defined and dedicated location, and de-installed by professionals”

Stakeholders further claim that the reference to the requirement “mobility... while working” is not included in the NRMM Directive (see Section 2.4) and that there are thus inconsistencies with the RoHS directive.

2.4 Product Group Description and Background

The NRMM Directive³ stipulates test procedures and regulates exhaust emissions from different types of engines. Directive 97/68/EC (the "main" directive) covers **diesel fuelled engines** for common NRMM. It became effective from 1 January 1999 for certain types of engines. Its first stages cover diesel fuelled engines between 37 and 560 kW. Directive 2002/88/EC, extends the scope of 97/68/EC to cover **spark ignited engines (petrol engines)** up to 18 kW for engines installed in handheld and non-handheld equipment. Directive 2004/26/EC (amendment) extends the scope of 97/68/EC, which covers diesel fuelled engines from 19 kW to 560kW for common NRMM and regulates the emissions in 3 further stages. The directive includes **constant speed engines** as well as **railway** and **inland maritime engines** (inland waterway transport sector). Though additional amendments of the Directive exist, they do not further extend the scope of machinery which is in scope.

Article 2 of Directive 97/68/EC⁴ and its amendments, defines “*non-road mobile machinery shall mean any mobile machine, transportable industrial equipment or vehicle with or without body work, not intended for the use of passenger- or goods-transport on the road, in which an internal combustion engine as specified in Annex I section 1 is installed*”. In this sense, it is possible that the definition of NRMM under RoHS 2 was formulated to include the “on-board power source” since Directive 97/68/EC defines NRMM among others on the basis of having an integral combustion engine.

The consultants would also like to draw attention to the reference to mobile machinery, transportable industrial equipment and vehicles. It seems clear that a “vehicle” is mobile while working and the same could be assumed for “mobile machinery”. In this second case, the word mobile is used to make a distinction from other machinery, which is thus understood not to be mobile. This is further supported by Article 3(16) of Directive 2007/46/EC⁵, according to which:

“mobile machinery’ means any self-propelled vehicle which is designed and constructed specifically to perform work which, because of its construction characteristics, is not suitable for carrying passengers or for transporting goods.

³ The EU legislative file of Non-Road Mobile Machinery (NRMM) currently contains seven directives: the "main" Directive 97/68/EC, and its amendments: Directive 2002/88/EC, Directive 2004/26/EC, Directive 2006/105/EC, Directive 2010/26/EU, Directive 2011/88/EU and Directive 2012/46/EU. See http://ec.europa.eu/enterprise/sectors/mechanical/documents/legislation/emissions-non-road/index_en.htm for further information.

⁴ DIRECTIVE 97/68/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 16 December 1997 on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery, Consolidated version of 10.01.2013, available under: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:1997L0068:20130110:EN:PDF>

⁵ Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles, available under <http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0046&from=EN>

Machinery mounted on a motor vehicle chassis shall not be considered as mobile machinery;”

The third formulation “transportable industrial equipment” however creates a separation between the type of equipment (industrial) and its mobility. The consultants interpret this to mean that the equipment can be transported from place to place, without its needing to be dis-installed and re-installed to enable mobility. However it remains unclear if this applies to mobility between work sites, to mobility while working or to both.

2.4.1 Problem Definition

As shortly discussed above, stakeholders have raised two types of equipment which they understand to be relevant to the review concerning NRMM. These contributions are summarised in Appendix A.1.0. Two main aspects have been raised by stakeholders regarding NRMM.

The first concerns machinery understood to be **NRMM**, for which there exist models **with an on-board power source** as well as models **with an external power source**. In light of the reference of the Articles 3(28) definition to an on-board power source, only the first would be excluded from the scope of RoHS. Relevant product groups include professional cleaning machinery; agricultural machinery (trailers and interchangeable towed equipment); and certain types of construction machinery. From the various models in the above mentioned product groups, only those with an integral combustion engine would be understood to be NRMM according to Directive 97/68/EC. However, according to the RoHS definition, there is no requirement for the on-board power source to be a combustion engine. This means, for example, that machinery with an on-board battery source could also benefit from the exclusion if other aspects of the RoHS NRMM definition are fulfilled.

The second concerns **large scale machinery used at multiple locations**, which would normally benefit from the RoHS exclusion as LSFI, but in this specific case is understood not to benefit from this exclusion in light of being portable. Despite the mobility aspect, it is unclear if the equipment would fall under the RoHS definition of NRMM as it is **not operated during mobilisation**. Relevant product groups include machinery using certain engine models which are sometimes classified in scope and sometimes out of scope, namely mobile electrical generators; petroleum extraction equipment; and industrial power systems. On the basis of the definition provided in the NRMM Directive, though it is said that such equipment would be understood to fall under 97/68/EC, it is unclear if it would be covered by the RoHS definition of NRMM in light of its operation only at fixed locations.

Both of these cases show that there are inconsistencies in the definitions of NRMM between the two Directives. Though it is not the purpose of this review to look into intra-Directive inconsistencies, this aspect should be noted in the case of an amendment of the current RoHS definition of NRMM (Article 3(28)). What becomes clear, however, is that the various aspects included in the wording formulation of Article 3(28), create cases in which similar equipment is in some cases required to comply with the substance restrictions, and in other cases is not. According to

stakeholders, in these cases, the current regulation shall result in compliance costs that are not justified by the expected environmental benefits.

2.4.2 NRMM with and without an On-Board Power Source

Three stakeholders provided information concerning NRMM inconsistently addressed by the NRMM exclusion. For such equipment there exist models, with an external power source (equipped with a cable), that are very similar to models with on-board power sources. Contributions were provided by three industry associations, with one of the contributions also supported by a cleaning machinery manufacturer.

The Committee for European Construction Equipment (CECE)⁶ explains that NRMM is excluded from the scope of the RoHS 2 Directive (Article 2(4)(g)). However, that the definition of non-road mobile machinery in the legal text limits its applicability to machinery with an on-board power source – contrary to other EU legislation defining the term of “NRMM”. Consequently cable-powered machinery would be in the scope of RoHS, regardless if all other conditions of the definition are fulfilled.

The NRMM Directive does not refer to an “on-board power source” in its definition for NRMM. However the consultants note that this Directive’s definition of NRMM requires that “an internal combustion engine as specified in Annex I section 1 is installed” in the machinery/equipment/vehicle.

EUnited Cleaning, the European Cleaning Machines Association⁷, provides information concerning **professional cleaning machines**. Examples include sweepers and scrubber driers, which are cord-connected, and that would thus be required to comply with the substance restrictions. EUnited Cleaning explains that the same products exist with an on-board power source, which would benefit from the exclusion. All in all EUnited Cleaning estimates that over 70,000 units are placed on the EU market per annum, with a distribution between models with an on-board power source and models without (cord connected) of 80:20.

EUnited Cleaning contends that in general, manufacturing companies are quite small in size, with the largest manufacturer having around 11,000 employees and the second largest manufacturer being half of this size. Most manufacturers are assumed to be close in size to SMEs or possibly slightly larger. It is further expected that all manufacturers produce both machines in on-board power source versions and in cable operated versions. This is a result of the similarity of such versions and of the fact that the power supply is configured according to the client’s preference.⁸

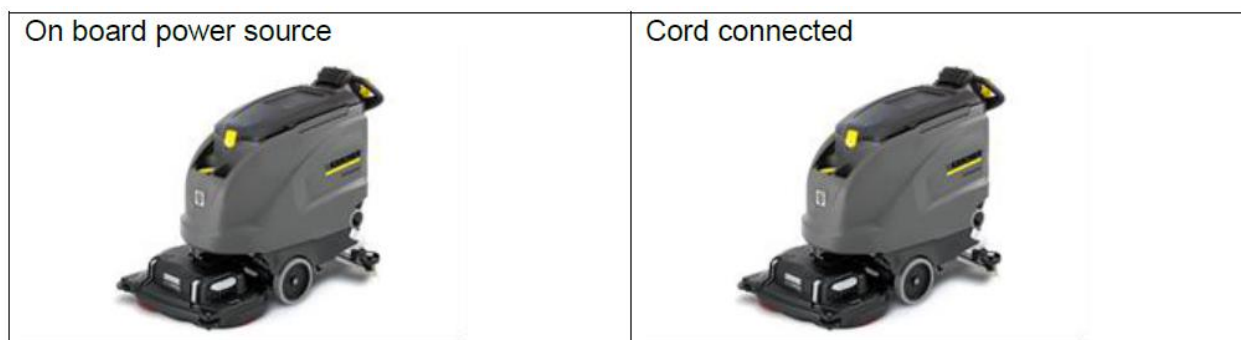
⁶ CECE (2014a), CECE Answers to NRMM Questionnaire, submitted per email on 05.12.2014

⁷ EUnited Cleaning (2014b), EUnited Cleaning Answers to NRMM Questionnaire, submitted per email on 28.11.2014

⁸ EUnited Cleaning (2014c), Summary of telephone conference with Charalambos Freed and Axel Leschtar, held 4.12.2014

According to EUnited Cleaning⁹ in cleaning machinery that could potentially benefit from the NRMM exclusion in Article 2(4), versions with an on-board power source will either have a battery similar to a car battery (Pb battery or Li-Ion battery, but not Cd battery) or work with a combustion engine running on diesel/petrol. Others will be cord-connected. For different models, both versions shall usually exist in light of customer preferences, whereas aside from the power supply the machines shall be almost identical in their design (see example in Figure 2-1 below). In this regard, it is estimated that above 95% of components are exactly the same and are manufactured on the same production line.

Figure 2-1: Pictures of identical machines with an on-board power source and cord connected for professional use.



