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 compressors for standard air applications

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1. 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.[1] Therefore, compressors are priority product groups considered for implementing measures under the Ecodesign Directive.

A technical, environmental and economic analysis ('preparatory study'[2]) has shown that (i) compressors are placed in large quantities on the internal market; (ii) the main environmental impacts in the life cycle of compressors are the energy consumption (electricity). These impacts are considered significant; and (iii) technically cost-effective solutions exist that could lead to significant improvements. The Commission considers that the conditions set out in Article 15 of Directive 2009/125/EC are satisfied and compressors should therefore be covered by an ecodesign implementing measure.

General context

Initially the scope of the preparatory study encompassed all compressors driven by electric motors. This group included compressors used for pressurized air (both oil-lubricated or –injected as well as oil-free), compressors for low pressure air, compressors used for process applications, including ones for handling hazardous gases, and vacuum pumps as these may rely on identical operating principles. Together with compressors used in various heating/ cooling applications the total electricity consumption of this group is estimated to be around 510 TWh/a[3].

Early on in the preparatory study it was decided to exclude from the study scope compressors that are designed or intended for use in vapour compression cycles used for generation of heat or cold, as the anticipated savings would already be covered to a great extent by 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.

[1] COM (2008) 660 WP for 2009-2011 under Ecodesign Directive
[2] ENER Lot 31 preparatory study on "Electric Compressors" http://www.eco-compressors.eu
[3] MEErP 2011 Methodology report Part 2: Environmental policies & data.
http://ec.europa.eu/enterprise/policies/sustainable-business/ecodesign/methodology/index_en.htm

The savings identified for these 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.

Vacuum pumps have also been excluded from the scope of this study on the basis of not compressing air above atmospheric starting conditions. Furthermore, the inclusion of the vacuum pumps would extend the application range of products covered by the study from a pressure difference from 10^{-12} mbar to over 1 000 bar - thus covering several orders of magnitude in primary product performance. Even the most complex products groups up to date (e.g. fans or central heating boilers) cover only a magnitude range of 10^2 or 10^3 (e.g. 4 to 400 kW or 0.1-500 kW).

The combined electricity consumption of the remaining group of electric motor driven compressors was estimated to be 175 TWh. The study then set out to collect data such as sales, energy efficiency, energy consumption and price in close collaboration with the relevant European industry association *Pneurop*. Even with the intensive participation of relevant industries only the subgroup of standard air compressors could be analysed in enough detail with a view to propose possible measures. The main compressor technologies used in standard air applications are screw and vane compressors, with either fixed or variable speed drives, and piston compressors. This subgroup is the largest of the overall group and the products apply to technologies that can be compared using known measurement standards and calculation methods (positive displacement compressors). It was not possible to analyse the other subgroups (low pressure, oil free and process gas compressors) at the same level of detail due to the unavailability of detailed data.

The study concluded that further study might be able to show the saving potential for the low-pressure and oil-free application ranges. An additional difficulty is that these subgroups comprise compressors that operate on the basis of very different technical principles (positive displacement versus turbo-machinery) and there is currently no agreed method to compare performances for these two principles.

For process gas compressors, a similar analysis would be even more complicated, as 1) the same remark regarding operating principles applies and 2) these products are often designed and built upon client's specifications and completely integrated into industrial process applications, with already a very high focus on energy efficiency because of the high energy costs involved. The remaining saving potential is estimated to be very small and difficult to unlock by eco-design implementing measures.

1.1. Scope

Considering the above, the scope of the proposed measure is set to cover rotary standard air compressors, with a volume flow rate of minimum 5 and maximum 1280 l/s and piston standard air compressors with a volume flow rate of minimum 2 and maximum 64 l/s, when driven by one or more three-phase electric motor(s). The rotary standard air compressors include both fixed speed and variable speed compressors.

