WORKING DOCUMENT ON

Possible ecodesign requirements for standard air compressor packages

DRAFT ECODESIGN REGULATION

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COMMISSION WORKING DOCUMENT

implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for compressors for standard air applications

THE COMMISSION OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products, and in particular Article 15(1) thereof,

After consulting the Ecodesign Consultation Forum,

Whereas:

(1) Under Directive 2009/125/EC ecodesign requirements are to be set by the Commission for energy-related products, representing significant volumes of sales and trade, having a significant environmental impact and presenting significant potential for improvement in terms of their environmental impact without entailing excessive costs.

(2) Article 16(2), first indent, of Directive 2009/125/EC provides that in accordance with the procedure referred to in Article 19(3) and the criteria set out in Article 15(2), and after consulting the Ecodesign Consultation Forum, the Commission will, as appropriate, introduce an implementing measure for standard air compressor packages. The product group has been incurred in the indicative list of the Working Plan for the period 2009-2011 (COM 2008 660).

(3) The Commission has carried out a preparatory study covering the technical, environmental and economic aspects of standard air compressor packages typically used in the Union. The studies were devised together with stakeholders and interested parties from the Union and third countries, and the results have been made publicly available.

(4) The environmental aspect of standard air compressor packages that has been identified as significant for the purposes of this Regulation is energy consumption in the use phase

(5) The preparatory study shows that requirements regarding other ecodesign parameters referred to in Annex I, Part 1, of Directive 2009/125/EC are not necessary as energy consumption of standard air compressors in the use phase is by far the most important environmental aspect.

(6) The annual energy consumption related to standard air compressors was estimated to have been 57.9 TWh (521 PJ) in the European Union in 2010 corresponding to 24 Mt CO_2 emissions. Unless specific measures are taken, the annual energy consumption related to standard air compressors is expected to be 57 TWh (513 PJ) in 2020 and 59.9 TWh (539 PJ) for 2030. The cost effective energy saving potential through more efficient design has been estimated at 0.8 TWh by 2020 and 1.6 TWh by 2030 compared to a business-as-usual scenario.

(7) Standard air compressors subject to this Regulation should be made more efficient by applying existing non-proprietary cost-effective technologies that can reduce the combined costs of purchasing and operating these products.

(8) The ecodesign requirements should not affect functionality from the end-user's perspective and should not negatively affect health, safety or the environment. In particular, the benefits of reducing energy consumption during the use phase should more than offset any additional environmental impacts during the production phase and the disposal.

(9) The ecodesign requirements should be introduced gradually in order to provide a sufficient timeframe for manufacturers to re-design products subject to this Regulation. The timing should be such as to avoid negative impacts on the functionalities of equipment on the market, and to take into account cost impacts for end-users and manufacturers, in particular small and medium-sized enterprises, while ensuring timely achievement of the objectives of this Regulation.

(10) Measurements of the relevant product parameters should be performed through reliable, accurate and reproducible measurement methods, which take into account the recognised state of the art measurement methods including, where available, harmonised standards adopted by the European standardisation organisations, as listed in Annex I to Regulation (EU) 1025/2012 of the European Parliament and of the Council of 25 October 2012 on European standardisation[1].

(11) In accordance with Article 8(2) of Directive 2009/125/EC, this Regulation should specify the applicable conformity assessment procedures.

(12) Compliance of products should be demonstrated either when the product is placed on the market or when it is put into service, not both.

(12) In order to facilitate compliance checks, manufacturers should provide information in the technical documentation referred to in Annexes IV and V of Directive 2009/125/EC insofar as this information relates to the requirements laid down in this Regulation.

(13) To improve the effectiveness of this Regulation and to protect consumers, products that automatically alter their performance in test conditions to improve the declared parameters should be prohibited from being placed on the market or put into service.

(14) To facilitate verification testing, market surveillance authorities should be allowed to test, or witness the testing of, larger products at premises such as those of the manufacturer.

(13) Benchmarks for currently available standard air compressor packages with high energy efficiency should be identified. This will help to ensure the wide availability and easy accessibility of information which will further facilitate the integration of best design technologies and facilitate the development of more efficient products for reducing energy consumption.

(13) The measures provided for in this Regulation are in accordance with the opinion of the Committee established by Article 19(1) of Directive 2009/125/EC.

HAS ADOPTED THIS REGULATION:

[1] OJ L 316, 14.11.2012, p. 12

Article 1 Subject matter and scope

1. This Regulation establishes ecodesign requirements for the placing on the market and/or putting into service of *rotary standard air compressor packages* with a *maximum volume flow rate* between 5 to 1280 l/s when supplying air at discharge pressure(s) equal to or higher than 7 bar(a) and not exceeding 15 bar(a).
2. This Regulation shall not apply to *rotary standard air compressor packages*:
    a. the *stages* of which is/are driven by single-phase electric motors;
    b. designed and specified to function in potentially explosive atmospheres as defined in Directive 94/9/EC of the European Parliament and of the Council[2];
    c. designed and specified to function at inlet air temperatures, the daily average value of which is below 15ºC or above 50ºC;
    d. designed and specified to function at ambient pressures prevailing at altitudes exceeding 1000 metres above sea-level.

Article 2 Definitions

In addition to the definitions set out in Article 2 of Directive 2009/125/EC, the following definitions shall apply for the purpose of this Regulation:

1. 'Rotary standard air compressor package' means a standard air compressor package in which air admission, forced expansion, and diminution of its successive volumes or its forced discharge are performed cyclically by rotation of one or more working members (such as rotors) and associated parts;
2. 'Standard air compressor package' means an air compressor specified and capable to supply air, drawn in from the ambient, at discharge pressures between 7 bar(a) and 15 bar(a), and in which the air that is compressed comes into contact with one or more intentionally added substances for sealing, cooling and/or lubrication (of moving members and/or the enclosure they move within) except water;
3. 'Air compressor' means a machine or apparatus that converts electric energy into the potential energy of air pressure, for displacement and compression of air to any higher pressure values above atmospheric pressure with a pressure ratio exceeding 1.1;
4. 'Stage' means the smallest discernible section of an air compressor in which the pressure of the air drawn in is increased by mechanical motions of one or more working members
5. 'Pressure ratio' means the rated discharge pressure divided by the inlet pressure (p_{2rated}/p_1);
6. 'Rated discharge pressure' (p_{2rated}) means any discharge pressure at which the compressor package can typically be operated as specified by the manufacturer, expressed in bar(a). Since multiple rated discharge pressures can be specified for the same compressor package, the symbol can include a subscript allowing identification of the different rated discharge pressures e.g. ($p_{2rated,i}$, for i=2 to n);

[2] OJ L 100, 19.4.1994, p. 1.