Source: EUnited Cleaning (2014d), Letter with Request/Comments Concerning RoHS 2, Definitions, sent per email on 8.12.2014

EUnited Cleaning¹⁰ explains that there are various reasons why some customers prefer the cord connected models, and others prefer models with an on-board power source, including:

- That the cable (or cord) connected models are in most cases cheaper;
- That having a battery operated machine requires the machine to be recharged from time to time and is in this respect less convenient for operation due to the loss of working time;
- Nonetheless, in some cases a cable connected version cannot be used as logistically the room to be cleaned is too large (length of cable not practical) or the amount of passers-by would raise the risk of accidents significantly (for example in airports);
- In a small part of models, battery operated models may also be heavier;

Concerning the presence of ROHS substances, EUnited Cleaning estimates that these are present in negligible concentrations in relation to the [weight of the] machine. RoHS substances are expected to be present in printed circuit boards; switches; and

⁹ Op. cit. EUnited Cleaning (2014c)

¹⁰ Op. cit. EUnited Cleaning (2014c)

different electronic components, all in very small quantities. The mechanical demands of such machinery through use make finding suitable substitutes very difficult, as machinery is exposed for example to in-harmonic vibrations and to corrosive heavy duty cleaning materials. ¹¹ During operation, strict requirements are put on all devices in terms of quality and safety. Factors include: ¹²

- Strong vibration;
- The effects of weather and road salt;
- Use of acid or alkaline cleaning agents;

The fact that cleaning machines operate with heavy-duty chemicals adds to the aspects of reliability that need to be considered when researching for substitutes, as faults of machinery resulting in leaks can result in emissions of chemicals and thus in impacts to the environment and to the health of operators and passers-by. ¹³

Possible alternatives are limited and not yet tested for suitability for these types of machines. For example, *“ROHS compliant alternatives must meet these requirements, e.g., secure solder joints, despite the use of lead-free solders, reliable corrosion protection, despite absence of chromium(VI), safe electrical lines, despite phasing out of lead and cadmium. Testing for one product part takes approx. 12-18 months and no guarantee it works. Implementation in safety standard → 3-4 years”*. EUnited Cleaning expects that manufacturers shall have high compliance costs in light of the need to find reliable alternatives and the costs and time needed for doing so. ¹⁴

It is however expected that as substitutes become more and more available for other products/machinery, there is a good chance that professional cleaning machinery shall also become more and more RoHS conform, as the cleaning machinery market share is too small for suppliers to manufacture components only for their use in such products. In other words, regardless of the question if such products shall remain in the scope of RoHS, compliance (and in this sense the respective environmental benefits that could result from compliance) is likely to be achieved in-directly in light of a decreasing supply of components which are not compliant with RoHS. ¹⁵

¹¹ Op. cit. EUnited Cleaning (2014b)

¹² EUnited Cleaning (2014a), EUnited Cleaning Letter to European Commission Concerning time frame Restriction of Hazardous Substances (RoHS, Directive 2011/65/EU) , submitted per email on 5.3.2014

¹³ Op. cit. EUnited Cleaning (2014c)

¹⁴ Op. cit. EUnited Cleaning (2014b)

¹⁵ Op. cit. EUnited Cleaning (2014c)

They propose resolving this the current problems by changing the Article 3(28) definition where the power source is mentioned as follows (addition in italics): “...with an on-board power source *or with a traction drive...*”¹⁶.

CEMA¹⁷ represents the Agricultural Machinery Industry in Europe, and has provided information concerning **agricultural NRMM**. This encompasses agricultural vehicles like tractors (category T), interchangeable towed equipment (category S) and agricultural trailers (category R) that fall under type approval like cars and trucks, and also agricultural non-road mobile machinery.

It is understood that in light of the definition of NRMM in Article 3(28), tractors and agricultural self-propelled machines are excluded from the scope of RoHS and do not need to comply with the substance restrictions. Agricultural trailers and interchangeable towed equipment (categories R and S respectively) however, do not benefit from this exclusion in light of the reference to ‘with an on-board power source’ of this definition.¹⁸

It is however possible that they are excluded through Article 2(4)(c)¹⁹ as the connection of these vehicles is only possible to tractors (which are excluded) and they are dedicated to a specialised function. According to CEMA, the interchangeable towed equipment are in fact machines under the Machinery Directive for dedicated functions (balers, towed spraying equipment, towed ploughing equipment, towed seeding equipment, towed harvesting equipment...) for professional use only. For road safety reasons they fall under the framework regulation for agricultural vehicles (167/2013).²⁰ CEMA adds to this explanation that the only issue of uncertainty for the exclusion of agricultural trailers and interchangeable towed equipment through Article 2(4)(c) may be the wording reference to “equipment which...is to be installed” as such vehicles are rather coupled and decoupled, and not installed.²¹

“99 % of interchangeable towed equipment receives its power from the power take off (PTO) of the tractor. This powers mechanically special tools on the towed vehicle. Less than 1 % of such vehicles are powered by electricity from the tractor, where ‘electrification’ is needed on the tractor to generate the high voltage necessary to power the different tools. The electronic equipment on board of the towed equipment is necessary to direct the different tools,

¹⁶ EUnited Cleaning (2014d), Letter with Request/Comments Concerning RoHS 2, Definitions, sent per email on 8.12.2014

¹⁷ CEMA (2014a), Personal communication titled “CEMA request – related to the analysis of impacts from RoHS 2 on various products: non-road mobile machinery without an on-board power source”, sent per email on 7.10.2104.

¹⁸ CEMA (2014b), CEMA Answers to NRMM Questionnaire, submitted per email on 03.12.2014.

¹⁹ Directive 2011/65/EU Article 2(4)(c) reads: “equipment which is specifically designed, and is to be installed, as part of another type of equipment that is excluded or does not fall within the scope of this Directive, which can fulfil its function only if it is part of that equipment, and which can be replaced only by the same specifically designed equipment;”

²⁰ Op. cit. CEMA (2014a)

²¹ Op. cit. CEMA (2014b)

providing them the necessary intelligence. The electronic equipment used is from suppliers that deliver components also to trucks and off-road vehicles. The agricultural vehicle sector is too small to have dedicated suppliers. As for agricultural trailers, some of them are equipped with tools on the back e.g. as in the case of a manure spreader. In addition any towed machine whose ratio between laden and unladen mass is higher than 3 is also seen as a trailer... These are dedicated vehicles, exclusively used by professionals, under very harsh conditions, pulled by tractors that are excluded from the scope as well".²²

CEMA²³ explains that in total the agricultural machinery park has around 450 different types of machines. Many of these types are interchangeable towed equipment. Comprehensive data for EU sales of the main interchangeable towed equipment in the EU28 is not available, however to provide some insight, volumes for the 'Sowing, Fertilizing, Plant Protection' equipment (turn-over of €1.5 Billion) were detailed as follows:

- *"Towed sprayers: around 10.000 units against 1000 units self-propelled*
- *Fertiliser spreaders: around 20.000 units*
- *Seed drills: 20.000 units*
- *Precision seed drills: 60.000 units"*

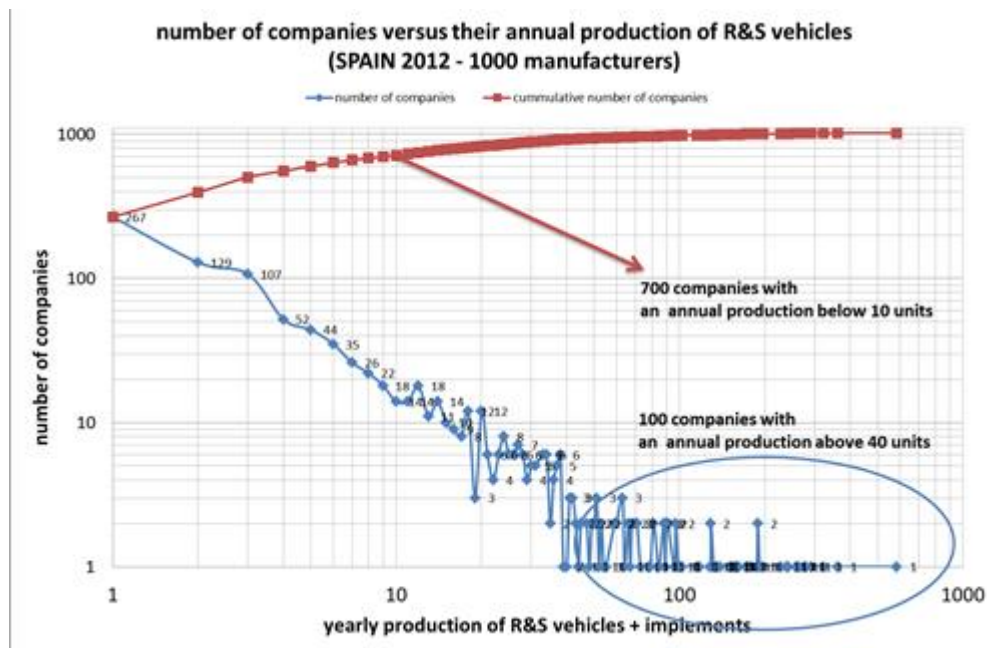
Of a total turnover for the agricultural machinery industry of around €29.8 billion in 2013, it is estimated that R&S vehicles/mounted implements count for about €8.4 Billion or 29 %. Agricultural trailers are said to have a total turnover of less than a Billion €, having only little electronics on-board (for instance anti-lock braking (ABS) systems). As for the volume of sales for such products, for a specific model, this can range from 1 per year up to several hundred per type but no more [the consultants understand this to mean that the sales of a specific model is one to several hundred per annum] . The larger-sized companies, specialised in R&S vehicles can have total production volumes of up to 20,000 units. Figure 2-2, shows a distribution of the number of companies and their total production volumes for Spain, giving an idea as to how many small manufacturers are present in this market.²⁴

²² Op. cit. CEMA (2014a)

²³ Op. cit. CEMA (2014b)

²⁴ Op. cit. CEMA (2014b)

Figure 2-2: Number of Companies Versus their Annual Production of R&S Vehicles (Spain 2012 - 1000 manufacturers)



Notes: “Even the large companies like Pöttinger, Lemken, Kuhn, Maschio Gaspardo, Kverneland... have low production volumes per type but many types. For example, for one company for which detailed information was provided to CEMA on volumes/types: the company had 7 different classes of machines like a loaderwagen, mower, teder... with in total of 72 types (separately type approved) with total production volume of 8,396 units (3,110 for the EU).