Standard air compressors means electric compressors designed to supply air, sucked in from the surrounding environment, at outlet pressure levels between 7 to 14 bar(g[4]) and which may have been in contact with oil or water inserted in the compression chamber for cooling, lubrication and sealing of that chamber and the moving components contained therein.

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

1.2. 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
pistons	49,5	55,7	52	55,3	59,3
TOTALS	100,7	113,4	105,8	112,5	120,6

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

	1990	**2000**	**2010**	**2020**	**2030**
fixed speed screw & vane	284	607	615	497	512
variable speed screw & vane	0	3	46	145	176
pistons	389	460	492	482	517
TOTALS	673	1070	1153	1124	1205

The data show that overall sales of products were 105 800 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 expenditure for compressors is estimated to be some 4.4 billion euro in 2010, of which the energy costs make up 70-75% of the total costs (i.e. approximately 3.3 billion euro).

[4] "bar(g)" refers to gauge pressure or the actual pressure measured (i.e. bar(a) or absolute pressure minus the ambient or atmospheric pressure)

[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)

1.3. Environmental significance

The preparatory study concluded that energy consumption during the use phase of these products is the most significant environmental aspect, even if basic assumptions regarding lifetime, efficiency and size are changed. The analysis is considered to be robust.

The annual energy consumption of standard air compressors in the EU is estimated to be some 58.8 TWh. The overall combined greenhouse gas emissions in 2010 by standard air compressors were estimated to be some 52.7 Mt CO_2-eq. If no specific measures are taken, the annual energy consumption is predicted to be 57 TWh in 2020 and 60 TWh in 2030 corresponding with 43.6 Mt CO_2 in 2020 and 43.8 Mt CO_2 in 2030. The energy consumption in 2020 is lower than in 2010 because of an ongoing shift in sales from fixed speed to variable speed compressors, and because of changes in capacities, which affect the efficacy of compressors placed on the market.

1.4. Improvement potential

In accordance with Annex II of Directive 2009/125/EC specific ecodesign requirements should be set at the level of least life cycle costs. The preparatory study identified improvement options for standard air compressors that would result in lower overall energy consumption and related emissions and which would be realisable at no excessive costs.

The improvement options have been represented by a proportional loss factor (d-value) which can be recalculated to the isentropic efficiencies using an appropriate formula for the type of compressor and its volume flow rate. The d-value signifies the proportional change in efficiency from average to theoretical optimum efficiency (i.e. 100%).

The analysis of the life cycle costs (LCC) in Task 7 of the preparatory study shows that the economic optimum for the average fixed speed compressor lies between d= 5-10 for the smallest compressors in this segment, to d=beyond 20 for the largest in this segment.