7. 'Discharge pressure' (p_2) means the absolute pressure of air measured at the discharge port of the product when supplying air, expressed in bar(a);
8. 'Inlet pressure' (p_1) means the absolute pressure of aspirated air at the inlet of the product, expressed in bar(a);
9. 'Maximum volume flow rate' (V_{1max}) means the highest inlet volume flow rate that can be supplied safe, continuously and reliably by the compressor package, for any rated discharge pressure, expressed in l/sec or as '100% ' when expressed as percentage points of maximum volume flow rate for that same discharge pressure;
10. 'Inlet volume flow rate' (V_1) means the volume of compressed air per unit of time supplied by the compressor package to a connected system, with inlet air at standard inlet conditions and expressed in l/s;
11. 'Standard inlet conditions' means the air aspirated by the compressor package is assumed to have an inlet pressure of 1 bar(a) (100 kPa), a temperature of 20°C and a relative water vapour pressure of 0 (zero), and the cooling water (if applicable) supplied to the compressor package has a supply temperature of 20 ºC and a temperature difference between inlet and outlet not exceeding 25 K (see also Table 3, Annex III - Measurements and calculations);
12. 'equivalent model' means a model which has the same technical characteristics relevant for the technical information to be provided, but which is placed on the market or put into service by the same manufacturer, importer or authorised representative as another model with a different model identifier;
13. 'model identifier' means the code, usually alphanumeric, which distinguishes a specific product model from other models with the same trade mark or the same manufacturer's, importer's or authorised representative's name;

Article 3 Ecodesign requirements

1. The ecodesign requirements for rotary standard air compressor packages set out in Annex II shall apply from the dates indicated therein.
2. Compliance with ecodesign requirements shall be measured and calculated in accordance with methods set out in Annex III

Article 4 Conformity assessment

The conformity assessment procedure referred to in Article 8(2) of Directive 2009/125/EC shall be the internal design control set out in Annex IV to that Directive or the management system for assessing conformity set out in Annex V to that Directive.

For the purposes of the conformity assessment pursuant to Article 8 of Directive 2009/125/EC, the technical documentation of standard air compressor packages shall contain a copy of the product information provided in accordance with point 2 of Annex II to this Regulation, and the details and results of calculations set out in Annex III to this Regulation.

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Where the information included in the technical documentation for a particular model has been obtained:

(a) from a model that has the same technical characteristics relevant for the technical information to be provided but is produced by a different manufacturer; or

(b) by calculation on the basis of design or extrapolation from another model of the same or a different manufacturer, or both,

the technical documentation shall include the details of such calculation, the assessment undertaken by the manufacturer to verify the accuracy of the calculation and, where appropriate, the declaration of identity between the models of different manufacturers.

The technical documentation shall include a list of all equivalent models, including the model identifiers.

Article 5 Verification procedure for market surveillance purposes

Member States shall apply the verification procedure laid down in Annex III when performing the market surveillance checks referred to in Directive 2009/125/EC, Article 3(2).

Article 6 Circumvention and software updates

The manufacturer, importer or authorised representative shall not place on the market products designed to be able to detect they are being tested (e.g. by recognising the test conditions or test cycle), and to react specifically by automatically altering their performance during the test with the aim of reaching a more favourable level for any of the parameters specified in this Regulation or declared by the manufacturer, importer or authorised representative in the technical documentation or included in any of the documentation provided .

The energy consumption of the product and any of the other declared parameters shall not deteriorate after a software or firmware update when measured with the same test standard originally used for the declaration of conformity, except with explicit consent of the end-user prior to the update. No deterioration of performance shall occur as result of rejecting the update.

A software update shall never have the effect of changing the product's performance in a way that makes it non-compliant with the ecodesign requirements applicable for the declaration of conformity.

Article 7 Benchmarks

The benchmarks for the best-performing rotary standard air compressor packages at the time of entry into force of this Regulation are set out in Annex IV.

Article 8 Review

1) The Commission shall review this Regulation in the light of technological progress and shall present the result of this review to the Consultation Forum no later than [five] years after its entry into force.
2) The review shall in particular address:
   a) The appropriateness of revising the ecodesign requirements;
   b) The appropriateness of introducing additional resource efficiency requirements for products in accordance with the objectives of the circular economy;
   c) The widening of scope to other types of air compressors.

Article 9 Entry into force and application

This Regulation shall enter into force on the twentieth day following that of its publication in the Official Journal of the European Union.

It shall apply from 1 June 2022.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels ……

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Annex I – Definitions

1. Definitions

1) Compressor package means a basic package or a feature package;

2) Basic package means an air compressor that contains not more than the minimum number of components required for safe, continuous and reliable operation and is used for verification of its performance. The minimum number of components shall include those indicated in point 4 of Annex III;

3) Feature package means an air compressor that comprises a basic package and any number of additional components, for instance for drying or filtering of compressed air and/or noise attenuation etc.;

4) Fixed speed rotary standard air compressor package means a rotary standard air compressor package which is not equipped with a variable speed drive when placed on the market, and/or the minimum volume flow rate of which is (at any discharge pressure) higher than 55% of the rated maximum volume flow rate (a that same discharge pressure);

5) Variable speed rotary standard air compressor package means a rotary standard air compressor package which is equipped with a variable speed drive when placed on the market and the minimum volume flow rate of which is 55% or less of the rated maximum volume flow rate;

6) Minimum volume flow rate (V_{1min}) means the lowest inlet volume flow rate that can be supplied safe, continuously and reliably by the compressor package, for a given discharge pressure, expressed in l/s or in percentage of the maximum volume flow rate for that same discharge pressure;

7) Variable speed drive means an electronic power converter integrated, or functioning as one system, with the motor(s) driving the stage(s) that continuously adapts the electrical power supplied to the electric motor in order to control the mechanical power output of the motor according to the torque-speed characteristic of the load being driven by the motor, excluding variable voltage controllers where only the supply voltage for the motor is varied;

8) Package efficiency means the fixed speed isentropic efficiency or the variable speed isentropic efficiency;

9) Fixed speed isentropic efficiency means the representative energy efficiency of the fixed speed rotary standard air compressor package, calculated for the discharge pressure(s) specified, expressed in percentages (%);

10) Variable speed isentropic efficiency means the representative energy efficiency of the variable speed rotary standard air compressor package, calculated for discharge pressure(s) specified, expressed in percentages (%);

11) Isentropic efficiency means the division of the power that is theoretically required to compress under constant entropy a given inlet volume flow rate of air (treated as an ideal gas), from a given inlet pressure and temperature to a given discharge pressure, by the actual electric input power to the basic package of the standard air compressor package compressing the same inlet volume flow rate of air from the same inlet pressure and

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temperature to the same discharge pressure, established for any required combination of discharge pressure and inlet volume flow rate, expressed as percentage;

12) Ideal gas means a hypothetical gas whose molecules occupy negligible space and have no interactions, and which consequently obeys the gas laws exactly;

13) Entropy means a quantitative measure of disorder in a thermodynamic system;

14) Proportional loss factor (d) means the factor to be used to express or calculate a target for a package efficiency relative to the average of package efficiencies of the product group the compressor package belongs to (defined by curve and constants) and proportional to the difference in the average efficiency of that group and the (theoretical) optimum package efficiency of that group (100%) when assessed for the maximum inlet volume flow rate;

15) Maximum discharge pressure (p_{2max}) means a discharge pressure of 15 bar(a) if at least one rated discharge pressures exceeds 15 bar(a) or the highest of rated discharge pressure(s) between 7 bar(a) and 15 bar(a), that can be supplied safe, continuously (without interruption of air delivery or unloading) and reliably by the compressor package, and the realisation of which involves no active reduction of the inlet volume flow rate (for instance through inlet throttling, etc.), with air at standard inlet conditions, expressed in bar(a);

Note: If only one rated discharge pressure within 7 bar(a) to 15 bar(a) is specified, the maximum discharge pressure, the minimum discharge pressure and the rated discharge pressure are identical;