Source: Op. cit. CEMA (2014b)

As for compliance with RoHS, CEMA²⁵ explains that the agricultural machinery industry has always been excluded from the RoHS directive. The exclusion of the automotive industry was always based on the more harsh environments under which such vehicles operate and on the safety requirements. Most components are the same or similar to those from the bigger automotive sectors. Therefore, when it comes to electronic components, manufacturers are mostly “followers” [i.e., do not have sufficient power to influence the design of supplied components]. A thorough analysis of the composition of electronic components has never been performed for this sector, with the exemption of some major manufacturers when the RoHS Directive was first launched. On this basis, CEMA could not provide information concerning the use of RoHS substances or concerning the availability of substitutes. Nonetheless, CEMA assumes that since for most electronic suppliers it was not feasible to continue manufacturing non-compliant electronic components solely for the automotive industry, that in some areas compliance may have already occurred for electronic components. As for the compliance of non-electronic parts, this could be a source for heavy compliance costs, as such components would also need to comply.

²⁵ Op. cit. CEMA (2014b)

The Committee for European Construction Equipment (CECE)²⁶ has provided information concerning **construction and mining equipment**.. According to CECE, several types of construction machinery are electric powered, and thus have cables that provide a power source, rather than an on-board engine. For example, the following machines, used primarily in mining, which are practically identical to diesel powered (or gas powered) NRMM in every other respect:

- Underground Coal Shuttle Cars (these products would likely fall under the “means of transportation” exclusion”).
- Underground Hard Rock Jumbo Drill – these products have a diesel engine drivetrain, but a trailing cable supplies power while drilling.
- Underground Rock Header.
- Rotary blast hole drills - this machine type includes both diesel and electric trailing cable models.
- Underground Coal Roof bolters.
- Underground Coal Continuous Miners.
- Electric Rope Shovels.
- Draglines.
- Hydraulic Mining Shovels - current models can be provided with external cable power source and on-board power source.
- Hauling trucks equipped with trolley system – these also likely fall within the “means of transportation” exclusion).

CECE does not have detailed statistics as to the electric powered NRM mining machinery market, however estimates the EU market share to be relatively low compared to the global market. Because of the size, expense and operating costs of these products, the market is for professional use in mines only, so a niche market exists for all of these products in mines in the EU. For example, approximately 40-80 electric shuttle cars are operating in coal mines in the EU, as well as a small number of electric rope shovels, and continuous miners. These products can be as large as a three story building and cost multiple millions of Euros. The total sales of each individual product is relatively low globally. For products that are available both with an on-board or with an electric power source, the customer has the option of selecting which model is preferred for its mine. Because of the small number of large mining machines available for sale annually, the share of electric machines varies widely from year to year. For the most part, however, many of the mining products are available only in electric versions, but these non-road electric powered mobile machines use many of the same components as the diesel and gas powered electric machines.²⁷

²⁶ Op. cit. CECE (2014a)

²⁷ Op. cit. CECE (2014a)

CECE explains that mining and construction equipment is typically operated in extremely harsh conditions and is constantly exposed to debris and vibration while expected to operate for thousands of hours. These products operate in a wide range of climates, some of which can be extreme due to the location of the job site. This type of equipment requires more durability and reliability than relevant consumer products because of the industrial setting and application. All mining and construction equipment are held to very high safety standards because of the close proximity to people while in use. Converting mining and construction equipment to RoHS compliant components may degrade the quality and durability of safety critical components and put operators and bystanders at risk. Lead-free solder is significantly more brittle than leaded solder and therefore is less able to function in extreme conditions. More work is required to validate its use on construction and mining machines.²⁸

Concerning presence of RoHS substances, CECE contend that as NRMM has up till now been excluded from RoHS, an analysis regarding “RoHS substances” has not yet been performed by construction equipment manufacturers. Such an analysis would largely depend on suppliers of such manufacturers to provide them with the information. Undertaking such an analysis is presumed to be a complex challenge for the industry. This is on the basis that manufacturers of the construction equipment sector develop and produce thousands of applications, many for niche markets with sales of less than one hundred units per year and even down to series of less than 10 units per year. As for complying with RoHS, manufacturers would face very similar technical challenges to make machines without on-board power source compliant with RoHS as they would for machines with on-board power source, because many components of these machines are very similar such as many electronic components on these machines. Such technical challenges could potentially prevent manufacturers from producing and placing RoHS compliant machines without on-board power source on the EU market, especially when similar machines with on-board power source are excluded.²⁹

2.4.3 Mobilised Machinery Operated at Fixed Locations

Four stakeholders provided information concerning NRMM, which is mobilised in between fixed working locations – three industry associations and one manufacturer of relevant equipment (diesel engines). The case for such machinery is based on two main arguments. The one concerning the inconsistency between the RoHS Directive NRMM definition and other legislation, and the other, in relation to the similarity of equipment in scope to other equipment, which is excluded. It is explained that in some cases identical equipment is treated differently in light of the dissimilarities in installation.

²⁸ Op. cit. CECE (2014a)

²⁹ Op. cit. CECE (2014a)

EUROMOT³⁰, the European Association of Internal Combustion Engine Manufacturers, explains that reciprocating engine models and families are applied across many end-use applications. The same basic engine model may be used in earthmoving equipment, generation sets (gen-sets) and marine engines. Engines used in earthmoving machinery are excluded on the basis of Article 2(4)(g) & 3(28) as they are professional use, have an on-board power supply, and their operation requires either mobility or continuous or semi-continuous movement between a succession of fixed working locations while working. Similarly engines used in means of transport, such as marine vessels, are out of scope according to article 2(4)(f). However, it could be interpreted that certain machines characterised as ‘non-road mobile machinery’ in the engine exhaust emission legislation 97/68/EC are not considered to be non-road mobile machinery under article 3(28) of 2011/65/EU, such as mobile gen-sets.

EUROPGEN³¹, the European Generation Set Association, explains that diesel engines are utilized in a broad array of end use applications due to their efficiency and reliability. Because of the many marketable uses of diesel power, a single engine platform, identical in design and construction, is commonly used in multiple applications. However, these end-use applications are regulated inconsistently. Permanently installed generating sets for either standby or continuous duty with power ratings greater than 375 kW are typically excluded from the RoHS Directive as ‘Large Scale Fixed Installations’. Identical models are also extensively used for temporary power at e.g., construction sites, disaster recovery zones and public events. Due to their temporary nature [in terms of location], these products do not benefit from the LSFI exclusion since they are moved from site to site and are not permanently installed at a pre-defined and dedicated location. Generators for non-permanent installations (e.g., rental application) utilize the same engine as the previous examples and are destined for very similar use: back-up power for critical applications such as communications equipment, data centres, refrigeration, and medical facilities. These would also not benefit from the NRMM exclusion, nor would they fall under the LSFI exclusion.

Similarly, NAM³², the National Association for Manufacturers, names mobile electric generators, petroleum extraction equipment and industrial power systems as professional product applications which are mobile in so far as they are intended to move between multiple job sites over the course of their useful life. These three types of equipment use the same “on-board power source” (an internal combustion engine) as well as other components applied in machines that are excluded from the scope of the Directive, however they are mobilised in between working locations and thus would not be covered by neither the NRMM nor the LSFI exclusions..

The current definition of NRMM, that is “machinery, with an on-board power source, the operation of which requires either mobility or continuous or semi-continuous

³⁰ EUROMOT (2014b), EUROMOT Answers to NRMM Questionnaire, submitted per email on 2.12.2014.

³¹ EUROPGEN (2014a), EUROPGEN Answers to NRMM Questionnaire, submitted per email on 2.12.2014.

³² NAM (2014a), NAM Answers to NRMM Questionnaire, submitted per email on 2.12.2014.

movement between a succession of fixed working locations while working...” does not apply to static generating sets, whether they are permanent or temporary as there is no mobility while working.³³

The rated power output of the power generation equipment in question is between 375kW to ~2.5 megawatts. Power generation equipment is currently manufactured and sold in all ranges in this power spectrum, with most of it benefiting from the LSFI exclusion, however with some not qualifying due to the fact that it is mobile while not in use. The products are engineered to be overhauled, which can effectively extend the useful life for an indefinite term. Generating sets above 375kW have a typical life of over 20 years. They are unlikely to enter the waste stream or end up in land fill as they contain precious metals and large quantities of recyclable materials. Generating sets such as these are also within scope of Directive 2012/19/EU (WEEE) and carry obligations on the manufacturer or seller. Table 2-1 below shows global market estimates of sales volume and turnover by kVA output. EUROPGEN estimates that the RoHS restrictions on temporary, non-stationary generating sets will have an impact throughout the power generation industry and also throughout the engine manufacturers’.³⁴

Table 2-1: 2013 Diesel Gen-Set Market, Parkinson’s data

Power Band (kVA)	World		Europe		Europe % World	
	Euro 000	Units	Euro 000	Units	Euro 000	Units
<7.5	910,928	608,705	54,295	33,266	6%	5%
7.5-250	3,357,914	507,664	408,023	50,241	12%	10%
251-750	1,989,620	71,025	242,811	8,453	12%	12%
751-2000	2,096,338	23,782	240,945	2,410	11%	10%
2000+	2,142,948	5,067	356,196	667	17%	13%
Total	10,497,747	1,216,243	1,302,270	95,037	12%	8%