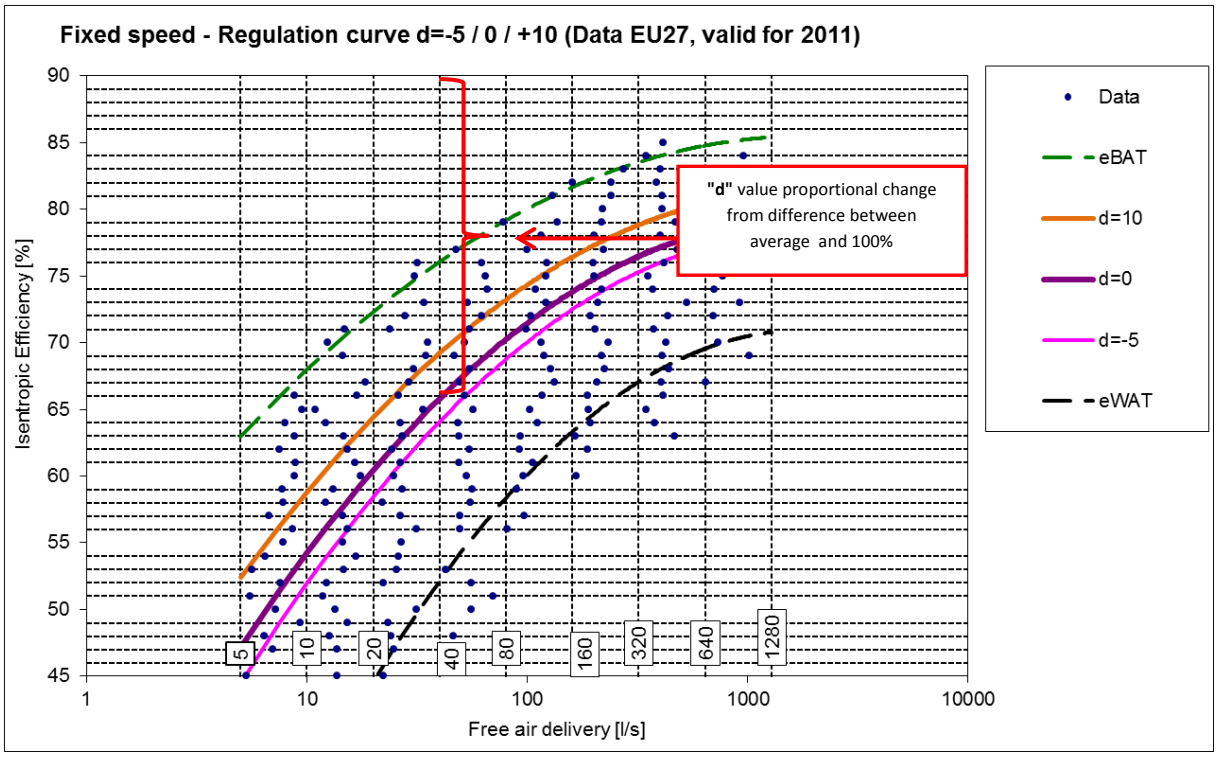
For variable speed compressors the optimum d-values are between d=10-20 for the smallest compressors to d= beyond 20 for the larger ones.

For piston compressors the situation is different. Historically the efficiency of piston compressors has improved from 1990 to 2010. Introducing specific ecodesign requirements would support or even encourage this trend in increase of efficiency. However, more than is the case for screw and vane compressors the LCC of piston compressors is influenced by assumptions regarding annual operating hours, purchase prices and energy prices and the preparatory study could not show that each increase in efficiency leads to lower LCC .

1.5. Ecodesign requirements

The study suggested setting minimum energy efficiency requirements for standard air compressors on the basis of the isentropic efficiency which 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.

The ecodesign requirements, based on the proportional loss factor 'd', propose a d=-5 for the first tier and d=0 for the second tier (see as an illustrated example the graph below with the case for rotary compressors at fixed speed). These targets result in a phase out of approximately 22-36% of 2011 models in the first tier and about 39-46% of 2011 models in the second tier. An energy savings of 0.7 TWh in 2020 and 1.6 TWh in 2030 can be expected.



In addition the setting of information requirements is proposed.

Energy labelling requirements have not been suggested as the study could not prove that this would lead to greater savings.

Savings at system level

It should also be mentioned here that the potential savings at system level (by addressing leakages, total air demand, etc.) vastly exceeds that at the (packaged) product level. An indicative analysis puts these savings, for the standard air application range, at some 10 TWh.[6]

However, neither the Ecodesign Directive, nor the Energy Labelling Directive, are suitable to unlock these system level savings as they extend the scope of the possible measures. Energy audits (EMAS), awareness raising campaigns, and educational initiatives are more likely to be effective in realising these savings.

[6] LOT 31 preparatory study on compressors; Final reports task 6-8; Chapter 3.4 and 3.6; Brussels/ Delft June 2014; VHK Available on: http://www.eco-compressors.eu/documents.htm

An ecodesign requirement, based on a fairly simple efficiency metric for standard air compressors, could be accompanied by a wider campaign addressing system level improvement options.