16) Minimum discharge pressure (p_{2min}) means a discharge pressure of 7 bar(a) if at least one rated discharge pressure(s) is less than 7 bar(a) or the lowest of rated discharge pressure(s) between 7 bar(a) and 15 bar(a), that can be supplied safe, continuously (without interruption of air delivery or unloading) and reliably by the compressor package and with air at standard inlet conditions, expressed in bar(a);

Note: If only one rated discharge pressure within 7 bar(a) to 15 bar(a) is specified, the maximum discharge pressure, the minimum discharge pressure and the rated discharge pressure are identical;

17) Input power (P_{real}) means the electric input power supplied to the compressor package, when running loaded and delivering compressed air, expressed in kW;

18) Full load power ($P_{full\ load}$) is the input power of the compressor package while supplying the maximum volume flow rate at the maximum discharge pressure(s), expressed in kW;

19) Idle power (P_{idle}) means the input power of the compressor package, with the electric motor running but the internal pressure vented (unloaded condition), expressed in kW;

20) Cycle energy requirement means the energy consumption of a compressor package when completing an operating cycle from standstill over start-up to full load and back via venting and idling to standstill, expressed in seconds of full load power (s) ;

21) Cooling method means the method applied to cool the stage(s) within the rotary standard air compressor package;

22) Compression stages means the number of successive compression stages within the rotary standard air compressor package;

23) Sound pressure level means the sound pressure emitted by the rotary standard air compressor package, expressed in (dB);

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24) Heat recovery option means a technical solution for the recovery of heat produced by the compressor package with the aim of energy saving within the compressor package (i.e. heat-driven drying processes, etc.) or in processes to which the recovered heat is delivered (i.e. space and/or water heating or (pre)heating of various media, etc.);

25) Customer means a natural or legal person who buys, hires or receives a product for own use whether or not acting for purposes which are outside its trade, business, craft or profession;

26) 'witnessed testing' means actively observing the physical testing of the product under investigation by another party, to draw conclusions on the validity of the test and the test results. This may include conclusions on the compliance of testing and calculations methods used with applicable standards and legislation;

27) 'factory acceptance test' means a test on an ordered product where the customer uses witnessed testing to verify the product's full accordance with contractual requirements, before they are accepted or put into service.

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Annex II – Ecodesign requirements

1. Energy efficiency requirements

The target efficiency for rotary air compressor packages shall be calculated using the equation below.

Equation 1

$$\eta_{target} = a*\ln^2(V_{1max}) + b*\ln(V_{1max}) + c + \{100 - (a*\ln^2(V_{1max}) + b*\ln(V_{1max}) + c)\}*d/100$$

Where:

η_{target} means the *isentropic efficiency* that the product shall achieve.

ln means the natural logarithm of the value indicated in brackets (..)

a, b and *c* are coefficients given in Table 1 for fixed speed rotary air compressor packages and variable speed rotary air compressor packages.

V_{1max} means the maximum volume flow rate per discharge pressure (minimum discharge pressure, maximum discharge pressure and rated discharge pressures higher than 7 bar(a) and less than 15 bar(a)

d is the proportional loss factor

Table 1

Standard air compressor type	**Coefficients of the formula to calculate the <u>minimum</u> isentropic efficiency, depending on flow rate ($V_{1,max}$)**		
	a	b	c
Fixed speed rotary standard air compressor	-0,928	13,911	27,110
Variable speed rotary standard air compressor	-1,549	21,573	0,905

a) From 1 June 2022, the fixed speed isentropic efficiency of a fixed speed rotary compressor package and the variable speed isentropic efficiency of a variable speed rotary compressor package at:

- the *minimum discharge pressure*;
- the *maximum discharge pressure* and;
- any other *rated discharge pressure* less than 15 bar(a) but exceeding 7 bar(a);

shall be equal to or exceed the corresponding *target efficiency* calculated on the basis of the same *maximum volume flow rate* specified for that same *discharge pressure* and for a proportional loss factor value of d = -15.

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b) From 1 June 2024, the fixed speed isentropic efficiency of a fixed speed rotary compressor package and the variable speed isentropic efficiency of a *variable speed rotary compressor package* at:

- the *minimum discharge pressure*;
- the *maximum discharge pressure* and;
- any other *rated discharge pressure* less than 15 bar(a) but exceeding 7 bar(a);

shall be equal to or exceed the corresponding *target efficiency* calculated on the basis of the same *maximum volume flow rate* specified for that same *discharge pressure* and for a proportional loss factor value of d = -10.

2. Product information requirements

(a) From 1 June 2022, the instruction manuals for installers and end-users, and free access websites of manufacturers importers and authorised representatives shall provide the following product information;

i. Minimum pressure ($p_{2,min}$) [bar(a)];

ii. Maximum pressure (p_{2max}) [bar(a)];

iii. Rated pressure(s) (p_{2rated}) [bar(a)];

iv. Maximum volume flow rate (V_{1max}) at minimum, maximum and rated discharge pressure(s) [l/s] ;

v. for variable speed rotary compressor packages only: Minimum volume flow rate (V_{1min}) of the basic package at minimum, maximum and rated discharge pressure(s) [l/s];

vi. Package efficiency:

a. For fixed speed rotary standard air compressor packages the fixed speed isentropic efficiency of the *basic package* of the standard air compressor package for the *minimum discharge pressure*, the *maximum discharge pressure* and any other *rated discharge pressure*(s) ($p_{2,rated}$) specified, the value of which lies between 7 bar(a) and 15 bar(a) calculated in accordance with Annex III;

b. For variable speed rotary standard air compressor packages the variable speed isentropic efficiency of the *basic package* of the standard air compressor package for the *minimum discharge pressure*, the *maximum discharge pressure* and any other *rated discharge pressure*(s) ($p_{2,rated}$) specified, the value of which lies between 7 bar(a) and 15 bar(a) calculated in accordance with Annex III;

vii. Full load power ($P_{full\ load}$) of basic package [kW];

viii. Idle Power (P_{idle}) of basic package [kW] ;

ix. Cycle energy of basic package [s] ;

x. Cooling method (water or air cooled);

xi. Description of at least one heat recovery option that can be applied in or in conjunction with the compressor package;

xii. Information relevant to improving resource efficiency:

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a. Information relevant for facilitating disassembly, recycling or disposal at end-of-life;

b. Information relevant for the installation, use and maintenance of the compressor package.

(b) Manufacturers, importers and authorised representatives of rotary standard air compressor packages shall provide to market surveillance authorities, upon request, the necessary information on the setting of the unit, as applied for the establishment of minimum, maximum and rated discharge pressures, maximum and minimum volume flow rate, and package efficiencies for each relevant combination of discharge pressure and inlet volume flow rate, and provide contact information for obtaining such information.

(c) The exact wording used in the list does not need to be repeated. Where applicable it may be displayed using graphs, figures or symbols rather than text.

3. Resource efficiency requirements

From 1 June 2022, manufacturers, importers or authorised representatives shall ensure that rotary standard air compressor package are designed in such a way that the materials and components referred to in Annex VII to Directive 2012/19/EU can be removed with the use of commonly available tools.

Manufacturers, importers or authorised representatives shall fulfil the obligations laid down in Article 15, Point 1 of Directive 2012/19/EU.