Source: Submitted in both EOROGEN (2014a) and EUROMOT (2014a)

Lead is explained to be the primary RoHS substance of concern. Typically lead is present in engine bearings, some electronic and cooling system components, and in some aluminium and copper alloys used in precision components such as housings, covers, connectors, and fittings. Lead quantities in these components can be above the restriction threshold at the homogeneous material level, though it is explained that it is present in very small quantities relative to the mass of the generating set. As an example, an audit of an electronic fuel injection diesel engine producing approximately 1800 kW electricity is given. The audit showed that the engine contained 16 grams of lead in total. This engine is similar in design and consistent in materials and supplies used to other larger diesel engines. A typical weight of a generating set employing such an engine would be 20 tonnes. On the basis of the

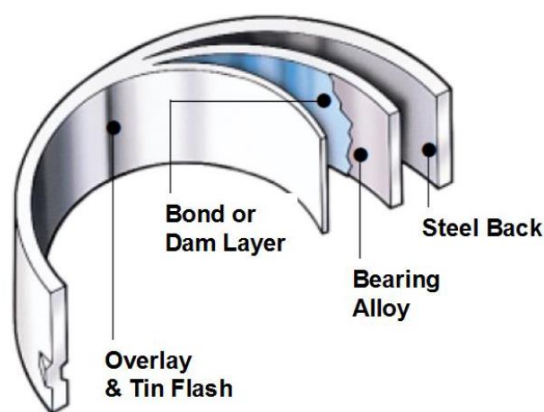
³³ Op. cit. EUROPGEN (2014a)

³⁴ Op. cit. EUROPGEN (2014a)

2013 total volumes from the Parkinson table above and using 16g per unit as a conservative estimate, EUROGEN estimate that a total of 1521 kg of lead could be placed on the EU Market through the sales of example products. It is further emphasized that this estimate is extremely conservative with the quantity per engine based on the larger engine sizes with relatively low volumes (3,077) whereas smaller engines (91,960) contain much less lead.³⁵

EUROMOT³⁶ explains that lead is present as an alloy element or thin layer in engine bearings and bushings, used for some components of complete engine packages including air compressors and starters. Of greatest concern is lead used in larger size main and connecting rod bearings where no effective substitute has yet been developed. On a typical tri-metal bearing for heavy duty application, the very thin overlay may contain up to 90% lead and the bearing alloy may be up to 20% lead (see Figure 2-3 below). Lead would typically comprise between 1 and 3% of a complete leaded bearing (based on total part weight). Lead from all these components would typically comprise less than 0.025% of a complete engine. This does not include RoHS compliant trace amounts of lead that may be in standard steel and aluminium alloys.

Figure 2-3: Tri-metal Bearing Illustration



Source: EUROMOT (2014a)

It is not completely clear to the consultants how the EUROMOT and EUROGEN statements concerning the possible Pb content of a complete engine correspond with each other. EUROMOT estimate that the total Pb from the components it details in “a complete engine” would comprise less than 0.025% of it. It is assumed that this statement regards the %weight of the Pb from the engine weight. EUROGEN estimate that a total of 16 gr of Pb would be present in a “generating set employing such an engine”. The weight of a typical generating set is estimated by EUROGEN to be 20 tonnes. This would suggest that the weight of the engine would need to be around

³⁵ Op. cit. EUROGEN (2014a)

³⁶ Op. cit. EUROMOT (2014b)

640 Kg, for 16 gr of Pb to represent 0.025% of the engines weight as estimated by EUROMOT.

Concerning substitution of RoHS substances, EUROPGEN explain that Lead-free bearings have been developed and tested for smaller (typically automotive) engines. However the technology for lead-free bearings in larger engines is not fully developed. Early indications show that the lead-free bearing alternatives are not as reliable in service, requiring more frequent major engine overhauls. This would create a significantly larger waste stream of consumable items, including used oil, coolant, gasket and sealant materials as well as the bearings themselves and therefore the impact to the overall waste stream could be considerably higher than when using the leaded bearing materials, where the mass of lead is very small. Significant research and development is still needed, particularly for larger engines.³⁷

NAM³⁸, elaborate on this, explaining that while work on alternatives is underway, using lead bearings in these applications remains the only way to ensure most engine debris embeds safely in the bearing. This allows the equipment to deliver the critical performance, reliability and durability necessary for power generation in multi-complex operational environments.

Lead-free solders for electronic components have been developed and industry is working toward introduction. However, such solders are significantly more brittle than leaded solder and more work is required to validate their use for on-engine applications such as the larger engine control modules. Lead-free solders for cooling system components such as radiators are still undergoing trials. In this regard, it is also explained that any impact on reliability will have a negative effect on the end users of the power generation equipment. This is particularly important when the generating sets are providing backup power to hospitals or other critical support systems.³⁹

EUROPGEN explain that the industry is diligently trying to work to the stated deadline but the outcome is uncertain for the reasons stated above. Many bearing manufacturers have conducted prototype and bench testing of RoHS compliant bearings for the >375 kW market segment, but none have undergone successful engine validation testing (~ 3years) and field testing (~3 years) nor are lead free bearings utilized as a leaded bearing substitute in critical power generation applications. It may not be possible to deliver a cost-effective compliant product with an acceptable reliability within the given timeframe. If this occurs, this may result in many companies removing product lines from the EU market, giving an unfavourable impact to the EU economy, including manufacturing industries, infrastructure and product end users (increased capital expenditure and period costs).⁴⁰

³⁷ Op. cit. EUROPGEN (2014a)

³⁸ Op. cit. NAM (2014a)

³⁹ Op. cit. EUROPGEN (2014a)

⁴⁰ Op. cit. EUROPGEN (2014a)

2.5 Applicability of the RoHS Article 2(4) Exclusions

As explained above, stakeholders have addressed two types of equipment, which are said to be regulated inconsistently. Thus an important aspect in terms of compliance is to understand how these product groups relate to the NRMM definitions.

In one case, the aspect raised is related to the power source. The RoHS NRMM definition depends on the existence of an on-board power source. This definition could be regarded as inconsistent with Directive 97/68/EC, however not in light of the requirement of an on-board power source, but rather in the lack of specification as to what power-source is required. In this regard, Directive 97/68/EC requires an internal combustion engine be installed in the machine/equipment/vehicle, as specified in Annex I of the Directive. At present Directive 97/68/EC and its amendments only relate to various types of diesel fuelled engines as well as various types of spark ignited engines (petrol fuelled). Other types of power sources are not mentioned, and in this respect the RoHS definition is understood to be wider than the Directive 97/68/EC definition, as it does not exclude for example battery powered machinery. The request should thus be understood as one to amend and widen the scope of the RoHS NRMM definition to include machinery with an off-board power-source.

Concerning agricultural equipment, it has been suggested that such equipment may also benefit from the Exclusion in Article 2(4)(c). In this concern the RoHS FAQ document states:

“...The exclusion in Article 2(4)(c) applies to equipment that is specifically designed to be fitted into another piece of equipment that is itself excluded from scope.

Specifically designed EEE normally means that it is tailor made; it is designed to meet the need of a specific application. For example, for EEE to be specifically designed to a LSFI it needs to be designed, dimensioned and customised according to the need of the application.

For ‘specifically designed’ EEE to benefit from the exclusion of 2(4)(c) it must be intended only to be installed in another type of equipment that is excluded. Thus if a particular EEE can function in excluded and in scope equipment, it would be in scope unless it can be demonstrated (e.g. with sales documents, installation instructions, marketing literature, etc.) that it is only to be installed in an excluded equipment.”⁴¹

Thus, assuming that the agricultural machinery of relevance is indeed only manufactured for the purpose of being installed in other equipment excluded from scope, it would possibly benefit from this exclusion, regardless of its definition as NRMM with or without an on-board power source.

⁴¹ EU COM (2012), RoHS 2 FAQ Document, Q4.1, available under: http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf

In contrast, where mobilised machinery is concerned, it seems that Directive 97/68/EC indeed may cover equipment which is mobilised between working locations and not only equipment mobile while working. This is interpreted through the reference in the Directive 97/68/EC NRMM definition to “transportable industrial equipment”, in which the mobility is understood to regard the possibility of moving such equipment from place to place. The RoHS NRMM definition, however does not seem to cover such equipment, as is understood from the Article 3(28) definition, stating “*the operation of which requires either **mobility** or **continuous or semi-continuous movement** between a succession of fixed working locations **while working***”.

It could be argued that such equipment may fall under the LSFI exclusion. The definition in Article 3(4) mentions that equipment is “intended to be used permanently in a pre-defined and dedicated location”. As mobile generation sets are installed on trailer trucks, to allow their mobilization, it could be interpreted that the equipment (the generation set) is used permanently in a predefined and dedicated location (the trailer truck). However, the FAQ Document clarifies that it was not the intention of the regulator for such equipment to be categorised as LSFI”Q.3.1 “...Machinery that has partial mobility, for example semi-mobile machinery running on rails, can be of ‘permanent use’. On the other hand, EEE that is intended to be used on different sites during its life is not considered as permanent. It is an indicator of permanent use if the equipment is not readily re-locatable (or ‘mobile intended’) and if it is intended for use at one single location...”

It is thus understood that though the various product groups may have been overlooked (in light of their similarities with excluded EEE) in both cases, it was not the original intention of the regulator for equipment from the mentioned product groups to be excluded from scope.