1.6. Time of implementation

The standard air compressors are considered to be mature products and the steps taken in the past to increase their isentropic efficiency cannot be repeated with the same magnitude in the future. The optimization of these products follows a learning curve with asymptotic behaviour, requiring ever longer development times that result in ever decreasing improvements. The proposed dates of implementation are 2018 for the first tier and 2020 for the second tier, allowing a 4 year period for redesign of product ranges between entry into force (assumed 2016) and the 2nd tier in 2020.

1.7. Consistency with other policies and objectives of the Union

The Ecodesign Framework Directive 2009/125/EC is an important instrument for achieving the objective of 20 % energy savings compared with projections for 2020, and its implementation is one of the priorities in the Commission's Communication on Energy 2020 and Energy Efficiency Plan 2011. Furthermore, implementation of the Directive 2009/125/EC will contribute to the EU's target of reducing greenhouse gases by at least 20 % by 2020, or 30 % if there is an international agreement that commits other developed countries to comparable emissions reductions. The proposed Regulation is a concrete contribution to this process and is in line with the Commission Action Plan on Sustainable Consumption and Production and Sustainable Industrial Policy.

Existing legislation

The product group standard air compressors is currently not subject to product specific EU environmental legislation. EU legislation in the field of product safety, both mechanical and electrical, applies.

Electric and mechanical safety (including operation in dangerous environments or handling of hazardous gases) of electric compressors is addressed by (a.o.):
- 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 packages of standard air compressors may be covered by:
- Electric Motors Regulation 640/2009;
- Fan Regulation 327/2011;

Certain environmental impacts are addressed by

- Noise by outdoor equipment - Directive 2000/14/EC;
- WEEE 2012/19/EU as electric driven compressors meet the generic definition of ‘electrical and electronic equipment’ or ‘EEE’ referred to in the RoHS Directive 2011/65/EU as it 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 1000 volts for alternating current and 1500 volts for direct current.

The (recast of) the RoHS Directive 2011/65/EC excludes large scale fixed installations from its scope (article 2, 4, b) which are defined 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; (article 3.4)*

This 'large-scale' definition likely covers most commercial and industrial applications of 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 would fit most of the piston compressor standard air application range.

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 IED - Industrial Emissions Directive 2010/75/EC.

Legislation in third countries

China
The preparatory study showed that China has introduced mandatory and voluntary measures for air compressors. The requirements for air compressors relate to minimum efficiency and labelling requirements for reciprocating, screw and vane compressors intended for various applications.

USA
During the course of the preparatory study it became evident that electric compressors will also be investigated by the US DOE. This study has started only very recently and no results have been presented in the preparatory study. Nonetheless it is known that the US are following the developments in the EU with regard to electric compressors with great interest, as the EU initiative could be a mandatory energy requirement that may have great impact in the EU and global market.

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

2. CONSULTATION OF INTERESTED PARTIES

2.1. Consultation of interested parties

Consultation methods, main sectors targeted and general profile of respondents

Stakeholders were consulted as part of the preparatory study as well as within the Ecodesign Consultation Forum on horizontal matters.

Stakeholder meetings within the context of the preparatory study were held on 14 March 2013 and 27 February 2014. The Consultation Forum (CF) meeting on horizontal matters covering also compressors was held on 5th May 2014.

Building on the results of the preparatory study, Commission services presented a brief working document (WD) which included two options for taking forward the work on this product group:

1. Postpone the development of implementing measures for standard air compressors, in view of including low-pressure and oil-free applications, after these have been further analysed based on appropriate data collection and progress with standardisation. The goal of postponing measures for standard air was to bring the analysis of the other application ranges on a par with the analysis for 'standard air', followed by a proposal for a single implementing measure for all three application ranges.