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Annex III – Measurement methods and calculations

For the purposes of compliance and verification of compliance with the requirements of this Regulation, measurements and calculations shall be made using harmonised standards the reference numbers of which have been published for this purpose in the Official Journal of the European Union, or other reliable, accurate and reproducible methods, which takes into account the generally recognised state-of-the-art, and in line with the following provisions:

1. Calculation of fixed speed isentropic efficiency

The *fixed speed isentropic efficiency* for each *discharge pressure* specified in Annex II, point 1 when supplying the *maximum volume flow rate* for that same *discharge pressure* is calculated using the equation below.

Equation 2

$$\eta_{isen,fixed} = \frac{V_{1max} * p_1 * \frac{\kappa}{(\kappa - 1)} * \left[\left({}^{p_2}/_{p_1} \right)^{\frac{\kappa - 1}{\kappa}} - 1 \right]}{(P_{real} * 10)}$$

Where:

$\eta_{isen,fixed}$ = *isentropic efficiency* of the compressor package when supplying the *inlet volume flow rate* for the applicable *discharge pressure*, multiplied by 100 gives percentages (%);

V_{1max} = *maximum volume flow rate* (l/s) for the applicable *discharge pressure* p_2, at standard inlet conditions;

p_1 = *inlet pressure* in bar(a), by default 1 bar(a);

p_2 = *discharge pressure* in bar(a), at standard inlet conditions

P_{real} = *electric input power* (kW) of the *basic package* for the applicable working point;

κ = isentropic exponent of air is 1.4 by convention

Where only one *rated discharge pressure* higher than 7 bar(a) but less than 15 bar(a) is specified, the calculation of *fixed speed isentropic efficiency* shall be done for just this rated discharge pressure.

2. Calculation of variable speed isentropic efficiency

The *variable speed isentropic efficiency* is calculated using the equation below, where *i* is the designation for an *inlet volume flow rate* of either 100%, 70% or 40% of the *maximum volume flow rate*.

Equation 3

$$\eta_{isen,var} = \sum_{i=1}^{n} (\eta_{isen,i} * fi)$$

Where:

$\eta_{isen,var}$ = *variable speed isentropic efficiency* of the compressor package, based on the *isentropic efficiency* when supplying either 100%, 70% or 40% of the *maximum volume flow rate* (l/s) for the applicable *discharge pressure*, weighted by factor f_i, multiplied by 100 gives percentages (%);

f_i = weighing factor, according to table 2.

The isentropic efficiency for test condition *i* is calculated using the equation below

Equation 4

$$\eta_{isen,i} = \frac{V_{1,i} * p_1 * \frac{\kappa}{(\kappa - 1)} * \left[\left({}^{p_{2,i}}/_{p_1} \right)^{\frac{\kappa - 1}{\kappa}} - 1 \right]}{(P_{real,i} * 10)}$$

Where, for each indent *i* referring to either 100%, 70% and 40% of the maximum volume flow rate:

$\eta_{isen,i}$ = the *isentropic efficiency* when supplying either 100%, 70% or 40% of the *maximum volume flow rate* (l/s) for the applicable *discharge pressure*, multiplied by 100 gives percentages (%);

$V_{1,i}$ = *inlet volume flow rate* (l/s) set at *i* is 100%, 70% or 40% of the *maximum volume flow rate* at the applicable *discharge pressure*, at standard inlet conditions;

p_1 = *inlet pressure* in bar(a), by default 1 bar(a);

$p_{2,i}$ = *discharge pressure* in bar(a) at 100%, 70% or 40% of *maximum volume flow rate*, at standard inlet conditions;

$P_{real,i}$ = *electric input power* (kW) of the *basic package* for the applicable working point (*i* is 100%, 70% or 40% of the maximum volume flow rate);

κ = isentropic exponent of air is 1.4 by convention.

The weighing factors f_i for the specified *inlet volume flow rates* are presented in table 2.

Table 2

Weighing factors for variable speed rotary standard air compressors

Inlet volume flow rate ($V_{1,i}$ expressed as % of maximum volume flow $V_{i,max}$)	**Weighing factor (f_i)**
100%	25%
70%	50%
40%	25%

General methodology

The calculation of the *fixed speed isentropic efficiency* at each required *discharge pressure* follows from the calculation of the isentropic efficiency at 100%, 70% and 40% of the *maximum volume flow rate*, resulting in $\eta_{isen,100\%}$, $\eta_{isen,70\%}$ and $\eta_{isen,40\%}$

For each of the required *discharge pressures* p_2 the *variable speed isentropic efficiency* $\eta_{isen,var}$ is the summation of $\eta_{isen,100\%}$ multiplied by $f_i = 0.25$, $\eta_{isen,70\%}$ multiplied by $f_i = 0.5$, and $\eta_{isen,40\%}$ multiplied by $f_i = 0.25$.

Where only one *rated discharge pressure* higher than 7 bar(a) but less than 15 bar(a) is specified, the calculation of *variable speed isentropic efficiency* shall be done for just this rated discharge pressure.

2a. Calculation of package efficiency at 40% of maximum volume flow rate if the minimum volume flow rate is > 40% and < 55%

If the *minimum volume flow rate* of a *rotary standard air compressor package* any *rated discharge pressure* between or equal to 7 bar(a) and 15 bar(a) is higher than 40% but less than 55% of the *maximum volume flow rate* the isentropic efficiency at 40% inlet volume flow rate shall be calculated on the basis of an extrapolation of known values, as follows:

The efficiency of a *variable speed rotary standard air compressor package* at 40% of *maximum volume flow rate* shall be established by the extrapolation of the parabolic function (2nd order polynomial) defined below, using and *isentropic efficiency* at 100% and 70% of *maximum volume flow rate* and the *minimum volume flow rate* and their *inlet volume flow rate* as anchor points.

Equation 5

$$y = ax^2 + bx + c$$

Where:

y = the extrapolated value for the *isentropic efficiency* at 40% of *maximum volume flow rate*

x = the *inlet volume flow rate* at 40% of *maximum volume flow rate*

a, b and c = constants, defined by the extrapolation, at sufficient

The extrapolated *isentropic efficiency* at 40% of *maximum volume flow rate* shall not exceed the *isentropic efficiency* at the *minimum volume flow rate* (between 40% and 55% of *maximum volume flow rate*) of the *variable speed rotary standard air compressor package*.

3. Standard inlet conditions

The *isentropic efficiency* of the *basic package* shall be calculated assuming *standard inlet conditions*, which means that inlet air pressure, inlet air temperature and water vapour pressure (and cooling water temperature if applicable) are as described inTable 3.