2.6 Critical Review

The on-set of this review is that the various product groups mentioned by stakeholders are in the scope of RoHS, whether intended by the regulator or not. Cord connected NRMM do not enjoy the current exclusion, as they do not have an on-board power source. Mobilised machinery operated at fixed locations also does not currently benefit from the NRMM exclusion, in light of its not being mobilised while working. Such equipment would also not benefit from the LSFI exclusion as explained above.

2.6.1 Difficulty of Compliance

Though stakeholders have mentioned different types of equipment in relation with the NRMM exclusion, a few similarities exist regarding the difficulties of such equipment to comply:

- To begin with, all product groups are said to be operated under conditions which pose higher reliability and safety requirements in comparison with consumer EEE: Machinery is explained to operate under harsh conditions, to be constantly exposed to debris and to vibration, while also being expected to have a relatively long service life (10-25 years, depending on product group). Products require more durability and reliability, in many cases also operating

in a wide range of climates (relevant for all machinery operated outside). These aspects mean that RoHS substance alternatives need to fulfil more stringent requirements as substitutes in comparison with, for example, consumer products with a short service life.

- All stakeholders have mentioned lead as a RoHS substance of particular concern. In engines, such as those of Gen-Sets, lead is present in engine bearings, in some electronic and cooling system components, and in some aluminium and copper alloys used in precision components such as housings, covers, connectors, and fittings. In NRMM equipment with an off-board power source, lead is anticipated in solder joints, printed circuit boards and other electrical components. For cleaning machinery, Cr VI could also be of concern, in light of the need for corrosion resistance where heavy duty cleaning materials are used, as well as cadmium and lead used as stabilisers in cables. All stakeholders explain that substitutes are currently not available, with research and testing of possible alternatives needing more time to validate that their use in the various product groups will provide comparable performance and reliability.
- In all cases, stakeholders have demonstrated that there exists similar types of equipment which are not in the scope of RoHS. In this sense, part of the argumentation of all contributors regards the **cost of compliance for similar equipment not in scope**, which may be impacted in light of the manufacture of components on the same production lines. For electronic components, compliance may be brought about in some cases through pressure from other markets of suppliers to be RoHS compliant (in many cases the manufacturers of equipment do not have sufficient power to influence suppliers). However, the compliance of non-electronic parts is said to be a possible source for heavy compliance costs.

In the case of NRMM with off-board power sources, it is further understood that equipment is usually manufactured in small quantities, further supporting that any changes in the design could affect all similar models. In cleaning machinery *“aside from the power supply the machines shall be almost identical... above 95% of components are exactly the same and are manufactured on the same production line”*; furthermore *“most manufacturers are assumed to be close in size to SMEs or possibly slightly larger”*.⁴² As for agricultural equipment, *“the volume of sales for such products, for a specific model, this can range from 1 per year up to several hundred per type but no more”*⁴³. Similarly, regarding construction and mining equipment, *“the total sales of each individual product is relatively low globally. For products that are available both with an on-board or with an electric [external] power source, the customer has the option of selecting which model is preferred for its mine... the share of electric machines varies widely from year to year. For the most part, however, many of the mining products are available only in electric versions, but these non-*

⁴² Op. cit. EUnited Cleaning (2914c)

⁴³ Op. cit. CEMA (2014b)

road electric powered mobile machines use many of the same components as the diesel and gas powered electric machines".⁴⁴It is thus understood that though compliance may be possible with time, this could require significant resources for researching possible alternatives and testing their reliability. In some of the mentioned cases, the product groups have a very wide range of different products, manufactured in relatively small quantities (between 1 and 100 per year). In such cases a further burden of compliance will be needed to ensure compliance for each and every model of a wide product portfolio, both from a technical perspective as well as from the administrative perspective of documenting compliance. In other cases the fact that most equipment is out of scope with a small share of equipment being in scope (20% and less) shall impact the burden of compliance, particularly in cases where the compliance of equipment which is out of scope is "forced", in light of mutual production lines

The costs of compliance are thus understood to be relatively high, especially where machinery is manufactured in small volumes per model.

2.6.2 Impact Review of the Various Product Groups

Since each of the product groups mentioned by the various stakeholders exhibits slight differences in various aspects, a short review of the main aspects for each is provided below, as well as conclusions and recommendations as to the possible courses of action.

Cleaning Machinery

In terms of **Environmental Impacts**, if cleaning machinery with an off-board power source is to remain in scope, environmental benefits could be expected, related to applications in which RoHS substances are to be replaced with time. Eunited Cleaning mention that RoHS substances are present in various components in negligible concentrations. However, this is understood to be in relation to the machine weight and not in relation to the homogenous material. Exact quantities are not provided, however for most of the applications mentioned, from the experience of the consultants', it can be followed that RoHS substances presence would be small in terms of the weight per machine (e.g. Pb in lead based solders; Cr VI in corrosion protection of metal parts). In light of the conditions of use of machinery it is expected that finding alternatives with comparable performance and reliability may be challenging (e.g. exposure to vibrations; exposure to changing weather conditions and road salts; exposure to acid or alkaline cleaning agents; design intended for long-life). Though this can be supported by exemptions currently available for other mobile equipment operating under similar conditions, e.g. Ex. 33⁴⁵, it is apparent that

⁴⁴ Op. cit. CECE (2014a)

⁴⁵ Quoted from Directive 2011/65/EU, Annex IV: Ex. 33: "Lead in solders on populated printed circuit boards used in Directive 93/42/EEC class IIa and IIb mobile medical devices other than portable emergency defibrillators. Expires on 30 June 2016 for class IIa and on 31 December 2020 for class IIb" This exemption is available for medical devices with long service lives, exposed among others to

substitutes may become available for some applications within the coming few years. It is thus assumed that such devices could become RoHS compliant through the development of substitutes, or where this would require additional time (post 2019), by requesting exemptions, until the reliability of possible alternatives could be proven.

EUnited Cleaning have further attested that manufacturers have little influence over their suppliers, where the use of RoHS substances in components is concerned; Though this may hinder their influence on the RoHS compliance of supplies, where alternatives are developed for other EEE manufacturers with larger market shares, these could with time lead to the phase-out of RoHS substances in cleaning machinery supplies as well.

It is thus understood that environmental benefits are expected connected to the phase-out of RoHS substances. However, in light of the cleaning machinery industries market share, it can also be followed that compliance shall depend on development of substitutes for other EEE, possibly requiring more time where reliability of alternatives is not proven. As it can be followed that the amount of RoHS substances in use is rather small in relation to machine weight, and as only 20% of cleaning machinery are said to be in scope, it is concluded that benefits would be small. Furthermore, the distribution of benefits could vary over time between the mid-term and the long term (5 to 10 years and above), with benefits expected at least in part, regardless of the equipment being in scope or not.

As for **Economic Impacts**, EUnited Cleaning expect costs of compliance to be high in light of the possible impacts of alternatives on reliability and the large development effort needed to make substitutes available.⁴⁶ It seems that these could be quite large in relation to the benefits expected. The cleaning machinery sector is said to be highly specialised and extremely export-oriented, with the European turnover amounting to 1.5 billion €. ⁴⁷ Only part of this is understood to be relevant for equipment which is in scope, as it has been stated that only 20% of the product range is in the scope of RoHS (off-board power source), amounting to 14,000 units placed on the market per annum. Furthermore, it is said that most manufacturers are SMEs or slightly larger than SMEs, with all manufacturers producing both models that are in and out of scope (off-board and on-board power source respectively). On this basis it can be followed that efforts towards RoHS compliance could create a large burden for this industry, especially where substitution is to require resources for research and development as well as for reliability testing over a longer period of time. Since the main market share of these companies is in the manufacture of machinery with on-board power sources, manufacturers could pull cord-powered models off the EU

strong mechanical strains such as vibrations during operation. As is clear from the exemption duration, substitutes are expected in some cases as early as 2016 and in others in 2020.

⁴⁶ Op. cit. EUnited Cleaning (2014b)

⁴⁷ See <http://www.eu-nited.net/cleaning/commercial-cleaning-industrial-cleaning-commercial-cleaning-indu/index.html>; EUnited Cleaning represents the leading producers of floor cleaning machines and high pressure cleaners for commercial and industrial use. It is thus assumed that these figures represent cleaning machinery for commercial and industrial use, i.e. for professional use, and do not reflect the turnover of consumer products.

market to avoid the need for compliance. This would impact (professional) consumers, in terms of loss of availability of part of the current product range. In light of the reasons stated for using cord-powered models (see Section 2.4.2), this would result in higher prices (costs) for consumers as well as a loss of effectiveness in operation where recharging needs create a loss of working time. Changes to market structure are not expected as all manufacturers produce both types of models in light of the similarity of both on and off-board powered equipment; all manufacturers are expected to be affected by RoHS similarly, regardless of types of machinery that they produce or the location of manufacturing sites (inside or outside EU). Though the impacts shall be similar, larger manufacturers may be able to cope slightly more easily with this burden in comparison with smaller manufacturers, which are understood to be more dominant in this industry. To conclude, costs are to be expected and could be substantial in light of:

- the efforts needed to support compliance;
- the related turnover of the relevant machinery; and
- the size of manufacturers.

If such costs are to be severe, manufacturers could phase-out of cord-powered models, shifting costs to consumers. A shift back could occur with time, if substitutes are to be found for similar applications of other product groups in scope.

Regarding **Social Impacts**, where a shift to battery operated machinery is to occur, in heavier models, operation convenience would be affected to some degree, though it is understood that this is only relevant in a few models. The need to recharge machinery from time to time may also make operation less convenient and consequently more expensive for the users of such equipment, needing more time to complete the a certain task. Both of these could be perceived as impacts on employment, though it is not expected that employees shall need other skills or are to experience a change in job opportunities. In terms of impacts on health, positive impacts are only to be expected in relation with the phase-out of RoHS substances. Such impacts are expected to be small or negligible in light of proportionality to environmental benefits and since emissions are not expected in relation to use, while expected to be controlled and contained during other life cycle stages. Negative impacts could be expected if substitution of Cr VI were to decrease the reliability of machinery in terms of corrosion protection where heavy duty cleaning materials are used. In cases where leaks or emissions of heavy duty cleaning materials occur during use this could result in impacts on operators and observers. Such impacts however are not expected as it is to be expected that an exemption would be requested for substitutes of lesser reliability, especially where this could result in impacts on environment or health.