2. Develop an implementing measure for standard air compressors, while in parallel continuing with the analysis for 'low-pressure' and 'oil-free' applications. This option would build on the current momentum for the possible introduction of measures for 'standard air', for which sufficient data and appropriate test methods are available. The other application ranges may still be included in these measures by introducing information requirements for 'low-pressure'/'oil-free' and/or by mentioning them specifically as subject for the revision of the measure.

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 and after the meeting.

Summary of responses and how they have been taken into account

During the CF itself, option 2 received the support from UK and NL (conditional upon to the information requirements). IT was more supportive for option 1, based on the low savings potential (1-2 TWh in 2030) of option 2. After the CF took place, EC services received in total four written comments (from FI, DE, ECOS and Pneurop). FI, DE and ECOS all supported the option 2 proposal. Only the industry association *Pneurop* supported neither of the two options and preferred a BAU scenario/option, as they felt a minimum requirement would add little to the savings already identified, and still to achieve, through voluntary product improvement (represented as the 'business-as-usual' scenario in the preparatory study). Having heard the opinion of the CF DG ENER decided to go ahead with *option 2*, the measure for 'standard air' applications and continue studying the other two application ranges (low pressure and oil-free), leaving the door open to include further information requirements

for these two other application ranges if deemed feasible in later phases of the regulatory process.

2.2. 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 manufacturers, installers, retailers and their associations, environmental NGOs, consumer organisations, EU/EEA Member State experts and experts from third countries.

3. 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** compressors with a volume flow rate between 5 to 1280 l/s and **piston standard air** compressors with a volume flow rate between 2 to 64 l/s, when driven by a three-phase electric motor.

2. Staged implementation of ecodesign requirements

The proposed measures would enter into force in two tiers, in 2018 and 2020, to allow time for manufacturers to redesign their product ranges.

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.

7 The terms of references requested the use of the MEEuP Methodology.

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 standard applicable to compressors covered by the proposed measure is ISO 1217. There is currently no EN version of this standard.

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 apply the following verification procedure for the requirements set out in Annex II.

a) The authorities of the Member State shall test one single unit per model.
b) The model shall be considered to comply with the applicable requirements set out in Annex I of this Regulation if the values in the technical documentation comply with the requirements set out in Annex I, and if the measured parameters meet the requirements set out in Annex I within the verification tolerances indicated in the Table of this Annex;
c) For models that are produced (on average) in quantities of five or more per year, if the result referred to in point 2 is not achieved, the market surveillance authority shall randomly test three additional units.
d) The model shall be considered to comply with the applicable requirements set out in Annex I of this Regulation if the average of the values of the three additional units in the technical documentation comply with the requirements set out in Annex I, and if the average of the measured parameters of the three additional units meet the requirements set out in Annex I within the verification tolerances indicated in the Table of this Annex.
e) If the results referred to in point 4 are not achieved, the model shall be considered not to comply with this Regulation. The Member States authorities shall provide all relevant information, including the test results if applicable, to the authorities of the other Member States and the Commission within one month of the decision being taken on the non-compliance of the model.
f) For models that are produced in lower quantities than five per year, if the result referred to in point 2 is not achieved, the model shall be considered not to comply with this Regulation. The Member States authorities shall provide all relevant information, including the test results if applicable, to the authorities of the other Member States and the Commission within one month of the decision being taken on the non-compliance of the model.

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 high isentropic efficiency are provided for best performing products. These benchmarks are based on a formula to calculate the minimum isentropic efficiency, depending on flow rate (V_1) and proportional loss factor (d) as established in the preparatory study.

8. Date for evaluation and possible revision

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

- the appropriateness of setting ecodesign requirements for greenhouse gas emissions;
- the appropriateness of setting stricter ecodesign requirements for energy efficiency of compressors;

Taking into account the time necessary 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.

Subsidiarity principle

The adoption of ecodesign measure for compressors by individual Member States' legislation 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. It also leads to higher savings than any other conceivable option with minimum administrative costs.

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.

4. BUDGETARY IMPLICATION

The proposal has no implications for the Community budget.

5. 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.