Table 3

Standard inlet conditions

Inlet condition parameter	Value
Inlet air pressure	1 bar(a) [100 kPa]
Inlet air temperature	20 °C
Relative water vapour pressure	0
Cooling water temperature (if applicable)	20 °C

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Temperature difference inlet/outlet cooling water	< 25 K

4. Basic package configuration and measurement

The relevant parameters shall be measured for the *basic package* of the *rotary standard air compressor package* or using a *feature package* in which case the following measurement procedure shall be applied so that the final results match as closely as possible the results that could have been expected for a basic package of that product:

1) All features not belonging to the *basic package* configuration (see Table 4) which have an additional electrical power consumption shall be switched off during measurement.
2) All features not belonging to the *basic package* configuration (see Table 4) which have an additional compressed air consumption shall be closed off during measurement.
3) All features not belonging to the *basic package* configuration (see Table 4) which produce an additional pressure drop shall be handled as follows:
    a) In case of pressure drop at the inlet/suction side or any intermediate level, the feature(s) not belonging to the *basic package* is/are allowed to be dismounted during the measurement, by replacing it with suitable piping if necessary.
    b) In case of a pressure drop at the discharge side due to feature(s) not belonging to the *basic package*, the *discharge pressure* p2 is allowed to be measured upstream to the feature.
    c) In case the procedure under b) is not feasible and the pressure drop caused by the feature(s) not belonging to the basic package is/are known, the *discharge pressure* p_2 of the package may be corrected for the given pressure drop by adding the known pressure drop of the feature(s) not belonging to the *basic package* to the *discharge pressure* p_2.

Table 4 gives a minimum configuration of the *basic package* for *fixed speed rotary standard air compressor packages* and *variable speed rotary standard air compressor packages*. If the absence of a component not listed in Table 4 hampers safe, reliable and continuous operation when the product is placed on the market and/or put into service, the component is considered part of the basic package.

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Table 4

Components of the basic package of *fixed speed rotary standard air compressor packages* and *variable speed rotary standard air compressor packages*

Inlet filter
Inlet valve
Compression element
Minimum pressure check valve / backflow check valve
Electric/electronic motor control [2]
Electric Motor, driving the stage(s)
Transmission (belt, gear, coupling) [1]
Compressor control device (pressure switch, pressure transducer etc...)
Cooling fan (incl. its controls)
Compressed air after-cooler
Oil separator
Oil pump (incl. its controls) [1]
Oil filter
Oil cooler
Thermostatic valve

[1] If the design of the *air compressor* requires the use of this component to function safe, continuous and reliable, then the component is part of the *basic package*. For *air compressors* designed to function safely, continuously and reliably without the use of this component (i.e. a transmission is not applied when the stage is driven by the electric motor directly, or oil is circulated without use of an oil pump), the component is not part of the basic package.

[2] The electric/electronic motor control controlling the electric motor driving the compressor stage(s) shall be included in the assessment of the *basic package*. For a *fixed speed rotary standard air compressor package* this is assumed to be electric switchgear, for a *variable speed rotary standard air compressor package* this is assumed to be a *frequency converter*. Other motor controls (controlling electric motors in fans and/or pumps that are part of the basic package) are to be included in the assessment as well, regardless of type.

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Annex IV – Verification procedure for market surveillance purposes

The verification tolerances defined in this Annex relate only to the verification of the measured parameters by Member State authorities and shall not be used by the manufacturer or importer as an allowed tolerance to establish the values in the technical documentation or in interpreting these values with a view to achieving compliance or to communicate better performance by any means.

Where a model has been designed to be able to detect it is being tested (e.g. by recognizing the test conditions or test cycle), and to react specifically by automatically altering its performance during the test with the objective of reaching a more favourable level for any of the parameters specified in this Regulation or included in the technical documentation or included in any of the documentation provided, the model and all equivalent models shall be considered not compliant.

When verifying the compliance of a product model with the requirements laid down in this Regulation pursuant to Article 3(2) of Directive 2009/125/EC, for the requirements referred to in this Annex, the authorities of the Member States shall apply the following procedure:

1) The Member State authorities shall verify one single unit of the model.
2) The model shall be considered to comply with the applicable requirements if:
   a) the values given in the technical documentation pursuant to point 2 of Annex IV to Directive 2009/125/EC (declared values), and, where applicable, the values used to calculate these values, are not more favourable for the manufacturer, importer or authorised representative than the results of the corresponding measurements carried out pursuant to point (g) thereof; and
   b) the declared values meet any requirements laid down in this Regulation, and any required product information published by the manufacturer, importer or authorised representative does not contain values that are more favourable for the manufacturer, importer or authorised representative than the declared values; and
   c) when the Member State authorities test the unit of the model, the determined values (the values of the relevant parameters as measured in testing and the values calculated from these measurements) comply with the respective verification tolerances as set out in Table 5.
3) If the results referred to in point (2)(a) or (2)(b) are not achieved, the model and all equivalent models shall be considered not to comply with this Regulation.
4) If the result referred to in point (2)(c) is not achieved;
   a) for models that are produced in quantities of less than five per year including equivalent models, the model and all equivalent models shall be considered not to comply with this Regulation;
   b) for models that are produced in quantities of five or more per year including equivalent models, the Member State authorities shall select three additional units of the same model for testing. As an alternative, the three additional units selected may be one or more of equivalent models.
5) The model shall be considered to comply with the applicable requirements if, for these three units, the arithmetical mean of the determined values complies with the respective verification tolerances given in Table 5.

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6) If the result referred to in point (5) is not achieved, the model and all equivalent models shall be considered not to comply with this Regulation.

7) The Member State authorities shall provide all relevant information to the authorities of the other Member States and to the Commission without delay after a decision being taken on the non-compliance of the model according to points (3), or (6).

The Member State authorities shall use the measurement and calculation methods set out in Annex III.

The Member State authorities shall only apply the verification tolerances that are set out in Table 5 and shall only use the procedure described in points 1 to 8 for the requirements referred to in this Annex. No other tolerances, such as those set out in harmonised standards or in any other measurement method, shall be applied.

Given the weight and size limitations in the transportation and testing of certain models of standard air compressor packages, Member States authorities may decide to undertake the verification procedure at the premises of manufacturers, authorised representatives or importers before the products are put into service. The Member State authority can do this verification using its own testing equipment.

If factory acceptance tests are planned for such rotary standard air compressor packages, which will test parameters laid down in Annex II to this Regulation, the Member State authorities may decide to use witnessed testing during these factory acceptance tests to gather test results, which can be used to verify compliance of the product under investigation. The authorities may request a manufacturer, authorised representative or importer to disclose information on any planned factory acceptance tests relevant for witnessed testing.

In the cases mentioned in the two paragraphs above, the Member States authorities only need to verify one single unit of the model. If the result referred to in point (2)(c) is not achieved, the model and all equivalent models shall be considered not to comply with this Regulation.

Table 5

Tolerances for verification purposes only

Parameters	**Verification tolerance** by maximum volume flow rate (l/s)			
	$0 < V_1 \leq 8.3$	$8.3 < V_1 \leq 25$	$25 < V_1 \leq 250$	$V_1 > 250$
Inlet volume flow rate	± 7%	± 6%	± 5%	± 4%
Isentropic efficiency	-8%	-7%	-6%	-5%
Idle power	± 10%	± 10%	± 10%	± 10%
Discharge pressure	± 2%	± 2%	± 2%	± 2%

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Annex V –Benchmarks

At the time of adoption of this Regulation, the best available technology on the market for compressors is as indicated in Table 6. These benchmarks may not always be achievable in all applications or for the *maximum volume flow rate range* and *discharge pressures* covered by the Regulation.

Table 6

Benchmarks of *rotary standard air compressor packages*

Rotary standard air compressor package type	Proportional loss factor (d) to be used for calculation of benchmark
Fixed speed rotary standard air compressor	+15
Variable speed rotary standard air compressor	+15

For the calculation of isentropic efficiencies the calculation method described in Annex II, point 1 and/or 2 shall apply.