All in all it is expected that costs of compliance may prove to be higher than the possible benefits thereof. Though information is not sufficient to make a quantitative comparison, it seems that costs are significantly higher, with environmental benefits expected in part, regardless of whether cord-powered equipment remains in scope or not. If the Commission can follow that such costs are higher than the expected benefits therefor, an amendment of Article 3(28) could be considered. In this regard, Eunited Cleaning have proposed to add “or with a traction-drive” to the current

formulation, to ensure that the change does not broaden the scope of this exclusion beyond their needs.

The consultants would like to note that the Commission should consider any changes while keeping in mind what the purpose of the limitation of the RoHS exclusion to equipment with an on-board power source was in the first place. If the purpose was alignment of RoHS 2 with the NRMM definition of Directive 97/68/EC, this would mean that professional cleaning equipment was not meant to benefit from this exclusion to begin with; Models with an on-board power source are equipped with a battery and do not use a combustion engine or a spark ignition engine as required in Directive 97/68/EC. Nonetheless, changing the formulation of Article 3(28) to clarify that all such machinery would be in scope, would be perceived as an act of legal inconsistency in light of its retroactive character and would also not be recommended.

Agricultural Machinery

In terms of **Environmental Impacts**, it is unclear how common the use of RoHS Substances is in agricultural machinery, as this product group was previously excluded from RoHS and a thorough analysis is yet to be performed. Where substances are in use, CEMA⁴⁸ explain that *“Given the small volumes and the fact that our industry are followers, specific components for our sector would never be developed by suppliers”*. It is thus concluded that where relevant, the phase-out of RoHS substances shall depend on their phase-out in other regulated equipment. Where components are manufactured by suppliers serving other EEE manufacturers, phase-in may occur regardless of if agricultural equipment remains in scope or not. In contrast, where components are produced by suppliers who do not serve other manufacturers of EEE (or manufacturers of equipment regulated under ELV which has similar restrictions), phase-out shall require time and shall mainly burden manufacturers of agricultural machinery.

In terms of **Economic Impacts**, the lack of data concerning RoHS substances makes an estimation of costs difficult. As stated above, it is clear that in some cases phase-out shall occur in light of compliance of other sectors. Here costs could be less significant, as they would be carried and shared with other sectors. In other areas, for example non-electrical components, where the agricultural machinery sector is to carry the main burden of compliance, costs could be significant if RoHS substances are used in applications for which substitutes are not available or do not provide comparable performance and reliability. To add to this, the product portfolio is understood to be very wide, with the sales of most models ranging from 1 to less than 100 devices per annum. This would mean that as compliance will need to be ensured for each and every model, that the cost could be significant in light of the low volume of production of various models. It is understood that taking products off the market

⁴⁸ Op. cit. CEMA (2014b)

is not plausible scenario in light of customer preferences⁴⁹, meaning that any costs of compliance would burden manufacturers, consequently set-off through higher prices for (professional) consumers.

It is difficult to estimate **Social Impacts** in light of the lacking information concerning the use of RoHS substances. Possible positive impacts would be related to the range of impacts expected in relation to the use of RoHS substances and their possible phase-out. If the availability of agricultural machinery is to be affected, or the price to agricultural consumers, this could impact employment or lead to social impacts where additional costs are to be passed on to consumers of agricultural produce.

The lack of information as to the actual use of RoHS substances in agricultural machinery and their range of application makes further conclusion as to the range of costs and benefits difficult. Possible phase-out of RoHS substances shall depend on the applications in which such substances are used and the existence of similar applications in other EEE (or in ELV regulated vehicles). Without understanding what applications are of relevance, it is difficult to conclude if substitutes candidates exist and how much time and resources are to be needed for their implementation in this sector. It is understood that only agricultural machinery which is not self-propelled may be in the scope of RoHS. Such equipment is further understood to always be towed by another vehicle, e.g. a tractor or a vehicle which would be exempt through Article 2(4)(f)⁵⁰. Art. 2(4)(c) excludes “*equipment, which is specifically designed, and is to be installed, as part of another type of equipment that is excluded or does not fall within the scope of this Directive, which can fulfil its function only if it is part of that equipment, and which can be replaced only by the same specifically designed equipment;*”. Agricultural machinery which must be towed to perform its purpose is understood to be designed as an interchangeable part of another type of equipment (vehicle) which is out of scope. It is further understood that such machinery would not be able to fulfil its function if it were not to be towed by such a vehicle, as it would lose its mobility which is necessary for its function. Agricultural machinery, which is not self-propelled, is further understood to receive any needed power from the towing vehicle, also making such machinery dependant on such vehicles. Aside from the term “installation”, such machinery adheres to the various conditions stipulated in Article 2(4)(c), and could benefit from this exclusion, if the interchangeable connection between agricultural machinery and the towing vehicle were clarified to fall under this term. The consultants recommend that the Commission clarify what is meant in this article by the term “installation”. This would allow certainty as to if agricultural machinery which is not self-propelled is in scope or not.

⁴⁹ CEMA (2014b) explain that „Given that there is a big difference between self-propelled (with power source) and towed (without power source) machines in customers/price and that therefore there is a market for both of them, taken products off the market is not an option. There are no alternatives.“

⁵⁰ Article 2(4)(f) excludes: “means of transport for persons or goods, excluding electric two-wheel vehicles which are not type approved”

Mining Machinery

CECE⁵¹ provide examples of electric powered non-road mobile machinery used primarily in mining, explaining that it is practically identical to diesel powered (or gas powered) NRMM in every other respect. Some of the detailed examples are understood to benefit from various exemptions such as “the means of transportation” exemption (Article 2(4)(f)) or products having both a diesel drive train and a trailing cable supplying power when drilling⁵². It is however also understood that some models do not have an on-board power source, meaning that here too; equipment is in the scope of RoHS and is required to comply with the substance restrictions.

Concerning possible presence of RoHS substances, it is explained that a general analysis has not been performed. Lead in solders is mentioned as a possible example of applications using RoHS substances, however aside from this example, it could not be said if RoHS substances are to be expected in equipment and at what range. Assuming such substances are present, their possible phase-out would create environmental benefits, however it is difficult to say what the range of such benefits would be. Since CECE explain that electric powered NRM mining machinery is understood to have a small EU market share⁵³, though Environmental Impacts could be expected where RoHS substances are to be phased out, it could be that absolute benefits would be small in light of the market share of equipment placed on the EU market.

In parallel, a small market share of electric powered NRM mining machinery could also mean that the market share is too small for manufacturers to be willing to carry the burden of RoHS compliance. This could further be supported by the harsh conditions under which such equipment is operated. As with other EEE, such conditions of use often require that available alternatives be tested and further developed before they can be applied as substitutes in equipment, requiring manufacturers to invest resources and time in compliance. In cases where the burden of compliance is small (alternatives used by other sectors can be easily adapted), they may be applied, possibly in both excluded and non-excluded equipment. This would mean that benefits are larger than expected as they are related to a larger range of equipment than the machinery regulated under RoHS. However, in cases where the burden of compliance is to be high, non-compliant equipment may be pulled off the EU market, leading to negative **Economic Impacts** for consumers (the mining industry) in light of a loss of product range. It is thus expected that either the mining machinery sector shall have small costs or that non-compliant machinery is to be pulled of the market, both creating a loss in income for mining machinery manufacturers as well for their clients – the mining industry – and those using mined resources.

⁵¹ Op. cit. CECE (2014a)

⁵² Article 3(28) does not specify that the on-board power source must be operated while the equipment is working but only that the equipment must be mobile while working

⁵³ Op. cit. CECE (2014a)

CECE did not mention potential social impacts, though the range of these shall be related to the various impacts mentioned above: Where RoHS substances are to be phase-out, some positive health impacts may be expected if this is to lead to lower emissions through the equipment life cycle. Where manufacturers are to be impacted, this may have subsequent impacts on employment. If less equipment is to be manufactured, this could have a negative impact on employment in the mining machinery sector, possibly also impacting employment in the mining industry. If however manufacture is mainly impacted in light of the research and development of RoHS substitutes, this could create employment opportunities related to R&D.

In lack of detailed information and data it is difficult to estimate the range of possible costs and benefits related to NRM mining machinery remaining in scope. In this sense concluding as to the net benefit and the relevance of excluding such equipment is not possible. However, in light of the similarities between equipment which is in scope and out-of scope, it can be followed that the need to comply with RoHS may create a burden for manufacture of equipment which is not in the scope of RoHS. This case is understood to be similar to that of cleaning equipment, with the additional justification that equipment, which is not in scope of RoHS would have a combustion engine and thus fall under the Directive 97/68/EC NRMM definition. It can thus be followed that manufacturers see inconsistencies in how NRMM is regulated under these two Directives.

To conclude, the case of NRM mining machinery may be resolved indirectly if the “off-board power source” aspect raised for cleaning machinery is to be resolved. Otherwise, the consultants would recommend the EU COM to consider adding an exclusion for mining equipment in the next recast of the Directive, possibly after additional information has been made available to clarify the relation between possible costs and benefits of compliance. An important question in this respect is if a shift from off-board to on-board power source mining machinery could impact the range of mining activity emissions, and how such impacts would relate to possible environmental benefits of such equipment being regulated under RoHS.

Generation Sets⁵⁴

In terms of **Environmental Impacts** it is understood that lead is the primary RoHS substance of concern in Gen-Sets. As explained in Section 2.4.3, EUROPGEN have estimated that approximately 1500 kg of lead could be placed on the EU Market through the sales of example products, explaining this to be a conservative estimation. This amount of lead could potentially be phased-out where alternatives are found and developed into reliable substitutes. This is thus understood to be the basis for estimating possible environmental benefits and their range. Where lead is to be phased out, any impacts connected with possible emissions during the various life cycle phases would decrease. Though the range of possible benefits (a decrease in the amount of Pb applied in GENSETs and placed on the EU market) is clear, the time

⁵⁴ NAM (2014a) have also mentioned petroleum extraction equipment and industrial power systems in their contribution as applications where combustion engines may be in use

needed for these benefits to incur is more difficult to estimate; EUROMOT⁵⁵ has explained in the past that although members have stated their intention to comply by the end of the transitional period [2019], present indications are that some products may not be capable of complying.⁵⁶ This means that even if some of these benefits could be expected to incur before 2019, in areas where substitutes are not yet suitable for use in GENSETs benefits could incur over a longer period.

Equipment with an internal combustion engine, such as GENSETs has been discussed in part in a scope review prepared by Oeko-Institute in 2014⁵⁷. At the time it was assumed that, where substitution would be possible, it could be achieved for a larger range of equipment than that falling in scope, meaning that compliance of RoHS regulated GENSETs may “force” partial compliance of non-regulated ones. It is unclear if this is indeed the case; however, this creates a relation between possible environmental benefits and possible **Economic Impacts**. It has been explained that LSFIs GENSETs and mobilised GENSETs are in principal identical, with the only differences related to the existence or non-existing of a transporting vehicle on which mobilised GENSETs are mounted. It is thus assumed that such GENSETs will be manufactured on the same production lines. Thus, where substitutes are to require a change in the design of Gen-Sets, they could be expected to be applied to a wider product range. If the costs of such changes were to be so high as propose a threat to the stability of this industry, manufacturers would either seek exemptions (benefits to remain in range) or discontinue the manufacture of mobilised GENSETs (resulting in costs for consumers in terms of loss of product range). As the development of substitutes is application specific, it is difficult to estimate on the basis of the present information, what the range of total benefits would be and how much time full compliance would require. None the less, it is understood that any impacts should affect manufacturers similarly; EUROPGEN estimates that the RoHS restrictions on temporary, non-stationary generating sets will have an impact throughout the power generation industry and also throughout the engine manufacturers. ⁵⁸

Estimating Social Impacts is difficult. Where manufacturers or suppliers of components are to be impacted by the need to comply with the RoHS restrictions, this could impact employment: If manufacture and sales of certain mobilised GENSETs for the EU market is to be discontinued or reduced, this could result in a decrease in employment. If this however results in larger sales of LSFIs GENSETs, such impacts would decrease or lose relevance. In parallel, where research into substitutes and

⁵⁵ EUROMOT (2014a), EUROMOT contribution to the RoHS Stakeholders consultation concerning the Article 2(2) Scope Review, submitted 7.3.2014 per email, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_IA_2_2/Products_newly_in_scope/20140307_EUROMOT_RoHS_2_Oeko-Institut_Review_EEE_newly_in_Scope-Questionnaire_Final_Response_2014-03-07.pdf

⁵⁶ Op. cit. EUROMOT (2014a)

⁵⁷ See Report under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/reports/201406012_RoHS_Scope_Review_report_final.pdf

⁵⁸ Op. cit. EUROPGEN (2014a)

redesign are to be needed, this shall have a positive influence on R&D employment in this sector. Impacts on health are to be related to the possible phase-out from lead. Though this may reduce any possible emissions, most emissions can be expected in the manufacturing and/or end-of-life phase, where it is assumed that they are at least partially controlled. Thus any such benefits would probably be small in range or possibly even negligible.

Despite a potential for environmental and health benefits, it seems there is a high risk that compliance of mobilised GENSETs could force compliance of LSFI GENSETs, resulting in high economic burdens affecting a sector understood to mostly manufacture equipment which is not in scope. The mobility of such equipment is understood to be different from that of NRMM covered in the RoHS Article 3(28) definition, as equipment is not operated while working. Without a change of this definition, such equipment could not benefit from the NRMM exclusion.

Examining the case of mobilised GENSETs solely within the RoHS 2 context suggests that they neither fall under the NRMM nor under the LSFI exclusions. This understanding would suggest that this case does not fall under the mandate of the consultants' in this review. However, it is understood that the RoHS definition of NRMM differs from the definition provided in Directive 97/68/EC, which also refers to "transportable industrial equipment", interpreted to cover mobilised Gen-Sets. In light of this inconsistency coupled with the risk of possible economic burdens for a sector understood to mostly manufacture equipment which is not in scope, the consultants recommend revising the NRMM definition to ensure that all equipment covered by Directive 97/68/EC would also be defined as NRMM under RoHS 2, thus benefiting from the NRMM exclusion.

It should further be mentioned that NAM (2014a) has also mentioned petroleum extraction equipment and industrial power systems in their contribution as applications where combustion engines are in use in equipment which is not mobile while working. Though the details of this equipment may be slightly different from Gen-Sets, it is understood that in both cases such equipment would fall under the Directive 97/68/EC NRMM definition and not under the RoHS NRMM definition. In this sense, the above recommendation is understood to also resolve this case.

2.6.3 Conclusions and Recommendations

To summarise, the consultants can follow that the NRMM Directive (97/68/EC) and the RoHS Directive regard non-road mobile machinery inconsistently. Under RoHS the type of power source of such machinery is irrelevant, as long as the power source is on-board. The NRMM Directive on the other hand only regulates such equipment in which an integral combustion engine is installed. Though the understood intention of the NRMM Directive, to prevent emissions of such machinery, may explain why other power sources are not mentioned, it is clear that the scope of NRMM is interpreted differently in each Directive. In all the product groups discussed in this review, the various inconsistencies create problems in terms of similar equipment in some cases being in scope and in some cases being excluded. Stakeholders raise concerns that the burden of compliance of NRMM which is in scope shall be high in relation to expected benefits thereof, particularly in cases where most equipment is excluded. It is also understood that compliance of equipment which is in scope may force

compliance of equipment which is excluded, in light of mutual production lines. This would mean that manufacturers of equipment not in the scope of the RoHS Directive are faced with compliance costs despite such equipment not needing to comply with the Directive.

The various product groups have been discussed in the sections above, to clarify how equipment may be affected and what costs and benefits the enforcement of the current RoHS Directive may result in for NRMM manufacturers. The main conclusions and recommendations are as follows:

For **professional cleaning NRMM** the costs of compliance may prove to be higher than the possible benefits thereof. It seems that compliance costs shall be high, with environmental benefits expected in part, regardless of whether cord-powered equipment remains in scope or not. If the Commission can follow that such costs are higher than the expected benefits therefor, an amendment of Article 3(28) could be considered. A possible amendment could be to add “or with a traction-drive” to the current formulation, to avoid unnecessary broadening of the scope of the exclusion.

Regarding **agricultural machinery**, it is understood that only agricultural machinery which is not self-propelled may be in the scope of RoHS. Such equipment was explained to always be towed by another vehicle, e.g. a tractor or a vehicle, which is itself excluded as a means of transport for persons or goods through Article 2(4)(f). Agricultural machinery which must be towed to perform its purpose is understood to be designed as an interchangeable part of another type of equipment (vehicle) which is out of scope. Such machinery would not be able to fulfil its function if it were not to be towed by other vehicles, as it would lose mobility and would also lose its power source. Aside from the term “installation”, such machinery adheres to the various conditions stipulated in Article 2(4)(c), and could benefit from this exclusion, if the interchangeable connection between agricultural machinery and the towing vehicle were clarified to fall under this term. The consultants recommend that the Commission clarify what is meant in this article by the term “installation”, as this would allow certainty as to if agricultural machinery which is not self-propelled is in scope or not.

Regarding **mining machinery** detailed information was not available to allow estimating the range of possible costs and benefits related to NRM mining machinery remaining in the scope of RoHS. The key issue for such equipment with the current interpretation of NRMM is for mining machinery with an off-board power source. In light of the similarities between equipment which is in scope and out-of scope, it can be followed that the need to comply with RoHS may create a burden for manufacturers of equipment. The harsh conditions of use of this machinery are explained to make the search and implementation of possible substitutes difficult and lengthy, probably resulting in high costs for compliance. In parallel, it is uncertain how successful this search may be and how much time shall be needed before benefits could incur. Adjusting the off-board power source aspect in the RoHS definition of NRMM (as may be found relevant for other equipment groups reviewed in this report), could resolve compliance issues of manufacturers of mining machinery which is in scope indirectly. If such an adjustment is decided against, it is recommended that the EU Commission review the impacts of excluding mining equipment from the scope of RoHS, once more detailed information is made available

to allow understanding the potential range for costs and benefits of remaining in the scope of RoHS.

As for **mobilised machinery operated at fixed locations**, despite a potential for environmental and health benefits, it seems there is a high risk that compliance of mobilised GENSETs could force compliance of LSFI Gen-Sets. This could result in high economic burdens affecting a sector understood to mostly manufacture equipment which is not in scope. The mobility of such equipment is understood to be different from that of NRMM covered in the RoHS Article 3(28) definition, as equipment is not operated while working. Without a change of this definition, such equipment could not benefit from the NRMM exclusion, despite the understanding that it falls under the NRMM definition of Directive 97/68/EC. In light of this inconsistency, coupled with the risk of possible economic burdens for a sector understood to mostly manufacture equipment which is not in scope, the consultants recommend revising the RoHS NRMM definition to ensure that all equipment covered by Directive 97/68/EC would also be defined as NRMM under RoHS 2, thus benefiting from the NRMM exclusion.