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Explanatory Memorandum

to the

Working Document on a draft COMMISSION REGULATION (EU) No …/…

implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for rotary standard air compressor packages

CONTEXT OF THE PROPOSAL

Grounds for and objectives of the proposal

The Ecodesign Framework Directive 2009/125/EC establishes a framework for the setting of ecodesign requirements for energy-related products. It is a key instrument of EU policy for improving the energy and other environmental performances of products in the Internal Market. The Directive lists products identified by the Council and the European Parliament as priorities for the Commission for implementation, including electric motor driven systems (Article 16). Electric motor driven compressors are considered to belong to electric motor systems just as electric motors, pumps and fans.[3] Therefore, compressors are priority product groups considered for implementing measures under the Ecodesign Directive. Compressors were also included in the Ecodesign Working Plan 2016-2019.

A preparatory study on electric motor driven compressors ("DG ENER Lot 31") was launched on 21 December 2011 with the aim to assess the eligibility, feasibility and appropriateness of possible policy options for such compressors. This study was finalised in June 2014.

This study showed that (i) such compressors are placed in significant quantities on the internal market; (ii) the main environmental impacts in the life cycle of such compressors are considered significant and are related to their energy (electricity) consumption during use; and (iii) technically cost-effective solutions exist that could lead to significant reductions of environmental impact. The Commission considered that the conditions set out in Article 15 of Directive 2009/125/EC are satisfied for these types of compressors and these compressors are to be covered by (an) ecodesign implementing measure(s).

The objective is to reduce the harmful impact on the environment of the sales and use of compressors.

The outcome of the study and a proposal for an ecodesign measure for standard air compressor packages were presented to the Consultation Forum on 23 October 2014.

General context

The scope of the first preparatory study initially covered all compressors driven by electric motors, but, in agreement with all stakeholders involved, and the Commission Services, it was decided at an early stage to exclude from the Lot 31 study scope vacuum pumps and refrigeration compressors.

Vacuum pumps were, although they share certain technological characteristics with air compressors, excluded because they do not operate with inlet air at atmospheric conditions (inlet pressure close to 1 bar(a)). Furthermore, the range in technologies applied in vacuum pumps is extremely wide, offering several magnitudes in range of performance (e.g. a pressure difference of 10^{-12} mbar to over 1 000 bar) and includes non-motor driven systems.

[3] COM (2008) 660 WP for 2009-2011 under Ecodesign Directive

Refrigeration compressors (also used heating applications such as heat pumps) were excluded as these neither have an atmospheric air intake nor a blow-off valve venting to the atmosphere. Furthermore, compressors in refrigeration and heating applications are covered by multiple implementing measures as (being) developed under:

1. Lot 1: Heat pumps for hydronic central heating;
2. Lot 2: Heat pumps for sanitary hot water;
3. Lot 10: Room air conditioners (< 12 kW);
4. Lot 12: Commercial refrigeration - display cabinets etc.;
5. Lot 13: Domestic refrigeration (household refrigerators and freezers);
6. Lot 21: Central heating (products other than CHP);
7. ENTR Lot 1: commercial refrigeration systems (chillers, etc.);
8. ENTR Lot 6: commercial (large) air conditioning systems.

The savings identified for the above product groups include improvements in the efficiency of the compressor part. Therefore it is expected that any remaining saving potential to be identified in the Lot 31 study for these products is greatly reduced.

The preparatory study then progressed to identify, in close collaboration with the European industry association *Pneurop*, preliminary data on sales and energy consumption of five compressor application ranges (standard air, low pressure, oil-free, process gas/inert and process gas/hazardous) with an estimated overall electricity consumption of 188 TWh/a[4].

However, these five areas still represented a too wide variety in technologies and applications to be covered in a single study and it was decided to focus on standard air compressors first, as these are considered the "work horses" of the industry, with the highest number of sales, the highest electricity consumption and the largest energy saving potential. The group is also fairly homogeneous as the main technologies applied (rotary screw and vane compressors, with either fixed or variable speed drives, and piston compressors) have the same basic working principle (positive displacement). A Working Document laying down a proposal for an ecodesign measure for standard air compressor packages was presented to the Consultation Forum on 23 October 2014.

That proposal included requirements for piston standard air compressor packages, but following comments from stakeholders on the limited savings offered by their inclusion, the present proposal does not cover piston standard air compressor packages.

The proposal introduces requirements for minimum energy efficiency and mandatory product information, aiming to correct the market failure of unrealised energy savings and incomparable information on energy efficiency of products, whilst taking into account relevant differences in functionality of products. Doing so contributes to a faster improvement in average energy efficiency than under a business-as-usual scenario.

Scope

The scope of the proposed measure covers rotary standard air compressor packages, with a maximum volume flow rate of between 5 and 1280 l/s, when providing discharge pressure(s) equal to or higher than 7 bar(a) and not exceeding 15 bar(a). This means that all air

[4] Ecodesign Preparatory Study on Electric motor systems / Compressors ENER Lot 31 FINAL Report of Task 1, 2, 3, 4, & 5 section 3.4 (p. 164) , VHK, 3 June 2014

compressors that meet the technical definition of rotary standard air compressor package (i.e. oil injected or lubricated) and provide a maximum volume flow rate at any given discharge pressure between 7 and 15 bar(a) is included in the scope. This means that even if the compressor is rated for discharge pressures partially outside the scope, the package is still regulated for its performance for pressures and flows that are within the scope.

The rotary standard air compressor packages include both fixed speed and variable speed compressors. The technologies covered are limited to compressor principles involving a rotary motion of working members, thus excluding piston type air compressors. From there on all rotary type standard air compressors are covered (twin screw, rotary vane, etc.).

The scope covers packaged products, including the motor(s), transmission and motor drives or switchgear and other components required for safe functioning as intended, in line with the 'extended product approach' [5].

Economic significance

Market and stock

The market significance (in sales and resulting stock, based on information in the preparatory study) of the products is shown below. Data are presented for the years 1990 to 2030.

Table 1 Sales of standard air compressors (in thousands of units)

	1990	2000	2010	2020	2030
fixed speed screw & vane	51.2	56.9	45.2	43.1	46.2
variable speed screw & vane	0	0.8	8.6	14.1	15.1
TOTALS	51.2	57.7	53.8	57.2	61.3

Table 2 Stock (installed base) of standard air compressors (in thousands of units)

Stock ('000)	**1990**	**2000**	**2010**	**2020**	**2030**
fixed speed screw & vane	284	607	615	497	512
variable speed screw & vane	0	3	46	145	176
TOTALS	284	610	661	642	688

The data shows overall sales of almost 54 000 units annually in 2010. Although this value does not meet the indicative sales threshold of 200 000 units/year indicated in Article 15.2.a of Directive 2009/125/EC, it is considered significant.

Expenditure

The total annual expenditure for buying and operating rotary standard air compressor packages is estimated to be 6.3 billion euro in 2020, of which 80% (5.1 billion) are energy costs.