Furthermore, the consultants recommend that any changes to be considered by the Commission, be decided upon while keeping in mind the intended purpose of the limitation of the RoHS NRMM exclusion to equipment with an on-board power source. If the intention of this limitation was alignment with the NRMM Directive, achieving this purpose should guide any possible decisions as to adjustments of the Directive.

2.7 References

CECE (2014a)	CECE (2014a), CECE Answers to NRMM Questionnaire, submitted per email on 05.12.2014
CEMA (2014a)	CEMA (2014a), Personal communication titled "CEMA request - related to the analysis of impacts from RoHS 2 on various products: non-road mobile machinery without an on-board power source", sent per email on 7.10.2104.
CEMA (2014b)	CEMA (2014b), CEMA Answers to NRMM Questionnaire, submitted per email on 03.12.2014.
EU COM (2012)	European Commission (2012), RoHS 2 FAQ Document, Q4.1, available under: http://ec.europa.eu/environment/waste/rohs_eee/pdf/faq.pdf
EUnited Cleaning (2014a)	EUnited Cleaning (2014a), EUnited Cleaning Letter to European Commission Concerning time frame Restriction of Hazardous Substances (RoHS, Directive 2011/65/EU) , submitted per email on 5.3.2014
EUnited Cleaning (2014b)	EUnited Cleaning (2014b), EUnited Cleaning Answers to NRMM Questionnaire, submitted per email on 28.11.2014
EUnited Cleaning (2014c)	EUnited Cleaning (2014c), Summary of telephone conference with Charalambos Freed and Axel Leschtar, held 4.12.2014
EUnited Cleaning (2014d)	EUnited Cleaning (2014d), Letter with Request/Comments Concerning RoHS 2, Definitions, sent per email on 8.12.2014
EUROMOT (2014a)	EUROMOT (2014a), EUROMOT contribution to the RoHS Stakeholders consultation concerning the Article 2(2) Scope Review, submitted 7.3.2014 per email, available under: http://rohs.exemptions.oeko.info/fileadmin/user_upload/RoHS_IA_2_2/Products_newly_in_scope/20140307_EUROMOT_RoHS_2_Oeko-Institut_Review_EEE_newly_in_Scope-Questionnaire_Final_Response_2014-03-07.pdf
EUROMOT (2014b)	EUROMOT (2014b), EUROMOT Answers to NRMM Questionnaire, submitted per email on 2.12.2014
EUROPGEN (2014a)	EUROPGEN (2014a), EUROPGEN Answers to NRMM Questionnaire, submitted per email on 2.12.2014
NAM (2014a)	NAM (2014a), NAM Answers to NRMM Questionnaire, submitted per email on 2.12.2014

A.1.0 Appendix 1: Summary of Stakeholder Contributions Related to the Review of Non-Road Mobile Machinery (NRMM)

Table 4-5: Summary of Stakeholder Contributions Related to the Review of NRMM

Supporting stakeholders	Products/ machines of relevance	Relevance to NRMM and Compliance with RoHS
EUnited Cleaning – European Cleaning Machines Association ¹⁷⁰	Professional cleaning machines and appliances - for example sweepers, scrubber driers which are cord-connected. Same product with on board power source out of the scope.	Understood to fall under the definition of NRMM as machines are in movement between a succession of fixed working locations while working and exclusion would only be relevant to machinery made exclusively available for professional use, which have more stringent mechanical demands in comparison with similar devices designed for private consumers. RoHS substances may be present in very low concentrations in different electronic components such as printed circuit boards; switches; In-harmonic vibrations and strong mechanical demand of the machine make substitutions difficult. For example, RoHS compliant alternatives must meet these requirements, e.g., secure solder joints, despite the use of lead-free solders, reliable corrosion protection, despite absence of chromium(VI), safe electrical lines, despite phasing out of lead and cadmium.
CEMA - the European association representing the agricultural machinery industry ¹⁷¹	Tractors and agricultural self-propelled machines; Agricultural trailers; truck trailers; interchangeable towed equipment;	<p>Tractors and agricultural self-propelled machines are excluded due to Article 2(4)(g).</p> <p>Agricultural trailers (category R) and interchangeable towed equipment (category S) are not excluded solely based on the definition provided for NRMM with the additional wording of ‘with an on-board power source’ (unless it is exempted by article 2 point 4 c) – <i>equipment which is specifically designed, and is to be installed, as part of another type of equipment that is excluded or does not fall within the scope of this Directive, which can fulfil its function only if it is part of that equipment, and which can be replaced only by the same specifically designed equipment</i>; - R&S vehicles are exclusively used with tractors. The only issue may be the wording ‘installation’ as it is rather coupled and decoupled, not installed).</p> <p>Concerning agricultural trailers: the truck trailers (category O) are excluded while agricultural trailers would not. It concerns a fraction of the truck trailers (ag. trailers have a total turnover of less than a Billion €). There is little electronics on such vehicles (braking...).</p>

¹⁷⁰ EUnited Cleaning (2014b), EUnited Cleaning Answers to NRMM Questionnaire, submitted per email on 28.11.2014

¹⁷¹ CEMA (2014b), CEMA Answers to NRMM Questionnaire, submitted per email on 03.12.2014.

		<p>Concerning interchangeable towed equipment: self-propelled versions like self-propelled sprayers, harvesters,... would be excluded but not the towed version. There are also interchangeable towed equipment that are unique in their functionalities.</p> <p>In addition there are many mounted implements that are coupled to the three point lift of the tractor, many have hardly electronics on board.</p>
<p>CECE – Committee for European Construction Equipment¹⁷²</p>	<p>Underground Coal Shuttle Cars (probably excluded); Underground Hard Rock Jumbo Drill (diesel engine drivetrain, but cable powered while drilling); Underground Rock Header; Rotary blast hole drills (diesel and electric trailing cable models exist); Underground Coal Roof bolters; Underground Coal Continuous Miners; Electric Rope Shovels; Draglines; Hydraulic Mining Shovels (external cable power source and on-board power source models); Hauling trucks equipped with trolley system – (probably excluded);</p>	<p>Several types of construction machinery are electric powered, and thus have cables that provide a power source, rather than an on-board engine. The provided example machines are electric powered non-road mobile machinery used primarily in mining that are practically identical to diesel powered (or gas powered) non-road mobile machinery in every other respect.</p> <p>Lead-free solder is significantly more brittle than leaded solder and therefore is less able to function in extreme conditions. More work is required to validate its use on construction and mining machines.</p>
<p>EUROMOT – The European Association of Internal Combustion Engine Manufacturers¹⁷³</p>	<p>Reciprocating engine models and families manufactured by most industry participants are applied across many end use applications. The same basic engine model may be used in gensets, earthmoving equipment and</p>	<p>EUROMOT explain that earthmoving equipment and marine engines are understood to be out of scope, however that it could be interpreted that certain machines characterised as ‘non-road mobile machinery’ in the engine exhaust emission legislation 97/68/EC are not considered to be NRMM under article 3(28) of 2011/65/EU. A non-exclusive example is mobile gensets, which can be found in sizes in excess of 2000 kW. A standard generator set may be trailer-mounted for mobile application, yet the same type of genset may be installed at a fixed location, comprising a large-scale fixed installation (excluded from scope as such). The latter are</p>

¹⁷² CECE (2014a), CECE Answers to NRMM Questionnaire, submitted per email on 05.12.2014

¹⁷³ EUROMOT (2014b), EUROMOT Answers to NRMM Questionnaire, submitted per email on 2.12.2014

	marine engines.	EEE designed to be mobile and move between a succession of fixed working locations, but they operate at the locations, and not while they are being moved between locations and thus do not fall under the definition of NRMM. The main RoHS substance of concern is lead. Lead is present as an alloy element or thin layer in engine bearings and bushings. It is used in bearings and bushings for some components of complete engine packages including air compressors and starters. Lead is used in solder for electronic and electrical components as well as in radiators and other coolers. Of greatest concern is lead used in larger size main and connecting rod bearings where no effective substitute has yet been developed. Lead from all these components would typically comprise less than .025% of a complete engine.
NAM – National Association for Manufacturers ¹⁷⁴	Mobile electrical generators; petroleum extraction equipment; industrial power systems	Mobile machinery with on-board power source, intended to be moved between multiple job-sites in the course of its useful life, however operative only when installed at a fix location. This aspect disqualifies such equipment from the LSFI exclusion, in light or equipment being moved from place to place (not exclusively fixed) and from the NRMM exclusion as equipment is not mobile while working. Main concern of non-compliance appears to be related to lead bearings, however input is not very detailed and so example may not be exhaustive.
EUROPGEN – the European Generation Set Association ¹⁷⁵ (Contribution also submitted by a manufacturer of diesel engines for a variety of applications and power generation equipment)	Assumed out of scope: Propulsion generators used in marine vessels; Engines in mining /construction equipment; Permanently installed power generation equipment (standby or continuous duty power ratings > 375 kW); Assumed in scope: Generator for non-permanent installation	Diesel engines are utilized in a broad array of end use applications due to their efficiency and re-liability. Because of the many marketable uses of diesel power, a single engine platform, identical in design and construction, is commonly used in multiple applications. However, these end use applications are regulated inconsistently. Typically lead is present in engine bearings, some electronic and cooling system components, and in some aluminium and copper alloys used in precision components such as housings, covers, connectors, and fittings.

¹⁷⁴ NAM (2014a), NAM (2014a), NAM Answers to NRMM Questionnaire, submitted per email on 2.12.2014

¹⁷⁵ EUROPGEN (2014a), EUROPGEN Answers to NRMM Questionnaire, submitted per email on 2.12.2014