[5] The extended product approach considers that the ErP will be subject to various loads/user demands; the product scope extends to include controllability (flexibility and efficiency to react to different load situations, e.g. variable speed drive, 'inverter'), the quality of possible controls (sensors, actuators, central processing unit) and/or the quality of auxiliary devices that may or may not be part of the ErP as placed on the market (MEErP 2011 Methodology part 1l; Task 3.1)

Environmental significance

The preparatory study on standard air compressor packages concluded that the energy consumption during the use phase is the most significant environmental aspect, even if basic assumptions regarding electricity rates, purchase price and efficiency are changed. The conclusions are considered to be robust.

The analysis shows an annual electricity consumption of rotary standard air compressor packages in the EU of some 56 TWh/year in 2020. This electricity consumption is responsible for a combined greenhouse gas emission in 2010 of approximately 21 Mt CO_2-eq. If no specific measures are taken, the annual electricity consumption is predicted to 57 27 TWh in 2030 and 59 TWh in 2040 corresponding with 19 Mt CO_2 in 2020 and 19 Mt CO_2 in 2030.

Note that the energy consumption of the installed stock is affected by both the number of units in stock and the average size (capacity) of the unit, which also has a relation to annual hours of operation and load factor. The annual greenhouse gas emissions are affected by both the annual energy consumption and the emission rates (kg of greenhouse gases emitted per kWh electricity consumed).

Improvement potential

In accordance with Annex II of Directive 2009/125/EC and Article 15.5(a-f) specific ecodesign requirements should be set at the level of least life cycle costs, but without entailing significant negative impacts on functionality, affordability, industry's competitiveness, proprietary technologies, etc.

The preparatory study identified improvement options for the energy performance of low pressure and oil-free compressor packages that would result in lower overall energy consumption and related emissions. This energy performance is expressed on the basis of the isentropic efficiency of the compressor package, in multiple test conditions. The isentropic efficiency is the ratio of the theoretically required power to compress an ideal gas under constant entropy, from a given inlet pressure to a given discharge pressure, over the actual power absorbed by the unit for these conditions.

The study showed that there is sufficient disparity in the energy efficiency of compressor packages placed on the market, which means there is potential for improvement of average efficiency. Improving the energy efficiency has been proven to be cost-effective at product level, as the decrease in energy costs, makes up for the increase in purchase costs and results in lower life cycle costs.

Ecodesign requirements

The data available in the study allowed calculating that Tier 1 of the proposed measure affects 26% of the 2011 catalogue of products in 2022 and 42% of the 2011 catalogue in 2024. The electricity savings are respectively 1.3 to 1.2 TWh per annum.

The information requirements include the identification of at least one heat recovery option for the compressor package. The preparatory study did not quantify the possible savings of increased heat recovery, but one can calculate that each 10% increase of stock that applies heat recovery will result in additional recovery of heat equal to almost 4.5 TWh[6], which translates to (with a fuel fired heater efficiency of approximately 70%) savings of 6.4 TWh of

[6] It is assumed that some 80% of the available heat can in principle be recovered. For each 10% of stock (56 TWh/a) this is 56*10%*80% is 4.5 TWh of heat. This heat displaces an alternative energy carrier for production of heat, presumably gas or another fuel.

fuel. This fuel savings is equivalent to 17 to 20 TWh savings of electricity (calculated with respectively PEF = 2.1 and PEF = 2.5).

Energy audits (EMAS), awareness raising campaigns, and educational initiatives are considered more appropriate than ecodesign to achieve the savings related to use of variable flow devices and heat recovery.

The proposal also introduces mandatory information requirements so that the performance of products can more easily be compared as the test conditions and equations for calculating efficiencies are harmonised. This is considered a major step forward as until now, such a direct comparison was not possible as most stakeholders are used to compare efficiency in Specific Energy Requirements (SER) expressed in W/m3 flow or any other unit that allows such a ratio to be established. Besides the confusion arising from units used, the value is also meaningless if the applicable discharge pressures (and inlet pressure) are not specified. Expressing efficiency as isentropic efficiency overcomes these problems and still allows recalculation to SER vales (using the required information on discharge pressure and inlet conditions).

The information requirements are in essence fairly similar to voluntary certification schemes operating elsewhere in the world (notably by CAGI in the USA).

The product information requirements extend to resource efficiency aspects (by requiring information on presence of permanent magnetic material, containing critical raw materials).

Energy labelling is not proposed as the study did not conclude that this would lead to greater savings. Most if not all products sold, are configured to the precise needs of customers and the harmonisation of information already helps in identifying more efficient products. Standard air compressor packages are typically not bought by a lay-person who visits a shop or via distance selling as is the case for many household appliances.

Time of implementation

The proposed dates of implementation of information requirements are 2022, allowing a 2 year period for changing product databases, brochures and websites.

The technical requirements related to use of heat recovery may be implemented by 2022 as well as these do not require profound changes to the products.

Consistency with other policies and objectives of the Union

The Ecodesign Framework Directive 2009/125/EC has been and still is an important instrument for achieving the objective Commission's Communication on Energy 2020 and Energy Efficiency Plan 2011 stating a goal of 20 % energy savings and greenhouse gas reductions compared with projections for 2020, and its implementation was one of the priorities in the.

As part of its long-term energy strategy, the EU has set targets for 2020 and 2030. These cover emissions reduction, improved energy efficiency, and an increased share of renewables in the EU’s energy mix. It has also created an Energy Roadmap for 2050, in order to achieve its goal of reducing greenhouse gas emissions by 80-95%, when compared to 1990 levels, by 2050.

The proposed Regulation is a concrete contribution to this objective and is in line with the goals set out in the Better Regulation Communication (COM(2016) 615) final to ensure the

proposal respects the principles of subsidiarity (no EU intervention when an issue can be dealt with effectively by EU countries) and proportionality (EU action must not exceed what is necessary to achieve the objectives).

Existing legislation

Rotary standard air compressor packages are currently not subject to product-specific EU environmental legislation. EU legislation in the field of product safety, both mechanical and electrical, does apply.

Electric and mechanical safety (including operation in dangerous environments or handling of hazardous gases) of electric compressors is addressed by (not exhaustive):

- LVD - Low Voltage Directive 2006/95/EC;
- MD - Machinery Safety Directive No 2006/42/EC;
- PED - Pressure Equipment Directive 97/23/EC ;
- Simple Pressure Vessels Directive (87/404/EEC);
- ATEX Directive 94/9/EC
- EMC Directive 2004/108

The environmental performance of certain parts and components used in rotary standard air compressor packages may be covered by:

- Electric Motors Regulation 640/2009, as amended by Regulation 4/2014;
- Fan Regulation 327/2011;

Certain environmental impacts may be addressed by the WEEE Directive 2012/19/EU and RoHS Directive 2011/65/EU as electric driven compressors meet the generic definition of (waste of) ‘electrical and electronic equipment’ or ‘EEE’ as 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 1000 volts for alternating current and 1500 volts for direct current.

However, both (the recast of) the WEEE Directive 2012/19/EU and the RoHS Directive 2011/65/EC exclude "large scale stationary industrial tools " from their scope, which are defined as:

> *'large scale stationary industrial tools’ means a large-scale assembly of machines, equipment, and/or components, functioning together for a specific application, permanently installed and de-installed by professionals at a given place, and used and maintained by professionals in an industrial manufacturing facility or research and development facility;*

This 'large-scale' definition likely covers most commercial and industrial applications of standard air compressors, except the smallest ones, where - for instance- a pressure vessel is part of the package and the required connections are simple to perform. This latter description could possibly fit the smallest products in the scope of the proposed regulation.

The use of electric compressors may also be affected by measures that impact the application at site or plant-level, such as introduced under the Industrial Emissions Directive (IED) 2010/75/EC or the EU Emissions Trading System (ETS) set up in 2005, as large compressor stations can be significant electricity consumers. The impacts are however not quantified as these are not product-specific measures.

Legislation in third countries

China

The preparatory study showed that China has introduced mandatory and voluntary measures for (standard air) compressors. The requirements for air compressors relate to minimum efficiency and labelling requirements for various types of reciprocating, screw and vane compressors intended for various applications, some of which are identified as 'standard air' and therefore at least partially overlap with the scope of the proposed regulation.

USA

During the course of the preparatory study electric compressors have been investigated by the US Department of Energy (DOE) and rules for improving their energy efficiency have been identified. However, the policy change introduced by the current president of the United States of America halted the policy process for regulating energy efficiency of compressors, and it is not known if or when it will be revived.

Nonetheless, several States have, or are considering, the introduction of the proposed DOE rules at State level.

Mexico

In Mexico a voluntary endorsement label scheme exists for air compressors.

CONSULTATION OF INTERESTED PARTIES

Consultation methods, main sectors targeted and general profile of respondents

Stakeholders, such as (but not limited to) the relevant industries, non-governmental organisations, experts from Member States and Europe Standardisation Organisations, were consulted during the preparatory study as well as through participation in the Ecodesign Consultation Forum dedicated to standard air compressor packages of 23 October 2014.

During the preparatory study a publicly accessible website was set up to disseminate the interim and final study results and to provide a means for feedback from stakeholders to study authors. Meetings with stakeholders were held on 26 April 2016 and 6 March 2017 within the context of the preparatory study.

The (first) Consultation Forum meeting dedicated to standard air compressor packages was held on 23 October 2014. The present (second) Working Document builds upon on the results of this first Consultation Forum meeting and the preparatory study, and includes:

1. Information requirements
2. Requirements to foster the application of heat recovery
3. Requirements related to material efficiency

The WD was sent to the members of the Consultation Forum and was published on DG ENER's ecodesign website and placed on the Commission's CIRCA port alongside the stakeholder comments received in writing before the meeting.

Summary of responses and how they have been taken into account

[to complete after the Consultation Forum Meeting]

Collection and use of expertise

Scientific/expertise domains concerned

External expertise was gathered through the preparatory study providing a technical, environmental and economic analysis, carried out by an external consultant on behalf of DG ENER .

Methodology used

The methodology followed the provisions of the Directive, in particular its Article 15 and Annexes I and II. The technical, environmental and economic analysis followed the structure of the 'Methodology Study Ecodesign of Energy-using Products' developed for the Commission's Directorate General for Enterprise and Industry and endorsed by stakeholders.[7]

Main organisations/experts consulted

The preparatory study was conducted in an open process, taking into account input (where available) from relevant stakeholders including experts from manufacturers and their association, environmental NGOs, consumer organisations, EU/EEA Member State experts and experts from third countries.

LEGAL ELEMENTS OF THE PROPOSAL

Summary of the proposed action

1. Definition of the scope of the proposed Regulation

The scope of the proposed ecodesign Regulation covers rotary standard air compressor packages with an maximum volume flow rate between 5 to 1280 l/s, when providing discharge pressure(s) equal to or higher than 7 bar(a) and not exceeding 15 bar(a).

2. Staged implementation of ecodesign requirements

The first tier of the proposed measure would enter into force in 2022, to allow time for manufacturers to change their product databases, brochures and websites and perform product tests if needed. The second tier would follow in 2024.

[7] The terms of references for the preparatory study requested the use of the MEErP Methodology.

3. Measurements and calculations

Measurements and calculations of the relevant product parameters should be performed taking into account the generally recognised state-of-the-art calculation and measurement methods.

In this context, manufacturers may apply reliable, accurate and reproducible measurement and calculation methods and harmonised standards set up in accordance with Article 10 of Directive 2009/125/EC, as soon as they are made available and published for that purpose in the Official Journal of the European Union.

Requirements for calculation and measurement methods are specified in Annex III.

The measurement standards applicable to compressors covered by the proposed measure are ISO 1217. There are currently no EN versions of these standards.

4. Conformity assessment procedures

As required in Article 8 of Directive 2009/125/EC the proposed Regulation specifies the applicable conformity assessment procedures.

5. Verification procedure for market surveillance purposes

When performing the market surveillance checks referred to in Article 3 (2) of Directive 2009/125/EC, the authorities of the Member States shall initially test a single model. If this model is produced in quantities of 5 or less units per year, this model must meet the requirements or else is considered to be non-compliant. If the model is produced in quantities of more than 5 units annually and fails the initial test, a further three units shall be tested and the arithmetical mean of the results of these tests shall be used as basis for compliance assessment. The Member States authorities shall apply verification tolerances as defined in the proposed text.

6. Information requirements

In order to facilitate compliance checks, manufacturers are requested to provide information in the technical documentation referred to in the conformity assessment procedures.

7. Benchmarks

Based on the currently available technologies, benchmarks for energy efficiency are provided for best performing products. These benchmarks are based on the average isentropic efficiency, varying per product flow control category (fixed or variable speed) and maximum volume flow rate (V_1) and the proportional loss factor (d) as established in the preparatory study to calculate the benchmark efficiency.

8. Date for evaluation and possible revision

The main issues for a possible revision of the proposed Regulation are:

- the appropriateness of widening or more exactly specifying the scope of products and/or its exclusions;
- the appropriateness of ecodesign requirements for energy efficiency;

- the appropriateness of information requirements;

Taking into account the time needed by manufacturers to adapt to the new situation and the time needed to collect, analyse and complement the data in order to properly assess the technological progress on compressors, a review can be presented to the Consultation Forum five years after entry into force of the proposed Regulation.

9. Derogation

[-]

10. Repeal

[-]

Legal basis

The proposed Regulation is an implementing measure pursuant to Directive 2009/125/EC, in particular its Article 15(1). The Directive was based on Article 95 of the Treaty, now Article 114 (TFEU).

Subsidiarity principle

The adoption of ecodesign measures for compressors by individual Member States would lead to obstacles to the free movement of goods within the Community. Such measures must therefore have the same content throughout the Community. In line with the principle of subsidiarity, it is thus appropriate for the measure in question to be adopted at EU level.

Proportionality principle

In accordance with the principle of proportionality, this measure does not go beyond what is necessary in order to achieve the objective. It offers requirements which act as an incentive for technology leaders to invest in high-efficiency compressor technology. Higher savings can only be obtained with considerable impacts on manufacturers and customers.

Choice of instruments

Proposed instrument: Regulation.

Other means would not be adequate for the following reason(s): The proposed form of action is a Commission Regulation implementing Directive 2009/125/EC, because the objectives of the action can be achieved most efficiently by fully harmonized requirements throughout the EU (including the date for entry into force), thus ensuring the free movement of complying compressors. No costs arise for national administrations for transposition into national legislation.

BUDGETARY IMPLICATION

The proposal has no implications for the Community budget.

ADDITIONAL INFORMATION

Review/revision/sunset clause

The proposal includes a review clause.

European Economic Area

The proposed act concerns an EEA matter and should therefore extend to the European Economic Area.

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